PACON INTERNATIONAL

Pacific Congress
on Marine Science and Technology

Marine Science and Technology for Sustainable Development

26th International Conference of Pacific Congress on Marine Science and Technology (PACON-2019)

July 16-19, 2019 Vladivostok, Russia

Abstracts

Vladivostok
2019

Organizers:

Far Eastern Branch of Russian Academy of Scineces

Far Eastern Federal University

V.I.Il'ichev Pacific Oceanological Institute

Sponsors:

Ministry of Science and Higher Education
of The Russian Federation

Russian Foundation for Basic Research

North Pacific Marine Science Organization

Office of Naval Research Science and Technology

Федеральное государственное бюджетное учреждение науки
Тихоокеанский океанологический институт им. В.И. Ильичева
Дальневосточного отделения Российской академии наук

V.I. Il'ichev Pacific Oceanological Institute
Far Eastern Branch
Russian Academy of Sciences

МОРСКИЕ НАУКИ И СОВРЕМЕННЫЕ ТЕХНОЛОГИИ ДЛЯ УСТОЙЧИВОГО РАЗВИТИЯ

26-я международная конференция
Тихоокеанского конгресса морских наук и технологий
(PACON-2019)

16–19 июля 2019 г., Владивосток, Россия

Тезисы докладов

MARINE SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

The 26th International Conference
of Pacific Congress on Marine Science and Technology
(PACON-2019)

July 16–19, 2019, Vladivostok, Russia

Abstracts

Владивосток
2019

УДК 551.468

Морские науки и современные технологии для устойчивого развития: тезисы докладов 26-й международной конференции Тихоокеанского конгресса морских наук и технологий (PACON-2019), 16–19 июля 2019 г., Владивосток, Россия. – Владивосток : ТОИ ДВО РАН, 2019. – 366 с.
ISBN 978-5-6043211-0-2

Научные конференции некоммерческой научной организации Тихоокеанского конгресса морских наук и технологий (PACON International) в течение 35 лет служат площадками, на которых ученые и инженеры обмениваются результатами исследований, технических и коммерческих разработок в области морских наук и технологий. На 26-й конференции PACON-2019, впервые проводимой во Владивостоке на базе ДВФУ, будут обсуждаться проблемы динамики океана, изменений глобального климата и их проявлений в Азиатско-тихоокеанском регионе и Восточной Арктике, исследования и прогнозирования морских опасных явлений, морской окружающей среды и экосистем, рыболовства и аквакультуры, морской геологии, морского инжиниринга и строительства, возобновляемой энергии, разработки подводных аппаратов и роботизированных устройств, акустики океана, разработки подводных аппаратов и роботизированных устройств, технологии морских измерений, экономические, общественно-политические и юридические аспекты освоения океана и морских побережий.

Проводится при финансовой поддержке Министерства науки и высшего образования РФ, РФФИ (проект № 19-05-20099), Всемирного бюро по военно-морским исследованиям (ONRG) и Северо-тихоокеанской организации по морским наукам (PICES).

Редакторы: к.г.н. В.Б. Лобанов, к.т.н. О.О. Трусенкова

Marine Science and Technology for Sustainable Development: Abstracts of the 26th International Conference of Pacific Congress on Marine Science and Technology (PACON-2019), July 16–19, 2019, Vladivostok, Russia. – Vladivostok : POI FEB RAS, 2019. – 366 p.

Regular conferences of Pacific Congress on Marine Science and Technology (PACON International Inc.) serve as forums for scientists and engineers for sharing state-of-the-art findings of research, engineering, and commercial developments in the field of marine science and technology. The 26th International Conference «Marine Science and Technology for Sustainable Development» to be held on 16-19 July, 2019, in the new campus of the Far Eastern Federal University, Vladivostok, Russia, will cover the themes of ocean dynamics, climate and hazards, marine geology and geological resources in the ocean, ocean environment, ecosystem, fisheries and aquaculture, polar ocean research and explorations, ocean engineering, marine constructions and renewable energy, undersea vehicles, robotics, acoustics, ocean observation technologies, sustainable economy, ocean policy making and education.

With financial support from the Ministry of Science and Higher Education of the Russian Federation, Russian Fund for Basic Research, ONR Global – Office of Naval Research, North Pacific Marine Science Organization (PICES).

Edited by Vyacheslav B. Lobanov, PhD, and Olga O. Trusenkova, PhD
ISBN 978-5-6043211-0-2

CONTENT

Keynote lectures

Deep sea ecosystems in the northwestern Pacific

A.V. Adrianov
A.V. Zhirmunsky National Scientific Center of Marine Biology,
Far Eastern Branch of Russian Academy of Sciences

The complex studies of biological diversity in deep waters of the ocean with underwater robotics and new deep-sea sampling technologies have brought a lot of interesting discoveries: they make us revise significantly our knowledge of the quantitative and qualitative composition of the deep-sea biota. Zones of high biological diversity were found on ocean slopes, in abyssal and even hadal environments, and thousands of new species from various taxa of the animal kingdom were collected there during the recent years. From the point of view of biological diversity, the unique deep-sea ecosystems of the Russian Far Eastern seas are of particular interest: they have areas of hydrothermal activity, marine volcanoes, deposits of gas hydrates, hydrocarbon seepages, mineral deposits, coral "gardens" etc. With new data, we should significantly revise our estimates of marine biological resources and, first of all, the reserves of deep-sea biota, especially mesopelagic fishes and benthic invertebrates.

Marine ecosystems attract particular attention as a giant reservoir of unique medicinal molecules with a higher degree of chemical diversity than on land. Deep-sea ecosystems are extreme and unusual habitats, causing the emergence of new structures of organic compounds with a high biological activity. Deep-sea organisms have adapted their biochemical mechanisms for survival under extreme conditions and have great potential for inducing primary and secondary metabolic pathways to create structurally unique metabolites. However, they now account for only about 2% of all known natural compounds of marine origin. At the same time, about 75% of all compounds isolated from deep-sea objects have biological activity, and almost half of them show cytotoxicity against a number of human cancer cell lines. The products isolated from these objects showed high antitumor, antiproliferative, and antibiotic activities.

New sub-sea robotics, including autonomous and remotely operated vehicles, allowed us to visualize information on the structure of bottom landscapes, to evaluate the diversity and population density of marine organisms, the patterns of their distribution, and even to assess their biomass without taking these organisms out of their natural environment. Now we have an opportunity to collect deep-sea biological material, perfectly preserved for subsequent biochemical and genetic studies. For the first time, we obtained the means to study biology of a number of deep-sea organisms, including those in unique deep-sea biotopes in the sites of gas hydrotherms and seepages.

But, it appears that these unique deep-sea ecosystems also need nowadays protection from damage caused by bottom trawling, as well as from garbage, which is now frequently found even at great sea depths.

Progress and Challenge of Ocean Science in Indonesia for Sustainable Development in the Western Pacific Region

Z. Arifin
Indonesian Institute of Sciences, Jl. Jend. Gatot Subroto, Kav 10., Jakarta Selatan, Indonesia
e-mail: zain003@lipi.go.id

Indonesia is the largest archipelagic state in the world with approximately 17,114 islands. It has the second longest coastline in the world after Canada (81 thousand km), and 5.8 million km^2 of marine area, and a continental shelf as far as the 200 m isobaths of around 2.7 million km^2. Indonesia is located geographically between two oceans (Indian and Pacific Oceans), and two continents (Asia and Australia). Indonesia is also potentially rich in natural resources (living and non-living resources), but the oceanic research is still at the stage of developing.

Indonesian Ocean Science was started in early 1950s when most works were on biological oceanography, focused on plankton research in Java Sea, while physical oceanography was studying the influence of monsoon on oceanic circulation around Indonesia. In mid 1960s, the Faculty of Fisheries at Bogor Agricultural University was established and fisheries studies were initiated. In mid 1980s, the marine science development was on the peak period by expanding new marine science program at six universities located in Western, Central and Eastern Indonesia. Until the 1990s, researches were mainly on the coastal area and only few works in the open ocean. With six new research vessels (BJ 1 – 4, BJ 7 and 8), the sea going program was becoming the research trend. Six marine stations were also established, mostly in Eastern Indonesia. However, the economic crisis has hampered the development of ocean science in the late 1990s. In 2000s the ocean science policy was shifted at the national level. The establishment of Ministry of Fisheries and Marine Affairs and Coordinating Ministry for Maritime made the national agenda more ocean-oriented at the political arena. On the other hand, in the science community, development of Indonesian Ocean Science Consortium (IOSC) by 12 national marine-related institutions and universities also provided a strong support to the government vision to be the world maritime fulcrum.

Research was progressing in 2013–2018: in the context of research publication, number of articles published in international journals increased significantly from 4th rank to 2nd rank after Malaysia in Southeast Asia. Similarly, number of domestic patents has increased each year from 233 units (in 2013) to 2842 units (in 2018). However, the challenge on ocean science is also huge despite the steady progress in the last 15 years. Three main challenges are capacity of marine scientists, research infrastructures and research governance. Number and qualification of marine scientists in all expertise is quite insufficient at the moment. Similarly, the research infrastructures are mostly at sub-standard level, especially outside Java research institutions. Furthermore, the current research governance is also still mainly terrestrial oriented, with huge overlap within ocean related researches. Several programs, at national level, were done to overcome the challenges: development of centers of excellence in several research institutions, research universities, science and techno-park, education endowment fund, and investment in research infrastructures can be named among others.

Key words
Ocean science, sustainable development, Indonesia, marine science.

Ocean Waves as a Missing Link Between Atmosphere and Ocean

A.V. Babanin
University of Melbourne, Australia
a.babanin@unimelb.edu.au

Role of the waves as a link between the ocean and atmosphere will be discussed. It is rapidly becoming clear that many large-scale geophysical processes are essentially coupled with the surface waves, and those include weather, tropical cyclones, ice cover in both Hemispheres, climate and other phenomena in the atmosphere, at air/sea, sea/ice and sea/land interface, and many issues of the upper-ocean mixing below the surface. Besides, the wind-wave climate itself experiences large-scale trends and fluctuations, and can serve as an indicator for changes in the weather climate. In the presentation, we will discuss wave influences at scales from turbulence to climate, on the atmospheric and oceanic sides.

At the atmospheric side of the interface, the air-sea coupling is usually described by means of the drag coefficient Cd, which is parameterised in terms of the wind speed, but the scatter of experimental data with respect to such dependences is very significant and has not improved noticeably over some 40 years. It is argued that the scatter is due to multiple mechanisms which contribute into the sea drag, many of them are due to surface waves and cannot be accounted for unless the waves are explicitly known.

The Cd concept invokes the assumption of constant-flux layer, which is also employed for vertical profiling of the wind measured at some elevation near the ocean surface. The surface waves, however, modify the balance of turbulent stresses very near the surface, and therefore such extrapolations can introduce significant biases. This is particularly essential for buoy measurements in extreme conditions, when the anemometer mast is within the Wave Boundary Layer (WBL) or even below the wave crests. In this presentation, field data and a WBL model are used to investigate such biases. It is shown that near the surface the turbulent fluxes are less than those obtained by extrapolation using the logarithmic-layer assumption, and the mean wind speeds very near the surface, based on Lake George field observations, are up to 5% larger. The dynamics is then simulated by means of a WBL model coupled with nonlinear waves, which revealed further details of complex behaviours at wind-wave boundary layer.

Furthermore, we analyze the structure of WBL for strong winds (U10>20 m/s) based on field observations. We used vertical distribution of wind speed and momentum flux measured in Tropical Cyclone Olwyn (April 2015) in the North-West shelf of Australia. A well-established layer of constant stress is observed. The values obtained for u_* from the logarithmic profile law against u_* from turbulence measurements (eddy correlation method) differ significantly as wind speed increases.

Among wave-induced influences at the ocean side, the ocean mixing is most important. Until recently, turbulence produced by the orbital motion of surface waves was not accounted for, and this fact limits performance of the models for the upper-ocean circulation and ultimately large-scale air-sea interactions.

While the role of breaking waves in producing turbulence is well appreciated, such turbulence is only injected under the interface at the vertical scale of wave height. The wave-orbital turbulence is depth-distributed at the scale of wavelength (~10 times the wave height) and thus can mix through the ocean termocline in the spring-summer seasons. Such mixing then produces

feedback to the large-scale processes, from weather to climate. In order to account for the wave-turbulence effects, large-scale air-sea interaction models need to be coupled with wave models.

Theory and practical applications for the wave-induced turbulence will be reviewed in the presentation. These include viscous and instability theories of wave turbulence, direct numerical simulations and laboratory experiments, field and remote sensing observations and validations, and finally implementations in ocean, Tropical Cyclone, ocean and ice models.

As a specific example of a wave-coupled environment, the wave climate in the Arctic as observed by altimeters will be presented. This is an important topic for the Arctic Seas, which are opening from ice in summer time. Challenges, however, are many as their Metocean environment is more complicated and, in addition to winds and waves, requires knowledge and understanding of ice material properties and its trends. On one hand, no traditional statistical approach is possible since in the past for most of the Arctic Ocean there was limited wave activity. Extrapolations of the current trends into the future are not feasible, because ice cover and wind patterns in the Arctic are changing. On the other hand, information on the mean and extreme wave properties is of great importance for oceanographic, meteorological, climate, naval and maritime applications in the Arctic Seas.

Baleen whale localization using a single-hydrophone: method, results, and perspectives

J. Bonnel[1*], A. Thode[2]
[1]*Applied Ocean Physics and Engineering department,*
Woods Hole Oceanographic Institution, Woods Hole, MA, USA
[2]*Marine Physical Laboratory,*
Scripps Institution of Oceanography, La Jolla, CA, USA
**e-mail: jbonnel@whoi.edu*

Passive acoustic monitoring is now extensively used to detect the seasonal presence and distribution of baleen whales. Although detection is an interesting first step in studying marine mammals, the ability to localize them is a key step in establishing population density estimations and evaluating subtle responses to anthropogenic activities. This talk will present a signal processing method to estimate the range and/or depth of baleen whale vocalizations in coastal waters, using a single-hydrophone. The method has been successfully applied for several baleen whale species in the Arctic. In particular, localization results will be shown for bowhead whales in the Beaufort Sea, and for North Pacific right whales (NPRW) in the Bering Sea. The depth estimates of NPRW vocalizations show that the mean calling depth differs for different call types (gunshots and upcalls). This method may help in identifying right whales calls from much more common bowhead and humpback whales calls, in situations where multiple species overlap in region and season.

Key words
Bioacoustics, Marine Mammal, Acoustical signal processing

Compatible laboratory modelling and numerical simulation of structured oceanic processes

Yu.D. Chashechkin
A.Yu. Ishlinskiy Institute for Problems in Mechanics RAS, 101/1 prospect Vernadskogo, Moscow, Russia, 119526
e-mail: yulidch@gmail.com

Compatible theoretical (analytical and numerical) simulation and laboratory modeling of processes in the environment — the atmosphere, hydrosphere and on mutual contact boundary — is carried out basing on the system of fundamental equations for density, substances concentrations, momentum and transport of the complete energy, closing equations of state for thermodynamic potentials and density, physically reasonable boundary and initial conditions [1]. The system of equations is analyzed taking into account the compatibility condition, which determines its rank, the degree of the linearized version, and the order of the characteristic (dispersion) equation. The scale invariant classification of the structural components of the flows, including waves, ligaments – thin interfaces and filaments – and vortices (definitions are given) was carried out basing on the results of investigation of the complete set of solutions of the linearized system [2]. All flow components are formed synchronously and permanently re-transformed providing evolution and temporal non-stationarity of the system. Experimental techniques and calculation codes have been developed taking into account the intrinsic own scales of the studied problem, which determine the size of the observation (calculation) area, the threshold of sensitivity, the temporal and spatial resolution of the instruments and codes. The experiments were performed on the stands of Unique experimental facilities (Hydrophysical complex IPMech RAS "HPhC IPMech RAS) for studying the dynamics and fine structure of fast processes in stratified and homogeneous fluids [3].

As an illustration, the results of comparing calculations and laboratory visualization of patterns of structure evolution of diffusion induced flows [4], flow patterns around various bodies – sloping plates, cylinders in a wide range of parameters [5], sound generation by droplets falling into a liquid [6] are presented. The formation and evolutions of parameters of every type of studied flows are investigated. The connection of structurization processes with the physicochemical properties of aqueous media [7] and the problem of transferring simulation results to environment are discussed.

References

[1] Yu. D. Chashechkin, *Math. Mod. Optim. Complex Struct.*, 2016, 61-91. DOI: 10.1007/978-3-319-23564-6-5.
[2] Yu.D. Chashechkin, *Math. Model. Nat. Phenom*., 2018, 13(2), 1-29. https://doi.org/10.1051/mmnp/2018020.
[3]. Hydrophysical complex IPMech RAS: *http://www.ipmnet.ru/uniqequip/gfk/#equip*
[4] N.F. Dimitrieva, Yu.D. Chashechkin, *Oceanology*, 2018, **58**(3), 340–349, DOI: 10.1134/S0001437018030.
[5] Y. D.Chashechkin, I. V. Zagumennyi, *Physica Scripta*, 2019, **94**(5), 1-17. doi:10.1088/1402-4896/ab0066.
[6] Yu. D. Chashechkin, V. E. Prokhorov, *Acoustical Physics*, 2017, **63**(1), 33–44. DOI: 10.1134/S1063771016060038.
[7] Yu. D.Chashechkin, O. M. Rosenthal, *Doklady Earth Sciences*, 2019. **484**(5). 194-197. DOI: 10.1134/S1028334X19020107

Acknowledgements

The work was supported by the Ministry of Science and Higher Education within the framework of the Russian State Assignment under contract No AAAA-A17-117021310378-8).and partially supported by RFBR Grant 18-05-00870.

Global impact of the Sato-Umi concept: Mankind in harmony with the Ocean Biome

M.P.Crosby
Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, Florida, 34236
**mcrosby@mote.org*

Cultural perspectives and concepts of the human relationship with nature significantly influence their interactions with the environment, and by extension - to the ecology of that environment in which they exist. The term "Sato-Umi" has been referred to as the concept of a coastal sea with high biological productivity and high biodiversity due to human activities. Given the literal translation of the phrase as village communities (sato) associated with the sea (umi), Sato-Umi may also be viewed in the context of a symbiotic relationship between human activities and the ocean. Both of these concepts build on a long history in Japan, from the early Edo Period, and the broad concept of Sato-Umi has been employed in various forms throughout Japan since a renewed application of this philosophy at the end of the 20th Century.

Sato-Umi will be discussed both as a concept and a marine and coastal ecosystems management strategy, and how it may provide a culturally-appropriate method for implementing provisions of the Convention on Biological Diversity as related to an ecosystem approach, traditional knowledge, innovations and practices, and biodiversity. The core idea of Sato-Umi is the synergetic co-existence of humans and nature within the boundaries of a coastal ocean ecosystem. Traditional knowledge is also merged with modern science as part of the modern Sato-Umi strategy to guide human actions towards wise use of coastal and marine resources. Such an arrangement allows for recognition of cultural heritage and establishment of a responsible production pattern and environmental conservation. Coastal users should be expected to experience economic growth while ensuring long term continuity of ecosystem services through responsible use, which reflects in both environmentally and economically sustainable and resilient communities and society. The Sato-Umi concept has enormous potential for aiding in efforts to harmonize human activity in marine and coastal ecosystems with sustainable use and conservation of marine habitats and biodiversity around the world, but perhaps particularly so with an evolution of the marine protected area concept, and grassroots, community engagement in enhancing conservation and sustainable use of marine ecosystems for high productivity and maintenance of biodiversity.

Key words
Sato-Umi, sustainibility, ecosystem management

Building on-the-ground capacity in scaling-up integrated coastal management: The role of higher education in implementing SDG 14 and other related goals

J. Diwa-Acallar[1]
[1]*Partnerships in Environmental Management for the Seas of East Asia*
**e-mail: jdiwa@pemsea.org/joandiwa@hotmail.com*

Climate change poses a grave threat in coastal areas that have already started feeling its impacts including flooding, increasing frequency and strength of typhoons and tropical storms, sea level rise, storm surges, etc. In spite of these threats, countries are expected to move towards their sustainable development goals, making sure their national policy, strategies and guidelines are in place to respond to these challenges through implementation of appropriate preventive and management measures.

A clear strategy and action programme in climate change adaptation and disaster risk reduction are vital now than ever as countries progress towards their respective sustainable development objectives. Through Integrated Coastal Management (ICM) development and implementation, countries across the East Asian Seas region are progressing towards their respective sustainable development objectives, advancing parallel Sustainable Development Goals (SDGs).

In line with this, PEMSEA's capacity development strategies include mobilizing universities and research institutes in increasing technical support available on the ground, providing scientific inputs from experts' advice in focus issues in various phases of ICM cycle and building capacity and skills to replicate and scale up the ICM practice in the region.

Higher education institutions play a vital role towards the sustainable development of the coasts and seas through its core activities in education, research, governance and external leadership (SDSN, 2017:10). Building on-the-ground capacity in implementing and scaling up ICM programmes involve training and maintaining a critical mass of ICM leaders and practitioners in the East Asian region who can contribute to effective and efficient implementation of Sustainable Development Goal 14 and other related ocean and coastal goals.

Through working and networking with leading higher education institutions from various countries in the region, the PEMSEA Network of Learning Centers (PNLC), as a network of ICM Learning Centers providing technical assistance to implementation of ICM, is uniquely situated to not only uncover the intersectionality of the objectives and initiatives of different sectors, but demonstrate as well how a unified, science-based approach can benefit all stakeholders and the planet.

References

SDSN Australia, New Zealand &Pacifc Edition. "GettingStarted with the SDGs in Universities: A Guide for Universities, Higher Education Institutions, and the Academic Sector," 2017. (www.ap-unsdsn.org/wp-content/uploads/2017/08/University-SDG-Guide_web.pdf)

Key words
Integrated coastal management, Higher education university networks, SDGs

Acoustics of shallow water areas with gas saturated sediments

A. Lunkov[1*], B. Katsnelson[2], V. Petnikov[1]
[1]*Prokhorov General Physics Institute of the Russian Academy of Sciences, 38 Vavilov Str., Moscow, Russia, 119991*
[2]*University of Haifa, 119 Aba Khoushy Ave., Mount Carmel, Haifa, Israel, 3498838*
**e-mail: lunkov@kapella.gpi.ru*

The presence of gas in sediments alters their acoustical properties. Bulk modulus (and hence the sound speed) is especially sensitive to this type of inclusion. 1% volume fraction of gas bubbles decreases the sound speed to 100 m/s, which is less than the sound speed in a pure gas. At a gas fraction of 0.001 %, the sound speed in sediments is close to that in water. On one hand, it leads to a specific regime of sound propagation in a shallow water waveguide both at short and long ranges. Simulated and experimental data [1,2] on transmission loss and impulse response at low frequencies (less than 2 kHz) for various scenarios (the Arctic shelf, the Sea of Galilee etc.) will be presented to demonstrate it. On the other hand, inverse problem of gassy sediment characterization can be solved using acoustic sensing. For example, gas fraction is estimated by analyzing the sound speed in sediments. Recently proposed acoustical methodology [2] for determination of gas content will be discussed.

References

1. V. Grigor'ev, A. Lunkov, V. Petnikov, *Acoust. Phys.*, 2015, 61(1), 85-95.
2. B. Katsnelson, R. Katsman, A. Lunkov, I. Ostrovsky, *Limnology and Oceanography: Methods*, 2017, **15(6)**, 531-541

Acknowledgements
This work was supported by RFBR and ISF. The authors also acknowledge the support from Presidium RAS Program No. 5: "Photonic technologies in probing inhomogeneous media and biological objects".

Key words
Shallow water acoustics, gassy sediments

Oceanic applications of ALOS PALSAR imagery

Leonid Mitnik, Vyacheslav Dubina, and Elena Khazanova
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail: mitnik@poi.dvo.ru

Synthetic aperture radar (SAR) in the L-band aboard the ALOS-2 satellite has continued to observe both the land surface and the surrounding seas since March 2014. SAR sensing is performed in several modes that differ in the polarization of the transmitted and received signals, the angle of incidence, the swath width and the spatial resolution. In this paper, we consider the efficiency of L-band SAR images for the study of dynamic oceanic and atmospheric phenomena by analyzing their fingerprints in the field of the sea surface roughness, along with auxiliary remote and ground data. The focus is on the coastal zones of the Asian marginal seas and the Indonesian Seas. In 2006-2019, more than 500 ALOS-1/-2 PALSAR (Phased Array type L-band SAR) images were used for the study. Surface manifestations of such oceanic phenomena as currents, eddies and eddy chains of various scales and origin, internal waves, upwellings, biogenic and anthropogenic films, wind waves and swell, as well as ships and ship wakes were found on PALSAR images acquired over the Bering, Okhotsk, Japan, East- and South-China Seas. The new valuable information on the sea ice, its spatial structure and evolution was also obtained. Imprints of the dynamic phenomena associated with atmospheric fronts, vortices and vortex chains, precipitations, squall lines, mesoscale organized structures such as rolls, open and closed cells, lee waves, were identified on SAR images. Interpretation and quantitative estimates of the revealed signatures were improved by the joint analyses of SAR, thermal infrared and visible images, scatterometer-derived wind fields, bottom topography maps and surface analyses maps, data of coastal meteorological stations, etc. The detailed analysis of PALSAR images clearly demonstrates the high potential of high resolution radar technique for study of the various phenomena in the ocean-atmosphere system independently on weather conditions.

References

Mitnik, L. M., V. B. Lobanov, *Oceanography of Asian Marginal Seas*, 1991, K. Takano (editor), 85-101.
Mitnik, L. M. *Proc. IGARSS'08*, 2008, **2**, 351-354.
Mitnik, L. M. *Proc, ALOS PI 2008 Symposium*. *ESA SP-664*, 2009, Greece, Rhodes, 5 pp.
Mitnik, L. M., V.A. Dubina, *Proc. IGARSS'09*, 2009, **3(4)**, 192-195.
Mitnik, L. M., V. A. Dubina, *Oceanography from Space, Revisited*, 2010, V. Barale, J. Gower, L. Alberotanza (eds), 113–130.
Mitnik, L. M., V. B. Lobanov, *Proc. IGARSS 2011*, 2011, 1589-1592. doi: 10.1109/IGARSS.2011.6049450.
Mitnik, L., V. Dubina, *Proc. IGARSS 2012*, 2012, 7632-7635, doi: 10.1109/IGARSS.2012.6351860.
Mitnik, L. M., E. S. Khazanova, [In Russian] *Current Problems in Remote Sensing of the Earth from Space*, 2012, **9(1)**, 100-113.
Mitnik, L.M., V.A. Dubina, *Proc. IGARSS 2012*, 2012, 7632-7635.
Mitnik, L.M., Yu. A. Kuzlyakina, [In Russian], *Vestnik DVO RAN*, 2013, **(6)**, 50-58.
L. M. Mitnik, E. S. Khazanova, [In Russian] *Current Problems in Remote Sensing of the Earth from Space*, 2016, **13(2),** 100-113, doi: 10.21046/2070-7401-2016-13-2-9-24.
Mitnik, L., V. Dubina, E. Khazanova, *Proc. IGARSS 2016*, 2016, 4853-4856.
Mitnik, L. M., V. A. Dubina, *Remote Sensing of the Asian Seas*. 2018. Springer, V. Barale, M. Gade (eds.), 159-175.

Acknowledgements
This work was partially supported by the grant of the Far East Branch of the Russian Academy of Sciences 18-I-010. Authors thank the Japan Aerospace Exploration Agency for providing ALOS-1 and ALOS-2 PALSAR images for joint POI FEB RAS - JAXA projects (PI 3072).

Key words:
ALOS PALSAR signatures, oceanic and atmospheric phenomena, sea ice

The United Nations Decade of Ocean Science for Sustainable Development (2021-2030): steps toward implementation phase

S. Shapovalov[1], V. Ryabinin[2]
[1] *P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*
[2] *** Intergovernmental Oceanographic Commission of UNESCO, Paris, France*
**e-mail: smshap@ocean.ru*

In December 2017, the United Nations General Assembly (UNGA) proclaimed a Decade of Ocean Science for Sustainable Development (2021-2030). The proposal for the Decade came from the Intergovernmental Oceanographic Commission (IOC) of UNESCO. It followed a number of key findings by international scientific communities. Oceans are facing multiple environmental stressors (climate change, marine pollution, ocean acidification) resulting in the loss of marine biodiversity and degradation of marine and coastal environments. The First Global World Ocean Assessment (WOA) in 2016 found out that much of the Ocean is now seriously degraded. We assist to a cycle of decline with changes and loss in the structure and function of the Ocean that will ultimately deprive society of many of the benefits currently derived from the marine systems. At the same time, society now depends on the Ocean more than at any time before. It is a vital source of nourishment, supporting the livelihood of about 500 million people, especially in the poorest nations. WOA concluded that our civilization is running out of time to start effectively managing the world ocean and the main reason for this inability is the negative impact on the ocean ecosystems from multiple stressors. Also in 2016, the Scientific Advisory Board of the UN Secretary General identified eight challenges for the future of the people and the planet, and one of them was the development of sustainable knowledge-based ocean economics. The UN Decade of Ocean Science seeks to transform and bolster the way in which the scientific community, governments, civil society, and the UN System coordinate their actions toward "conserving and sustainably using the oceans, seas and marine resources for sustainable development"– as stated in Sustainable Development Goal 14 of the 2030 Agenda. It is critical to keep the central mission of the Decade in mind at all times: Ocean Science for Sustainable Development, not just any ocean science.

The UNGA resolution on the Decade requests IOC to prepare an Implementation Plan for the Decade in consultation with Member States, UN partners and other relevant stakeholders. As a first step in this process, with the assistance of an Interim Planning Group, the IOC prepared a "Roadmap for the UN Decade of Ocean Science for Sustainable Development". That document provides an initial guide detailing the Decade governance arrangements, a tentative strategy, an outline of what is required to complete a draft Implementation Plan by the end of the first half of 2020, as well as the preliminary objectives and expected outcomes of the Decade.
The 51st Session of IOC Executive Council in July 2018 formally established the Executive Planning Group (EPG). A call for nominations for experts was issued and widely disseminated to IOC Member States, UN agencies and the Decade institutional partners (academics, international organizations, NGOs, foundations, etc.).The Roadmap also serves as a guiding framework to the EPG, composed of 19 appointed experts across science, management and policy fields. Furthermore, a stakeholder forum is being established to unite Member States, specialized agencies, funds, programmes and UN bodies, and other intergovernmental and nongovernmental organizations and relevant stakeholders, in contributing their ideas and commitments to the Implementation Plan.

The Road Map identified some social outcomes of the Decade. There are 6 societal outcomes:

- A Clean Ocean: sources of pollution should be identified, quantified and reduced, and pollutants removed from the Ocean.

- A Healthy and Resilient Ocean: marine ecosystems will be mapped and protected, multiple impacts, including climate change, are measured and reduced, and the provision of Ocean ecosystem services is maintained.
- A Predicted Ocean: society will has the capacity to understand current and future Ocean conditions, forecast their change and impact on human wellbeing and livelihoods.
- A Safe Ocean: human communities will be protected from ocean hazards and the safety of operations at sea and on the coast is guaranteed.
- A Sustainable and Productive Ocean: the people will be secured provision of food supply and alternative livelihoods.
- A Transparent and Accessible Ocean: All nations, stakeholders and citizens will have access to ocean data and information, technologies, and are capable of making informed decisions.

These outcomes are considered to be highly transformative because they are expected to trigger environmental, societal and policy changes. They serve not only the SDG 14, but also other SDGs.

The Decade will address both deep disciplinary understanding of ocean processes and solution-oriented research to generate knowledge. This knowledge will support societal actors in reducing pressures of the ocean, preserving and restoring ocean ecosystems and safeguarding ocean-related prosperity for generations to come. The Decade should turn the scientific knowledge and understanding into effective actions supporting improved ocean management, stewardship and sustainable development.

Decisive and fast progress in a number of thematic areas is necessary to achieve them. Among these areas are following.

Comprehensive map (digital atlas) of the ocean

Augment the vision for the Digital Atlas to cover more than bathymetry and physical data. It should also map habitats and species, on the bottom and in the water column, and all the key physical, chemical, biological, geological, archaeological, and human impact variables. Basic mapping should support development of more complex products: mapping of risks, of habitat loss, of hotspots, of scenarios. While much emphasis has been put on mapping the bottom of the deep ocean, it is in the coastal zone that humans have the greatest use of and impact on the ocean. The ambition of the Decade should not be to create simply a Digital Atlas of bathymetry but rather a Digital Aquarium that allows anyone to dive and explore the ocean virtually for a better understanding and application of science.

Observing System

The Observing System is currently unsustainable. The success of the Decade and its legacy depend on making the observing system sustainable, both in terms of infrastructure and financial support. It is necessary to enhance and transform ocean observing networks, data systems and other infrastructure, and the cooperation and partnerships that support it to service the demands of all nations by 2030 and beyond.

Ocean Ecosystems

It is important to transform understanding, and elucidate the cumulative impacts of multiple stressors and develop a comprehensive evidence base and capacities for an interdisciplinary adaptive approach towards ecosystem-based management that will reverse ocean health degradation and promote a blue economy.

Ocean Data and Information System
We have to enhance cooperation, coordination, and communication between stakeholders, including the private sector, in ocean science, with faster and more effective delivery of new and existing data and knowledge to policy and decision-makers in the context of the 2030 Agenda, and beyond. Focus will be placed on infrastructure and data system that make this information available to all.

Comprehensive DRR System (DISASTER RISK REDUCTION)
One of the most important tasks is to reduce risks of disasters from extreme events and ocean-related hazards for coastal communities and people using the sea through an accelerated program of research and development supporting integrated multi-hazard early warning systems, accompanied by improved community preparedness awareness.

Ocean in the Earth System
It's necessary to transform knowledge of the ocean system, its role in the earth and climate system, including the human component, its biodiversity and the seabed, to support sustainable management.

Strengthen capacities and accelerate technology transfer and ocean literacy
If the Decade does not lead to significant capacity development, particularly for SIDS and LDCs, it will be a failure. The Decade must make Ocean Literacy a priority for youth, the general public, policy makers and business sectors.

These initial priority areas of research and development are interconnected but allow focused design and planning. Once the progress in these areas is achieved and is communicated to potential beneficiaries, it will stimulate the variety of ways for sustainable use of the ocean.
In order to achieve "the ocean we need for the future we want", first, the Decade has to generate major positive transformation in our quantitative understanding of ocean processes, coastal and marine environments and of the socio-economic pathways that connect ocean research and observations to sustainable use of the ocean. The resulting information will effectively support management and policy needs at local, regional and global scales. The Decade's success will be ultimately measured by improving the ocean science capacity in all regions of the world and nations, and particularly in developing countries, by mobilizing partnerships, transfer of technology and increasing investment in priority areas where action is urgently needed.

More than 200 representatives of academic, governmental, communication, and private organizations brainstormed in the First Global Planning Meeting for the Decade that was held in Copenhagen in May 2019. The Meeting launched a one-year consultation process to seek inputs and ideas from global and regional stakeholders to shape the Decade's implementation. Some issues were identified at the Meeting that provide global guidance about what will be most important for the success of the Decade. Addressing sustainable development issues will require interdisciplinary and trans-disciplinary approaches with a broad range of stakeholders, with a critical need for the social sciences to be included in the early design of the programme and in every societal area. Achieving the goals of the Decade will require a conscious adoption and promotion of a new ocean narrative that acknowledges that challenges are unprecedented and complex but not insurmountable, and that new science – carried out through new partnerships and taking advantage of advances in technology and innovation – will be able to address these challenges. New partnerships with other stakeholders, particularly the Blue (Ocean) Economy sector and the (Re-)Insurance sector, will be essential to meet the goals of the Decade, both in terms of developing the science needed for sustainable use of the ocean and its resources, and in terms of partnerships for augmenting observing systems and data sharing from private sector

platforms (merchant ships, oil and gas platforms, fishing fleets, wind farms, submarine cables, aquaculture infrastructure, exploration platforms, etc.), and increasing data streams, financing, and outreach. Young professionals, who represent the generation that will do the work of the Decade and carry on its legacy, must be involved in its design. This global dialogue will be continued throughout 2019 and 2020 via regional Decade workshops, conference side-events, and further thematic workshops, to inform the planning of the Decade. The first version of the Plan will be submitted to United Nations in summer 2020.

Coastal Sea level monitoring using satellite radar altimetry: a decade of progress and beyond

S. Vignudelli
Consiglio Nazionale delle Ricerche (CNR-IBF), Via Moruzzi 1, I-56100 Pisa, Italy,
vignudelli@pi.ibf.cnr.it

Satellite altimetry experts worldwide have put considerable efforts in the last 15 years to recover more and better observations of sea level closer to the coasts from radar altimetry measurements. Those efforts have marked the initiation and development of a new discipline, Coastal Altimetry. In the coastal zone, the quality of altimeter data is expected to be degraded with respect to the open ocean due to the effects of land returns and heterogeneities in ocean surface backscatter within the altimeter radar footprint. These issues make waveform processing more complicated and add difficulties with some of the corrections needed to achieve acceptable sea level measurement accuracy. As a result, until the early 2000s most of the data in the coastal band used to be flagged as bad and discarded. However, a number of scientists started to believe that most of those coastal data could be recovered and used for applications. The newly formed coastal altimetry community started gathering around regular international workshops and has already held ten of them, all well attended by both altimeter experts and coastal oceanographers. (see http://www.coastalt.eu).

A number of studies have demonstrated that conventional (i.e. 'pulse-limited') altimeter measurements, if reprocessed with specialized waveform re-trackers and optimized corrections, can provide reliable data down to 3–4 km to the coastline. Another step forward has been achieved with the advent of new technologies such as Ka-band altimetry or SAR and SAR in mode altimetry. A case in point is the Sentinel-3 altimeter, operating in SAR mode over the global ocean, semi-enclosed and inland seas and lakes, which can be considered the first operational coastal altimetry mission. Its narrow along-track resolution cell (around 300 m) permits less contaminated measurements to be obtained much closer to the coast than for pulse-limited missions. This finer along-track resolution, combined with the enhanced signal-to-noise ratio, can capture the spatial complexity of the coastal zone much better than what is possible with only pointwise in situ observations.

Coastal altimetry is now an important component of coastal observing systems and has potential to support a wide range of applications, from monitoring storm surges and the rate of sea level change at the coast, to quantifying the natural variability in coastal sea level and sea state, information that can then be assimilated in coastal models to improve predictions and forecasting skills, all contributing to the WCRP Grand Challenge on Regional Sea-Level Change and Coastal Impacts.

The present contribution gives an update of the technical advances, challenges and difficulties, emerging applications, the favorable prospects deriving from a full exploitation of the information in SAR-mode altimetry data and the new generation of instruments using radar interferometry technology (e.g., SWOT).

Coastal observational site for permanent oceanographic research and testing of new measuring techniques: case of the Black Sea

A.G. Zatsepin, E.G.Arashkevich, V. I. Baranov, O. Yu. Kochetov, S. B. Kuklev, O. I. Podymov, V. V. Ocherednik, A. G. Ostrovskii
P.P. Shirshov Institute of Oceanology Russian Academy of Sciences, Moscow, Russia

An observational site for permanent oceanographic research and monitoring of the Black Sea coastal zone based on combined utility of anchored autonomous measuring platforms and regular multidisciplinary R/V surveys is developed by IO RAS in the NE Black Sea. The site occupies an area of 15*10 km^2 near Gelendzhik, where the Southern Branch of IO RAS is situated and used as a monitoring center. Several types of autonomous platforms are exploited: 1) acoustic Doppler velocity profiler (ADCP) at the bottom station, 2) thermo-chain at the mooring line, 3) robotic profiler "Aqualog" at the moored buoy station, 4) automatic meteorological station at the moored navigational surface buoy. By these platforms the long rows of hydrophysical (vertical profiles of temperature, salinity, density, current velocity, acoustic backscatter) and meteorological (atmospheric temperature, humidity, pressure and wind velocity) of high spatial and temporal resolution are obtained. The data from certain autonomous stations are transferred real-time to the coastal center and used for studies of the marine environment and biota, exchange processes between the shelf zone and the deep basin, the ocean-atmosphere interactions, regional climate change, etc. Other applications include validation of the satellite measurements, verification of the results numerical modeling. The site is also used for testing of new techniques constructed for automatic monitoring purposes and real-time data transfer.

Acknowledgements
This research was funded by the IO RAS State Assignment, Theme 0149-2019-0004.

Recent changes in the Okhotsk Sea ecosystem

Y. Zuenko[1*], N. Aseeva[1], A. Dubinina[2], E. Dulepova[1], A. Figurkin[1], S. Glebova[1], S. Loboda[1], A. Lysenko[1], V. Matveev[1], L. Muktepavel[1], E. Ovsyannikov[1], T. Shatilina[1], A. Zolotov[1]
[1] *Russian Research Institute of Fisheries and Oceanography, Pacific Branch (TINRO), Vladivostok, Russia, 690091*
[2] *Russian Research Institute of Fisheries and Oceanography, Sakhalin Branch, Yuzhno-Sakhalinsk, Russia, 693023*
[*] *e-mail: zuenko_yury@hotmail.com*

Recent changes of the main oceanographic, chemical, and biological parameters of the Okhotsk Sea ecosystem are considered briefly for the last decades (2000s-2010s), mostly on the data of scientific surveys conducted annually by TINRO. Since the mid-2000s, anomalous oceanographic regime was observed there with prevailing heightened temperature in all layers of the sea and lowered ice cover that was conditioned by changes in the atmosphere circulation and accompanied with weakening of the winter convection and geostrophic currents. As the result, ventilation of the intermediate layer became weaker and dissolved oxygen content decreased in this layer, spring phytoplankton bloom was poorer provisioned by nutrients and its intensity became weaker, too, and zooplankton biomass decreased, particularly for phytophages. However, these changes did not cause negative trends in fluctuations of stocks for the main commercial fish and crab species, or even the abundance increased for some ones, presumably because of better conditions for reproduction. There is concluded that recent changes in the macroecosystem of the Okhotsk Sea correspond to the conception of the sub-polar ecosystems transformation under climate warming toward decreasing of their productivity and increasing of their functioning efficiency.

Key words
Climate warming, productivity, marine biological resources.

T01: Ocean dynamics and climate

T01-1: Changing climate and ENSO complexity and modulation

Modulation of the impacts of the Indian Ocean basin mode on tropical cyclones over the Northwest Pacific during the boreal summer by La Niña Modoki

Jingliang Huangfu[1*], Wen Chen[1], Ronghui Huang[1], Juan Feng[1]
[1] *Center for Monsoon System Research, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100190, China*
**e-mail: hfjl@mail.iap.ac.cn*

This study investigated how La Niña Modoki modulates the impacts of the warm Indian Ocean basin mode (IOBM) on the boreal summer climate and the genesis of tropical cyclones (TCs) over the Northwest Pacific (NWP). The results showed that the influence of the Indian Ocean sea surface temperature (SST) on TC genesis is the primary mechanism during the boreal summer, while La Niña Modoki exerts a secondary influence. However, although the summertime index of the IOBM shows a high negative correlation with the number of TCs generated over the NWP, warm IOBM events without La Niña Modoki have only limited influences on the boreal summertime circulations and TC genesis. The present study showed that when warm IOBM events and La Niña Modoki coexisted, the average location of TC genesis shifted westward, and the annual number of generated TCs substantially decreased. La Niña Modoki-related cold sea surface temperature anomalies over the central Pacific further suppressed convective activities over the eastern NWP compared with warm IOBM events without La Niña Modoki. Upper-level convergence and enlarged tropospheric vertical wind shears both contributed to the weakening of the low-level relative vorticity in the coupled cases, leading to a suppressed NWP monsoon trough. Additionally, together with the weaker moisture supply, the impacts of warm IOBM cases were significantly enhanced under the modulation of La Niña Modoki, leading to poorer TC genesis conditions over the eastern NWP. In addition, the energy conversion processes in the aforementioned modulation showed that joint cases will provide fewer initial disturbance seedlings for TC genesis. These results are useful for further understanding the role of warm IOBM cases in TC genesis over the NWP.

References

Cai, W., and T. Cowan, La Niña Modoki impacts Australia autumn rainfall variability, *Geophys. Res. Lett.*, 2009, 36, doi:10.1029/2009gl037885.
Ding, S., W. Chen, J. Feng, and H.-F. Graf, Combined Impacts of PDO and Two Types of La Niña on Climate Anomalies in Europe. *J. Climate*, 2017, 30, 3253-3278.
Ha Y, Zhong Z, Yang X, Sun Y. Contribution of East Indian Ocean SSTA to Western North Pacific tropical cyclone activity under El Niño/La Niña conditions. *Int. J. Climatol.*, 2015, 35, 506-519.
Song, L., S. Chen, W. Chen, and X. Chen, Distinct impacts of two types of La Niña events on Australian summer rainfall. *Int. J. Climatol.*, 2017, 37, 2532-2544.
Zhan, R., Y. Wang, and L. Tao, Intensified impact of East Indian Ocean SST anomaly on tropical cyclone genesis frequency over the western North Pacific. *J. Climate*, 2014, 27, 8724-8739.
Zhang, W., L. Wang, B. Xiang, L. Qi, and J. He, Impacts of two types of La Niña on the NAO during boreal winter. Climate Dynamics, 2015, 44, 1351-1366.

Acknowledgements

This work was supported by the National Key Research and Development Program of China (2018YFC1506003) and the National Natural Science Foundation of China (Grant Nos. 41705071)

Key words:
La Niña Modoki, Indian Ocean basin mode, Tropical cyclone genesis over Northwest Pacific

Oxygen regime shifts in the Black Sea: climate and/or human effects

S. Konovalov[1*], V. Belokopytov[1], A. Vidnichuk[1]
[1]*Marine Hydrophysical Institute RAS,.2 Kapitanskaya Str., Sevastopol, Russia, 299011*
**e-mail: director@mhi-ras.ru*

The Black Sea is a well-known oxic-anoxic marine system with the onset of sulfidic conditions at a depth of 100-150 meters. Several dramatic shifts in oxygen regimes have been reported and attributed to anthropogenic eutrophication and/or climate changes. Time-series of observational data from 1890 make possible to trace and to study oscillations, trends and catastrophic changes in physical and biogeochemical properties of the Black Sea.

We trace long-term changes in the distribution of oxygen since 1923, identify individual regimes in ventilation of the Black Sea waters, evaluate the role of anthropogenic eutrophication and climate changes in ventilation and saturation of the Black Sea waters with oxygen.
We demonstrate several climate-induced shifts between natural regimes, and we demonstrate an additional oxygen-deprived regime due to anthropogenic pressure.

Acknowledgements
This work has been partially supported from project 18-05-80028\18 of Russian Fund for Basic Research and project 0827-2018-0003 of Ministry for science and higher education of Russian Federation.

Key words
Black Sea, oxygen regimes, ventilation and consumption

Do CMIP5 models reproduce El Niño diversity?

Tao Lian*, Jie Feng, Jun Ying, Junde Li

State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources, Hangzhou, China
**e-mail: liantao@sio.org.cn*

Previous studies suggested that more than half of CMIP5 models reproduce El Niño diversity to some extent, and the diversity tends to be intensified, if not weakened, with the global warming in the future. However, as there are strong and varying westward displacements of sea surface temperature (SST) anomalies associated with modeled El Niño, techniques that were designed to classify El Niño in observation cannot be directly applied to model simulations. In this study, we developed a cluster analysis to investigate El Niño diversity in CMIP5 models. As the method does not rely on patterns of El Niño types in observation, it provides an objective and universal way to analyze El Niño diversity in models.

In contrast to previous findings, only 4 of 30 CMIP5 models show El Niño diversity at the 95% confidence level under historical scenario, and only one of them reproduces the patterns of the two types of El Niño as that in observation. The degree of modeled El Niño diversity is related to the climatological zonal SST gradient in the equatorial warm pool. With the weakening of the gradient under future global warming, the degree of El Niño diversity is found to be reduced. We also apply this method to La Niña and find insignificant La Niña diversity in both observation and CMIP5 models. These results indicate that ENSO simulated in the state-of-the-art models are quite symmetric, and processes which are crucial for generating El Niño diversity are not properly simulated.

Key words
El Nino diversity, CMIP5

Multidecadal climate oscillation and changes in global climate regime at the turn of 20-21 century

V. Ponomarev, E. Dmitrieva, S. Shkorba
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041

Rapid changes in the climate characteristics of the ocean – atmosphere system in large-scale areas of the Earth are often referred to as shifts in climate regime. The climate regime shift that occurred in the late 70s of the 20th century is associated with further amplification of global warming in the 80s and 90s of the 20th century. The shift of the climate regime at the turn of the 20th - 21st century is associated with further global warming hiatus (Trenberth, Fasullo, 2013; Yan, et al., 2016) and amplification of warming in Arctic in the 21st century (Serreze, et al., 2009; Svendsen, et al., 2018). At the same time, the rapid changes in climate regime are also related to the change in phase of multidecadal oscillations in Arctic (Frolov, et al., 2009), Atlantic and Pacific (Byshev et al., 2017) oceans.

In our study, changes in the climate regime are estimated on the basis of the methods of Principal Component and clustering analyses via PC of a set of time series of different characteristics of the ocean – atmosphere system averaged in the selected large-scale areas of the World Ocean and Eurasia (Ponomarev et al., 2018). We use seasonal and annual mean time series of surface heat fluxes, sea level pressure, precipitation, Precipitable Water Content (PWC) in the atmosphere, surface air temperature from NCEP reanalyses, as well as Reynolds SST.

It is shown that the changes in climate regimes in the Indian and Indo-Pacific Oceans in early 21 century and in late 70th of the 20^{th} century are closely related to the inversed changes in phase of multidecadal oscillations with period about 40-46 years in annual mean surface evaporation, latent heat flux (LH), net heat flux (Q) and PWC in the atmosphere. It is most clear seen in the ocean area (20°S - 45°S, 60°E -100°E) where the linear trends from 1946 to 2017 in Q and PWC, as well as in SST and SAT are insignificant. New climate regime in early 21 century is associated with rising in annual mean LH, Q and PWC in the most areas of latitude band from 50°S to 50°N (Ponomarev et al., 2018). The increase in evaporation, LH and PWC correspond to the strengthening of tropical, mid-latitude cyclones, storms, heavy rainfall and snowfall in land-ocean marginal zones with wet maritime climate, as well as in adjacent continental regions. During 18 years of the 21st century the number of extreme precipitation and floods has increased in Eurasia and North America. The lack of precipitation and the increase in forest fires in the continental areas, including southern Siberia, are also a consequence of climate regime change.

References

V. Byshev V., Neiman., M. Anisimov, et al., *Pure and Applied Geophysics*, 2017, 174(7), 2863–2878. A. Author, B.
I. Frolov, Z. Gudkovich, V. Karklin, et al., 2009 *Springer Praxis Books Geophys. Sciences, Chichester, UK*, 164p.
V. Ponomarev, E. Dmitrieva, S. Shkorba, et al., *Vestnik MGTU*. 2018, 21(1), 160–169 (in Russian).
M. Serreze, A. Barrett, J. Stroeve , et al. *The Cryosphere*, 2009, 3, 11–19.
L. Svendsen, N. Keenlyside, I. Bethke, et al., *Nature Climate Change*, 2018, 8, 793–797.
K.Trenberth, J. Fasullo, *Earth's Future*, 2013, 1,19-32
X. Yan., T. Boyer, K. Trenberth, et al. *Earths Future*, 2016, 4, 472–482.

Key words
Climate, change, 21 century

Effects of westerly wind bursts on ENSO based on CESM

Youmin Tang[1, 2*] and Xiaoxiao Tan[1]

[1]*State Key Lab of Satellite Ocean Environment Dynamics,Second Institute of Oceanography, Hangzhou, China*
[2]*Environmental Science and Engineering, Universityof Northern British Columbia, Prince George, Canada*

Numerous works have indicated that westerly wind bursts (WWBs) have a significant contribution to the development of El Niño events. However, the simulation of WWBs commonly exist large biases in current coupled general circulation models (CGCMs), limiting our ability in predicting El Niño events. In this study, we introduce a WWBs parameterization scheme into the global coupled Community Earth System Model (CESM) to improve the representation of WWBs and to study the impacts of WWBs on ENSO characteristics. It is found that WWBs have important effects on ENSO asymmetry and ENSO diversity. With the parameterized WWBs, extreme El Niño and central Pacific El Niño events could be well reproduced in CESM. Further diagnoses show that the increased horizontal advection in the central Pacific and vertical advection in the eastern Pacific, which are triggered by WWBs, are crucial factors responsible for the improvement in the ENSO simulation skill.

A positive feedback onto ENSO due to tropical instability wave (TIW)-induced chlorophyll effects in the Pacific

Feng Tianand, Rong-Hua Zhang

Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, China; Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China

Tropical instability waves (TIWs) induce large physical and biological perturbations, which have a feedback onto the tropical Pacific climate and ecosystem. However, the extent to which TIW-induced chlorophyll perturbations (Chl_{TIW}) can influence ENSO remains unknown. Here, we used a hybrid-coupled model to investigate the Chl_{TIW} effect on ENSO. Two experiments are conducted, one with the Chl_{TIW} effect being represented in the control run (CTRL) and other with the Chl_{TIW} effect being purposely excluded by filtering out Chl_{TIW} signals (FILT). Results show that the amplitude of ENSO is increased by 27% in CTRL compared to FILT. Chl_{TIW} tends to modulate the penetrative solar radiation in the upper ocean, acting to weaken the intensity of TIWs. Then, the weakened TIWs lead to a reduction in the equatorward meridional heat transport and consequently less warming effect on the cold tongue. Therefore, La Niña conditions tend to be intensified and ENSO amplitude is increased.

Key words:
Tropical instability waves (TIWs); ENSO; TIW-induced chlorophyll effect; penetrative solar radiation

Influence of South Pacific Subtropical Dipole on ENSO

F. Wang[1*]
[1]*Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China, 266071*
**e-mail: faming_wang@qdio.ac.cn*

Previous studies have identified a sea surface temperature anomaly (SSTA) dipole in the subtropical South Pacific (SPSD), which peaks in austral summer (January–March). It's natural to suspect this SPSD mode may have some influence over certain ENSO events. To test such a possibility, observational analyses and numerical experiments were carried out here. The model is an atmospheric general circulation model coupled to a reduced gravity ocean model. An SPSD-like SSTA was imposed on 1 March, after which the model was free to evolve until the end of the year. The coupled model response showed that warm SSTAs extend toward the equator with northwesterly wind anomalies and then grow to El Niño–like anomalies by the end of the year. SPSD forcing weakens southeasterly trade winds and propagates warm SSTAs toward the equator through wind– evaporation–SST (WES) feedback. Meanwhile, relaxation of trade winds in the eastern equatorial Pacific depresses the thermocline and upwelling. Eastward anomalous currents near the equator cause warm horizontal advection in the central Pacific. Further experiments showed that thermodynamic coupling mainly acts on but is not essential for SSTA propagation, either from the subtropics to the equator or westward along the equator, while oceanic dynamic coupling alone also appears to be able to initiate anomalies on the equator and plays a critical role in SSTA growth in the tropical Pacific. This is consistent with observational analyses, which indicated that influence of WES feedback on SSTA propagation associated with the SPSD is limited. Finally, the warm pole close to the equator plays the dominant role in inducing the El Niño–like anomalies.

References

Impact of South Pacific Subtropical Dipole Mode on the Equatorial Pacific.J. Zheng, F. Wang, M.A. Alexander, M. Wang,*Journal of Climate*, 2018, **31**, 2197-2216.

Acknowledgements

This work was supported by Natural Science Foundation of China.

Key words

ENSO, Subtropical Dipole, Thermodynamic Feedback

Uncertainty in the change of ENSO's amplitude under global warming: Role of the response of atmospheric circulation to SST anomalies

Jun Ying[1], Ping Huang[2,3]*, Tao Lian[1] and Dake Chen[1]

[1]*State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, State Oceanic Administration, Hangzhou, 310012, China*
[2]*Center for Monsoon System Research and State key Laboratory of Numerical Modeling for Atmospheric Sciences and Geophysical Fluid Dynamics, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100190, China*
[3]*Joint Center for Global Change Studies, Beijing 100875, China*
** email: huangping@mail.iap.ac.cn*

This study investigates the mechanism of the large inter-model uncertainty in the change of ENSO's amplitude under global warming, based on 31 CMIP5 models. We find that the uncertainty in ENSO's amplitude is significantly correlated to that of the change in the response of atmospheric circulation to SST anomalies (SSTAs) in the eastern equatorial Pacific Niño3 region. This effect of the atmospheric response to SSTAs mainly influences the uncertainty in ENSO's amplitude during El Niño (EN) phases, but not during La Niña (LN) phases, showing pronounced nonlinearity. The effect of the relative SST warming and the present-day response of atmospheric circulation to SSTAs are the two major contributors to the inter-model spread of the change in the atmospheric response to SSTAs, of which the latter is more important. On the one hand, models with a stronger (weaker) mean-state SST warming in the eastern equatorial Pacific, relative to the tropical-mean warming, favor a larger (smaller) increase in the change in the response of atmospheric circulation to SSTAs in the eastern equatorial Pacific during EN. On the other hand, models with a weaker (stronger) present-day response of atmospheric circulation to SSTAs during EN tend to exhibit a larger (smaller) increase in the change under global warming. The result implies that an improved simulation of the present-day response of atmospheric circulation to SSTAs will be effective in lowering the uncertainty in ENSO's amplitude change under global warming.

References

An, S.-I., and J. Choi, Why the twenty-first century tropical Pacific trend pattern cannot significantly influence ENSO amplitude? *Climate Dynamics*, 2015, **44,** 133-146.

An, S.-I., E. S. Heo, and S. T. Kim, Feedback process responsible for intermodel diversity of ENSO variability. *Geophysical Research Letters*, 2017, **44,** 4272-4279.

Bjerknes, J., Atmospheric teleconnections from the equatorial Pacific. *Monthly Weather Review*, 1969, **97,** 163-172.

Bracegirdle, T. J., and D. B. Stephenson, On the robustness of emergent constraints used in multimodel climate change projections of Arctic warming. *Journal of Climate*, 2013, **26,** 669-678.

Cai, W., and Coauthors, Increasing frequency of extreme El Nino events due to greenhouse warming. *Nature Climate Change*, 2014, **4,** 111-116.

Cai, W., and Coauthors, Increased frequency of extreme La Nina events under greenhouse warming. *Nature Climate Change*, 2015, **5,** 132-137.

Cai, W., and Coauthors, ENSO and greenhouse warming. *Nature Climate Change*, 2015, **5,** 849-859.

Chen, L., T. Li, and Y. Yu, Causes of Strengthening and Weakening of ENSO Amplitude under Global Warming in Four CMIP5 Models. *Journal of Climate*, 2015, **28,** 3250-3274.

Chen, L., T. Li, Y. Yu, and S. K. Behera, A possible explanation for the divergent projection of ENSO amplitude change under global warming. *Climate Dynamics***, 2017,** 1-13.

Collins, M., and Coauthors, The impact of global warming on the tropical Pacific Ocean and El Niño. *Nature Geoscience*, 2010, **3,** 391-397.

Deser, C., M. A. Alexander, S.-P. Xie, and A. S. Phillips, Sea Surface Temperature Variability: Patterns and Mechanisms. *Annual Review of Marine Science*, 2010, **2,** 115-143.

DiNezio, P. N., B. P. Kirtman, A. C. Clement, S.-K. Lee, G. A. Vecchi, and A. Wittenberg, Mean Climate Controls on the Simulated Response of ENSO to Increasing Greenhouse Gases. *Journal of Climate*, 2012, **25,** 7399-7420.

Ham, Y.-G., and J.-S. Kug, How well do current climate models simulate two types of El Nino? *Climate Dynamics*,

2012, **39,** 383-398.
Ham, Y.-G., J.-S. Kug, J.-Y. Choi, F.-F. Jin, and M. Watanabe, Inverse relationship between present-day tropical precipitation and its sensitivity to greenhouse warming. *Nature Climate Change*, 2018, **8,** 64-69.
Held, I. M., and B. J. Soden, Robust Responses of the Hydrological Cycle to Global Warming. *Journal of Climate*, 2006, **19,** 5686-5699.
Huang, P., and S.-P. Xie, Mechanisms of change in ENSO-induced tropical Pacific rainfall variability in a warming climate. *Nature Geoscience*, 2015, **8,** 922-926.
Huang, P., D. Chen, and J. Ying, Weakening of the tropical atmospheric circulation response to local sea surface temperature anomalies under global warming. *Journal of Climate*, 2017, **30,** 8149-8158.
Johnson, N. C., and S.-P. Xie, Changes in the sea surface temperature threshold for tropical convection. *Nature Geoscience*, 2010, **3,** 842-845.
Kang, I.-S., and J.-S. Kug, El Niño and La Niña sea surface temperature anomalies: Asymmetry characteristics associated with their wind stress anomalies. *Journal of Geophysical Research: Atmospheres*, 2002, **107,** 1-10.
Lloyd, J., E. Guilyardi, and H. Weller, The Role of Atmosphere Feedbacks during ENSO in the CMIP3 Models. Part III: The Shortwave Flux Feedback. *Journal of Climate*, 2012, **25,** 4275-4293.
Lloyd, J., E. Guilyardi, H. Weller, and J. Slingo, The role of atmosphere feedbacks during ENSO in the CMIP3 models. *Atmospheric Science Letters*, 2009, **10,** 170-176.
Power, S., F. Delage, C. Chung, G. Kociuba, and K. Keay, Robust twenty-first-century projections of ElNino and related precipitation variability. *Nature*, 2013, **502,** 541-545.
Rashid, H. A., A. C. Hirst, and S. J. Marsland, An atmospheric mechanism for ENSO amplitude changes under an abrupt quadrupling of CO2 concentration in CMIP5 models. *Geophysical Research Letters*, 2016, **43,** 1687-1694.
Taylor, K. E., R. J. Stouffer, and G. A. Meehl, An Overview of CMIP5 and the Experiment Design. *Bulletin of the American Meteorological Society*, 2012, **93,** 485-498.
Watanabe, M., J.-S. Kug, F.-F. Jin, M. Collins, M. Ohba, and A. T. Wittenberg, Uncertainty in the ENSO amplitude change from the past to the future. *Geophysical Research Letters*, 2012, **39,** L20703.
Zheng, X.-T., S.-P. Xie, L.-H. Lv, and Z.-Q. Zhou, Intermodel Uncertainty in ENSO Amplitude Change Tied to Pacific Ocean Warming Pattern. *Journal of Climate*, 2016, **29,** 7265-7279.

Acknowledgements
This work was supported by the National Natural Science Foundation of China (Grants 41706024, 41690121, 41690120,41621064, 41575088, 41722504), the Youth Innovation Promotion Association of CAS, and the Fundamental Research Funds for the Central Universities.

Key words
Global warming, ENSO amplitude, inter-model uncertainty

Contrasting the Skills and Biases of Deterministic Predictions The 21st-Century El Niño: Why is it so different?

Jin-Yi Yu

Department of Earth System Science University of California, Irvine

The El Niño is one of the most powerful climate variation phenomena and has profound impacts on the global climate. Extensive research since the 1970s has resulted in theoretical frameworks capable of explaining the observed properties and impacts of ENSO as well as predictive models. However, the properties and impacts of the El Niño events observed so far in the 21st century have been noticeably different from those observed in the 20th century, which has motivated the research community to revise conventional theories of El Niño. In this talk, I will describe my views on the dynamics of the 21st century El Niño, which is not the same as the 20th-century El Niño dynamics.

I have developed a dynamical framework to study the source of event-to-event differences in ENSO (i.e., ENSO complexity), which focuses on the seasonal footprinting (SF) mechanism that involves subtropical Pacific Ocean-atmosphere couplings and the charged-discharged (CD) mechanism that involves tropical Pacific couplings. Both mechanisms are key coupling processes that affect how the ENSO onsets and evolves from one event to another. Using this framework, we find the CD mechanism was stronger in the 20th-century and acts to reduce the complexity but the SF mechanism became stronger in the 21stcentury and works to increase ENSO complexity.

Contrasting the Skills and Biases of Deterministic Predictions for the Two Types of El Nino

F. Zheng[1*], J. Zhu[1], J.-Y.Yu[2], R.-H. Zhang[3]
[1]*Institute of Atmospheric Physics,Chinese Academy of Sciences, Beijing 100029, China*
[2]*Department of Earth System Science, University of California, Irvine, CA 92697-3100, USA*
[3]*Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China*
**e-mail: zhengfei@mail.iap.ac.cn*

The tropical Pacific has begun to experience a new type of El Nino, which has occurred particularly frequently during the last decade, referred to as the central Pacific (CP) El Nino. Various coupled models with different degrees of complexity have been used to make real-time El Nino predictions, but high uncertainty still exists in their forecasts. It remains unknown as to how much of this uncertainty is specifically related to the new CP-type El Nino and how much is common to both this type and the conventional Eastern Pacific (EP)-type El Nino. In this study, the deterministic performance of an El Nino – Southern Oscillation (ENSO) ensemble prediction system is examined for the two types of El Nino. Ensemble hindcasts are run for the nine EP El Nino events and twelve CP El Nino events that have occurred since 1950. The results show that (1) the skill scores for the EP events are significantly better than those for the CP events, at all lead times; (2) the systematic forecast biases come mostly from the prediction of the CP events; and (3) the systematic error is characterized by an overly warm eastern Pacific during the spring season, indicating a stronger spring prediction barrier for the CP El Nino. Further improvements to coupled atmosphere – ocean models in terms of CP El Nino prediction should be recognized as a key and high-priority task for the climate prediction community.

References

References text: Times New Roman 10 pt, 1 line spacing. A. Author, B. Author, M. Author, *Journal*, year, **volume(issue)**, page1-page2.

Zheng, F., and J.-Y. Yu, 2017: Contrasting the skills and biases of deterministic predictions for the two types of ElNino. *Adv. Atmos. Sci.*, 34(12), 1395 – 1403.

Zheng, F., and J. Zhu, 2016: Improved ensemble-mean forecastingof ENSO events by a zero-mean stochastic error model of anintermediate coupled model. *Climate Dyn.*, 47, 3901 – 3915.

Zheng, F., J. Zhu, R.-H. Zhang, and G.-Q. Zhou, 2006: Ensemblehindcasts of SST anomalies in the tropical Pacific using an intermediatecoupled model. *Geophys. Res. Lett.*, 33, L19604,doi: 10.1029/2006GL026994.

Key words
ENSO, prediction skill, systematic bias

Compensated effects on ENSO due to freshwater flux and ocean chlorophyll in the tropical Pacific bio-climate system

Rong-Hua Zhang, FengTian
Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China
Email: rzhang@qdio.ac.cn

Various forcing and feedback processes coexist in the tropical Pacific which can modulate the El Niño-Southern Oscillation (ENSO). In particular, large co-variabilities in chlorophyll (Chl) and freshwater flux at the sea surface (FWF) are observed during ENSO cycles, acting to execute feedbacks on ENSO through the related ocean biology-induced heating (OBH) and FWF forcing, respectively. At present, the related effects and underlying mechanism are strongly model-dependent and are still not well understood. Here, a new hybrid coupled model (HCM), developed to represent interactions between the atmosphere and ocean physics-biology (AOPB) in the tropical Pacific, is used to examine the extent to which ENSO can be modulated by the interannually covarying anomalies of FWF and Chl. HCM AOPB-based sensitivity experiments indicate that individually, the FWF forcing tends to have amplifying effect on ENSO via its influence on the stratification and vertical mixing in the upper ocean, whereas the OBH feedback tends to have damping one. While the FWF- and OBH-related individual effects tend to counteract each other, their combined effects reveal unexpected situations in which an increase in the FWF forcing acts to decrease the ENSO amplitude when the OBH feedback effects coexist at a certain intensity. The nonlinear modulation of the ENSO amplitude can happen when the FWF-related amplifying effects on ENSO are compensated for by OBH-related damping effects. The results offer insight into diversified effects on ENSO which are evident in nature and different climate models.

Key words:
Freshwater flux forcing; ocean biology-induced heating feedback; compensated modulatingeffects; ENSO; a hybrid coupled model.

The role of eastern Pacific meridional winds on the 2015/16 El Niño

W. Zhong[1,2,3,4], W.Cai[3,5,*], X.-T. Zheng[3,4], and S. Yang[1,2]

[1]*School of Atmospheric Sciences, and Guangdong Province Key Laboratory for Climate Change and Natural Disaster Studies, Sun Yat-sen University, Guangzhou, China,510275*

[2]*Southern Laboratory of Ocean Science and Engineering (Guangdong, Zhuhai), Zhuhai, China, 519082*

[3]*Physical Oceanography Laboratory/CIMST, Ocean University of China and Qingdao National Laboratory for Marine Science and Technology, Qingdao, China, 266003*

[4]*Key Laboratory of Ocean-Atmosphere Interaction and Climate in Universities of Shandong, Ocean University of China, Qingdao, China,266100*

[5]*CSIRO Marine and Atmospheric Research, Aspendale, Victoria, Australia,3195*

**e-mail: Wenju.Cai@csiro.au*

Extreme El Niño convection center features obviously eastward shift, except the 2015/16 event with anomalous diabatic heating center confined to Niño3.4 region. Meridional winds over the eastern tropical Pacific, which could be modulated by convective activity, profoundly impacted ocean-atmosphere coupling processes related to the 2015/16 El Niño. After the early spring of 2015, strengthened easterlies over far-eastern equatorial Pacific covaried well with anomalous equatorward winds. During the boreal summer of 2015, intensified southerly winds over the southeastern tropical Pacific generated ocean upwelling. It resulted in surface cooling along the South American coastal region and offset positive sea surface temperature (SST) anomalies there. Restoration of the climatological zonal SST gradient over the far-eastern Pacific anchored the anomalous precipitation center to the west compared to the 1982/83 and the 1997/98 events. We found that the unique meridional wind variability during the 2015 may be related to the initial warming state of 2014.

Key words
El Niño diversity, meridional winds, coastal region cooling

The relationship among probabilistic, deterministic and potential skills in predicting the ENSO for the past 161 years

Xiangming Zhang*, Ting. Liu
State Key Laboratory of Satellite Ocean Environment Dynamics, Second Institute of Oceanography, Ministry of Natural Resources,Hangzhou, China
**e-mail: zhangxm@sio.org.cn*

Here, we explored in depth the relationship among the deterministic predictability skill, the probabilistic predictability skill and the potential predictability skill. This was achieved by theoretical analyses and, in particular, by an analysis of long-term ensemble ENSO hindcast over 161 years from 1856 to 2016. First, a nonlinear monotonic relationship between the deterministic predictability and the probabilistic predictability, derived by theoretical analysis, was examined and validated using the ensemble hindcast. Further, the covariability between the potential predictability and the deterministic predictability was explored in both perfect model assumption and actual model scenario. On these bases, we investigated the relationship between the potential predictability and probabilistic predictability from both the practice of ENSO forecast and theoretical perspective. The results of the study indicate that there are nonlinear monotonic relationships among these three kinds of predictability measures. The potential predictability is considered to be a good indicator for the actual predictability in terms of both the deterministic measures and the probabilistic framework. The relationships identified here exhibit considerable significant practical sense to conduct predictability researches, which provide an inexpensive and moderate approach for inquiring prediction uncertainties without the requirement of costly ensemble experiments.

Acknowledgements
This work was jointly supported by the National Key Research and Development Program (2017YFA0604202), the National Natural Science Foundation of China (41690124, 41690120), and the National Programe on Global Change and Air-Sea Interaction (GASI-IPOVAI-06).
Key words
ENSO, ensemble forecast, Predictability

T01-2: Observation and modelling of ocean processes

Wave Attractors in Laboratory and Environment

C. Brouzet[1], I. Sibgatullin[2], E. Ermanyuk[3*], S. Joubaud[4], G. Pillet[4], T. Dauxois[4]
[2]*IRPHE, Technopôle de Château Gombert, 49 rue Frédéric Joliot Curie, Marseille, France, 13384*
[2]*P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*
[3]*VLavrentyev Institute of Hydrodynamics SB RAS,.15 Lavrentyev Ave., Novosibirsk, Russia, 630090*
[4]*Laboratoire de Physique ENS de Lyon, 46, alleed'Italie, Lyon, France, 69364*
**e-mail: ermanyuk@hydro.nsc.ru*

The continuous energy input to the ocean interior comes from the interaction of global tides with the bottom topography yielding a global rate of energy conversion to internal tides of the order of 1TW (Morozov 1995, Egbert & Ray 2000). The subsequent mechanical energy cascade to small-scale internal-wave motion and mixing is a subject of active debate in view of the important role played by abyssal mixing in existing models of ocean dynamics. The oceanographic data support the important role of internal waves in mixing (Polzinet al. 1997). A question remains: how does energy injected through internal waves at large vertical scales induce the mixing of the fluid?
The anisotropic dispersion relation for internal (and inertial) waves requires the preservation of the angle of the wave beam to the horizontal upon reflection at a rigid boundary. In presence of a sloping boundary, this property gives a geometric reason for the variation of the beam width (focusing or defocusing) upon reflection (Dauxois & Young 1999). In confined domains focusing prevails, leading to wave rays converging to a closed loop, the wave attractor (Maas et al. 1997).
At large energy input internal wave attractors are prone to triadic instability (Scolan et al 2013). Using laboratory experiments and numerical simulations (Brouzet, Sibgatillun et al. 2016), we suggest the energy cascade in internal wave attractors in nonlinear regime as a novel laboratory model of a natural cascade (Brouzet, Ermanyuk et al. 2016). We show that energy transfer from global to small scales in attractors operates via a hierarchy of triadic resonant interactions. Convincing evidences of a wave turbulence framework for internal waves are also provided. Spontaneous summation of the wave field components produces more overastatistically significant amount of extreme overturning events which eventually lead to a well-measurable mixing. This suggests that such a set-up is appropriate to study abyssal mixing in the laboratory. We also discuss the effects of weak and strong focusing (Brouzet, Ermanyuk et al. 2017), scale effects (Brouzet, Sibgatullin et al. 2017) and 3D effects (Pillet, Ermanyuk et al. 2018), and possible relevance of attractors to natural oceanic environment.

References

E. Morozov, *Deep-Sea Research*, 1995, **I(42)**, 135-148.
G. Egbert, R. Ray, *Nature*, 2000, **495**, 775-778.
K. Polzin, J. Toole, J. Ledwell, R. Schmidt, *Science*, 1997, **276(5309)**, 93–96.
T. Dauxois, W. Young, *J. Fluid Mech.*, 1999, **390**, 271-295.
L. Maas, D. Benielli, J.Sommeria, F. Lam,*Nature*, 1997, **388**, 557–561.
H. Scolan, E. Ermanyuk, T. Dauxois, *Phys. Rev. Lett.*, 2013, 110, 234501.
C. Brouzet, I. Sibgatullin, H. Scolan, E. Ermanyuk, T. Dauxois, *J. Fluid Mech.*, 2016, **793**, 109-131.
C. Brouzet, E. Ermanyuk, S.Joubaud, I. Sibgatullin, T.Dauxois, *Europhys. Letters*,2016, **113**, 44001.
C. Brouzet, E. Ermanyuk, S. Joubaud, G. Pillet, T. Dauxois, *J. Fluid Mech.*, 2017, **811**, 544-568.
C. Brouzet, I. Sibgatullin, E. Ermanyuk, S. Joubaud, T. Dauxois, *Phys. Rev. Fluids*, 2017, 2, 114803.
G. Pillet, E. Ermanyuk, L. Maas., I. Sibgatullin, T. Dauxois,*J. Fluid Mech.*, 2018, **845**, 203–225

Key words
Geophysical flows, mixing, wave turbulence

Hydrodynamics of a drop impact and splash: immiscible fluids

Yu.D. Chashechkin[1*], Ilynukh A.Yu. [1**]

[11]*A.Yu. Ishlinskiy Institute for Problems in Mechanics RAS, 101/1 prospect Vernadskogo, Moscow, Russia, 119526*
**e-mail: yulidch@gmail.com, **ilynykh@ipmnet.ru*

Due to the fundamental nature of related processes and the importance of practical applications, the studies of hydrodynamics of a drop impact are being conducted more and more actively. Among the achievements of recent years, a detailed study of the drop pinch-off dynamics [1], observations of oscillations of a detached drop in flight [2], a high-resolution visualization of small secondary droplets shocks on the surface of the drop [3], and the drop substance transport, which is collected in fibers forming a regular discrete structure on the surface of the cavity and the crown [4]. The drops falling into the water causes the generation of sound packets, both high-frequency at initial contact [5] and in the acoustic range of frequencies due the formation of gas bubbles [6]. Sound measurements are used to assess the dynamic of state and rains intensity of remote regions of the Pacific Ocean. The study of the structure and dynamics of processes that differ markedly for cases of mixing and immiscible media [7] is of interest to the ecology of the ocean, wherein the oil droplets are among the major sources of contaminants. With the help of high-resolution photo and video recordings, the pattern of the flows is studied when immersing a drop of different oils in water and water drops in various oils. The evolution of the geometry of the cavity, the crown, the splash and the limiting domains of location of the falling substances is traced. An important role in the process of the substance transfer is played by a thin double layer, consisting of contacting immiscible liquids adjacent to a rapidly moving continuous contact surface at the initial stage of the evolution of flows. Gradually, voids of waters separated by thin filaments appear on the surface in the decay phase of the crown. Later, when the continuity of the double layer is broken, the water in the oil is concentrated in separate drops of various sizes. The contact surfaces in the flows forming from the spreading of oil droplets in water prove to be continuous at all stages of the process. The final geometry of the oil patch depends on the initial state of the surface. At large times, oil drop is flowed out upon the surface of pure water. On the dusty surface of the water or in the presence of an oil film, the residue of the oil is collected into a compact droplet which is conserved for a long time.

References

[1] Yu.D. Chashechkin, V.E. Prokhorov, *Journal of Applied Mechanics and Technical Physics*, 2016. **57** (3). 402–415.
[2]Yu.D. Chashechkin, *Proceedings Topical Problems of Fluid Mechanics*, 2019. 45-52. /
[3] A.Yu. Ilynykh, Yu.D. Chashechkin, *Fluid dynamics*, 2016. **51** (2). 127-135. DOI: 10.1134/S0015462816020010
[4] A.Yu. Ilynykh, Yu.D. Chashechkin, *Fluid dynamics*, 2017. **52** (2). 309-320. DOI: 10.1134/S0015462817020144
[5]Yu.D. Chashechkin, V.E. Prokhorov, *J. Experimental and Theoretical Physics*, 2016. **122** (4).748–758.
[6]Yu.D. Chashechkin, V.E. Prokhorov, *Acoustical Physics*, 2017, **63**(1), 33–44. DOI: 10.1134/S1063771016060038
[7] Yu.D. Chashechkin, A.Yu. Ilinykh, *Problems of evolutions of open systems*, 2016. **19** (2). 2-30

Acknowledgements
The work was supported by the Russian Science Foundation under grant 19-19-00598.

Key words
Drop, impact, splash, experiment

Sea fog and clouds in the coastal sea generated by cold front drawing jet stream downward and internal gravity waves in the coastal steep mountains

H. Choi[1*], S. M. Choi[2], D. S. Choi[1*], M. S. Lee[1]
[1]*Atmospheric & Oceanic Disaster Research Institute, Dalim Apt. 209ho,Songjungdong, Gangneung 25563, Korea*
[2]*Dept. of Computer Engineering, Konkook University, Chungju, 27478, Korea*
**e-mail: du8392@hanmal.net*

The formation of fog in the Korean eastern mountainous coast and offshore was investigated, using a 3D-WRF-3.6 model from 09LST, October 26 to 09LST, October 28, 2003. As the cold front passing by the Bohai Sea and stretching from Manchuria to Sandoing peninsula moved eastward, south-westerly surface wind ahead of the front became more intensified by supplying more moisture from the Yellow Sea surface into the lower atmosphere within 2km height, resulting in the formation of big stratus-clouds from the Yellow Sea to the west of Mt. Taegullyung near Gangneung city. For daytime, as convective boundary layer (CBL) was developed and extended from the ground surface to 1km height, an upward motion of air from the surface to its top could force the clouds to remain in the top of CBL without fog near the surface. On the other hand, at night, nocturnal cooling of the ground surface could cool down air near the ground surface, producing nocturnal surface inversion layer (NSIL) of which atmospheric temperature increases with height. This NSIL makes a downward motion of air from the top of NSIL to the ground surface. Due to the cooling of the ground surface, air near the ground surface should be cooled down to be condensed to form nocturnal surface inversion fog or radiation fog, combining with the daytime uplifted clouds downward, within 1.2km height in the west basin of the mountain top. However, in the steep eastern slope of Mt. Taegullyung in the coastal side, westerly wind moving over the mountain top was intensified into a strong downslope wind, depicting Internal Gravity Waves (IGW) bounding down and up with a wind speed over 16m/s, which was associated with the downward upper jet stream and could dissipate both cloud and fog under adiabatic heating of air by compressing air to heat up the cooled air parcel, resulting in neither the formation of fog nor cloud in the coastal inland. Otherwise, the formation of big cloud clusters in the side of bounding up of air which was produced by the IGW. In the open sea (the East Sea/Japan Sea), both sea fog near the sea surface and a big cloud cluster was produced vertically by uplifting warm moist water particles from the sea surface into 6km height, ahead of cold front which was still associated with upper jet stream.

Referencese

H. Choi and M.S. Speer, The influence of synoptic-mesoscale winds and sea surface temperature distribution on fog formation near the Korea western peninsula, Meteorological Applications, 13(4), 347-360 (2006)

Key words
Sea fog, cold front, internal gravity waves

Numerical simulations of the mesoscale circulation on the eastern Sakhalin shelf under sea-ice

N. Diansky[1,2], V. Fomin[2], D. Stepanov[3*]
[1]*Lomonosov Moscow State University, GSP-1, Leninskie Gory, Moscow, Russia, 119991*
[2]*N.N. Zubov State Oceanographic Institute, Kropotkinsky Lane 6, Moscow, Russia, 119034*
[3]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: step-nov@poi.dvo.ru*

The Sea of Okhotsk is one of the marginal seas in the northwestern Pacific Ocean and to be the southernmost sea, which is covering by the sea-ice in the Northern Hemisphere. It has been established that the Sea of Okhotsk is an important location for the ventilation of North Pacific Intermediate Water [1,2].

In this study, based on the long-term eddy-permitting numerical simulations [3], the mesoscale variability is investigated on the eastern Sakhalin shelf during the winter-spring period. We estimate the spatial and temporal scales of the mesoscale dynamics and consider mechanisms driving its formation, with special emphasizing on the hydrodynamic instability of the East Sakhalin current.

It was found that the nearshore component of the East- Sakhalin Current was potentially baroclinic unstable in the first half-year. The simulated circulation uncovered mesoscale anticyclonic eddies on the eastern Sakhalin shelf. An analysis of the rate of eddy energy conversion shows that the generation of the mesoscale eddy results from, mainly, baroclinic instability, whereas barotropic instability can be both favoring and preventing to the generation of the mesoscale eddies on the eastern Sakhalin shelf.

References

1 L. Talley, *Deep-Sea Research I*, 1991, **38**, 171-190.
2. S. Gladyshev, L. Talley, G. Kantalov, G. Khen, M. Wakatsuchi, *Journal of Geophysical Research* 2003, **108,** 2156- 2202.
3. D. Stepanov, N. Diansky, V. Fomin, *Ocean Dynamics,* 2018, **68**, 825-845

Acknowledgements

This work was supported by the by the Russian Scientific Foundation, project no. 19-17-00006.

Key words

Numerical simulations, mesoscale dynamics, Sea of Okhotsk

Mesoscale and submesoscale features of the circulation in Peter the Great Bay (Japan/East Sea)

P. Fayman[1*], A. Ostrovskii[2], V. Lobanov[1]

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*Shirshov Institute of Oceanology, Russian Academy of Sciences, 36 NahimovskiyProspekt, Moscow 117997, Russia*
**e-mail: pavel.fayman@gmail.com*

The circulation in Peter the Great Bay was studied using the CTD-data from FERHRI (Far Eastern Regional Hydrometeorological Research Institute), measurement from the AQUALOG profiler, model results from the ROMS(Regional Ocean Modeling System) and MHIOM (Marine Hydrophysical Institute Ocean Model).

Those results showed that the Primorye Current consists of two branches. The first branch, the most stable, is oriented along the continental slope and exists from the surface to depth. The second branch follows the edge of the shelf and the outer shelf of Peter the Great Bay. The most intense synoptic variability is founded in the region of this branch.

Coastal mesoscale anticyclonic eddies are regularly generated by the Primorye Current flowing past the capes in the Peter the Great Bay. Such coastal eddies are typical for the summer period in the Bay regulating water exchange between the continental shelf and open sea. They are shown to be generated after intensification of the eastern wind which is sufficiently strong to produce downwelling and increased horizontal density gradients and to generate an anticyclonic vorticity past the capes.

Submesoscale cyclonic eddies are formed on the periphery of mesoscale anticyclonic eddies. During the winter period of time, such submesoscale eddies are responsible for the transport of cold water from shallow bays to the open part of Peter the Great Bay.

Acknowledgements
This work was supported by using funding of the Russian State Basic Research task no. 0149-2018-0010, Russian Foundation for Basic Research grants 16-05-00899 and 16-55-50071jf-a and FEBRAS Priority Program "Far East" grant 18-1-010.

Key words
Moored automatic mobile profiler, Regional ocean modeling system, Submesoscale eddy, water particle pathways, Dense water production rate, Peter the Great Bay, Japan/East Sea, eddy dynamics, generation mechanism.

Patterns of the Deep convection in the Greenland Sea

A.M. Fedorov[1,2*], I.L. Bashmachnikov[1,2]
[1]Saint-Peterburg State University,.7-9, Universitetskaya Emb., St. Petersburg 199034, Russia
[2]Nansen International Environmental and Remote Sensing Centre, office 49, 7, 14th Line of Vasilievsky Island, St. Petersburg,199034, Russia
*e-mail: aandmofficially@gmail.com; aleksandr@niersc.spb.ru

The most probable region of the deep convection (DC) development, in the central Greenland basin, was first detected by Nansen (1912), its boundaries specified in further studies (Marshall and Schott, 1999; Fedorov et al., 2018, Bashmachnikov et al., 2018). The convection depth is detected from vertically homogeneous upper ocean density profiles (the mixed layer depth - MLD) or high oxygen concentration (Sverdrup et al., 1942). Variations in the winter MLD maxima are used for evaluation of interannual variability of the DC intensity (Kantha and Clayson, 2000).

A primary sources of data for this study were ARMOR 3D data-set and GLORYS (12 v1) ocean reanalysis. The first data -set provides monthly mean values of temperature and salinity on 1/4°x1/4° spatial grid and standard oceanographic depth levels, obtained optimal interpolation algorithm of in-situ and satellite data . The GLORYS reanalysis assimilates satellite and in -situ data and provides daily mean profiles on 1/12°x1/12° spatial grid for 50 depth levels. The MLD was calculated using Dukhovskoy's method (Bashmachnikov et al. 2018): the mixed layer depth is fixed on a potential density profile when the local potential density gradient exceeds three standard deviations in a 100-meter layer, centred at the study level. Daily MLD from GLORYS were averaged to monthly means. Spatial distributions of the MLD were used for further analysis.

It is shown that variability of DC intensity in the Greenland Sea can be efficiently described by the winter maximum MLD together with the area of the region with MLD over 800m (SDC). Cluster analysis demonstrates three types of convection conditions: deep MLD and large SDC, deep MLD and small SDC, shallow MLD and small SDC. With intensification of the DC, the maximum winter MLD increases until reaching a threshold value, after which SDC starts increasing, while winter maximum MLD remains nearly constant. This dependency is observed in both datasets used in this study.

References

F. Nansen, Das Bodenwasser und die Abkühlung des Meeres, Internationale Revue der Gesamten Hydrobiologie and Hydrographie, 1912, 1, 1–42.

J. Marshall, F. Schott, Open-ocean convection: Observations, theory, and model, Rev. Geophys., 1999, 37(1), 1–64.

A. M. Fedorov, I. L. Bashmachnikov, T. V. Belonenko Localization of areas of deep convection in the Nordic seas, the Labrador Sea and the Irminger Sea. Vestnik of Saint Petersburg University. Earth Sciences, 2018, 63(3), 345–362.

I.L. Bashmachnikov; A.M. Fedorov; A.V. Vesman; T.V. Belonenko; A.V. Koldunov; D.S. Dukhovskoy, Thermohaline convection in the subpolar seas of the North Atlantic from satellite and in situ observations. Part 1: Localization of the deep convection sites. Sovremennye Problemy Distantsionnogo Zondirovaniya Zemli iz Kosmosa, 2018, 15(7), 184-194.

L.H. Kantha, C.A. Clayson, Small Scale Processes in Geophysical Fluid Flows International Geophysics Series, Academic Press, San Diego, 2000, 67, 888 pp.

H. U. Sverdrup, M. W. Johnson, R. H. Fleming, The Oceans: Their Physics, Chemistry and General Biology, Prentice-Hall, New York, 1942.

Acknowledgements: The research is funded by the Russian Scientific Foundation: Project No. 17-17-01151
Key words: Deep convection, the Greenland Sea

Vortex-Vortex interactions in the Lofoten Basin of the Norwegean Sea

A.M. Fedorov[1,2*], T.V.Belonenko[1], I.L. Bashmachnikov[1,2]
[1]*Saint-Peterburg State University,.7-9,UniversitetskayaEmb., St. Petersburg 199034, Russia*
[2]*Nansen International Environmental and Remote Sensing Centre, office 49, 7,14th Line of Vasilievsky Island, St. Petersburg,199034,Russia*
**e-mail: aandmofficially@gmail.com; aleksandr@niersc.spb.ru*

Positive anomalies of heat and salt in the central part of the Lofoten Basin are formed under effect of topography resulting in mesoscale eddy transport (Volkov et al., 2015). The basin is famous for the quasi-permanent anticyclonic Lofoten vortex located at the central part of the Lofoten Basin. The vortex stability is provided by both winter mixing (Alexeev et al., 2016) and interactions with other eddies. Such a dynamically active region is a good field for investigation of vortex-vortex interactions.

A primary source of data for this study was ocean eddy-resolving reanalysis GLORYS 12 v1 (http://marine.copernicus.eu) with satellite and in-situ data assimilation. GLORYS has spatial 1/12° resolution. Usage of daily reanalysis makes it possible to describe real vortex-vortex interactions. We consider barotropic conversions relevant to eddy kinetic energy (Dong et al., 2007) (KmKe), and apply a vortex tracking algorithm (Bashmachnikov et al., 2017) to define location of eddy centres and to estimate subsequently radiuses of the vortex cores.

We assess relative vorticity and Okubo-Weiss parameter (Okubo, 1970; Weiss, 1991) for detecting vortex interactions events. Thereafter we consider kinetic energy flux variability during lifecycle of mesoscale eddies and vortex dipoles continuously for chosen events. Depth integrated spatial distributions of Km - Ke for chosen event are matched with a volume integrated inside the vortex timeseries of Km - Ke.

Finally, we analyze qualitative and quantitative properties of energy exchange during vortex-vortex interactions based on KmKe as well as estimations of potential and kinetic energy pulsations.

References

D. L. Volkov, A. A. Kubryakov, R. Lumpkin, Formation and variability of the Lofoten basin vortex in a high-resolution ocean model, Deep Sea Research Part I: Oceanographic Research Papers, 2015, 105, 142-157.
V.A. Alexeev, V.V. Ivanov, I.A. Repina, O.Y. Lavrova, S.V. Stanichny, Convective structures in the Lofoten basin based on satellite and ARGO data, Izvestiya. Atmospheric and Oceanic physics, 2016, 52 (9), 1064-1077.
C. Dong, J.C. McWilliams, A.F. Shchepetkin: Island Wakes in Deep Water. J. Phys. Oceanogr., 37, 2007, 962–981,
J. Weiss, The dynamics of enstrophy transfer in two-dimensional hydrodynamics, Physica D: Nonlinear Phenomena,1991,48(2-3), 273-294.
A.Okubo, Horizontal dispersion of floatable particles in the vicinity of velocity singularities such as convergences, Deep Sea Research and Oceanographic Abstracts, 1970, 17(3), 445-454.
I.L. Bashmachnikov, M.A. Sokolovskiy, T.V. Belonenko, D.L. Volkov, P.E. Isachsen, X. Carton,On the vertical structure and stability of the Lofoten vortex in the Norwegian Sea,Deep Sea Research Part I: OceanographicResearch Papers,2017,128,1-27.

Acknowledgements: The authors acknowledge support of the Russian Science Foundation (project No. 18-17-00027).

Key words:
Vortex-vortex interaction, LofotenBasin, KmKe

Statistical analysis of mesoscale eddy activity in the Lofoten Basin of the Norwegian Sea

S. M. Gordeeva[1,2,3], V. A. Zinchenko[1,2*], T. V.Belonenko[1]

[1]*Saint Petersburg State University, Universitetskaya nab. 7–9, St. Petersburg, Russian Federation*
[2] *Russian State Hydrometeorological University, 79, Voronezhskayaul., Saint Petersburg, Russia*
[3]*Shirshov Institute of Oceanology of the Russian Academy of Sciences, 36, Nahimovskiy pr., Moscow, Russia*
**e-mail: vadimzin@gmail.com*

Background: The objective of our study is to investigate mesoscale eddy activity in the Lofoten Basin (LB) of the Norwegian Sea based on statistical analysis of eddies using the automatic identification method and the database developed by Faghmous et al. (2016). The LB is the deepest and broadest reservoir of Atlantic Water and thereby of ocean heat content, and furthermore the most eddy-rich region of the Nordic Seas. It is called a 'hot spot' of the Nordic Seas because of its high intense of mesoscale eddy activity (Belonenko et al., 2014; Volkov et al., 2013). Similar to other parts of the world ocean, both anticyclonic eddies (ACEs) and cyclonic eddies (CEs) characterize the mesoscale eddy activity of the LB.

Material: We use high-resolution sea level anomalies (SLA) for the period 1993-2017 to study the mesoscale eddies in the LB from the Copernicus Marine Services. The open-source code for automatic identification and tracking of eddies developed by Faghmous et al. (2015) were applied on the SLA for the detection and tracking of mesoscale eddies in the LB. Faghmous et al. (2015) define eddies as the outermost closed-contour SLA containing a single extreme (maximum/minimum).We also use the GLORYS12V1 product of the Global Ocean Physics Reanalysis available at CMEMS (Copernicus Marine Environment Monitoring Services). It is the global ocean eddy-resolving (1/12° (approximatively 8 km) horizontal resolution and 50 standard levels).This product includes daily mean files of temperature, salinity, currents, sea level, mixed layer depth and ice parameters from the top to the bottom.

Methods and Results: We divide all mesoscale long-lived eddies (120 CEs and 210 ACEs) into 4 groups based on the location of generation and decay and analyze all statistical features for every group separately.

Conclusions: We found out three distinct areas of eddy formation in the frontal zone of the NwASC, from where eddies shift to the north-west, forming three main trajectories. The temporal variability of the characteristics of eddies on tracks reveals differences between the two groups of eddies reflected different genesis. Eddies in the LB have a more pronounced variability during life and possess characteristics of a larger scale than at the periphery of the Norwegian Current. The average speed of movement of eddies on tracks has a pronounced seasonal variation when the maxima of the speeds of movement of both types of eddies appear in winter (February-April).

References:

Belonenko, T. V., D. L. Volkov, V. K. Ozhigin, Yu. E. Norden (2014), Circulation of waters in the Lofoten Basin of the Norwegian Sea [In Russian], *Vestn S. Petersbur. Un-ta*, 7(2):108-121.

Faghmous, J.H., I.Frenger, Y. Yao, R.Warmka, A. Lindell, V. Kumar (2015), A daily global mesoscale ocean eddy dataset from satellite altimetry. Sci. Data 2: 150028. Doi:10.1038/sdata.2015.28.

Volkov, D. L., T. V. Belonenko, V. R. Foux (2013), Puzzling over the dynamics of the Lofoten Basin – a sub-Arctic hot spot of ocean variability,*Geophys. Res. Lett.*, 40 (4): 738-743. doi:10.1002/grl.50126.

Acknowledgements

This work was supported by**Russian Scientific Foundation** (pr.No. **18-17-00027**).

Key words: Norwegian Sea, Lofoten Basin, statistical analysis, mesoscale eddies

Simulation of seasonal circulation in the Sevastopol Bay

A. I. Kubryakov, V.N. Belokopytov
Marine Hydrophysical Institute RAS, 2, Kapitanskaya Str., Sevastopol, Russia, 299011
**e-mail: alex.kubr@gmail.com*

Sevastopol Bay is one of the marine areas that are subject to constant anthropogenic impact. For many decades, the bay serves as the base of the naval and commercial seaports, dry cargo and oil terminals with all characteristic industrial and economic infrastructure. The economic development of the city of Sevastopol, located on the shores of the bay, is largely due to the use of transport, recreational and fishing potentials of the Sevastopol bay. The intensification of economic activity in the water area of the bay inevitably leads to an increase in the probability of major disasters with irreparable damage to the recreational and biological resources of the sea. Solving emerging problems requires the development and creation of control systems for the marine environment, an integral part of which are interdisciplinary mathematical models describing the state and dynamics of marine coastal waters. Circulation models constitute the main part in such systems.

The version of Princeton Ocean Model is used to study the climatic seasonal evolution of thermohaline structure and circulation in the Sevastopol Bay in response to wind, surface heat flux and river discharge. The model has grid in the horizontal with spacing about 20 m along latitude and about 40 m along longitude with 11 levels in the vertical. It is initialized and forced at the open boundary with climatic average monthly fields of temperature and salinity prepared on the data for 2,709 hydrological stations for the period 1923–2014. The numerical experiments are forced by monthly climatological heat and mass fluxes from the reanalysis data set ERA-40 and wind and river discharge from Sevastopol hydrometeorological station.

The circulation quickly spins up to periodic annual run. Various wind conditions during the seasonal cycle produce different surface and vertical circulation, modify water exchange between the Sevastopol Bay and the open sea and between the inner bays, while general pattern of water flow, caused by the inflow of freshwater at the top of the Bay, is remained throughout the year: seawards in the upper layers and from the open sea to the Bay in the subsurface layers. Fresh and colder water discharge and maximum surface current velocities peak during February and March. An extensive anticyclone is formed in the western part of the Bay across the entire width in the spring and summer seasons. Localized mesoscale eddies form in numerous inner bays. The interaction of fresh and saline waters produces a highly complex density structure. In winter, the waters of the Bay are mixed to the bottom, a sharp thermocline forms in summer. When winter cooling erodes the stratification, the flow, coming out of the Bay, occupies a more extensive layer.

The performed numerical experiments showed the efficiency and adequacy of seasonal circulation reconstruction in the model, which provides further planning of the forecast calculations of dynamic and thermohaline structure of the Sevastopol Bay. Test calculations of contaminants spreading, coming from one of the inner bay are carried out. The model also can be used as an instrument for engineering or ecological purposes, such as pollutants propagation, deposit transport, fluxes of nutrients, etc.

Acknowledgements. This work was supported by the Russian Foundation for Basic Research (RFBR) (Grant Nos. 18-05-80028 and 18-45-920018)

Key words: modeling, Sevastopol Bay, annual variation

Interannual Variability and Trends of Sea Surface Temperature, Sea Surface Wind, and Sea Level Anomaly in the South China Sea

C.L Liu[1*], X. Li[2], S.F. Wang[3], D.L. Tang[3], D.H. Zhu[4]
[1]*Marine college, Shandong University (Weihai), 264209, China*
[2]*Key Laboratory of Underwater Acoustic Communication and Marine Information Technology (Xiamen University), Xiamen, China*
[3]*The State Key Laboratory of Tropical Oceanography, South China Sea Institute of Oceanology, Chinese Academy of Sciences, 510301, China*
[4]*Ocean College,Zhejiang University, 316021, China*
**e-mail: chunliliu@sdu.edu.cn*

Interannual variabilities of the sea surface temperature (SST), sea surface wind (SSW), and sea level anomaly (SLA) of the South China Sea (SCS) in 1985–2016 are analyzed using monthly satellite-derived datasets. An empirical orthogonal function (EOF) analysis is performed to evaluate the interannual variabilities of these parameters. Results show that the warming rising rate of the SST is 0.18 ± 0.26 ° decade^{-1} in the SCS. The first EOF of the SST is characterized by basin-wide warming, with the highest anomalies in the northern deep basin. The first temporal coefficient is negatively correlated with the Nino3.4 index with a lag of six months. The mean rising rate of the SLA is 7.6 cm decade^{-1} with the greatest trend in the coastal water of Vietnam, that presents the similar spatial pattern with the first EOF of the SLA. The temporal coefficient of the SLA is negatively correlated with the SST, with a lag of five months. The trend of SSW is around 0.8 ms^{-1} decade^{-1} over the SCS. The first EOF of the SSW is characterized by a basin-wide cyclonic pattern. The temporal coefficient is correlated with the SST, with a lead of two months. The wavelet coherence is used to investigate the cross-correlation relationship between SST and other parameters. The SST and SLA have a strong negative correlation in the8- to 16-month (1–1.5 year) band. The high positive wavelet coherencies between SST and SSW, Nino3.4, are mainly in the 32–64 month (3–5 year) band in the South China Sea.

References

1.K. S.Casey, P. Cornillon, Global and regional sea surface temperature trends, J. Clim., 2011, 14, 3801–3818.
Chu PC, Lu S, Chen Y (1997) Temporal and spatial variabilities of the South China Sea surface temperature anomaly. J Geophys Res Oceans 102(C9):20937–20955. doi:10.1029/97JC00982.
2. G.Fang, H.Chen, Z. Wei, Y. Wang, X.Wang, C.Li (2006), Trends and interannual variability of the South China Sea surface winds, surface height, and surface temperature in the recent decade. J Geophys Res, 2006, 111:C11S16. doi:10.1029/2005JC003276.
3.Y.Wang, G. Fang, Z. Wei, F. Qiao, and H. Chen, Interannual variation of the South China Sea circulation and its relation to El Nino, as seen from a variable grid global ocean model, J. Geophys. Res, 2006, doi:10.1029/2005JC003269.

Acknowledgements

This study was supported by the National Natural Science Foundation of China-Shandong joint fund (U1806203); The National Science Foundation of China (41206166); The Fundamental Research Funds for the Central Universities (2019ZRJC005); Postdoctoral Science Foundation of China (2017M622180); Guangdong Key Laboratory of Ocean Remote Sensing, South China Sea Institute of Oceanology Chinese Academy of Sciences (2017B030301005-LORS1803).

Key words

South China Sea; sea surface temperature; sea surface wind; sea level anomaly; interannual variability

Detection of breaking waves in single wave gauge records of surface elevation fluctuations

D. Liberzon[1*], A. Vreme[1], S. Knobler[1]
[1]*VFaculty of Civil and Environmental Engineering, Technion, Haifa, Israel, 3200003*
**e-mail: liberzon@technion.ac.il*

Background. Despite its importance and many years of reserch efforts, the breaking of water waves is not entirely understood till nowadays [1], one of the main obstacles being the lack of a reliable and cost-effective method for breaking waves detection. As of today, the most reliable detection technique is the visual detection of breaking waves, seeking for prominent features of breaking waves, such as the whitecaps generated by significant breakers. Alternatively, instrumental detection methods rely on direct measurements of a specific waves related parameter variations. Data about such parameters [2]are recorded and passed through a detection filter. Here we discuss the development of a new breaking detection method addressing the need for a cost effective, in terms of the required instrumentation, data storage and data processing, method independent of human decision and applicable in the widest possible range of conditions. This new method relies on the Phase Time Method (PTM) [3, 4] processing of the water surface elevation fluctuations records obtained by one simple wave gauge.

Material and Methods. The detection is based on the identification of breaking associated patterns in the surface elevation fluctuations instantaneous frequency variations, provided by the Phase Time Method (PTM) analysis. Wavelets based pattern recognition algorithm is devised to detect such patterns and to provide accurate detection of breakers in the examined records. Validation and performance tests are reported, conducted using both laboratory and open sea data, including mechanically generated and wind forced waves.

Results. The tests allowed derivation of a set of parameters assuring high detection accuracy rates. The results confirm the same normalized detection energy threshold can be used for wave records for different scales obtained at different sampling frequency and resolution. The method is shown to be capable of achieving a positive detection rate exceeding 90 percent.

Conclusions. The new method was designed to be cost-effective in terms of instrumentation and data processing, implementing a combination of PTM processing of the surface elevation fluctuations records and pattern recognition algorithm based on wavelet analysis. This opens the possibility for implementation of the presented here method in all possible experimental setups, especially promising is the ability to detect breaking waves in highly irregular wave fields forced by the above blowing wind.

References

1. Babanin A V. (2011) Breaking and Dissipation of Ocean Surface Waves. Cambridge University Press.
2. Tucker MJ, Pitt EG (2001) Waves in ocean engineering.Elsevier Ocean Engineering Book Series.
3. Huang NE, Long SR, Tung C-C, et al (1992) The local properties of ocean surface waves by the phase-Time method. *Geophys Res Lett* 19:685–688.
4. Stansell P, MacFarlane C (2002) Experimental investigation of wave breaking criteria based on wave phase speeds. *J Phys Oceanogr* 32:1269–1283.

Acknowledgements
This work was generously funded by the Israeli Science Foundation (ISF) grant 1251/15.

Key words:
Breaking waves, Phase Time Method, detection of breakers

Tilt of mean sea level along the coast of mainland China

Wenqiang Lin[1], Hongyang Lin[1*], Jianyu Hu[1]

[1]*State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, Fujian*
**e-mail:hylin@xmu.edu.cn*

The tilt of mean sea level along the coast of mainland China is estimated based on three independent data sources: altimeter, tide gauge and an ocean model. The former two sources are associated with the geodetic approach while the last is referred to as the oceanographic approach. A key finding is that there is a close agreement in the estimated mean dynamic topography (MDT) based on the above independent approaches and datasets. Along the coast of mainland China, there is a clear northward drop in the mean coastal sea level, with the highest slope appearing from Zhapo to Lianyungang. An analysis of the alongshore momentum balance suggests that the coastal MDT is in fact a counter balance of the contribution of alongshore wind stress and bottom friction. That is, the alongshore wind is the main driver for this tilt, and its effect on the coastal sea level could be explained by the arrested topographic wave theory.

References

Altamimi Z, Collilieux X, Métivier L. ITRF2008: an improved solution of the international terrestrial reference frame[J]. *Journal of Geodesy*, 2011, **85**(8): 457-473.

Bingham R J, Haines K. Mean dynamic topography: Intercomparisons and errors[J]. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 2006, **364**(1841): 903-916.

Chassignet E P, Hurlburt H E, Metzger E J, et al. US GODAE: global ocean prediction with the HYbrid Coordinate Ocean Model (HYCOM)[J]. *Oceanography*, 2009, **22**(2): 64-75.

Cummings J A, Smedstad O M. Variational data assimilation for the global ocean[M]//Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications (Vol. II). *Springer, Berlin, Heidelberg*, 2013: 303-343.

Cummings J A. Operational multivariate ocean data assimilation[J]. *Quarterly Journal of the Royal Meteorological Society: A journal of the atmospheric sciences, applied meteorology and physical oceanography*, 2005, **131**(613): 3583-3604.

Featherstone W E, Filmer M S. The north- south tilt in the Australian Height Datum is explained by the ocean's mean dynamic topography[J]. *Journal of Geophysical Research: Oceans*, 2012, **117**(C8).

Higginson S, Thompson K R, Woodworth P L, et al. The tilt of mean sea level along the east coast of North America[J]. *Geophysical Research Letters*, 2015, **42**(5): 1471-1479.

Kuroishi Y. Comparison of latest global and regional gravimetric geoid models with GPS/leveling geoidal undulations over Japan[M]//Reference Frames for Applications in Geosciences. *Springer, Berlin, Heidelberg*, 2013: 221-227.

Lin H, Thompson K R, Huang J, et al. Tilt of mean sea level along the Pacific coasts of North America and Japan[J]. *Journal of Geophysical Research: Oceans*, 2015, **120**(10): 6815-6828.

Menéndez M, Woodworth P L. Changes in extreme high water levels based on a quasi- global tide- gauge data set[J]. *Journal of Geophysical Research: Oceans*, 2010, **115**(C10).

Nakano M, Yamada S. On the mean sea levels at various locations along the coasts of Japan[J]. *Journal of the Oceanographical Society of Japan*, 1975, **31**(2): 71-84.

Pugh D, Woodworth P. Sea-level science: understanding tides, surges, tsunamis and mean sea-level changes[M]. *Cambridge University Press*, 2014.

Thompson K R. An analysis of British monthly mean sea level[J]. *Geophysical Journal International*, 1980, **63**(1): 57-73.

Véronneau M, Duval R, Huang J. A gravimetric geoid model as a vertical datum in Canada[J]. *Geomatica*, 2006, **60**(2): 165-172.

Woodworth P L, Hughes C W, Bingham R J, et al. Towards worldwide height system unification using ocean information[J]. *Journal of Geodetic Science*, 2012, **2**(4): 302-318.

Xu F H, Oey L Y. The origin of along-shelf pressure gradient in the Middle Atlantic Bight[J]. *Journal of Physical Oceanography*, 2011, **41**(9): 1720-1740.

Yin J, Goddard P B. Oceanic control of sea level rise patterns along the East Coast of the United States[J]. *Geophysical Research Letters*, 2013, **40**(20): 5514-5520.

Zhaokang Y, Jiayong G, Xiliang W. DIFFERENCE BETWEEN MEAN SEALEVEL AND NATIONAL GEOID (1985) ALONG THE COAST OF CHINA[J]. *Journal of Oceanography In Taiwan Strait*, 1989, 2. (In Chinese)

Acknowledgements

This work was supported by the National Basic Research Program of China (2015CB954004), the National Natural Science Foundation of China (41606009, 41776027, 91858201, 41890801), Xiamen University Fundamental Research Funds for the Central Universities (20720180099), and Laboratory for Regional Oceanography and Numerical Modeling, Pilot National Laboratory for Marine Science and Technology (Qingdao)(No. 2017A02).

Key words

Alongshore sea level tilt; alongshore momentum balance; alongshore wind stress; bottom friction

On the role of various factors in the formation of the sea level trend

Malinin V.N., Gordeeva S.M., Shevchuk O.I. Mitina J.V., Averkiev A.S.
Russian State Hydrometeorological University, St. Petersburg, Russia,
**e-mail: malinin@rshu.ru*

This paper discusses the new results of estimating the contribution of eustatic factors to the formation of the global sea level (GSL) trend. Altimetry observations (from http://sealevel.colorado.edu) served as the initial data for the GSL, evaporation and precipitation over the World Ocean (WO) being estimated using the NCEP/NCEP Reanalysis-2 reanalysis archive, and other eustatic and steric factors – using the results of various authors. The trend is known to describe the overwhelming proportion of the GSL variance (more than 90%).

In RSHU, the freshwater balance equation of the World Ocean is used to estimate the contribution of level-forming factors to the formation of the GSL trend. Therefore, taking into account the steric factor, we have the following equation [1]: $\Delta h_{MO} = A_{MO}^{-1}(P_{MO} + Q + I - E_{MO} + \Delta V_{ster.})$, where A_{MO} is the WO area, P_{MO} is the precipitation falling over the WO area; Q is the continental (surface and underground) runoff to the WO; I is the glacial runoff in the WO; E_{MO} is evaporation from the WO, $\Delta V_{ster.}$ is the steric fluctuations of the GSL. Abroad used is the equation of balance of the cryospheric and continental waters. In this case, it is necessary to calculate the balance of ice sheets of Antarctica, Greenland, mountain glaciers and groundwater, requiring the knowledge of a large number of different hard-to-determine factors, the accuracy of which in many cases cannot even be controlled. Thus, the variability of continental groundwater is almost impossible to estimate. Moreover, foreign researchers make a fundamental mistake in considering the melting of mountain glaciers as a contribution to the GSL changes. However, the melting of mountain glaciers located in Europe, Asia, Africa and South America can influence GSL only through the inflow of river waters to the ocean. But its part that causes the melting of mountain glaciers is still unknown.

The table provides estimates of contribution of various factors to the formation of the GSL trend for different time periods. Almost complete similarity between the calculated and actual GSL values is easily seen, especially for the period 1993-2017. The accuracy is noticeably worse when using the water balance equation of the cryosphere and land. According to [2], the discrepancy for the period 1993-2003 equals to 0.3 mm per year, and reaches 1 mm per year, being one third of the GSL rise, without taking into account the melting of mountain glaciers. The results indicate a greater reliability of the proposed approach compared with the use of the water balance equation of the cryosphere and land in foreign studies.

Table. Estimates of the contribution of various factors to the formation of the GSL trend, mm/year

Source of the GSL rise	1980–2005 [1]	1993–2017
Steric fluctuations	0,30	1,60
Total runoff from Greenland	0,14	0,50
Solid runoff from the Antarctica	0,24	0,23
Inflow of continental waters	0,16	0,12
Vertical moisture exchange (precipitation minus evaporation)	0,62	0,68
Total contribution of factors	1,56	3,13
GSL rise according to observation data	1,79	3,10
Disbalance (discrepancy)	0,23	0,03

References

1. Malinin V.N. Global sea level: past and future.– SPb, RSHU, 2012. 260 p. (in Russian: Malinin V.N. Uroven' okeana: nastoyashcheye i budushcheye).
2. IPCC. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2013. 1535 p.

Key words:
Global sea level, the contribution of eustatic factors to the global level trend

Salt, heat and mass fluxes through the Lofoten Basin

L. M. Naumov[1,2*], S. M. Gordeeva[1,2,3], T. V. Belonenko[1]
[1] Saint Petersburg State University, Universitetskaya nab. 7–9, St. Petersburg, Russian Federation
[2] Russian State Hydrometeorological University, 79, Voronezhskaya ul., Saint Petersburg, Russia
[3] Shirshov Institute of Oceanology of the Russian Academy of Sciences, 36, Nahimovskiy pr., Moscow, Russia
*e-mail: levnaumov96@gmail.com

Background. Lofoten Basin is the highly dynamical region in the Norwegian Sea with the stationary eddy in its center. Additionally this zone is active in ocean-atmosphere interaction and play key role in heat, mass and salt transfer to Arctic region. Proper assessment of these flows is necessary for studying climate processes by reanalysis products which must reproduce balances on the climate time scale. The goal of study is to compare some reanalysis products by the heat, mass and salt fluxes.

Material. In this study we used data from three different reanalysis products: ECMWF ORAS4, new ECMWF ORAS5, GLORYS12V1 reanalysis developed by CMEMS with spatial resolution1x1 deg., 0.25x0.25 deg. 1/12x1/12 deg. respectively. All this reanalysis based on the NEMO model, but different versions are used. Also, all these products have a data assimilation system based on the Kalman filtering. All variables have been temporally averaged from 1993 to 2015. Research area is rectangle 68.5–72°N, 0– 8°E.

Methods. Horizontal volume transport through the area perimeter F_u [Sv=$10^6 \cdot m^3/s$] was calculates as $F_u = V \cdot S$, where V – horizontal current velocity y[m/s], S–vertical section area [m^2]. Heat flux F_t [Wt/m^2] was defined as $F_t = C_p \cdot \rho \cdot (T - T_f) \cdot V$, where ρ– sea water density[kg/m^3], C_p– specific heat of water [J/(kg·C)]. T and T_f–in situ temperature and freezing point temperature respectively. Salt flow F_s [$kg/(m^2 \cdot s)$] defined as: $F_s = S_w \cdot \rho \cdot V$, where S_w– sea water salinity [g/kg]. T_f and C_p has been calculated using UNESCO polynomial equation, ρ has been calculated using TEOS-10 equation of state.

Results. By all of reanalysis the strongest water inflow observed on the southern boundary and the strongest water outflow on the eastern boundary :for GLORYS12V1 data on the southern boundary +3.92 Sv, on the eastern boundary –2.52 Sv, total inflow is+4.92 Sv, total outflow –4.48 Sv, difference in balance +0.44 Sv; by ORAS4 data on the southern boundary +2.19 Sv, on the eastern boundary –4.03 Sv, total inflow is+3.56 Sv, total outflow –4.13 Sv, difference –0.57 Sv ;by ORAS5 data – on the southern boundary +2.98 Sv, on the eastern boundary –3.75Sv, total inflow is +4.79 Sv, total outflow –4.49 Sv, difference is 0.3 Sv.

As well as volume transport the strongest heat and salt inflows observed on the southern boundary and the strongest outflows on the eastern boundary. In total by GLORYS12V1 data heat and salt inflowsis83.98 TWt and 147.67 t/s, total heat and salt outflows–90.49 TWt and –160.16 t/s, difference is–6.51 TWt and –20.65 t/s,by ORAS4 data heat and salt inflows is+92.44 TWt and 101.92 t/s, total heat and salt outflows–135.22 TWt and –149.19 t/s, difference is –42.78 TWt and –47.27 t/s, by ORAS5 data heat and salt inflows is109.9 TWt and 173.08 t/s, total heat and salt outflows is–109.97 TWt and –162.52 t/s, difference is –0.03 TWt and 10.56t/s.

Conclusions: Volume, heat and salt transport general directions through Lofoten Basin are similar –from south to east. New reanalysis product ECMWFORAS5 have the minimum accuracy in all calculated fluxes even it hasn't the smallest resolution in comparison with other two reanalysis. It should be noted that based on ORAS5 data in Lofoten eddy region occurs salt and water volume accumulation but heat loss a little.

Acknowledgements. This research was supported by Russian Scientific Foundation (pr. No. 18-17-00027).

Key words:
Lofoten eddy, volume transport, heat flux, salt flux, reanalysis data.

Discerning the world ocean wave fields from long-term spectral wave data

Jesús Portilla-Yandún[1*]
[1]*Escuela Politecnica Nacional, Quito-Ecuador*
**e-mail: jportilla@ymail.com*

Ocean waves at any particular location are the result of the superposition of locally generated waves by wind and swells advected from remote generation areas. Swells in particular can travel very long distances with marginal energy loss such that their signal, albeit reduced by dispersion, can be detected all across the oceans (see e.g., [1]). Although our current approaches for wave modeling and description have the wave spectrum as standard variable, most wave characterization methods are based on simplified integral parameters (e.g., Hs, Tp). These are indicative of the overall magnitude, but loose all the information stored in the spectral structure. Therefore, wave fields derived from integral parameters are smooth and continuous while in reality wave fields have well defined spatial domains, they overlap one another, and they vary significantly along the seasons in response to the ever changing meteorological forcing. Using spectral partitioning techniques a global wave spectral characterization has been developed in [2]. From there, the different wave systems at any particular point can be elucidated, and furthermore, the spatial coherence of those wave systems allows discerning the individual wave fields from the integrated one. The individual characterization of these wave fields opens the way to more advanced wave analysis methods. In the climate context for instance, it has been shown in [3] that ENSO years in the eastern equatorial Pacific are characterized by weaker trade winds and stronger northerly storms. However, since the total signal is dominated by southerly swells, which appear rather unaffected, these specific details cannot be observed from the total signal.

References

[1] MacAyeal, et al. (2006), Transoceanic wave propagation links iceberg calving margins of Antarctica with storms in tropics and Northern Hemisphere. Geophys. Res. Lett., 33, L17502,
[2] Portilla-Yandún (2018). The global signature of ocean wave spectra. Geophysical Research Letters, 45, 267–276. https://www.modemat.epn.edu.ec/nereo/
[3] Portilla-Yandún et al. (2016). Climate patterns derived from ocean wave spectra. Geophys. Res. Lett., 43, 11,736– 11,743,

Key words
Ocean wave fields, wave spectral wave climate, spectral partitioning.

Lagrangian analysis of quasi-stationary Kamchatka trench eddies

S. Prants, M. Budyansky, V. Lobanov
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: prants@poi.dvo.ru*

The western boundary currents, flowing past coastal headlands and capes or over submarine canyons, mounts and ridges, often generate eddies. The trains of mesoscale anticyclonic eddies, moving southward along the eastern coastline of the Kamchatka peninsula with the East Kamchatka Current, have been recognized on IR satellite images from the end of 70s. Some of them reach the western slope of the Kuril-Kamchatka Trench (KKT) near the southern tip of the peninsula and slowdown, partly due to weakening of the parent current and often have stalled there slightly migrating along the KKT slope which serves as a catching area. Increased calculated values of the mean velocity and kinetic energy there give evidence of the presence of a mesoscale quasi-stationary vortex feature which we call Kamchatka trench eddy (KTE). The eddies, advected from the north, merge occasionally with those KTEs creating a stronger and larger vortex that may stagnate in this area for periods ranging from a few months to longer than a year. The KTEs interact with the meandering current and ambient eddies and eventually shed from the slope to be dispersed into the Kuril-Kamchatka Current or breakup due to splitting into smaller vortices. The persistent KTEs is a regular and intriguing feature of the regional circulation that has not been mentioned, studied and explained before.

Using altimetry-based daily Lagrangian maps, computed from January 1, 1993 to December 31, 2018, we document all quasi-stationary mesoscale KTEs at the western edge of the KKT and record how long they have been stalled there and how they decay. We study in detail the KTE2017 which persisted there for 8 months and was sampled in September 2017 in the 53th cruise of the R/V *"Academik Oparin"*. Using different Lagrangian indicators, we study the entire life cycle of this eddy, including the event of its formation, strengthening, merger with another eddies, deformation and final splitting which gave birth to the next KTE2018. Analyzing behavior and properties of the KTEs, we explain qualitatively why they are attracted to the western KKT slope and stalled there despite strong interaction with ambient eddies and background currents and why they eventually lose stability and erode.

Acknowledgements
This work was supported by the Russian Science Foundation (project no.~19-17-0006) and its methodological part was carried out within the State Task for the POI FEBRAS (project No.~0271-2019-0001).
Key words
Kamchatka trench eddies, Lagrangian maps

Long-term changes in waters of the Kamchatka Current eddies

Konstantin Rogachev, Natalia Shlyk

Email: rogachev@poi.dvo.ru
V.I. Ilichev Pacific Oceanological Institute, Vladivostok

Background. The Kamchatka Current flows along the Russian coast from Cape Olutorskiy to the Paramushir Island. The Alaskan Stream reaches the Kamchatka Current near the Kamchatka Strait. The Kamchatka Current and Alaskan Stream both have anticyclonic eddies with distinct size. These eddies have prominent thermohaline characteristics. The Kamchatka Current eddies have a thick fresh and cold core and propagate southward with the Kamchatka Current from the Bering Sea. Long-term variations of the Kamchatka Current eddies during recent decades have not been studied. We use satellite data along with surface drifters to follow the Kamchatka Current eddies.

Materials and methods. Moderate resolution imaging spectroradiometer (MODIS) installed on satellites Aqua and Terra data along with surface and Argo drifters are used for this study. This data collected at the Center for Regional Satellite Monitoring of Environment (*www.satellite.dvo.ru*). Historical CTD data collected at the Pacific Oceanological Institute. Surface and Argo drifters data were collected by the Coriolis project (www.coriolis.eu.org).

Results. We found significant freshening of the eddies core and prominent deepening of its isopycnals. We also found significant warming of the mesothermal layer in the Kamchatka Current from 1990 to 2017. Temperature in the cold core increased up to 1° and salinity decreased to 0.5 units. This corresponds to the decrease of specific density and deepening of isopycnals. This deepening of the cold core isopycnals corresponds to the increase of stratification of the intermediate layer at the base of the main halocline.

Conclusions. The comparison of recent Kamchatka Current eddies with the data from the previous century shows distinctive increase in temperature and freshening in a thick eddies core and prominent deepening of its isopycnals.

Keywords*:* Moderate resolution imaging spectroradiometer (MODIS) data, Kamchatka Current, Kamchatka Current eddies; Aleutian eddies

Characteristics of the variability of the parameters of the marine environment and meteorological fields in the coastal zone of the Black Sea

Yu.V. Simonova, V.V. Metik-Diyunova, S.A. Mayboroda
Black Sea Hydrophysical Proving Ground RAS, 9 Shuleykin Str., Katsiveli, Yalta , Russia, 298688
e-mail: julia.simonova.0502@gmail.com

Currently, one of the most important tasks is to assess the quantitative characteristics of climatic parameters in certain physiographic conditions in order to identify direct and inverse relationships for regional ecosystems, which manifest themselves in the form of both negative and positive effects [1, 2].

The aim of the study is to assess the characteristics of the variability of regional climatic features in the coastal zone of the Black Sea using the example of the Southern Coast of Crimea (SCC) based on the analysis of hydrometeorological parameters. Due to its isolation, the Black Sea has its own unique marine ecosystem, which, according to long-term measurements, has undergone significant changes during the last decades of the last century [3]. Hydrometeorological regime of the SCC is mainly determined by macrocirculation processes, configuration of the coastline, orographic features. In addition, the presence of mountain ranges contributes to the emergence of local features of atmospheric circulation (breezes, bora). Crimean bora can be a significant danger to human activities, coastal infrastructure and near-shore shipping. Upwelling plays a large ecological and climate-forming role [4]. The rise of cold deep waters in the warm period of time in certain areas of the SCC seashore has a negative impact on the conditions of recreation. At the same time, this process is important for marine ecosystems as a whole, since it is one of the ventilation mechanisms of near-surface and bottom (in the shelf part) waters.

The study is conducted of the annual, seasonal and synoptic variability of the sea surface temperature (SST) based on the analysis of historical data of hydrometeorological observations at SCC, Cape Kikineiz, obtained at the Black Sea Hydrophysical Proving Ground. Extreme values of SST are given, the relationship between the intra-annual variability of upwelling characteristics and hydrometeorological parameters is estimated, and a general description of the temporal variability of surge driving events in the SCC near-shore waters for the period from May to October 2014-2018 is given.

A general increase in the SST of SCC near-shore waters for the period 1989–2018 has been revealed. During this period, a decrease in the number of upwelling phenomena was recorded. This may adversely affect the ecological condition of the SCC near-shore waters, as the “purifying” effect of the upwelling decreases.

References

1.V.N. Malinin. Global ecological crisis and climate // Proceedings of RSHU (Russian State Hydrometeorological University), 2017. No 48. P. 11 – 32 (In Russian)
2.V.N. Malinin. Global sea level and climate variation // Proceedings of RSHU (Russian State Hydrometeorological University), 2015. No 41. P. 100 – 115 (In Russian)
3.A.A. Novikov, V.S. Tuzhilkin. Seasonal and regional variations of water temperature synoptic anomalies in the northeastern coastal zone of the Black Sea // Physical Oceanography– 2015. – No 1. – P. 39 – 48. DOI: 10.22449/1573-160X-2015-1-39-48 (In English)
4.V.S. Tuzhilkin, A.A. Novikov. Thermal effects of upwelling in the Russian part of the Black Sea coastal zone // Series 5, Geography. – MSU, 2011, No 6. – P. 43 – 53 (In Russian)

Acknowledgements
This work was supported by the Russian Federation State Tasks № 075-00803-19-01.
Key words: Coastal zone of the Black Sea, regional climate features, hydrometeorological parameters.

Variability peculiarities in the of atmosphere force centers above the Far East during 1980-2017 summer periods and statistics processing of timer data parameters to identify these centers

T.A. Shatilina[1], G.Sh Tsitsiashvili[2], T.V Radchenkova[2], V.A.Kochetova[3]
[1] *Research institute of fisheries and oceanography, VNIRO, pacific branch of VNIRO (TINRO),4,,pereulok Shecvenko, Vladivostok, Russia 690091*
[2] *Institute of Applied Mathematics, Far Eastern Branch of RAS, 7, Radio, Vladivostok, Russia 690041*
[3] *Free-lance translator, Vladivostok, Russia*
**e-mail: tatyana.shatilina@ tinro-center.ru*

Regime features of the atmospheric force centers (AFC) located within the second natural synoptic region of the Northern hemisphere (2 NSR), namely, Asian depression (AD), Hawaiian anticyclone (HA), summer Far East depression (FED) and Okhotsk anticyclone (OA) were investigated. An analysis of H_{500} geopotential, above-Earth surface pressure and air temperature over the AFC admitted to highlight the periods of 1950-1979 and 1980-2017, which differed in the directionality of physical processes (trends). The change in trends was also found in such important climatic parameters as the air and water temperature. The analysis of short time series (1980-2017), that had large fluctuations, magnifies requirements for the evaluation of parameters to characterize AFC. The need to develop special data processing methods based on the consideration of extremes was shown. Analysis of fluctuations on the trend background, Fourier coefficients verification in the time series with discrete moments in time were held. The application of Fourier precise function allowed us to identify the dominant cycles over AFC and compare their power. The dominant cycles for each regional center were highlighted. It was demonstrated that those cycles differed by region and by month. Detection of the cycles with 2-10 years periods in regional AFCs exhibited that large-scale climate signals of the atmosphere-ocean interactions were also reflected in the regional structures. Years with extreme values of parameters characterizing the AFCs were determined. Most often, the extremes in AFC regime were noted in 1998, 2010 and 2016. This extreme circulation was one of the cause for local extremes generation in the thermal regime of region located in Kuroshio-Oyashio system.

References

Shatilina T.A., Anzhina G.I. Features of atmospheric circulation and climate in the Far East in the beginning of 21 Century // Izv. TINRO. - 2008.- Vol. 152- P. 225-239.

Shatilina T.A, Kravchenko R.B. Results of classifying for SST time series in the South Kuril region and their correlation with regional atmospheric indices // Izv. TINRO. - 2013.- Vol. 172- P. 208-223

Clustering floating particles in velocity field with stochastic component and regular component of the Japan/East Sea circulation

D. Stepanov[1*], K. Koshel[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: step-nov@poi.dvo.ru*

It is well-known that floating impurities can cluster into narrow elongated stripes. Existing theories predict the occurrence of clustering into stochastic compressible velocity fields [1]. At considering a velocity field with potential (compressible) and solenoidal (incompressible) components, complete clustering is possible only if the potential component magnitude exceeds the solenoidal one. However, this result is valid only asymptotically.

In the ocean, ageostrophic component of velocity field is, in most cases, small. Thus, for floating particles the potential component of velocity field is also small in comparison with the quasi-geostrophic (incompressible) component. The theories do not give us a good result for the case of mutual influence of regular (averaged) velocity field and stochastic one. In the present work, we numerically investigate the clustering of floating impurities under the mutual influence of the regular velocity field and stochastic one.

As a model of the random velocity components we consider a random velocity field with only compressible, only incompressible and both components [1]. As a regular component of the velocity field we consider the sea surface velocity field in the Japan/East Sea, which was simulated with using the eddy-resolving INMOM model configuration [2]. The regular component of the velocity field includes anticyclonic and cyclonic mesoscale eddies, as well as filaments.

We found that when the regular and stochastic velocity components were considered, the impure transport weakened, in contrast to the case, when the velocity field has only regular velocity component; regions occupied by mesoscale eddies and the transport corridors demonstrated intensive impurity clustering. However, the intensive and extent of the impure clustering were lower than in the case, when the velocity filed had only stochastic velocity component.

References

1. V. Klyatskin, K. Koshel, *Physical Review E*, 2017, **95**,
2. D. Stepanov, N. Diansky, V. Fomin, *Ocean Dynamics*, 2018, **68**, 825-845.

Acknowledgements

This work was supported by the by the Russian Scientific Foundation, project no. 19-17-00006.

Key words

Clustering floating particles, stochastic velocity component, mesoscale circulation of the Japan/East Sea

Features of winter thermohaline characteristics according to reanalysis ARMOR 3D in the Labrador Sea

V. S.Travkin[1], A. M.Fedorov[1,2], T. V.Belonenko[1], V. S. Travkin[1*]
[1]*Saint Petersburg State University, Universitetskaya nab. 7–9, St. Petersburg, 199034, Russian Federation*
[2]*Nansen International Environmental and Remote Sensing Center,14 Line, 49-H, St. Petersburg, 199034, Russian Federation*
**e-mail: st055372@student.spbu.ru*

Background: Deep convection in the North Atlantic is one of the key processes that directly affect the intensity of the return flow of the Atlantic Meridional Overturning Circulation and it is an important component of the global climate system. Current Intensity Trends and Steric Level Fluctuations connected in deep convection were investigated (Belonenko et al., 2018;Belonenko and Fedorov, 2018).

Material and methods: We used ARMOR 3D data available at CMEMS (Copernicus Marine Environment Monitoring Systems, http://marine.copernicus.eu). We analyze thermohaline characteristics in two points located in the Labrador Sea for the period 1993-2016.

Results: 1993-1999 is the period of intensive deep convection, 2000-2004 is the period of less intensive deep convection, 2005-2013 is the period of weak intensity with a gradual subsequent weakening and, finally, 2014-2016 is the period of new amplification of deep convection. Events of deep winter convection are observed with the penetration of cold and freshened waters to great depths in 2008 and 2009, but not leading to the formation of stable water masses with characteristic for periods of deep convection properties. Based on the potential density distribution for the point 1, we propose to classify the intensity of deep convection, comparing the maximums of isopycnal 27,599 kg/m3. According to this classification, years: 1993-1995, 1998, 1999, 2015-2016 belong to the class "d" – maximum intensity of deep convection; years: 1996, 1997, 2001 belong to the class "i" – average intensity of convection; years: 2000, 2002, 2003; 2008 belong to the class "s/i" which is characteristic lower intensity compared to "i"; and, finally, years 2004-2007, 2009-2014 belong to the class of low intensity convection. Anomalies of thermohaline characteristics relative to the average seasonal variation are also considered. For the selected horizons of 1000 m and 15000 m, trends in the variability of anomalies, as well as wavelet diagrams, are analyzed. At each point, trends are estimated separately for two periods: January 1993 – March 2014 and April 2014 – December 2016.

Conclusions: We demonstrate that four periods, according to the intensity of winter convection associated with the formation of the Labrador water mass, can be distinguished in the variability of temperature, salinity and potential density. These four periods have different impact on the Atlantic Meridional Overturning Circulation.

References:

Belonenko T. V., Fedorov A. M., Bashmachnikov I. L., and Fuks B.R. Current Intensity Trends in the Labrador and Irminger Seas Based on Satellite Altimetry Data. *Izvestiya, Atmospheric and Oceanic Physics*, 2018, 54 (9), 1031–1038. DOI: 10.1134/S0001433818090074.

Belonenko T.V. and Fedorov A.M. Steric Level Fluctuations and Deep Convection in the Labrador and Irminger Seas. Izvestiya, *Atmospheric and Oceanic Physics*, 2018, 54 (9), 1039–1049. DOI: 10.1134/S0001433818090086.

Acknowledgements
This work was supported by Russian Scientific Foundation (RSF, project No. 17-17-01151).

Key words
Labrador Sea, deep convection, ARMOR 3D

Study of seasonal variability of amount and thermohaline features of mesoscale eddies in the Lofoten Basin

V. S.Travkin*, T. V.Belonenko
Saint Petersburg State University, Universitetskayanab. 7–9, St. Petersburg, 199034, Russian Federation
**e-mail: st055372@student.spbu.ru*

Background: The Lofoten Basin (LB) in the Norwegian Sea is an area where the warm Atlantic Water is subject to the greatest heat losses anywhere in the Nordic Seas. It is called a 'hot spot' of the Nordic Seas because of its high intense of mesoscale eddy activity (Belonenko et al., 2014; Volkov et al., 2013). The mesoscale eddies of the Lofoten Basin can be coupled to the heat transport, local climate, and fisheries of the region. A purpose of this study is examination of seasonal variability of mesoscale eddies in the Lofoten Basin using satellite altimetry data and GLORYS reanalysis.

Material: We used "Mesoscale Eddy Trajectory Atlas Product" available at https://www.aviso.altimetry.fr. We also use the GLORYS12V1 product of the Global Ocean Physics Reanalysis available at CMEMS (Copernicus Marine Environment Monitoring Services). It is the global ocean eddy-resolving (1/12° horizontal resolution and 50 vertical levels).We analyzed data for the period 1993-2017.

Methods and Results: From 25 years of altimetry data, 1079 unique anticyclonic eddies (ACEs) and 1026 unique cyclonic eddies (CEs) were detected in the LB out of the total eddy observations. We explored seasonal variability of mean mesoscale eddy characteristics in the LB for 1993−2017 based on satellite altimetry as well as seasonal variability of time-space averaged thermohaline characteristics of mesoscale eddies in the LB at 450 m of depth based on the GLORYS12V1 for 1993−2017. We also analyzed seasonal temperature anomalies inside of cores of mesoscale eddies in the LB for the period 1993–2017 at depth 450 m as well as longitude vertical sections of temperature, salinity, and potential density (kg m^{-3}) anomalies along the 69.8° Nin different seasons for 1993-2017.

Conclusions: Seasonal variability of mesoscale eddies in the Lofoten Basin is manifested both in the seasonal change in their number and in the corresponding change of their thermohaline characteristics. A number of ACEs in winter and spring is more than number of CEs while there is almost no difference between them in summer and in autumn (even CEs dominate a bit). The average orbital speed and the amplitude are a bit less for CEs than for ACEs in the LB in summer and autumn. Maximum number of CEs and ACEs it is shown in the central and eastern part of the LB, where number of eddies can reach 30 eddies per grid unit for all seasons, while the western and north-western part of the LB is characterized by less number of eddies (less than 15 eddies per season).

References:

Belonenko, T. V., D. L. Volkov, V. K. Ozhigin, Yu. E. Norden (2014), Circulation of waters in the Lofoten Basin of the Norwegian Sea [In Russian], *Vestn S. Petersbur. Un-ta*, 7(2):108-121.
Volkov, D. L., T. V. Belonenko, V. R. Foux (2013), Puzzling over the dynamics of the Lofoten Basin – a sub-Arctic hot spot of ocean variability,*Geophys. Res. Lett.*, 40 (4): 738-743. doi:10.1002/grl.50126.

Acknowledgements
This work was supported by Russian Scientific Foundation (pr.No. 18-17-00027).

Key words
Norwegian Sea, Lofoten Basin, seasonal variability, mesoscale eddies

Regularities of formation and distribution of continental runoff under the influence of seasonal variability of forcing: the Black Sea North-Western shelf case study.

M. Tsyganova[1], E. Lemeshko[1,2]
[1]Marine Hydrophysical Institute RAS, 2бKapitanskaya Str., Sevastopol, Russia, 299011
[2]Black Sea Hydrophysical Proving Ground of RAS, 9, Shuleykina Str., Katsiveli, Russia, 298688
*e-mail: m.tsyganova@mhi-ras.ru

The purpose of this work is to study the physical patterns of desalinated waters distribution for the North-Western shelf of the Black Sea on the basis of numerical modeling [1]. The formation of the hydrological water structure due to continental runoff, the plume response to wind effects and seasonal variability of river flow are investigated. The archive of hydrological data and satellite observations are analyzed in comparison with numerical modeling results [2].

As a result, typical hydrological characteristics of the spatial propagation of riverine waters on the North-Western shelf are obtained depending on a number of factors: seasonal variability of the Danube water inflow; the influence of seasonal variability of the shelf water stratification on the process of plume formation and transport of desalinated waters. The impact of wind of different velocity magnitude and direction on the plume dynamics and the trajectory of desalinated water distribution are obtained too. In addition, qualitative and quantitative estimates of the position of the runoff hydrofront and the types of the spatial position of the alongshore flow depending on the wind direction were obtained. Results of numerical modeling are compared with hydrological maps of surface salinity and satellite images of upward radiation at a wavelength of 551 nm.

Thus, for the North-Western shelf of the Black Sea case study and the inflow of the largest river in Europe, the Danube obtained physical laws of spatial and temporal variability of the plume and the alongshore current, depending on the seasonal variability of forcing (river flow, wind velocity, stratification of shelf waters). The obtained regularities are confirmed by the results of the analysis of hydrological surveys and remote sensing data for a number of episodes for the period 2005-2018.

References

1. Ivanov, V.A., Fomin, V.V., [Mathematical modeling of dynamic processes in the sea-land zone], Marine Hydrophysical Institute, Ukrainian Academy of Sciences, Sevastopol, 363p. (2008) [in Russian].
2. M. V. Tsyganova, E. M. Lemeshko, "Variability of chlorophyll-a concentration in the north-western part of the Black Sea based on satellite data analysis and modeling", Proc. SPIE 10466, 23rd International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics, 104662H (30 No-vember2017); doi: 10.1117/12.2284311

Acknowledgements

Acknowledgements text: This work was supported bythe Russian Federation State Tasks № 075-00803-19-01and № 0827-2019-0004.

Key words

River plume, numerical modelling, Danube.

Variability of thermohaline characteristics in the upper and lower intermediate layers at the continental slope off the Russian coast in the northwestern Japan Sea

O.O. Trusenkova[1], A.G. Ostrovskii[2], A.A. Lazaryuk[1], V.B. Lobanov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*
**e-mail: corresponding@poi.dvo.ru*

The coastal zone in the northwestern Japan Sea is a dynamically active area of the southwestward flowing cold western boundary current – the Primorye (Liman) Current, slope eddies, shelf and slope waves, while transformed subtropical water is advected to this area from south and east. To study this variability the autonomous *Aqualog* profiler was moored at the continental slope off the Primorye coast during the period from April 18 through October 14, 2015. Time series of hydrophysical characteristics for the depth of 64–300 m, with the depth step of 1 m and time step of 6 hours, provide the unique dataset suitable for analysis of variability on time scales from submesoscale to several months. It was revealed that variability in the upper and lower profiled layers were of different nature. Comparison with satellite imagery made it possible to link temperature anomalies in the upper profiled layer to intrusions of waters of different origins.

The purpose of this study is to estimate variability in the entire profiled layer, penetration depth of the upper layer anomalies, and variability time scales in the upper and lower layers. High data quality made it possible to employ Empirical Orthogonal Functions (EOF) analysis (depth vs. time) to reveal statistical patterns of temperature variability. EOF 1 covering 57.4% of the total variance accounts for temperature anomalies below 150 m which can be explained by vertical fluctuations in the pycnocline (isopycnal displacements). EOF 2 covering 21.0% of the total variance accounts for temperature anomalies above 120 m which can be related to horizontal advection of alien waters. The vertical stratification estimated by the buoyancy frequency reveals the out-of-phase change pattern above and below 120–160 m on. These changes are consistent with the vertical fluctuations in the pycnocline: when the pycnocline deepens, for instance during the passage of anticyclonic eddies, stratification weakens in the upper layer and strengthens in the lower layer.

Vertical fluctuations in the pycnocline, temperature anomalies in the lower layer and stratification changes manifest coherent temporal variability, with time scales of 2 – 6 days (submesoscale), 8–12 days (mesoscale), 20–30 (wave-like), 80–110 days (of unclear nature). The most intense are the fluctuations with the longest periods (80–110 days), which were 180° out-of-phase above and below 100–150 m. However, the lower layer fluctuations on the other time scales weaken from mid August. Fluctuations in the upper layer are the strongest in July and August when advection of subtropical water is the most intense.

Key words
The Japan Sea, the Primorye (Liman) Current, moored autonomous profiler

Oceanographic conditions in recent years during the saury, sardine and mackerels feeding migrations east of the Kuril Islands

E. Ustinova*, A. Figurkin, V. Filatov
Russian Research Institute of Fisheries and Oceanography, Pacific Branch (TINRO),
4, Shevchenko Alley, Vladivostok, Russia, 690091
**e-mail: elena.ustinova@tinro-center.ru*

The change of the dominant fish species in the nekton community of the upper epipelagic layer in the Northwest Pacific east of the Kuril Islands to subtropical migrants in summer and autumn has been observed since 2014 (Khoruzhiy et al, 2015). The purpose of the study was to assess the current state of the environment habitat of these migrants (sardine (*Sardinops melanostictus*), mackerels (*Scomber japonicus and Scomber australasicus)* and saury (*Cololabis saira*)) and to identify patterns of oceanographic conditions influence on the formation of possible migration routes and fishing grounds areas.

We used the databases "Marine Biology" and "Oceanography" of fishery-independent TINRO-Center complex surveys, materials from fisheries expeditions and satellite data in summer and autumn 2004-2018. We also use NEAR-GOOS gridded SST and temperature at 50, 100, 200, and 400 m and currents from the Ocean Surface Current Analyses Real-time (OSCAR) project.

In summer and autumn 2014-2018 sardine and mackerels migrate actively to the feeding area within the cyclonic Western Subarctic Gyre. As the abundance of these species increases, they penetrate further north. Oceanographic conditions were characterized by relatively weak Oyashio Current, strong branch of the Subarctic Current (Western Subarctic Current by Favorite et al, 1976) and intense inflow of less saline and warmer waters from the northeast. In June, high concentrations of mackerel and sardines were confined to the high-gradient zone of the Northern Subarctic Front, mostly from the warmer water side. In July-August 2015–2017, the maximum catches were recorded in the food-rich waters of the central Western Subarctic Gyre.

This "sardine wave" differs from the previous ones because it is coincident with positive temperature anomalies. When the "feeding area" reached northern subarctic area, positive temperature anomalies strengthened both at the surface and at the 50–100 m depths and deeper. This "heat wave" may force, through feeding conditions, sardine migration for feeding far northward in the present period of the population growth. Key dynamic structures, such as branches and meanders of the Kuroshio, Oyashio, Kuril Current, Soya Current, Subarctic Current, Isogichi Jet, mesoscale eddies, and related oceanographic fronts affect the migration patterns of the fisheries species.

References

Khoruzhiy A.A., Somov A.A., Emelin P.O., Starovoitov A.N. and Vanin N.S. The appearance of high-yielding generations of Japanese mackerel and Far-Eastern sardines in the Northwest Pacific waters near the Kuril Islands. *Fishery*, 2015, **6**, 74-77.

Favorite F., Dodimead A. J. and Nasu K. Oceanography of the Subarctic Pacific region, 1960–71. *Int. N. Pacific Fish. Comm. Bull.*, 1976, **33**, 1–187.

Acknowledgements

The authors are sincerely grateful to TINRO-Center's R/V's crews and scientists who collected the important information used in the study. We also thank Eu. Basyuk for the assistance with data on currents from OSCAR. This work was supported by the Russian Federal Agency for Fishery (Government project No 076-005-19-00).

Key words: current, Western Subarctic Gyre, feeding migrations

Eddy-induced intrusion of saline Kuroshio water into the northern South China Sea

Yikai Yang[1,2], Dongxiao Wang[1], Qiang Wang[1], Lili Zeng[1,*], Tao Xing[3], Yunkai He[1], Yeqiang Shu[1], Ju Chen[1]

[1]*State Key Laboratory of Tropical Oceanography (LTO), South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, 510301, China*

[2]*University of Chinese Academy of Sciences, Beijing, China*

[3]*MLR Key Laboratory of Marine Mineral Resources, Guangzhou Marine Geological Survey, Guangzhou, China*

Email: zenglili@scsio.ac.cn

To better understand eddy-induced heat and salt transport, a targeted joint hydrographic investigation focusing on an anticyclonic eddy was carried out in July 2017 in the northern South China Sea (NSCS). In situ and satellite observations together with Hybrid Coordinate Ocean Model (HYCOM) output show the transport of subsurface saline Kuroshio water into the NSCS by an anticyclonic eddy. Subsurface high-salinity cores are consistent with the anticyclonic eddy centers. The eddy-induced intrusion of saline Kuroshio water occurs in two stages. First, saline Kuroshio water is trapped within the anticyclonic eddy at its generation location. Then, although the salinity within the eddy gradually weakens as the eddy carries the saline water northward, the high salinity intensity shows a sharp increase, dominated by eddy-induced salinity advection. A diagnosis of the salinity budget further confirms that the contribution of eddy flow advection is greater than that of mean flow advection. The saline Kuroshio water is trapped and conveyed in this anticyclonic eddy, providing vital evidence and important implications for eddy-induced salt transport and water exchange.

Recent decades of Sea Surface Salinity Variability and its Relationship with Fresh Water Flux in the Northern Pacific

Hai Zhi[1], Rong-Hua Zhang[2, 3*],Lixin Tai[1]

[1] *College of Atmospheric Sciences, Nanjing University of Information Science and Technology, Nanjing, China, 210044,*

[2] *Key Laboratory of Ocean Circulation and Waves, Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China, 266071,*

[3]*Laboratory for Ocean and Climate Dynamics, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266237, China*

* Corresponding author: Dr. Rong-Hua ZHANG

E-mail: rzhang@qdio.ac.cn

The sea surface salinity (SSS) is analyzed by using SODA (version: 3.3.1) reanalysis data in the northern Pacific. Results illustrate that: 1) in the northern Pacific salinity trends to be increased from 1914 to 2013 with a period of 30-year. However, after 1979, SSS presented a decreased tendency with the 7-to-12-year period in the northern Pacific. 2) There are two key regions of SSS variability in the northern Pacific, which are located in the middle of the northern Pacific (A) and the Middle East (B). Both the two regions can indicate the temporal change in the northern Pacific SSS. 3) SSS of the key regions are significantly related to fresh water flux (FWF) in the northern Pacific. However, SSS in the region A is greatly affected by the local FWF, and the maximum correlation coefficient is 0.56 when FWF leads16 month, while in the region B, the relationship between SSS and the local FWF is not significant, with the value of -0.21 and 20-monthleading of the FWF. In addition, SSS and FWF revealed positive correlation in the region A. The main positive area occurred in the eastern extension part of the Kuroshio, with the peak value located at the middle of the northern Pacific. The large-value area moved eastward with the shortening time of leading FWF phase. SSS in the region B is positively related to that of the central northern Pacific. The most significant area is located west of the region B without shifting. In our study, it can be concluded that in the northern Pacific SSS oscillation exist obvious inter-decadal features and SSS climate variability in the northern Pacific can be represented by the changes of SSS in the key areas. Furthermore, it can also be served as an index of the FWF variability in the northern Pacific.

Keyword:

Sea surface salinity variability, Fresh water flux, Northern Pacific

Reference

Boyer T P, Levitus S. 2002. Harmonic analysis of climatological sea surface salinity[J]. Journal of Geophysical Research, 107(C12), 1-14.

Carton J A, Giese B S. 2008. A reanalysis of ocean climate using Simple Ocean Data Assimilation(SODA)[J]. Monthly Weather Review,136,2999-3017.

Delcroix T, Mcphaden M. 2002.Interannual sea surface salinity and temperature changes in the western Pacific warm pool during 1992-2000[J]. Journal of Geophysical Research, 107(C12), 8002-8005

Di Lorenzo E, Schneider N, Cobb K M, et al.2008. Northern Pacific Gyre Oscillation links ocean climate and ecosystem change[J]. Geophysical Research Letter, 35, L08607,1-6.

Durack P J. 2015. Ocean salinity and the global water cycle[J]. Oceanography, 28(1),20-31.

LagerloefG S E. 2002. Introduction to the special section: The role of surface salinity on upper ocean dynamics, air-sea interaction and climate[J]. Journal of Geophysical Research, 107 (C12), SRF 1-1- SRF 1-2.

Lau N C, Nath M J. 1994. A modeling study of the relative roles of tropical and extratropical SST anomalies in the variability of the global atmosphere-ocean system[J]. Journal of Climate. 7,1184-1207.

Li Y L, Wang F, Han W Q. 2013.Interannual sea surface salinity variations observed in the tropical North Pacific Ocean[J]. Geophysical Research Letters, 40,2194-2199.

Mantua N J, Hare S R. 2002. The Pacific decadal Oscillation[J]. Journal of Oceanography, 58, 35-44.

Miller A J, Cayan D R, Barnett T P, et al. 1994. Interdecadal variability of the Pacific Ocean: Model response to

observed heat flux and wind stress anomalies[J]. Climate Dynamics. 9(6),287-302.
Minboe S. 1997. A 50-70 year climatic oscillation over the north pacific and north America[J]. Geophysical Research Letters, 24,683-686.
Newman M. 2007. Interannual to decadal predicatability of tropical and North Pacific sea surface temperatures[J]. Journal of Climate, 20(11),2333-2356.
Skliris N, Marsh R, Josey S A, et al. 2014. Salinity changes in the world ocean since 1950 in relation to changing surface freshwater fluxes[J]. Climate Dynamics, 43(3-4), 709-736.
Uehara H, Suga T, Hanawa K, et al. 2003. A role of eddies in formation and transport of North Pacific Subtropical Mode Water[J]. Geophysical Research Letters, 30(13), 38-1 - 38-4.
Vinogradova N T, Ponte R M.2013. Clarifying the link between surface salinity and freshwater fluxes on monthly to interannual time scales[J]. Journal of Geophysical Research Oceans, 118(6), 3190-3201.
Yasuda T, Hanawa K. 1997. Decadal changes in the mode waters in the midlatitude North Pacific[J]. Jounal of Physical Oceanography, 27, 858-870.
Yeh S, So J, Lee J, et al. 2017. Contributions of Asian pollution and SST forcings on precipitation change in the North Pacific[J].Atmohpheric Research, 192, 30-37.
Yu L S. 2011. A global relationship between the ocean water cycle and near-surface salinity[J]. Journal of Geophysical ResearchOceans, 116(C10), 6-1 - 6-15.
Zhang R H, Wang Z P, Fei Y, et al. 2015. The difference in nutrient Intakes between chinese and mediterranean, japanese and American diets[J]. Nutrients, 7(6), 4661-4688.

Acknowledgements The authors wish to thank the anonymous reviewers for their numerous comments that helped to improve the original manuscript. This study was supported by the grants from the National Natural Science Foundation of China (41690122, 41690120, 41475101), the NSFC–Shandong Joint Fund for Marine Science Research Centers (Grant No. U1406401), the NSFC Innovative Group Grant (Project No. 41421005),and Taishan Scholarship.

QNLM's High-Resolution Earth Prediction System: A Local Adaptive Strategy to Global Change - Present Status and Future Plan

S. Zhang[1,2,3]

[1] Key Laboratory of Physical Oceanography, MOE, China; Ocean University of China, Qingdao, China
[2] Pilot National Laboratory for Marine Science and Technology (QNLM), Qingdao, China
[3] International Laboratory for High-Resolution Earth System Model and Prediction (iHESP), Qingdao, China
[4] The College of Oceanic and Atmospheric Sciences, Ocean University of China, Qingdao, China.
*e-mail: szhang@ouc.edu.cn

Climate science studies clearly reveal that Earth Systems (ESs) and Human Systems (HSs) impact with respect to each other, and HSs produce anthropogenic climate process drivers by greenhouse gas and aerosol emissions. Given that ESs provides resources and environments for human living and development, while global change brings out severe local climate abnormality, what is the adaptive strategy for us local people? Also, two scientific questions are at the front of climate science community: 1) how global change impacts on local weather-climate anomalies and 2) how local weather-climate perturbations feedback to large scale changes/variations? This talk will show the present status and future development plans in Qingdao Pilot National Laboratory for Marine Science and Technology (QNLM) on earth modeling and predictions to address these issues, and discuss significant challenges as well as potential solutions.

Key words
High-resolution earth modeling and prediction; Seamless weather-climate predictions; Local adaptive strategy to global change

Heat and Salt Transports by Mesoscale Eddies in the Lofoten Basinof the Norwegian Sea

V. A. Zinchenko[1,2*], S. M. Gordeeva[1,2,3], T. V.Belonenko[1]

[1]*Saint Petersburg State University, Universitetskaya nab. 7–9, St. Petersburg, Russian Federation*
[2] *Russian State Hydrometeorological University, 79, Voronezhskayaul., Saint Petersburg, Russia*
[3]*Shirshov Institute of Oceanology of the Russian Academy of Sciences, 36, Nahimovskiy pr., Moscow, Russia*
**e-mail: vadimzin@gmail.com*

Background: The Lofoten Basin (LB) is the deepest and broadest reservoir of Atlantic Water and thereby of ocean heat content, and furthermore the most eddy-rich region of the Nordic Seas, where large ocean-atmosphere interactions occur. Being a transit area for the warm and saline Atlantic Water on its way to the Arctic Ocean, it plays an important role in sustaining the Meridional Overturning Circulation for it is a region, where the Atlantic Water loses its heat to the atmosphere and mixes with surrounding water. The LB is an area where the warm Atlantic Water is subject to the greatest heat losses anywhere in the Nordic Seas. It is called a 'hot spot' of the Nordic Seas because of its high intense of mesoscale eddy activity (Belonenko et al., 2014; Volkov et al., 2013). Similar to other parts of the world ocean, both anticyclonic eddies (ACEs) and cyclonic eddies (CEs) characterize the mesoscale eddy activity of the LB. Oceanic mesoscale eddies contribute important horizontal heat and salt transports on a global scale. Temperature and salinity (T/S) anomalies inside individual eddies tend to move with eddies because of advective trapping of interior water parcels, thus eddy movement causes heat and salt transports. What is the respective role of such eddies on the volume, heat and salt transports? We try to answer these questions.

Material: We use high-resolution (0.25° x 0.25° grid) sea level anomalies for the 25-year period (1993 – 2017) the AVISO gridded altimetry data. We also use the GLORYS12V1 product of the Global Ocean Physics Reanalysis available at CMEMS (Copernicus Marine Environment Monitoring Services). It is the global ocean eddy-resolving (1/12° (approximatively 8 km)horizontal resolution and 50 standard levels).This product includes daily mean files of temperature, salinity, currents, sea level, mixed layer depth and ice parameters from the top to the bottom.

Methods and Results: We exclude tracks of eddies with a lifetime of less than 35 days (99% eddies) in order to exclude the vortices associated with synoptic variability, as well as errors that could arise due to the small discreteness of satellite measurements in the study basin. Only 120 CEs and 210 ACEs are found to study. We divide all onto 4 groups and calculated the available heat (**AT**) and salt (*AS*) content anomalies: $AT = \rho\, C_p \int T' dx\, dy\, dz$, $AS = \rho \int S' dx\, dy\, dz$.

Conclusions: We do not confirm significant heat and salt transport to the area of the LV from outside and from the periphery of the Norwegian Current. The magnitude of heat and salt transports to the area of the LV from outside is estimated to be $0.9*10^{13}$ W and $1.8*10^{5}$ kg* s^{-1}, respectively. Annual average means are $3.6*10^{11}$ W for the heat and $7.2*10^{3}$ kg* s^{-1} for the salt transports.

References:
Belonenko, T. V., D. L. Volkov, V. K. Ozhigin, Yu. E. Norden (2014), Circulation of waters in the Lofoten Basin of the Norwegian Sea [In Russian], *Vestn S. Petersbur. Un-ta*, 7(2):108-121.
Volkov, D. L., T. V. Belonenko, V. R. Foux (2013), Puzzling over the dynamics of the Lofoten Basin – a sub-Arctic hot spot of ocean variability,*Geophys. Res. Lett.*, 40 (4): 738-743. doi:10.1002/grl.50126.

Acknowledgements
This work was supported byRussian Scientific Foundation (pr.No. 18-17-00027).

Key words:
Norwegian Sea, Lofoten Basin, heat and salt transports, mesoscale eddies

CMIP6 Simulations with a coupled model--CAS FGOALS3

Yongqiang Yu[1,2]*, Pengfei Lin[1,2], Bian He[1], Lijuan Li[1,2], Hailong Liu[1,2], Qing Bao[1], Yanli Tang[1], Weipeng Zheng[1,2], Yuyang Guo[1,2], Shuwen Zhao[1,2], Yihua Luan[1]

[1]*Insitute of Atmospheric Physics, Chinese Academy of Science, Beijing 100029*

[2]*University of Chinese Academy Sciences, Beijing100049*

**e-mail: yyq@lasg.iap.ac.cn*

This study describes the framework of the Flexible Global Ocean-Atmosphere-Land System (FGOALS) model version3.0 known as FGOALS3, and CMIP6 simulations with it. FGOALS3 consists of the following components: GAMIL3 or FAMIL (atmosphere), LICOM3 (ocean), CICIE4 (sea ice), and CLM4 (land). There are two options for atmospheric component models: GAMIL3 and FAMIL, and the corresponding names of coupled models are FGOALS-g3 and FGOALS-f3. These components are coupled together with the flux coupler from NCAR. FGOALS-s2 has been used to conduct the experiments for analysis studies in support of the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC AR6) and phase 6 of the Coupled Model Intercomparison Project (CMIP6). In this study, both the 500-year preindustrial control run and 165-year historical run with FGOALS-g3 and FGOALS-f3 from 1850-2015 are evaluated.

Key words
CMIP6, Climate System Model, Climate Change

A modified vertical mixing scheme and its improved simulations in the tropical Pacific

Yuchao Zhu[1, 2, 3*] and Rong-Hua Zhang[1, 2, 3, 4]

1CAS Key Laboratory of Ocean Circulation and Waves, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China;

2University of Chinese Academy of Sciences, Beijing, China;

3Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, China;

4Pilot National Laboratory for Marine Science and Technology (Qingdao), Qingdao, China

**e-mail: yuchaozhu@qdio.ac.cn*

The sea surface temperature (SST) plays an important role in the climate system by controlling energy and mass exchanges between the ocean and the atmosphere. However, climate models suffer from significant SST biases over the tropical Pacific Ocean, including a too cold tongue and too diffuse termocline. The emergence of model biases can be partly attributed to vertical mixing parameterizations, in which the selections of functional forms and empirical parameters have great uncertainties. In this paper, we have investigated the impacts of two different vertical mixing schemes on the tropical Pacific temperature simulations of the version 5 of the Modular Ocean Model (MOM5). One vertical mixing scheme is the widely used K-Profile Parameterization (KPP) scheme and the other is the Chen scheme, which is a hybrid mixing scheme combining a Kraus-Turner type mixed layer model and Peters' shear instability mixing model (PGT scheme). It shows that Chen scheme works better than KPP scheme for SST simulation, but produces an increased subsurface warm bias simultaneously. Improvements in SST simulation can be attributed to the employment of PGT scheme, which produces a lower level of shear instability mixing than its counterpart in KPP scheme. The increased subsurface warm bias is induced by the overestimated m_0 off the equator, which scales the wind stirring effects in Kraus-Turner type mixed layer model. Furthermore, an optimized KPP scheme is proposed through replacing its shear instability mixing model and constant background diffusivity by PGT scheme and Argo-derived background diffusivity, respectively. This new scheme is then employed into MOM5-based ocean-only and coupled simulations, demonstrating substantial improvements in temperature simulations over the tropical Pacific. The optimized KPP scheme proposed in this paper can be easily employed into other ocean models and offers an effective way for improving ocean simulations.

References

Zhu, Y. and R.H. Zhang, 2019, *J. Phys. Oceanogr.*, **49**, 21–37.

Acknowledgements

This research was supported by the National Natural Science Foundation of China [NFSC; Grants 41690122(41690120), 41475101, and 41490644(41490640)], the NSFC–Shandong Joint Fund for Marine Science Research Centers (U1406402), and the Taishan Scholarship..

Key words

Vertical mixing schemes, model biases, tropical Pacific.

T01-3: Extreme Metocean conditions and tsunami

Directional wave spectrum characteristics near the typhoon path

Taerim Kim[1*], Jaehyuk Lee[1]

[1]*Ocean Engineering Dept. Kunsan University, Kunsan, Korea, 54150*
**e-mail: trkim@kunsan.ac.kr*

The characteristics of wave directional spectrum near the typhoon path were intensively studied during Typhoon Bolaven (1215) (hereinafter TB). The typhoon passed through the East China Sea and the Yellow Sea in August 2012 and generated extraordinarily high waves. During TB, the maximum wind velocity and central pressure reached 53 m/sec and 920 hPa, respectively. It also generated extreme waves with maximum wave height of over 10 m lasting over 10 hours in the west coast of Korea with record-breaking maximum wave height of 19.7 m, and caused severe damages to the ports near the path.

Three wave measurements were executed during TB in the East China Sea. Ieodo station was located just to the left of the path. Two Korea Ocean Gate Array (hereinafter KOGA) buoys were located right side to the path where KOGA-S04 was north east compared to KOGA-S01. All three were able to observe wave directional spectrum during extreme typhoon path conditions but only Ieodo station could measure wind velocity. The characteristics and changes of wave directional spectrum according to relative position and distance to the center of the typhoon were examined. They were also compared with spectrum calculated by WAVEWATCH III numerical wave prediction model using RDAPS (Regional Data Assimilation and Prediction System) wind data.

Key words
Typhoon, wave directional spectrum, numerical wave prediction model

A study of the winter subtropical cyclone in the North-Western Pacific ocean using the method of Hart

Kotovich N.G.[1,2 *], Vasilevskaya L.N.[1], Krokhin V.V.[3], Lisina I.A.[1]
[1]*The Department of Oceanology and Hydrometeorology FEFU*
[2]*Far Eastern Hydrometeorological Research Institute, Vladivostok*
[3]*V.I.Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, Vladivostok,*
** E-mail: ngkotovich@mail.ru*

The purpose of this study is an assessment of the thermal structure of the subtropical cyclones of the northwestern part of the Pacific Ocean in winter using the Hart technique (2002) to further understand the evolution of these cyclones.
The baseline material for the study was the surface and altitude analysis maps for December-February 1996-2018. From the site of the Japanese meteorological agency JMA; archive ERA INTERIM, accumulated in the department of tropical cyclones, Far Eastern Hydro-meteorological Research Institute.
The cyclone asymmetry in the lower troposphere (parameter "B") and thermal wind (parameter "V_T") in the lower and upper troposphere was calculated using the algorithm proposed by E. Hart. A strictly defined combination of calculated parameters indicates the possibility of the formation of a warm core in the troposphere.
The results of the study showed that out of 215 subtropical cyclones that originated above the sea surface, 63% had a warm core in the lower or upper layer of the troposphere. Usually, a warm core in the center is formed when the cyclone is located north of 45° N. In the lower troposphere, a warm core is formed as a result of cold advection from the north and a sharp deepening of the cyclone. This process captures the warm air in the "trap" and forms the lower warm core. The release of latent heat of condensation occurs due to the activation of convective processes, resulting in the formation of the upper tropospheric warm core. The minimum surface pressure for the entire study period was 928 hPa. Such cyclones cause high sea surges on the coast of the Sea of Okhotsk and the Bering Sea (Lyubitsky Y.V., Alisimchik N. G. 2014).
We have identified cyclones, which by the presence of a warm core are similar to subtropical, but originate in temperate latitudes over the relatively cold sea surface of the Far Eastern seas and over land. These cyclones were called hybrid. The process of formation of a warm core in these cyclones is also associated with the release of heat of condensation. Over the entire study period, the minimum surface pressure was 940 hPa. Subtropical and hybrid winter cyclones have a large supply of energy, heat and moisture compared to conventional cyclones of temperate latitudes. Significant wind speeds and heavy precipitation are associated with these cyclones.
Using the Hart technique over the northwestern part of the Pacific Ocean showed that the model can work on any sufficiently accurate reanalysis data. The technique is quite slim and allows you to get accurate data on the cyclone life.

Key words
Keywords: subtropical cyclone, Pacific Ocean, hybrid cyclones.

Momentum fluxes in the wind-wave boundary layer during Tropical Cyclones Olwyn and Veronica

J. J. Voermans[1], A. V.Babanin[1]
[1]*University of Melbourne, Parkville 3010, Victoria, Australia*
**e-mail: jvoermans@unimelb.edu.au*

In-situ measurements of ocean wind stresses during extreme wind conditions are a necessity for the improvement of our understanding and our predictive capabilities of tropical cyclone intensity and track. Progress is currently hindered by the limited number of observations of wind and wave properties during high wind speeds. When observations of air-sea interactions during extreme conditions are successfully obtained, these measurements are often measured within the wave-boundary layer making interpretation of the data difficult[1]. In particular, direct measurements of momentum fluxes within the wind-wave boundary layer using the eddy-correlation method (i.e., the turbulent shear stress) become insufficient to determine the local wind stress[2]. Here, we present results of momentum fluxes measured in the wind-wave boundary layer during Tropical Cyclone (TC) Olwyn and Veronica.

Data was obtained on the north shelf of Western Australia during the near passages of TC Olwyn and TC Veronica in 2015 and 2019, respectively. Wind speed was measured by two ultrasonic anemometers, positioned approximately 9 and 15 m above mean sea level. Waves were recorded using four laser gages. Maximum significant wave height recorded by the lasers during TC Olwyn and Veronica was 7 and 8 m, respectively. Highest wind speeds recorded at 10 m above mean sea level by the anemometers were approximately 22 and 29 m/s, respectively. As momentum fluxes are measured within the wind-wave boundary layer, stresses imposed by the waves on the air are modeled through the wind input source function[3].

Even though wave-induced stresses decay exponentially with distance from the ocean surface, our results suggest that the wave-induced stress is still similar in order of magnitude as the turbulent stress for high wind speeds at heights of O(10 m) above the ocean surface. Hence, estimating wind stress during extreme wind events by considering measurements of turbulence stresses alone will significantly underestimate the actual wind stress. Such errors can propagate into predictive models that use these field observations for calibration and validation and obscure our understanding of air-sea interactions during extreme wind conditions.

References

[1]A.V. Babanin, J. McConochie, D. Chalikov,*Journal of Physical Oceanography*, 2018, **48(5)**, 1079-1088.
[2]J.J. Voermans, H. Rapizo, H. Ma, F. Qiao, A.V. Babanin,*Journal of Physical Oceanography*, 2019.
[3]M.A. Donelan, A.V.Babanin, I.R. Young, M.L. Banner,*Journal of Physical Oceanography*, 2006, **36(8)**, 1672-1689.

Acknowledgements

This research was supported by the DISI Australia-China Centre through Grant ACSRF48199. Data was kindly provided by Woodside Ltd.

Key words

Tropical Cyclone, wind-wave boundary layer, wind stress.

Waves in the refreezing eastern Chukchi Sea during 2018 Mirai Cruise

T. Waseda[1], T. Nose[1], T. Kodaira[1], A. Kohout[4], J. Gemmrich[3], H.Shen[4], and J. Inoue[5]
[1]*Department of Ocean Technology Policy and Environment, The University of Tokyo*
[2]*University of Victoria,* [3]*National Institute of Water and Atmospheric Research*
[4]*Bedford Institute of Oceanography,* [4]*National Institute for Polar Research*
**e-mail: waseda@k.u-tokyo.ac.jp*

The sea ice in the Pacific side of the Arctic Ocean starts to melt in August, retreats the most in September, and advances again in October. In November, in typical years, most of the Chukchi Sea is covered by ice. Waves generated in the open waters are largest in October. During the R/V Mirai (JAMSTEC) expedition in November 2018 (MR18–05C, PI J. Inoue, JAMSTEC (2019)), anomalously warm surface waters delayed freezing of Chukchi Sea providing a unique opportunity to observe ocean waves in the freezing period. A drifting wave buoy, ship-borne wave gauge, and satellite synthetic aperture radar data was analyzed to characterize the waves during that period. The drifting wave buoy was deployed at the edge of the Marginal Ice Zone, gradually migrated to the west, and eventually got trapped in the sea ice. During this period, the largest significant wave height observed by a buoy was 2.6 m. Once trapped in ice, the buoy-detected wave energy significantly reduced from the open water wave height detected by ship-borne wave gauge. Combined knowledge from the in-situ wave measurements, satellite SAR images, and visual inspection provided us a unique opportunity to observe waves in the marginal ice zone. The ice formation was delayed due to anomalously warm water possibly from the Bering Sea (Kodaira et al. 2019), and the waves were generated in the open water which otherwise is covered by ice in November. The two on-ice and off-ice events (Nose et al. 2019) provided us with an opportunity to study the wave decay in ice-covered ocean and wave generation in the ice-covered ocean.

References

JAMSTEC (2019): R/V Mirai cruise report MR18-05C. Tech. rep., Japan Agency for Marine-Earth Science and Technology (JAMSTEC), in preparation.

Nose, T., T. Waseda, T. Kodaira, and J. Inoue, 2019, Sea ice observations along a fixed Marginal Ice Zone transect in the refreezing eastern Chukchi Sea, The 34th International Symposium on the Okhotsk Sea & Polar Oceans 2019

Kodaira, T., T. Nose, T. Waseda, and J. Inoue, 2019, Oceanographic Observation of theRefreezing Warm Chukchi Seaduring 2018 Mirai Cruise, The 34th International Symposium on the Okhotsk Sea & Polar Oceans 2019

Acknowledgements

This work was sponsored by the Japanese Ministry of Education, Culture, Sports, and Technology through the ArCS project and Kakenhi of the Japan Society for Promoting Science.

Key words

Wave-ice interaction, Marginal Ice Zone, Chukchi Sea

Variation of pCO_2 concentrations induced by tropical cyclones in the middle-latitude surface oceans: a comparative study

HaijunYe[1], Evgeny Morozov[1,2], Danling Tang[1*], SufenWang[1], Fenghua Zhou[1]
[1]South China Sea Institute of Oceanology, Chinese Academy of Sciences, No 164 Xingang West, Guangzhou, China,510301
2Nansen International Environmental and Remote Sensing Center, Saint-Petersburg, Russia
*e-mail: Danling Tang, lingizstdl@126.com

Distributions of partial pressure of CO_2 at the sea surface (pCO_{2sea}) depend strongly on the temperature, dissolved inorganic carbon, total alkalinity and salinity. Due to tropical cyclone (TC) "Wind-pump" effects, cold and CO_2-rich subsurface waters were upwelled and mixed with the surface water, which in turn decrease or increase the$pCO_{2sea.}$ In order to quantify the effects of TCs and water vertical salinity gradient on the pCO_{2sea}, the Bermuda Test bed Mooring (BTM) and Bay of Bengal Ocean Acidification (BOBOA) mooring measurements were used to identify changes in the $pCO_{2sea}$and air-sea CO_2 fluxes (F_{CO2}) associated with passage of TCs Florence and Hudhud, respectively. TC Florence passed about 165 km off the BTM mooring site with strong wind speeds of 24.8 m s^{-1} and translation speed of 7.23 m s^{-1}. TC Hudhud passed about 178 km off the BOBOA mooring site with wind speeds of 14.0 m s^{-1} and translation speed of 2.58 m s^{-1}. The present study examined the effect of the change of temperature, salinity, dissolved inorganic carbon, total alkalinity, air-sea CO_2 flux, and phytoplankton on the response of pCO_{2sea} to TCs. Enhanced mixed layer depths were observed due to TCs-induced vertical mixing at both moorings. Decreased pCO_{2sea} (–15.16±5.60 μatm) at the BTM mooring site and enhanced pCO_{2sea} (14.81±7.03 μatm) at the BOBOA mooring site were observed after the passage of Florence and Hudhud, respectively. Strong vertical salinity gradient in the upper layer of the ILD (0.031 psu m^{-1}), the depth of the top of the termocline, that supply much salinity, dissolved inorganic carbon and total alkalinity from the thermocline was the cause of the increased pCO_{2sea} in the BOBOA mooring water. Weak vertical salinity gradient in the upper layer of the ILD (0.003 psu m^{-1}) was responsible for decreasing pCO_{2sea} in the BTM mooring water. The results of this study showed that the vertical salinity gradient in the upper layer of the ILD along with the TC intensity and translation speed played most significant roles in the pCO_{2sea} variation after the passages of TCs.

References

Ye, H.J., Sheng, J.Y., Tang, D.L., Eko, S., Kalhoro, M.A., Sui, Y., 2017. Storm-induced changes in pCO_2 at the sea surface over the northern South China Sea during Typhoon Wutip. J. Geophys. Res. 122, doi:10.1002/2016JC012643.

Ye, H.J., Sheng, J.Y., Tang, D.L., Morozov, E., Kalhoro, M.A., Wang, S.F., Xu, H.B., 2018b. Examining the impact of tropical cyclones on air-sea CO_2 exchanges in the Bay of Bengal based on satellite data and in-situ observations. J. Geophys. Res. 123, doi: 10.1029/2018JC014533.

Acknowledgements

This work was supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (XDA19060501), the National Natural Sciences Foundation of China (41806146, 41876136 and 41430968), the Collaborative Innovation Centre for 21st-Century Mari-time Silk Road Studies (2015HS05) and the Chinese Academy of Sciences (XDA13010404). The authors thank the GTMBA Project Office of NOAA/PMEL (https://www.pmel.noaa.gov/) and the BATS team (http://bats.bios.edu/) for provision of the data.

Key words

Tropical cyclone, pCO_2, Vertical salinity gradient

T02: Marine geology and geological recourses

T02-1: Gas hydrates in the Pacific Ocean

Deep-sea piston-gravity pressure coring technology

Jiawang Chen[1*], Bo Xiao[2],Lieyu Tian[2], XueQiao Geng[2], Linyi Gu[1]
[1]*Ocean College, Zhejiang University, Zhoushan, China, 316021*
[2]*Institute of Marine Geological Exploration Technology, Guangzhou Marine Geological Survey, Guangzhou, China,*
**e-mail: arwang@zju.edu.cn*

Gas hydrate has been confirmed as a most potential type of new clean energy in the future. To analyze the physical and chemical characteristic of it scientifically, the best method to obtain sediment samples which containing the gas hydrate is to keep their submarine features in-situ, including the stratum configuration, composition, salinity, pressure, temperature and living microorganisms, because the marine gas hydrate is apt to resolve for the changes of in-situ salinity, pressure and temperature. And 1 m^3 gas hydrate can resolve into 164 m^3 natural gas and 0.8m^3 water. When we carry out the marine gas hydrate survey, we should consider the pressure and temperature effect factors during the geological drilling and sampling. Only in this way we can get detail parameters of the formation of the sediment, porosity, permeability and saturation of the core as well as of the biological living environment.

So far, the marine gas hydrate can be classified into two types, the diffusive and the leaking respectively. The first one deposits in deep marine stratum with relatively large scale, which has one distinct geophysical interface -BSR (Bottom Simulation Reflector). The second one scatters in shallow marine surface layer, such as the cold seeps with sole seabed ecological environment.

For the first one, we can apply either the ship drilling or underwater drill rig to recover the column core. But for the shallow gas hydrate leaking stratum, there are lots types of pressure corers , but it will be very difficult to get deep sea pressure sediment core over 3 meters, we had developed one pressure corer based on gravity-piston from 2005, which had been applied in gas hydrate survey in South China Sea more than 40 times with 40% pressure success ratio, and we got one 14.5m long pressure column sediment core in 2011, and we completed the structure modification of this pressure corer and connect with the new developed pressure transferring equipment, and the whole set were successfully be applied in sea trial in 2016.

This article mainly presents the overall structure, working principles, key pressure-retained components, coring mechanism, development of pressure transferring equipment and sea trials.

References

ZhibinSha,JinqiangLiang,GuangxueZhang,ShengxiongYang,JinganLu,ZijianZhang,Daniel R. McConnell,Gary Humphrey,A seepage gas hydrate system in northern South China Sea: Seismic and well log interpretations, Marine Geology,2015,**366(1)**,69-78.
Timothy S. Collett, Arthur H. Johnson, Camelia C. Knapp, Ray Boswell; Natural gas hydrates--Energy resource potential and associated geologic hazards: AAPG Memoir 89, 2009,146-219.
Jiawang Chen, Wei Fan, BrianBingham, YingChen, LinYiGu, ShiLunLi, A Long Gravity-Piston Corer Developed for Seafloor Gas Hydrate Coring Utilizing an In Situ Pressure-Retained Method[J], Energies, 2013,**6(7)**,3353~3372

Acknowledgements

This work was supported by The National Key Research and Development Program of China (No.2017YFC0307503),

Key words: Marine gas hydrate; Gravity-piston pressure corer

Age of the accumulation of gas hydrates, development of a low-salinity water cap, and the occurenceof gigantic submarine slides in Tatar Trough and Tatar Strait

R. Matsumoto[1*], Y. Kakizaki[1], T-L. Yu[2], C-C. Shen[2], R. Shakirov[3], and A. Obzhirov[3]
[1]*Gas Hydrate Research Laboratory, Meiji University, 1-1 Kanda-Surugadai, Tokyo, Japan, 1038301*
**e-mail: ryo_mat@meiji.ac.jp*
Dept of Geosciences, National Taiwan University, No.1, Sec.4, Roosevelt Rd., Taipei, Taiwan, 10617
[3]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041*

Gas chimney structures in the Sea of Japan are often several hundred meters in diameter and 100~150 m deep below seafloor, and they frequently host the accumulation of thick, massive gas hydrate deposits (Matsumoto et al., 2017; Matsumoto, 2017). One of the key questions to understand the origin and geologic background of these structures is the age of the formation of gas hydrates. Subsurface methane (CH_4)migrates upward to shallow subsurface, and primarily accumulates as shallow gas hydrates, while sulfate (SO_4) in the overlying seawater diffuses down into shallow methane-bearing sediments, and oxidizes methane to generate bicarbonate ($HCO3^-$), which precipitates as methane-derived-carbonates (MDAC) in close association with shallow gas hydrates. As it is difficult to directly determine the age of hydrates, we measured the age of the MDACs utilizing the technique of radiogenic U-Th disequilibrium as a proxy for hydrate age.

Tatar Trough carbonates were collected from the slope sediments at the water depth of 845m, approximately 30 km off Primorye, and Tatar Strait carbonates were recovered from slide-scarp or huge slump blocks at600 m, about 80 km west of Sakhalin. Trough carbonates range in age between 1.5ka and 35.2ka and the Tatar Strait carbonates are between 18.4ka and 60.0ka. With the exception of one outlier, results from the other five samples are included within the glacial period, when the sea level of the Sea of Japan dropped by 130 m and the basin was closed and separated from the Pacific Ocean by shallow sills.

The $\delta^{18}O$ of the carbonates is similar between the Trough (2‰ to 5‰) and the Strait (1.5‰ to 5.5‰). Assuming affirmation temperature of carbonates of -0.5℃ and +0.5℃during the last glacial maxima, the $\delta^{18}O$ of the interstitial waters in the shallow subsurface is calculated to be +1‰ to -5‰. This significant depletion in O^{18}, implies that a 600 m to 800 m thick, low-salinity water cap developed during the LGM in the northern part of the Sea of Japan, due to riverine fresh water flux into the silled basin which was separated from the Pacific Ocean.

During the glacial low-stand, deep-seated gas hydrates were dissociated, resulting in renewed generation of methane and migration through gas chimneys. This resulted in the enhanced accumulation of newly-formed gas hydrates within the shallow reaches of the gas chimneys. On the other hand, the massive dissociation of deep-seated gas hydrates also facilitated gas seeps on the sea floor, resulting in slope failure and gigantic landslides as depicted on the seismic profiles of the Tatar Strait. The U-Th ages of carbonates of the Tatar Strait suggest that the gigantic slope failure may have happened during the LGM. Sea-level drop during the glacial low stand caused a serious impact on the ocean environment of the Sea of Japan through as a result of the unusual behavior of subsurface gas hydrates.

References

R. Matsumoto, and others, Fire in the Ice, 2017, 17, 1-6.
R. Matsumoto, Proc. 9th ICGH, Denver, Co., 2017

Key words: U-Th age, low salinity water mass, LGM

Gas Hydrate Migration and Accumulation System (GHMAS): Key Controlling Factors for Gas Hydrate Formation and Distribution

Su Ming[1*], WuNengyou[2], Liang Jinqiang[3], HuGaowei[2], QiaoShaohua[4]
[1]*School of Marine Sciences, Sun Yat-sen University, Zhuhai, China, 519082*
[2]*Qingdao Institute of Marine Geology, Qingdao,China, 266071*
[3]*Guangzhou Marine Geological Survey, Guangzhou,China, 510075*
[4]*Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou, China, 510640*
**e-mail: suming3@mail.sysu.edu.cn*

The concept of gas hydrate-petroleum system has been acted as a comprehensive and rapid integrated evaluation method to study the potential formation, occurrence and distribution of gas hydrate for a large and less study area. However, the occurrence and distribution of gas hydrate is obviously heterogeneous in nature. By summary and comparison of hydrate controlling factors in the world, it is revealed that the stability conditions of temperature and pressures, gas composition and their sources are little changed within a relatively small area of hydrate occurrence, whereas the fluid migration condition and favorable sediment body are so much different. Therefore, a concept of gas hydrate migration and accumulation system was proposed and discussed preliminarily in the northern South China Sea.

In the northern South China Sea, hydrate investigation were widely carried out during the past ten years and different hydrate-types were discovered by drilling expeditions of Guangzhou Marine Geological Survey in the Shenhu and Dongsha areas. Hydrate reservoir occurs in several ten meters above BSR in Shenhu area. Re-transported through small-scale channels and submarine canyons, the fine-grained turbidites may have relatively good physical properties, thus provide favorable spaces for hydrate formation. The high-angle fault/fissure system and gas chimney contribute to the gas-bearing fluid migration pathway. Deep hydrate reservoir occurs in several ten meters above BSR, whereas shallow hydrate reservoir exists in the near-surface sediments in the Dongsha area. The hydrate formation and accumulation were controlled by the activity of dissolved and free gas-rich fluid. Dissolved gas-rich fluid forms pore-filling hydrates above BSR. Free gas-rich fluid is more favorable to generate near-surface nodules or massive hydrates.

Focused on the spatial distributions of fluid migration pathways and favorable sedimentary bodies, the concept, GHMAS, could be suggested as the key controlling factors for hydrate formation and distribution. Also, analysis of fluid migration pathways and the sedimentological interpretation of hydrate reservoir are the important direction for hydrate exploration.

References

Sha, Z.,Liang, J., Zhang, G., Yang, S., Lu, J., Zhang, Z., McConnell, R., Humphrey, R., *Marine Geology*, 2015, **366**, 69-78.
Su, M.,Yang, R.,Wang, H.,Sha, Z.,Liang, J.,Wu, N.,Qiao, S.,Cong, X.,*GeologicaActa*, 2016, **14(2)**, 79-100.
Su, M., Sha, Z., Zhang, C., Wang, H., Wu, N., Yang, R., Liang, J., Qiao, S., Cong, X., Liu, J., *ActaGeologicaSinica (English Edition)*, 2017, **91(1)**, 219-231.

Acknowledgements

This work was supported bythe National Natural Science Foundation of China (No.41576048), the Pearl River S&T Nova Program ofGuangzhou (No. 201710010198), and the Guangdong Special Fund forEconomic Development (Marine Economy) (No. GDME-2018D001).

Key words

Fluids migration; deep-water sediments; gas hydrate.

Thermal-gaseous divergence of marine waters in the Seas of Okhotsk and Japan

V. Mishukov [1*], G. Mishukova[1], A. Obzhirov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, .43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: vmishukov@poi.dvo.ru*

Thermal-gaseous divergence of marine waters is a natural phenomenon that occurs in areas of the emission of natural gas in the form of gas "flares". As a result of gas entry in this field, the formation of gas emulsion was observed with a change of density and viscosity of marine environment.

As shown in the work of (Mishukova et al. 2010), the presence of flares of gas bubbles changes the sea water hydrological characteristics. In the sites of gas emission the involvement of water into the stream of gas bubbles is observed, which facilitates migration of bottom seawater to the overlying horizons. During the rising of bubbles, active dissolution of methane from gas bubbles to seawater was accompanied by the processes of transition of oxygen and nitrogen, dissolved in the seawater, into a gas phase of bubble (Mishukova et al. 2010, Leifer and Patro 2002). Accordingly, seawater is getting enriched with methane in conjunction with a decrease of dissolved oxygen and nitrogen in sea water.

Single gas bubbles with a diameter less than 1 mm dissolve in water within vertical transportation at a distance of 60-100 m. But depending on the strength of the flair, the bubbles may reach the surface, and even in deep-water areas methane emission into the atmosphere can be recorded. During the arrangement of source at the large depth, where according to acoustic data gas flare are registered, the bubbles of natural gas completely to be dissolved in the sea water at a distance 100-300 meters from the bottom, and the molecule of gas to form gas hydrate structures. Under the action of constant and tide currents the ellipsoidal zone of the sea water with the increased concentration of methane with the horizontal sizes about 50 km at a distance 100-300 meters from the bottom is formed. A similar picture of the distribution of methane is given in dissolved plumes of the Santa Barbara Channel, California and Cascadian Margin (Mau et.al. 2012, Suess et al. 2001).

During the more widespread arrangement the sources of natural gas on the slope of shelf with the depths of more than 100 meters also enriched methane zones are formed the horizontal tapered zone of carrying above the more deep water regions with the horizontal sizes from 50 to 100 km and the thickness 100-200 m. These zones can be located at the different depths. Such intrusions are widespread in the northeastern shelf of Sakhalin and specify the appearance of several maximums of methane concentration at different depths (Mishukova et al. 2010).

References

- Leifer I, & Patro RK (2002) The bubble mechanism for methane transport from the shallow sea bed to the surface: A review and sensitivity study. Continental Shelf Research. 22 (16): 2409–2428. doi:10.1016/S0278-4343(02)00065-1
- Mau S, Heintz MB, Valentine DL (2012) Quantification of CH_4 loss and transport in dissolved plumes of the Santa Barbara Channel, California. Continental Shelf Research 32: 110–120
- Mishukova GI, Mishukov VF, Obzhirov AI (2010) Distribution of methane contents in sea waters and its fluxes on boundary of water–atmosphere at some regions of the Sea of Okhotsk. Vestnik DVO RAN, 6: 36-43 [in Russian]
- Suess E, Torres ME, Bohrmann G et al. (2001) Sea floor methane hydrates at Hydrate Ridge, Cascadian Margin, Natural Gas Hydrates: Occurrence, Distribution, and Detection, Geophys. Monogr. Ser. 124 (eds. Pauli CK, Dillon WP), AGU, Washington, D. C: 87–98.

Methane Fluxes on the Water-Atmosphere interface in the north-west of the Sea of Japan during spring – summer – autumn (2010-2018)

O. Mishukova[1*], R. Shakirov[1], A. Yatsuk[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: omishukova@poi.dvo.ru*

The present paper demonstrates the spatial distribution of methane fluxes on the water-atmosphere border in the northwest of the Sea of Japan basing on the data of the research vessel "Akademik M.A. Lavrent'ev" (81) in May, 2018; (54) in May and June, 2011; (52), in September, October, 2010; (51) in August, 2010. Variations of methane fluxes on the Water-Atmosphere interface in the north-west of the Sea of Japan during spring of 2018 ranged from 1.1 to 14.4 mol/(km^2·day) – average value was 3,8 mol/(km^2·day). These fluxes were lower than in eastern part of the Sea of Japan during the spring of 2011 and the autumn of 2010 [Obzhirov, et al., 2016]. Averaged data are higher than in the north-western part of the Sea of Japan during summer in 2010 [Vereshchagina et al., 2013]. The measured methane concentrations in the surface water layer were changing from 4.2 nmol/l to 7.3 nmol/l – average value was 5.2 nmol/l. This is slightly higher than the figures given in [Watanabe et al., 1995] 2.7 nmol/l for subsurface water layer in the Pacific Ocean along the 165° east longitude from 05S° to 40° north latitude. Because of the strong dependence of the solubility of methane on the temperature, the average percentage of oversaturation was from 33% beside to 130% supersaturating. Averaged data are lower than it in the eastern part of the Sea of Japan [Gamo et al., 2012] and in the northwestern Pacific Ocean in 1991 [Watanabe et al., 1995]. It is known that in May sea waters with winter characteristics usually changed to summer ones at the north-western part of the Sea of Japan. Low temperature of water surface layer in may of 2018 from 3.2° C up to 9.0° C, average 6.3° C, led to the highest values of equilibrium concentrations of methane, regarding its content in the atmosphere, from 3.0 nmol/l up to 3.4 nmol/l, average 3.2 nmol/l. They were higher than in May of 2011 (from 2.9 nmol/l to 3.0 nmol/l, average 3.0 nmol/l) and June of 2011, and significantly higher than in September (from 2.3 nmol/l to 2.5 nmol/l, average 2.4 nmol/l) and October (from 2.1 nmol/l to 2.2 nmol/l an average 2.2 nmol/l) of 2010.

The variations in intensity of methane fluxes on the water–air interface are associated with inhomogeneous spatial distribution of methane in the surface water layer. Methane concentrations exceeded the equilibrium with the atmospheric value throughout the water area under study during the observation period. In general, the study area is a region of stable methane emission into an atmosphere. The results show that there are both local areas of low and elevated fluxes.

Acknowledgements
The research is performed within the state basic research programs: "Gasgeochemical fields of the seas of Eastern Asia, geodynamic processes and natural gas flux, which influence the formation of geological structures with hydrocarbon deposits and authigenic mineralization in the bottom sediments".

References
Gamo T., Tsunogai U., Hirota A., Nakayama N., Kang D., Kim K. First measurements of methane and its carbon isotope ratio in the Japan Sea (East Sea) Marine Chemistry. 2012.128-129. 92-99.
Obzhirov A. I., Pestrikova N. L., Mishukova G. I., Mishukov V. F., and Okulov A. K. Distribution of Methane Content and Methane Fluxes in the Sea of Japan, Sea of Okhotsk, and Near-Kuril Pacific. Russian Meteorology and Hydrology. 2016. V. 41. N. 3. 205-2012.
Vereshchagina OF., Korovitskaya EV. Mishukova GI. Methane in water columns and sediments of the north western Sea of Japan. Deep Sea Research Part II: Topical Studies in Oceanography. 2012. V. 86-87. 25-33.
Watanabe S., Higashitani N.,Tsurushima N., Tsunogai S., Methane in the Western North Pacific. J. of Oceanography (Japan). 1995. 51. N. 1. 39-60.

Gas geochemical investigation in Japan and Okhotsk Seas

A. Obzhirov
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: obzhirov@poi.dvo.ru*

Gas geochemical investigation in the Japan and Okhotsk Seas was provided in frame international projects from 1998 year. These are Russian-Germany (KOMEX, 1998-2004), Russian-Japan-Korea (HAOS, 2003-2006 and SAKHALIN, 2007-2012 and 2013-2017). Thus, complex investigations with international cooperation allow us to discover methane fluxes, gas hydrate and to find much regularity to form and to destroy gas hydrate in the Japan, Okhotsk Seas. There is show that it is present relationship between methane fluxes, gas hydrate and oil-gas deposit.

During the process of gas geochemistry investigations in the Far Eastern Seas to paid attention to study gas fluxes, gas hydrate, zones faults, to determine of disturb surface sediment in the bottom Sea in area with anomalies gas, special of CH4. There are sampling sediment and water in the Sea and gas extract from samples in the degassing equipment. There are analyze methane, heavy hydrocarbon (C2-C4), CO2, N2, He, H2 in gas. Concentrations and quantity gas components may use like indicator to search seismic-tectonic activity or period of stability. In Far-Eastern region this process to start from 1990 and it to continue now. From 1990 to 2015, 500 events of methane fluxes were detected in the Okhotsk Sea. In zones of fluxes methane and gas hydrate to disturb sediment in bottom Sea, to appear pits and knoll (valleys and mountains) 10-20 m size and to appear layers of gas hydrates, carbonate concretions, benthos and other modification.

Natural gas participates in many geological processes. Different gas come from inside of Earth and create special physics-chemical environment (reduced or oxidized) that influence on geological, geophysics, hydro-acoustics, hydrology parameters and gas geochemistry criterions, including methane fluxes, gas hydrate, activity seismic - tectonic zones faults, earthquake, volcano. It is important not only to decide geological tasks but to understand possible of influence geological regularities to form biological community – benthos on the bottom and to appear some different fish, plankton and microbes.

Key words
Gas fluxes, gas hydrate, zones faults, geological regularity, biological associations.

Complex Study of the Gas hydrates in the Asian Seas (CoSGAS): multinational project endorsement

Renat Shakirov[1*], Anatoly Obzhirov[1], Ryo Matsumoto[2], Wu-Cheng Chi[3], Young Keun Jin[4], Nguyen Nhu Trung[5], Vyacheslav Lobanov[1]

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041, ren@poi.dvo.ru*
[2]*Meiji University, Gas Hydrate Laboratory, 1-1 Kanda-Surugadai, Chiyoda-ku, Tokyo 101-8301, Japan*
[3] *Institute of Earth Sciences, Academia Sinica, Taipei 11529, Taiwan*
[4]*Korea Polar Research Institute (KOPRI), 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Korea*
[5]*Institute for Marine Geology and Geophysics VAST, 18 Hoang Quoc Viet, Nghia Do, Cau Giay, Ha Noi ,Vietnam*
**e-mail: ren@poi.dvo.ru*

Gas hydrates - green energy resource of the future and modern marine phenomena, which significance growing up from year to year but still studied poorly in marine expeditions due to the lack of international cooperative study. Gas hydrates were found in many areas of the marginal Asian seas and evidently closely interrelated to the gas geochemistry, geology, geophysics, oceanography and environment of the Asian Seas (AS) both seafloor and water column (gas-geochemical regime, earthquakes, fluid dynamics, hydrology, hydrochemistry, hydrooptics and ecotoxicology). Marginal seas of the Eastern Asia is a specific region manifested by insufficient studied gas hydrates phenomena as a resource, climate link and geochemical drive force, methane and accompanying gases fluxes in the "seafloor-water column-atmosphere" system. Numerous unique gas hydrate accumulations nowadays are object of few focused projects studies in Bering Sea, Japan Sea, Sea of Okhotsk, East-China Sea, South-China Sea and Philippine Sea separately by the Asian countries. Most of gas hydrate accumulations located within the international waters and EEZ of many countries (Russia, Japan, Korea, China, and Vietnam, Malaysia, Philippine, Indonesia and others). The geopolitics is one of the factors of low intensive research of such gas hydrate clusters and offshore gas hydrate research opportunity in these countries is very different. Moreover, gas hydrate resources in the Eastern Arctic numerously discussed but almost not studied. There for, nature and evolution of the gas hydrate system in the lithosphere and hydrosphere of the AS, which in respect to energy resources and environmental agent is one of the most uncertain and debatable problem of World Ocean. We suggest organizing long-term complex study of the gas hydrates by Asian community on bases of mutual understanding, scientific, administrative and diplomatic collaboration. The core of the Project is a set of annual carefully planned international expeditions on the research vessels hosted by Asian countries in the gas hydrate hydrocarbon promising basins. We expect that all countries involved into this project will benefit greatly in all listed points and become leading gas hydrate association in the World. The important outcome is involving and attracting of the young scientists to the ocean sciences through the complex study on gas hydrates and related phenomena and processes.

We recovered massive gas hydrates. Methane resources trapped in Western Pacific gas hydrates can be estimated based on latest investigations at least for $5\times10^{12\text{-}14}$ cubic meters, but this under discussion. We propose to conduct multinational gas hydrate research project in poorly studied areas of East Asian Seas.

Acknowledgements
The study supported by RFBR grant 18-05-00153.

Key words: gas hydrate, resources, East Asian Seas

Microdolomite grains in Japan Sea Gas Hydrate: What do they tell us about present and past hydrate growth?

G. Snyder[1*], R. Matsumoto[1], Y. Kakizaki[1,2], Y. Suzuki[2], N. Zhang[1,3], Y.Sano[4], N. Takahata[4], K. Tanaka[4], T. Imajo[5], S. Bowden[6], H. Tomaru[7]

[1]*Gas Hydrate Research Laboratory, Meiji University,Tokyo, Japan*
[2]*Department of Earth and Planetary Science, University of Tokyo, Tokyo, Japan*
[3]*Tokyo Institute of Technology, Tokyo, Japan*
[4]*Atmospheric and Ocean Research Institute, University of Tokyo, Japan*
[5]*Tokyo Institute of Marine Science and Technology, Tokyo, Japan*
[6]*University of Aberdeen, Scotland, Great Britan*
**e-mail:glen@meiji.ac.jp*

Spherulitic aggregates of dolomite were recovered as impurities within massive gas hydrate in the Japan Sea. Such aggregates range in diameter from 5μm to nearly 200μm, however mean values from any given hydrate sample range from 18μm to nearly 114 μm. These dolomitic aggregates are in some cases associated with oils that also occur as impurities within the hydrate. The microdolomites are unusual in a number of regards. Firstly, the $\delta^{13}C$ values range from around +18‰ to +42‰, completely distinct from the larger methane derived authigenic carbonates found in sediment in proximity to the massive hydrates which have$\delta^{13}C$ values ranging from roughly -60‰ to +30‰. Secondly, the dolomite grains seem to be associated with anaerobic microbial populations of Bacteroidetes sp. which derive energy from breaking down complex macromolecules rather than AOM or sulfate reduction. A number of downhole trends in the microdolomite composition give some indication as to the dynamics of gas hydrate chimneys. Where gas hydrate is growing slowly around shallow seep sites, some oxidation of methane occurs as the hydrate is growing, leading to less positive $\delta^{13}C$ values. As the hydrate is buried over time, these dolomites continue to grow and their bulk carbon isotopic composition becomes more positive. Where hydrate is rapidly formed near gas vent sites, the $\delta^{13}C$ values remain high in shallow dolomites as well as deeply buried hydrate. In either case, during the burial process, the oils found within the hydrate undergo progressive biodegradation and the dolomites continue to grow. Samples collected at less than 30 mbsf have preserved seawater and microbial communities within the inner surface of the dolomite shell, whereas the larger dolomites that have resulted from deeper burial seem to have grown larger as a result of dehydration of surrounding water within the growing hydrate.

Acknowledgements
This study was conducted under the commission from AIST as part of the methane hydrate research project funded by the Ministry of Economy, Trade and Industry, Japan. Ongoing work is being carried out thanks to a Grant-in-aid provided by the Japan Society for Promotion of Science and the Japanese Ministry of Education, Culture, Sports, and Technology (Kaken Project # 17K05712).

Key words
Japan Sea, microdolomite, gas hydrate

DISTRIBUTION OF HELIUM AND HYDROGEN IN BOTTOM SEDIMENTS AND WATER AROUND SHALLOW GAS HYDRATES IN TATAR STRAIT

N.S. Syrbu, Shakirov R.B.
V.I.Il`ichev Pacific Oceanological Institute, Russia, PrimorskyKray 690041, Vladivostok, Baltiyskaya 43
e-mail: syrbu@poi.dvo.ru

Helium and hydrogen are recognized indicators of minerals, deep seated faults, seismic activity, and ascending abyssal fluids. Their anomalous concentrations also serve as a marker of metamorphic processes. Helium and hydrogen anomalies (He up to 60 ppm) were identified in the hydrate bearing sediments in the fault zones. It was also found that helium concentrations in the water column of the Tatar Strait are higher than in the studied area of the Okhotsk Sea, possibly, due to the seismotectonic activity.

By the author it is established that natural gas in gas hydrate sediments is helium bearing, the found anomalies of helium demonstrate inflow of deep gases on a southeast slope of Sakhalin Island (a northwest board of the Kuril hollow). These data well correlate with the content of helium in mud volcanoes and mineral sources of the southern part of Sakhalin Island [1].
Deep helium, most likely, migrates together with natural gas (methane) through deposits of the western part of the Kuril hollow. In this area in the 1-3 km sedimentary thickness there is an intensive formation of hydrocarbon gases, and anomalies of helium points at deeper gas sources in the western part of the Kuril hollow. Deep helium is involved in a gas methane stream and rises to a seabed surface. Anomalies of helium in sediments with gas hydrates prove migration (thermogene) origin of natural gases (methane and its gaseous homologs) which are crystallize as methane hydrates in superficial sediments of this region and form abnormal gas-geochemical fields in sediments and water thickness.

Coincidence of anomalies of helium, methane and hydrogen demonstrates activity of geological structure within which there is a transfer of thermogene and deep gases. Abnormal on the content of helium and hydrogen and also gas hydrates, are in intersection node of tectonic faults. Such places in the Sea of Okhotsk are optimum for active venting of gases and fluids.

In the presence of the intensive ascending stream of natural gas favorable conditions for development of microbic processes are created, and the isotope ratio $^{13}C/^{12}C$ of thermogene methane masks addition of a considerable share of microbic gas from the top sediment horizons. In such cases passing measurements of helium and hydrogen are necessary for recognition of the nature of a gas stream.

References

1. Shakirov R. B., Syrbu N. S., Obzhirov A. I. Distribution of helium and hydrogen in sediments and water on the Sakhalin slope // Lithology and Mineral Resources, 2016, Vol. 51, No. 1, pp. 61–73. ISSN 0024-4902

Acknowledgements

This work was supported by RFBR 18-35-00047 and «Study on sedimentary and gas-geochemical processes, coastal hazards,climate change and geo-ecological analysis in the Red River Delta forsustainable coastal management strategy, Vietnam» (VAST codeQTRU02.03/19-20).

Key words

Helium, hydrogen, deep fluid

Compositions of authigenic minerals around the sulphate-methane transition in the sediments at cold-seep of the northern South China Sea: Inorganic geochemical evidence

Tiantian Sun[1,2] , Daidai Wu[2*,3], Lihua Liu[2,3],Xuegang Chen[1] , Ying Ye [1]

1Ocean College of Zhejiang University, Zhoushan 316021, China,
2Key Laboratory of Gas Hydrate, Guangzhou Institute of Energy Conversion, Chinese Academy of sciences, Guangzhou, China, 510640,
3Institution of South China Sea Ecology and Environmental Engineering, Chinese Academy of Science, Guangzhou, China, 510301,
**e-mail: wudd@ms.giec.ac.cn*

In modern oceans, most of the seeping methane is consumed by sulfate-dependent anaerobic oxidation of methane (AOM) in the uppermost sediments (Reeburgh, 2007). However, AOM signals might be obscured in bulk sediments in gas hydrate-bearing environment due to several factors especially for flood and turbidite deposition. Our comprehensive inorganic data were determined to explore the availability of related records at cold seeps and to provide insights into the evolution of past methane seepage activities. Chromium reducible sulfur in samples was extracted by using $CrCl_2$ and HCl (Li, 2015). The analysis of $\delta^{34}S$ was performed by using an elemental analysis-isotope ratio mass spectrometer (DELTA V PLUS). The major and trace element analysis was performed using X-ray fluorescence (XRF) and Agilent 7700e ICP-MS. Here, various carbon and sulfur contents, $\delta^{13}C$ values of total organic carbon ($\delta^{13}C_{TIC}$), $\delta^{34}S$ values of chromium reducible sulfur ($\delta^{34}S_{CRS}$) as well as foraminiferal oxygen and carbon isotopes were characterized, confirming a close relationship between authigenic minerals formation and AOM in sediments of gas hydrate-bearing sediments (973-4 site), collected from Taixinan Basin on the northern slope of the South China Sea. It can be speculated that 973-4 site has experienced multi-episodes of methane seep events. The formation of the foraminifera-rich turbidities reported here might be closely related to the gas hydrate dissociation and increased carbonate productivity during the Last Glacial Maximum, which provides a broad context for the settings and specific controls that should facilitate AOM. Further exploration of AOM should be caution rapid deposition especially for gas hydrate-bearing sediments impact by flood and turbidite deposition.

References

[1]Reeburgh, W.S. Oceanic methane biogeochemistry. Chem. Rev, 2007, 107, 486–513.
[2]Li Niu. Geochemical characterization of cored sediments on the northern continental slope of the South China Sea and responses to cold seep activities, Chinese Academy of Sciences, 2015, 25-26.

Acknowledgements

This work was supported by the voyage scientists for their hard work in collecting the research samples.

Keywords

Anaerobic oxidation of methane (AOM), methane seepages, South China Sea (SCS)

Gas-geochemical features of hydrocarbon gases of the bottom sediments in the Tatar Strait, Sea of Japan, Russia

A. Yatsuk[1,2*], R. Shakirov[1], A. Gresov[1], A. Obzhirov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova Str., Vladivostok, Russia, 690090*
**e-mail: yatsuk@poi.dvo.ru*

Currently, carrying out gas geochemical studies in various sea areas are widespread. One of the most important tasks in the field of gas geochemistry is to determine of background and anomalous gas-geochemical fields of hydrocarbon gases (HCG) in bottom sediments [Abrams, 2005]. Gas-geochemical data about distribution of hydrocarbon gases in the bottom sediments of the Tatar Strait, Sea of Japan were obtained during five research cruises in 2012-2017. As a result of these works, the areas of gas hydrates, gas flares, anomalous gas-geochemical fields in the bottom sediments and water column were discovered.

During all expeditions on board the vessel, the content of hydrocarbon gases C1-C5 (methane, ethane, ethylene, propylene, propane, n-butane, i-butane and pentane) was determined by chromatographic method in the bottom sediments. The predominant component in all samples was methane. The HCG concentration varied from 0.38 ppm to 14.9% (median - 177.48 ppm). Analysis of the total distribution of hydrocarbon gases in bottom sediments is possible using frequency diagrams and a cumulative frequency distribution [Abrams 2005]. The HCG distribution is lognormal. There are three frequency peaks of the highest occurrence of hydrocarbon gas concentrations: <25.7 ppm (frequency - 355), 250-500 ppm (frequency - 116), 5-10% (frequency - 183). This feature emphasizes the influence of a variety factors and the existence of various sources of hydrocarbon gases. The cumulative frequency of the concentration range <25.7 ppm corresponds to the boundary of the lower 25% quartile of distribution, this concentration range is close to the background HCG content in the surface layer of bottom sediments. The intermediate range from 25.7 ppm to 20149 ppm is 50% and corresponds to the range of quartile range. The cumulative frequency of anomalous concentrations> 20149 ppm corresponds to the boundary of the upper 25% quartile distribution. Gas samples with super anomalous concentrations HCG >5% is 14.5%. In general, 50% of samples have concentrations less than 177.48 ppm, which may correspond to the conditionally background concentration level for all bottom sediment intervals. The vertical distribution is also complex and non-uniform. Maximum gradients of changes in the concentrations of hydrocarbon gases were found in the eastern part of the Tatar Strait in cores containing gas hydrates and gas-saturated sediments.

Results confirm the high oil and gas potential of the Tatar Strait water area and the presence of deep migration routes for hydrocarbon gases.

References

M. Abrams. Significance of hydrocarbon seepage relative to sub-surface petroleum generation and entrapment. Marine and Petroleum Geology, 2005, volume 22, 457–477.

Acknowledgements

We are grateful to all our colleagues from the laboratory of gas geochemistry POI FEB RAS. Special gratitude to Olga Vereshchagina, Natalya Pestrikova, Elena Maltseva, Nadezhda Syrbu for performing high-quality chromatographic analysis. This work was supported by the Russian Foundation for Basic Research (RFBR) grant No. 18-35-00047.

Key words

Hydrocarbon gases, bottom sediments, Tatar Strait

Environmental monitoring and evaluation of China's first offshore natural gas hydrate production test in the South China Sea, 2017

Dong Yifei[1,2,3], Liang Qianyong[2,3], Guo Binbin[2,3], Zhong Chao[2,3], Chen Jiawang[1], Sun Yuxia[1]

[1] *Ocean College, Zhejiang University, Zhoushan 316021, China*

[2]*Gas Hydrate Engineering Technology Center, China Geological Survey, Guangzhou 510075, China*

[3]*Guangzhou Marine Geological Survey, China Geological Survey, Guangzhou 510075, China*

**e-mail: yfdong1987@zju.edu.cn*

Natural gas hydrate (NGH) is widely considered to be one of the key clean energy sources for replacing coal, oil and natural gas in the future. However, it also has strong environmental effects and may leads to serious environmental disasters. Therefore, the environmental influence of NGH exploration should be assessed scientifically to ensure safe and efficient use of NGH resources. The first offshore NGH production test in the South China Sea (SCS) was successfully conducted by the China Geological Survey (CGS) from May 10 to July 9, 2017, which created world record with the longest continuous duration of gas production and maximal gas yield. During the whole process of the production test, environmental security has been effectively guaranteed via a comprehensive environmental monitoring system for atmosphere, sea water, seabed and underground. In addition, after the test, three environmental investigations were organized to evaluate the sustaining environmental impact of the NGH production test in Oct. 2017 and 2018.The integrated analysis of the data showed that the NGH production test did not cause environmental problems such as methane leakage. Based on the current monitoring and investigation results, the NGH production test was safe and controllable.

References

LiJinfa, YeJianliang, Qin Xuwen, et al., The first offshore natural gas hydrate production test in South China Sea. China Geology, 2018, **1(1)**, page5-page16.

YeJianliang,Qin Xuwen, QiuHaijun, Liang Qianyong, **Dong Yifei**, et al., Preliminary results of environmental monitoring of the natural gas hydrate production test in the South China Sea. China Geology, 2018, **1(2)**, page202-page209.

Acknowledgements

This work was supported byChina National Project "NaturalGas Hydrate Exploration and Production Test"(No.DD20160217, DD20190218),National Key R&D Project “Application ofEnvironmental Monitoring Technology Demonstration” (No.2017YFC0307605)and Open Fund of Key Laboratory belongto Seabed Mineral Resources of Ministry of Land andResources (No. KLMMR-2017-A-10)

Key words:
Natural gas hydrate, production test, environmental monitoring

T02-2: Marine geology and geological recourses

Pyrolusite deposits from the deep-waterbasin of the Sea of Japan

N.V. Astakhova
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail: n_astakhova@poi.dvo.ru

Hard fragments (crushed only by a hammer) of manganese deposits differing strongly in appearance from the regional ferromanganese crusts were sampled from depths of 3500–3200 m during the dredging of an unnamed seamount in the Central Basin of the Sea of Japan. Their surface has a black carbonaceous coating; after its removal, the crusts become steel-gray. Sections formed by the aggregates of fine crystals of adamantine luster are distinguished in the sample fractures. Lighter gray veinlets with cavities covered with the same crystals were found. Sections formed by radial aggregates of acicular crystals are revealed in several samples. The specific weight of these crust fragments is 3.35 g/cm3, whereas the regional crusts have a specific weight of <2 g/cm3. X-ray diffraction analysis showed that the sampled fragments consist of pure pyrolusite. There are also fragments of crusts formed by a mixture of pyrolusite and birnessite or oftodorokite and birnessite.

All pyrolusite samples have an abnormally high content of Mn (up to 63%). The Mn/Fe ratio reaches 9016 [1]. Probe microanalysis of the polished sections of pyrolusite showed that its matrix has a homogeneous composition expressed by chemical formula MnO_2, with permanent minor impurities of Si and Ca. Impurities of P, Cl, and, more seldom, Fe, Mg, S, Zr, and Mo are also often present.

Manganese crusts formed on the seamount as a result of intense element fractionation of the ore-forming solution in the Late Pleistocene–Holocene. This phenomenon is specific to hydrothermal deposits. The formation of crusts might have been due to the rapid deposition of manganese hydroxides in the zone of mixing of hydrothermal solutions with the seawater. The (Mn + Fe)/Ti and Al/(Al + Fe + Mn) ratios also point to a high content of exhalative component in the ore deposits. Todorokite–birnessite assemblage is typical of hydrothermal crusts. The microstructure of the studied samples indicates that the composition of ore-forming solutions changed in time and in space.

The Sea of Japan differs from other seas in the abnormally high content of dissolved oxygen. The average annual content of dissolved oxygen in the zone of the unnamed seamount in the Central Basin varies from 6.3 ml/L at a depth of 300 m to 5.0 ml/L at a depth of 1500 m (oxygen minimum) and to 5.3 ml/L at a depth of 2800 m [3]. The oxygen minimum in the World Ocean waters, including the waters in the Magellan Mountains area, occurs at a depth of 1000–1200 m and is 1.0–1.2 ml/L [2]. Despite the depth of more than 3000 m, we cannot rule out partial replacement of birnessite and todorokite by pyrolusite in the Central Basin of the Sea of Japan because of the specific hydrochemical composition of its waters, although no massive monomineral pyrolusite deposits were found here earlier.

Acknowledgements
This study was financially supported by the Far Eastern Branch of the Russian Academy of Sciences (Grant no. 18-1-008).

References

1. AstakhovaN.V., Lopatnikov E.A. Composition and parageneses of massive pyrolusite from the deep-waterbasin of the Sea of Japan//Russian Geology and Geophysics 57 (2016) 1465–1476. doi.org/10.1016/j.rgg.2016.09.003
2. National Oceanographic Data Center (NODC). http://www.nodc.noaa.gov/cgibin/OC5/WOA09F/ woa09f.pl?parameter=o. Cited April 5, 2013.
3. Hydrometeorology and Hydrochemistry of Seas.Vol. 8.Sea of Japan [in Russian].Gidrometeoizdat, St. Petersburg. 2004. 268 p.

Evidences of submarine environment in formation the Miocene basaltic andesite ignimbrites at Eastern volcanic belt, Kamchatka

O. Bergal-Kuvikas[1,2*], A. Rogozin[1], E. Kliapitskiy[1]
[1] *Institute of Volcanology and Seismology, Petropavlovsk-Kamchatsky FED RAS, Piip Avenue 6, Petropavlovsk-Kamchatsky, Russia, 684009*
[2]*Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry RAS, Staromonetny str. 35 buil. 2, Moscow, Russia, 119077*
**e-mail: kuvikas@mail.ru*

Basaltic andesite ignimbrites are rare pyroclastic rocks on Earth. Their genesis is interesting and still discussed. During the last decades in Kamchatka Institute of Volcanology and seismology works on field mapping ignimbrites and rocks of caldera-forming eruptions were done. The Miocene (5.78-5.58 Ma) basaltic andesite ignimbrites were founded on Verhneavachinskaya caldera, Mt. Stol and numerous outcrops in basement of Eastern volcanic belt, Kamchatka.

In order to understand origin of such types unusual rocks, such as basaltic andesite ignimbrites we analyzed global database of Smithsonian Institute (USA). We used follows criteria for comparing and finding mafic calderas with basaltic andesite ignimbrites: (1) caldera, as a type of volcano, (2) silica contents, as basaltic andesites, (3) ignimbrite, as a type of the rocks. In results of works only 5 calderas with basaltic andesite ignimbrites were founded: Coli Albaniin Italy, Lican ignimbrite of Villarica volcano in Chile, Massaya in Nicaragya and caldera complexes in New Hebrides, e.g. Ambrym, Tanna, Santa Maria, Kuwai. The uniform features for all listed above volcanoes are genesis of basaltic andesite ignimbrites are related with eruptions hot pyroclastic flows in the external water basin (e.g. lagoon/sea/ lake) or under the water. In order to estimate possibilities of existence marine environment in Miocene at Eastern Volcanic belt we made paleoreconstruction of environment based on stratigraphic and paleontological methods. Combination various types of the data clearly show that all area of Eastern volcanic belt was under the water. Moreover, numerous mollusks on Mt. Stolobviously identify submarine environment in the Miocene. In the basement of studied outcrops observed tuffs with pebbles, boulders. Upper part of the outcrops represented by interbeded layers of ignimbrites, sandstones and lava flows. Columnar joins of ignimbrites, their locations in the outcrops, interbeded layers of ignimbrites and layers of volcanogenetic sediments with rounded clasts of ignimbrites, pumices and hyaloclastites confirmed our hypothesis about external water interactions in formation the basaltic andesite ignimbrites. Irrefutable evidences of formation ignimbrites in submarine environments and hydrothermal activities are finds of palagonites, which formed due to alteration process between basaltic glass and external water.

Results of our research are important to understand origin of unusual basaltic andesite ignimbrites and show significant role of the external water in formation magmatic suites in early stage of Kurile-Kamchatka arc in Northwest Pacific.

Acknowledgements
This work was conducted in frames of National programs of Russian Academy of Sciences for Institute Volcanology and Seismology and Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry.

Key words
Submarine volcanism, basaltic andesitic ignimbrites, Kamchatka

A rapidly circulated tidal-influenced hydrothermal system temporarily cooled by a tropical storm

Xue-Gang Chen [1]*, Ming-Zhen Yu [1], Pei-Sun Loh [1], Dieter Garbe-Schönberg [2], Zhongyan Qiu[3], Mark Schmidt [4], Chen-Tung Arthur Chen [1, 5], Hao Zheng [1], Ying Ye [1]

[1] *Ocean College, Zhejiang University, Zhoushan 316021, China*

[2]*InstitutfürGeowissenschaften, Christian-Albrechts Universität zu Kiel, 24118 Kiel, Germany*

[3] *Key laboratory of submarine Geosciences, Second Institute of Oceanography, Minister of Natural Resources, Hangzhou 310012, China*

[4] *Helmholtz Center for Ocean Research Kiel GEOMAR, Kiel 24118, Germany*

[5] *Department of Oceanography, National Sun Yat-Sen University, Kaohsiung 804, Taiwan*

**e-mail: chenxg83@zju.edu.cn*

The Lutao hydrothermal field is an intertidal arc-volcanic system located at offshore southeast Taiwan, hosting a Zhudanqu (ZDQ) vent and a Huwaichi (HWC) spring. The totally depleted Mg, moderately enriched chloride and H^+ with respect to seawater indicated that the ZDQ end member was solely derived from the brine phase resulted from low-degree subcritical phase separation. The vapor phase comprised the end member for the HWC vent fluids. The temperature and pressure of the phase separation were estimated as ~ 150 ^oC and ~ 5 bar, respectively. The water/rock ratio was calculated as about 2.

The Lutao hydrothermal system was slightly affected by semi-diurnal tides, either by tidal loading, or tidal currents, or a joint effort of both. The active circulation period of the Lutao system was about 3 h according to the time delay of its response to tides. Freshwater was almost absent in the HWC vent fluids at normal conditions. The typhoon Fung-wong that attacked the island on Sep 21st, 2014, however, imported freshwater into the vent fluids with a percentage of ~ 16%. Both the ZDQ and the HWC end members were a little changed after the typhoon event, suggesting a cooling of the reaction zone. Presumably, the seawater was cooled by the tropical storm by 2-5 oC which consequently quenched the reaction zone and declined the degree of phase separation. After the typhoon passing by, the hydrothermal system began to recover, evidenced by increasing percentages of the HWC end member and decreasing freshwater contributions. The flux of the HWC end member was estimated as ~ 500 L h^{-1} based on these observations. This study, for the first time, reports a shallow-depth hydrothermal system that was cooled by a tropical storm and affected by tides.

Acknowledgements

The authors thank the Green Island Marine Research Station, Academia Sinica for providing accommodation. This work was financially supported by the National Natural Science Foundation of China (NSFC No. 41806051), the China Ocean Mineral R&D Association (COMRA) project (DY135-G2-01-03, and DY135-S2-01-03), National Natural Science Key Foundation of China (NSFC No. U1709201), and the Aim for the Top University Program of Taiwan (03C0302).

Key words

Hydrothermal system; Tide; Typhoon;

Biological leaching of non-ferrous metals under the seabed

Yury Elkin

Pacific Institute of Bioorganic Chemistry Far East Branch of Russian Academy of Sciences, 159, Ave. Stoletia Vladivostoka, Vladivostok, 690022, Russian Federation.
E-mail: yurielkin@list.ru, Tel: +7 908 968 9134

Background: Bioprocessing of ores is already working in various technological schemes, allowing the extraction of non-ferrous and precious metals, although it still remains a niche in the spectrum of mining and metallurgical technologies.
The development of the ore resources of the Ocean becomes necessary, following the shift of the region of hydrocarbon production from land to sea.
Obviously, operating terrestrial biotechnologies are not always acceptable in the marine environment, if only because of the high probability of environmental threats. However, the biotechnological potential of hydrometallurgy of marine microorganisms is practically unknown. Fact was became a challenge to our interdisciplinary team.

Material and methods: The search for the niches of the existence of the marine biotechnology of biodegradation and diagenesis of the seabed minerals was conducted among the communities of benthic marine organisms whose representatives consume the mineral substrate. The comparative mineralogical survey of the grains deposited in the gastrointestinal tract and faeces of the sand dollars *Scaphechinus mirabilis* and minerals of sandy habitat of this species was used. The animals were found on siliceous sandy terrigenous substrate in Cholernaya inlet (Pos'et Bay, Sea of Japan) and collected by scuba divers. Separation of mineral grains was carried out under gravity in a high-density liquid and under stepwise magnetization. Techniques of the visual microscope inspection, SEM/EDX, ICP MS, TRFA and X-ray diffraction were applied for analysis of the mineral grains and the products of its biological transformations.

Results: The gut diverticulum was filled with only zircon ($ZrSiO_4$, 85 w. %) and ilmenite ($TiFeO_3$, 15 w. %) while the sandy substrate contains 6 more minerals. The SEM/EDX studies of organic free faeces found the shapeless formations consisting of titanium dioxide, silicate nodules containing the silver (up to 50%) and also rounded silicate nodules of iron (~ 30%).

Conclusions: It seems that the gastrointestinal tract of animals of this echinoid family keeps unique niche for the microbial consortium to domesticate which is an attractive challenge on the way to the development of the mineral resources of the Ocean.

Soils in coastal-marine ecosystems of the Japanese sea coast

A. Brikmans[1*], A. Hohlova[1], V. Semal'[1,2], O. Nesterova[1], N. Rybachuk[1]
[1]*Far Eastern Federal University, st.Sukhanova, 8, Vladivostok, 690090, Russia*
[2]*Federal Scientific Center on the East Asia Terrestrial Biodiversity of FEB RAS, Vladivostok 690022, Russia*
**e-mail: chernovalova.avl@dvfu.ru*

The Far East is characterized by monsoon climate, mountain-valley relief in combination with tectonic depressions, and by diversity of landscapes. The abrasive-accumulative relief of landscapes covers the sea coastline of Primorye and is represented by areas of mainly accumulative-leveled, rias, abrasion-bay and abrasion-aligned shores (Korotkii,1970). Since the coasts are subject to anthropogenic load, it is necessary to understand the human influence on the soil cover of the coasts, which directly affects the coastal-marine zone.

The aim of the work was to study the ecological state of the coastal soils of the Japanese Sea coast on the example of Peter the Great Bay. The tasks included the study of the classification regularity of the distribution of soils in the space of coastal territories; the study of the chemical properties of the soil (heavy metal content) on the example of various catenas; assessment of the ecological state of the soil cover of coastal areas. The study area was the soils of the coastal part of the Amursky, Ussuriysky Bays and the Bezymyammaya Bay in the Sea of Japan.

The objects of the study were the soils of the Japanese sea coast, located near the city of Vladivostok. Nine soil catenas were studied (geochemically related soils along the relief), each catena was represented by soils directly entering the tidal zone (hydromorphic series), semi-hydromorphic series (submerged sea waters) and zonal soils. The soil particle size distribution, acid-base properties, organic matter content and heavy metals (gross content and mobile forms)in soil samples were investigated. The content of heavy metals in soils was established by atomic absorption analysis on a Shimadzu AA-6800 spectrophotometer in an acetylene-air flame.

The bay area is represented by Tidalic Arenic Fluvisols and Tidalic Histic Arenic Fluvisols. Inland these soils are changing with flood-free, but flooded marine groundwater Tidalic Histic Arenic Gley soils and Artnic Histosols Fluvic. The most remote soils from the coast deep into the continent and already non-flooded sea waters of the zonal soil series: Haplic Cambisols and Gleyic Cambic Luvisols (Mollic).

Zonal soils are highly clayey and can influence subsurface runoff on the underlying areas and waters (polluting marine ecosystems and causing eutrophication and sterilization of water areas). The granulometric composition is semi-hydromorphic and hydromorphic soils, mainly light-grained (sand and sandy loam), so they have high water permeability and water conductivity. By acidity, zonal soils have an acid reaction, which contributes to the removal of heavy metals, if present, semi-hydromorphic and hydromorphic, have a neutral and slightly alkaline reaction of the environment, which translates mobile forms of heavy metals into a more stable state. Studies of the presence of heavy metals in mobile form in soils showed no contamination in all soils. The gross content of heavy metals showed an excess of data on two elements: iron and manganese, which is explained by the peculiarities of the genesis of zonal soils of the Far East.

References

Korotkii A.M. *Correlation of modern relief and precipitation for paleogeography (for example, the mountainous countries of the south of the Far East)* / - Vladivostok, 1970. – 167 p.

Key words: Soils, heavy metals, the coast of the Japanese Sea coast

Pyrolysis–gas chromatography–mass spectrometry of insoluble organic matter of the Cape Muostach sediments (Bykovsky Peninsula, Laptev Sea coast)

A.A. Grinko[2], A.S. Ruban[2], I.V. Goncharov[2,3], N.E. Shakhova[2], I.P. Semiletov[1,2*]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, .43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*School of Earth Sciences & Engineering, Tomsk Polytechnic University, Tomsk, 634050, Russia*
[3]*JSC "TomskNIPIneft", Tomsk, 634027, Russia, Tomsk, 634050, Russia*
**e-mail: grinko@tpu.ru*

The most developed processes on the shores of the East Siberian Arctic seas (ESAS) are thermal destruction, thermal erosion, thermokarst, solifluction (cryosolifluction) and cryogenic weathering, with thermoabrasion being the leading geomorphological process in the investigation coastal zone (Slagoda, 2004; Günther et al., 2013; Grigorievet al., 2009). The objective of this research is to study the insoluble organic matter of the outcrops of Cape Muostakh (Bykovsky Peninsula) using pyrolysis–gas chromatography–mass spectrometry method (Py□GC□MS) to describe the intensive thermal abrasion currently taking place on the Laptev Sea coast. Samples for this study were selected on the Cape Muostakh, (Bykovsky Peninsula, Laptev Sea coast). All samples, except for the sample KV1, were selected on the coastal cliff of Cape Muostakh at different levels relative to sea level □ 1, 5, 11, 15, 20 and 21.5 meters. The Py□GC□MS method is used to obtain information on the composition of organic matter and this method is a fast and reliable for studying macromolecular organic compounds in sediments (White and Beyer, 1999; Sparkes et al., 2015, 2016). Using this method, we can obtain information on the composition of macromolecular organic compounds that are not extracted by organic solvents (NEOC– non-extractable organic compounds). NEOC contains macromolecular components such as lignin, proteins, cellulose, and their decomposition products (Sparkes et al., 2016).The amount of NEOC in the sediments organic matter is much greater than that extracted by solvents (according to the Rock□Eval data). The measurements were carried out on a pyrolytic console CDS Pyroprobe 5150, which was connected to a GC□MS injector via heated transfer-line. Pyrolysis products contain the hundreds components, the peaks of the most intense of them were identified and summarized. Pyrolysis products have a similar composition of the components with those analyzed in (Sparkes et al., 2016; Guo et al., 2004; Melenevskii, 2011, 2017), but also were identified furan, benzofuran, pyrrole, indole, indene and their methyl derivatives, acids, alcohols, and other oxygen-containing compounds. A smaller number of components formed during pyrolysis, falls on the sample collected at the level 5 m. The pyrolysis products of the samples "20" and "21.5"comprise more oxygen-containing components compared with the other samples. A sample collected at the level 5 m of the cliff contains the maximum amount of the aromatic hydrocarbons (56.79 %) in the pyrolysis products. This fact suggests that the NEOC in this sample is composed mainly of the condensed aromatic structures formed as a result of intensive diagenetic transformations (including oxidation) of the organic matter, while here it is important to note the actual missing of aromatic hydrocarbons in the extractable OM. At the levels 11 and 15 m, an increased content of aromatic hydrocarbons is also observed, which may indicate that erosion oxidation of the OM in these samples also occurred. Sample "5" contains the minimum amount of phenols, which were probably removed during the erosion effects on this level of the cliff.

References

M.Grigoriev, V.Kunitsky, R.Chzhan, V. Shepelev, *Geography and Natural Resources*, 2009, v.30, issue 2, 5-12.
F.Günther, P.Overduin, A.Baranskaya, T.Opel, M.Grigoriev, *The Cryosphere Discuss.*, 2013, 7, 4101-4176, 2013.
F.Günther, P.Overduin, A.Sandakov, G.Grosse, M.Grigoriev,*Biogeosciences*, 2013, 10, 4297- 4318.
V.Melenevskii, G.Leonova, A.Konyshev, *Russian Geology and Geophysics*, 2011, 52, 6, 583-592.
V.Melenevskii, S.Saraev,E.Kostyreva,V.Kashirtsev,*Russian Geology and Geophysics*, 2017, v.58, issue 2, 225-239.
Sladoga E.A.: Cryolithogenic Deposits of the Laptev Sea Coastal Plain: Lithology and Micromorphology. Tyumen: Publishing and Printing Centre "Express", 119 pp, (in Russian).
R. Sparkes,A.DogrulSelver,J.Bischoff, H.Talbot, O.Gustafsson, I.Semiletov, O. Dudarev, B. van Dongen., *Biogeosciences*, 2015, 12, 3753–3768.
R.Sparkes, A.Selver, Ö. Gustafsson, I.Semiletov, N.Haghipour, L.Wacker, T.Eglinton,H.Talbot, B.van Dongen, *The Cryosphere*, 2016, 10, 2485-2500.
D.White, L.Beyer,*Journal of Analytical and Applied Pyrolysis*, 1999, 50, 63-76.

Acknowledgements

This research was supported by Tomsk Polytechnic University CE Program.

Key words

Arctic, Cape Moustakh, Pyrolysis–gas chromatography–mass spectrometry

Millennial scale Cycles in the Bering Sea during Penultimate and Last Glacials; Similarities and Differences

S.A. Gorbarenko[1]*, G.Yu. Malakhova[2], X. Shi[3], A.A. Bosin[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2] *North-East Interdisciplinary Science Research Institute, Far East Branch Russian Academy of Science, Magadan, Russia*
[3]*Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, MNR, Qingdao, China*
e-mailgorbarenko@poi.dvo.ru

The chronology of the western Bering Sea core 85KL was modified through correlation of new and earlier-measured productivity proxies with the Chinese interstadials described by δ18O records of Hulu and Sanbao caves and the relative paleointensity events in the studied core with those in the dated records (Riethdorf et al., 2013; Wang et al., 2008). The pattern of the frequency and amplitude distribution of the millennial productivity/climate variability in the Bering Sea during the penultimate glacial resembles that initially depicted in the δ18O of Chinese cave stalagmites and is quite similar to one of the Dansgaard–Oeschger cycles during last glacial (NGRIP members, 2004), except for their terminations. Contrary to well-pronounced interstadial A1 during termination TI, an interstadial B1 over the TII has lower duration and is weakly observed in Antarctic temperature(EPICA members, 2006). Our results provide robust evidence that the bipolar seesaw mechanisms of millennial climate changes in the Northern and Southern Hemispheres were similar during the last and penultimate glacials.

References

J.-R.Riethdorf, D. Nürnberg, L.Max, R.Tiedemann, S.A. Gorbarenko, M.Malakhov, *Climate of the Past*, 2013, 9(3), 1345-1373.
Y.Wang, H.Cheng, R.L.Edwards, X.Kong, X.Shao,S.Chen et al.,*Nature*, 2008, 451, 1090-1093.
North Greenland Ice Core Project members,*Nature*, 2004, 431, 147-151.
EPICA Community Members,*Nature*, 2006, 444, 195-198.

Acknowledgements

This work was supported by the Russian Foundation for Basic Research (19–05–00663a), Russian state budget theme № 7 of POI FEB RAS № AAAA-A17-1170301100330 and international Taiwan-FEB RAS grant № 17-MHT-003 and the National Natural Science Foundation of China (grant nos. 41476056, 41611130042 and U1606401).

Key words

Dansgaard–Oeschger cycles; Penultimate and Last Glacials; Similarities and Differences

Potentially diamondiferous vortex structure of the Sea of Japan

L.A. Izosov*, Yu.I. Melnichenko, T.A. Emelyanova, N.S. Lee
V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: izos@poi.dvo.ru*

The Japan marginal Sea together with its continental and island frame is allocated as the seismic active vortex structure created in a zone of rotary shift as a result of side interaction of the Eurasian and Pacific lithospheric plates (Izosov, Chuprynin, 2012; Chuprynin, Izosov, 2017). Opening of the Sea of Japan happened mainly in a Miocene-Pliocene and was followed by intensive basalt volcanism. In the Sea of Japan depression by us it is allocated (Izosov et al., 2000, 2018)potentially diamondiferous the Neogene-Quarternary alkaline basalt Formation, including the volcanic neck facies of the Neogene basalts with deep xenoliths of ultrabasites. Explosive bodies of alkaline basalts enter into big community of nonconventional indigenous shows of diamonds (Kaminsky, 1984).

This alkaline basalt Formation began to attract fixed interest after opening in Western Australia of the Jurassic and Miocene pipes of diamondiferous lamproites and the similar kimberlite rocks to which can be compared (Kushev, Tyulenev, 1988) close to them on age and on genesis (Gapeeva, 1960)leytsitovyankaratrite and ankaratrite-picrite of the Lesozavodsk explosion pipe of Primorye.

Sea of Japan depression is a highly movable and permeable volcano-tectonics system, formed in the result of a combination of the rise of a mantle diaper and rotational shear (Chuprynin, Izosov, 2017). The manifestation of diapirism causes the formation of the explosion pipes and the removal of diamonds from the mantle through these channels, and rotational movements – "tightening" them into the weakened moving vortex zones.

It is earlier shown (Lapin, Tolstov, 2007), that alkaline basalts and alkaline lamprophyres can transport diamondiferous mantle inclusions from zone of stable formation of diamond on higher levels on the mechanism of the rotating mantle diaper. With respect to the volcanic neck facies of the given Formation in Precambrian blocks of the Japan Sea depression detection of diamondiferous placers, as it takes place in the Yellow Sea region of the Liaodong Peninsula is predicted (Izosov et al., 2000).

References

ChupryninV.I., IzosovL.A.,*Doklady Earth Sciences*, 2017, Vol. 472, No. 1, 16-19.
GapeevaG.M.,*Geology and Geophysics*, 1960, No. 10, 56-63.
IzosovL.A., ChupininV.I.,*Geotectonics*, 2012, Vol.46,Iss.3, 232-250.
IzosovL.A.,ChupininV.I., LeeN.S.,*Vestnik FEB RAS*, 2018, 41-51.
IzosovL.A., KonovalovYu.I., YemelyanovaT.A.,*The problems of geology and diamondiferous of the continent – ocean transition zone (Japan Sea and Yellow Sea regions)*, Dalnauka[Vladivostok, Russia], 2000, 326 pp.
KaminskyF.V.,*Diamondiferous of not kimberlite igneous rocks*,Nedra[Moscow, Russia], 1984, 173 pp.
KushevV.G.,TyulenevA.E.,*Reports Acad. Sci.of USSR*, 1988,Vol. 298, No. 1, 170-173.
LapinA.V., TolstovA.V.,*In;Alkaline magmatism of Earth and its rudonosnost: materials of reports of the International (CIS countries) meeting*, 2007, 143-146.

Acknowledgements
The work was performed in the framework of the state task of the Institute (No. AAAA-A17-117030110033-0 and No. AAAA-A17-117030110035-4), and with the support of the Far East Program (No. 18-1-008, No. 15-1-1-017).

Key words
Vortex structure, diamond.

Fluid permeable fracture zones of the Northwest Pacific, linear gas hydrate ranges in the Sea of Okhotsk Area and prospects for hydrocarbon resource potential

S. Kasatkin[1], N. Boriskina[1,2], V. Khomich[1,2*]
[1]*Far East Geological Institute, FEB RAS, 159, Prospect 100 let Vladivostoku, Vladivostok, Russia, 690022*
[2]*School of Engineering, Far Eastern Federal University, 8, Suhanova Str., Vladivostok, Russia, 690950*
**e-mail: khomich79@mail.ru*

Fluid permeable significance of the fracture zones such as Nosappu, Iturup and Urup in the Sea of Okhotsk Region and Southern Kurile Islands are established (Kasatkin, Obzhirov, 2018; Shakirov, 2014; Khomich et al., 2019). These fracture zones are known in the northwestern part of the Pacific Plate and its subducting slab.

To study gas hydrate occurrences and to search oil deposits in the back-arc basins and continental shelf, the focal mechanism solutions and seismic tomography data are used. We have analyzed the focal mechanisms data of the all strong earthquakes ($M \geq 5$) in the Benioff seismic zone (depth range of 50–700 km) of the Sea of Okhotsk region for the period from 1977 to 2010 using records of the U.S. National Earthquake Information Center. Moreover, just strike-slip earthquakes were selected to estimate their distribution within the subducting slab. Because it is the strike-strip faults that can form the syn-fault extensional structures (permeability channels) allowing the fluids from the asthenosphere and mantle to penetrate through the slab. In addition, the seismic tomography profiles show the channels as low speed P-wave areas in the slab.

The hydrocarbon flows are known in the Sea of Okhotsk and in the water-fluid discharging places that confined to numerous volcanoes of the Kuril Islands, especially those in the south: Mendeleev, Golovnin (Kunashir Isl.), and Medvezhii (Itupur Isl.), and other volcanoes above Nosappu, Iturup and Urup fracture zones. The main component (up to 90-95 vol.%) of volcano discharging is water vapor. Other compounds found are CO_2, CO, HCL, HF, H_2S, NH_3, N_2, CH_4, HCNS, F_4, $B(OH)_3$, Ar, etc. (Shakirov, 2014). In active high-temperature solfataras, thermal springs and mud pots there are methane (up to 800 nl/l), ethane (up to 40 nl/l), ethylene (up to 100 nl/l), propane, butane, complex compounds of hydrocarbons with chlorine, phosphorus, rhenium and platinum, as well as other noble metals (Khomich et al., 2019). Besides, oil and gas occurrences are also fixed above the fracture zones in the abyssal of the northwestern Pacific (Lomtev et al., 2016), between the Kuril-Kamchatka Trench and the Shatsky Rise, as well as in the south Sea of Okhotsk that requires more detail geological and geophysical studies and drilling in the Kuril Basin, in the Shantar Archipelago and in the southeastern flank of the Aldan Anticlise (Uchur structure-facies zone, Siberian Craton).

References

S. Kasatkin, A. Obzhirov, *Russian Journal of Pacific Geology*, 2018, **12,** 57-62.
V. Khomich, N. Boriskina, S. Kasatkin, *Ore Geology Reviews*, 2019, **105**, 151-162.
V. Lomtev, O. Veselov, D. Kozlov et al. Features of the structure and geodynamics of tectonosphere of north-western part of the Pacific ocean and Far Eastern seas. Dalnauka, Vladivostok, 2016, 1-148 (in Russian).
R. Shakirov, *Geochemistry International*, 2014, **52,** 247-259

Key words
Mantle fluids, fracture zones, hydrocarbon resources.

Signs of vortex geodynamics in the western Pacific morphostructure

Y.I. Melnichenko*, L.A. Izosov, V.V. Lepeshko, N.S. Lee, E.B. Osipova
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: yumel@poi.dvo.ru*

The role of the earth's axial rotation and the change in its velocity in global geodynamics has attracted much attention since the last century. Rotation and pulsation forces are subject trans-regional faults and tectonic shifts. The contours of the eastern Asian marginal seas are also determined by the forces of the planet rotation in some way. The influence of the Earth rotation should be expected on the formation of the earth's crust deformations – the appearance of nonlinear dislocations, in particular. The report presents an analysis of the Pacific margin of Asia morphological tectonics, which includes sea basins and adjacent areas of the ocean and continent. Geological and geophysical materials and data of space altimetry are used in analytical research. Geological structures were the subject of research. They manifest themselves in the earth's surface forms (morphostructures), and the various deformations of their occurrence – in the form of lineaments. Therefore structural and comparative tectonic methods of earth crust analysis were the main ones in the study. Digital relief model (site "ETOPO1") converted into Surfer and WinLESSA programs, methods of mathematical statistics are used. Mechanical-mathematical simulation of the ocean margin morphological evolution held. Cartographic schemes of the Earth's surface heights (minimum, average, maximum and standard deviations) and gravitational anomalies in the Fay reduction are obtained. Continental-Island Land and ocean floor lineaments are calculated and allocated. They constitute the structural drawings of the earth's surface, which reflect the tectonic deformations of the earth's crust. There are different morphostructures of the block dislocation type, mantle diapirs (domes), and cyclonic vortexes. Dislocations with a special type of symmetry – "Yin-Yang system" are distinguished. (Kazanskiy, 1997). Such structures probably reflect cyclonic phenomena in the Earth's tectonosphere. They arise under the influence of the planet rotational and pulsating forces and are caused by local convection of material masses. These processes cause the torsion effect of tectonic masses, which probably contributes to the development of lithospheric vortexes on the "continent – ocean" border. The Sea of Japan depression formation can serve as an example of the upward tectonic masses streams in convection mode (Osipova, 2010). The appearance of faults, the island arcs formation and other morphotectonic processes that organize the earth's topography mega-structure are probably associated with them. Further study of lithospheric vortexes can undoubtedly change the understanding of the tectonic interaction processes in the continental – ocean geological system.

References

KazanskyB.A., *Russian Journal of Pacific Geology*, Vol. 16, No. 3, 29-33.
OsipovaE., MelnichenkoY., S'edinV., *In; 5th PEACE Workshop*, 2010, 227-234.

Acknowledgements

The work was performed in the framework of the state task of the Institute (No. AAAA-A17-117030110035-4 and No. AAAA-A17-117030110033-0), and with the support of the Far East Program (No. 15-1-1-017, No. 18-1-008), RFBR (№ 18-05-00153 A).

Key words

Morphostructures, vortex geodynamics.

INDUSTRIAL PROCESSING OF COASTAL-MARINE PLACERS OF TITANOMAGNETITE

V. Molchanov[1*], A. Yudakov[2]
[1]*Far East geological Institute FEB RAS, 159, Prospect 100 years of Vladivostok, Vladivostook, Russia, 690022*
[2]*Institute of Chemistry FEB RAS, 159, Prospect 100 years of Vladivostok, Vladivostook, Russia, 690022*
**e-mail: vpmol@mail.ru*

The purpose of the research was the development of a technology for the production of materials for powder metallurgy from titanium-magnetite sands of the Primorye shelf (Russia).
The main ore component of these sands is titanium magnetite $nFeTiO_4 \cdot (1\text{-}n)Fe_3O_4$, noted in the form of rounded grains of disturbed octahedra and sharp corners and is a solid solution with an isomorphic occurrence of titanium in the magnetite lattice. Along with titanomagnetite, oxides and silicates in the form of ilmenite and pyroxenes are present in an insignificant amount in the material. Ilmenite ($FeTiO_3$) forms grains with well pronounced crystallographic forms in the form of lamellar hexagonal crystals.

Based on experimental studies, a technological process has been developed for the processing of titanium-magnetite sands by powder metallurgy methods, which consists in enriching sand, fine grinding, restoring concentrate, pressing and sintering the powder material. To remove non-magnetic components, a two-stage enrichment scheme is recommended using magnetic and electromagnetic separation methods. As a result, iron-rich titanomagnetite concentrate of the following composition was isolated from sand: Fe_3O_4 of 85,32 мас.%, TiO_2 -8,25, $A1_2O_3$ - 2,6, MgO - 2,49, МпО - 0,57, SiO_2-5,21, V_2O - 0,47, Cr_20_3 - 0,06, $Zr0_2$ - 0,02 мас.%.In the process of recovery annealing, the mass of titanomagnetite concentrate is sintered, forming an agglomerate, the strength of which increases with the annealing temperature. Therefore, the treated powder samples must be crushed in a ball mill. The powder processed at a temperature of 750^0 C does not sinter, and after three hours of reaction, it is possible to obtain fully metallized iron. Samples were made from the obtained powder by cold pressing at a specific pressure of 7 t / cm^2 and sintering in vacuum at a temperature of 1150° C. The study of metallographic sections of sintered material under a microscope shows a clearly differentiable structure of an alloy of two phases: iron containing titanium, and a phase formed by oxides of titanium, vanadium, aluminum, magnesium and other elements.

The proposed technical solutions are only the first step in the development of alluvial coastal-marine deposits of titanomagnetites. It is obvious that further research should be carried out in the direction of complex processing of titanomagnetites, which will reduce the cost of obtaining individual products and ensure higher production efficiency. An integrated approach seems to be the best solution to the development of these fields, since the production of a number of commercial products (metal, ferrovanadium, titanium, pigmentary titanium dioxide, powder materials) will allow for highly profitable processing of cheap local raw materials and create a stable export potential.

Key words
Shelf, titanomagnetite, processing

Assessment of saltwater intrusion vulnerability in the coastal aquifers of NinhThuan province in the context of climate change

Pham Quy Nhan,Ta Thi Thoang, Tran Thanh Le
Hanoi University of Natural Resources and Environment
No 41 A PhuDien Road, PhuDien precinct, North-TuLiem district, Hanoi
Tel: (84-4) 38370598 - Fax: (84-4) 38370598

NinhThuan province is the most arid region of Vietnam where the dry season lasts for 9 months per year with the average annual rainfall of 300-400mm. As the decline of the surface water source under climate change condition and human being activities, groundwater became the most important source of water supply for the province. Due to groundwater extraction and sea level rise, groundwater in coastal aquifers of NinhThuan is now facing with seawater intrusion with more than 60% of the salinity zone out of the aquifer distribution. As seawater intrusion became the biggest concern for the groundwater resources of the province, it is necessary to evaluate the saltwater intrusion vulnerability in aquifers for planning and sustainable exploitation of groundwater in this province. In this study, an overview of previous current status groundwater salt interface and updated geophysical investigation (Vertical Electrical Sounding - VES) was carried out to understand on the situation or status of the salinity of groundwater. Chemical compounds of water sources were also analyzed to clarify the recharge sources. Based on these information, GALDIT method was used for an assessment of saltwater intrusion vulnerability in the coastal aquifers of the study area with six factors incorporated are groundwater occurrence, aquifer hydraulic conductivity, depth to groundwater level, distance from shore, impact of existing seawater intrusion, and aquifer thickness allowing us to rank and map the vulnerability of the coastal aquifers from low to very high. Within this study, each of GALDIT factor will be evaluated based on the data collected from various sources includes hydrogeological mapping projects, groundwater investigation reports, and groundwater chemistry analyses. The weight of each GALDIT index was used based on analytical hierarchical process (AHP) method. The result of vulnerability areas zoning in the study area is a good information to manage sustainable ground water development

Key words:
Seawater intrusion, GALDIT method, Climate change, Groundwater extraction, NinhThuan province

THE ROLE OF TECTONICS ON EVOLUTION OF THE RED RIVER DELTA, NORTH VIET NAM

Phung Van Phach[(1)*], Lobanov Viacheslav[(2)], Shakirov Renat[(2)], Yin Pin[(3)], Lai Vinh Cam [(4)]
[(1)]*Institute of Marine Geology and Geophysics, VAST, 18- Hoang Quoc Viet Street, Hanoi, Vietnam.*
[(2)]*V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, Baltiyskaya Str.43,Vladivostok, 690041 Russia.*
[(3)]*Institute of Marine Geology, Qingdao 266071, P.R. China*
[(4)]*Institute of Geography, VAST, 18- Hoang Quoc Viet Street, Hanoi, Vietnam.*
e-mail: pvphach@yahoo.com

The Red River Delta (RRD), North Viet Nam, has been forming since early Holocene (~9 k years ago) and is one of the most significant river deltas of the World. It occupies about 12,000-15,000 km^2, that equals the Nil river delta. The evolution of the RRD was controlled by many factors, but the tectonic activity is the most special. In fact the RRD is situated on top of the Hanoi graben that presents the NW part of the large Red River-Tonkin basin (RRTKB). The RRTKB occupies an area of 150,000 km^2, with enormous volume of sediment, which can reach 4,500-5,000 km^3.

The RRD is situated in the tectonically active region, along the Red River Fault Zone (RRFZ) that is a boundary between two tectonic plates: the South China Plate in the NN and the Indo-China Plate in the SW. The central part of the RRD laid over the Ha Noi graben, which is controlled by Lo River fault in the NE and Chay River fault in the SW. Due to tectonic activity the relief of the RRD basement is differentiated and revealed as in-uniform distribution of Quaternary sediments.

Evolution of the RRD has been closely connected with the Pliocene-Quaternary tectonics, specifically during transgression period after Last Glacial Maximum (LGM). Sea had advanced along the NE and SW subsidence zones of the RRD and created two remarkable lagoons; meanwhile the central part of the RRD had somehow resisted transgression process and created a protrusive zone.

The Late Miocene tectonic compressive activity had created a reversed central block with the Tien Hai and Kien Xuong uplifted zones, while the Pliocene-Quaternary extension activity had produced several young graben structures, such as the Ninh Binh graben along Red River fault and Dong Quan sag along Lo River fault. Meanwhile the central sector of the RRD remained relatively stable or underwent a slight uplift.

Our study recognized that there were at least two tectonic movements have been occurred in the region since the Late Miocene, after a cessation of left-lateral strike slip of the Red River fault zone: those are NE-SW compression and then NE-SW extension according to the general right-lateral strike slip of the Red River Fault Zone (RRFZ).

This research was completed thank to two International Joint Projects: (1) The Project between Viet Nam and China "Comparative study of Holocene sedimentary evolution of the Red River Delta", coded as NĐT.01.CHN/15; (2) The project Between Viet Nam and Russia "Role of catastrophic processes in the formation, development of coastal complexes of South Pacific (Russia and Vietnam) and problems of coastal reasonable usage"; Coded as QTRU02.02/18-19. Joint research partially conducted by the Joint Vietnam-Russian Laboratory for marine geosciences (IMGG VAST – POI FEB RAS).

SPATIAL CORRELATION OF SIMUSHIR EARTHQUAKES WITH THE BLOCK STRUCTURE OF TECTONIC DESTRUCTION ZONE IN THE FRONTAL SLOPE OF CENTRAL KURIL REGION

Z.N. Proshkina *, R.G.Kulinich, M.G.Valitov
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: pro-zo@yandex.ru*

The shallow focus character of the Simushir earthquakes (2006–2007) provided a basis for searching for the sources of these events in the crustal structure of the frontal slope of the Central Kuriles zone. By this time, complex geological and geophysical expeditions were held in the area of the former "seismic gap" organized by V.I. Il'ichev Pacific Oceanological Institute FEB RAS with the participation of P.P. Shirshov Institute of Oceanology RAS. As a result, a large amount of new information was obtained, which served as a good basis for the implementation of the task. Studies were performed in two stages. The first of them revealed the spatial correlation of the epicenters of these earthquakes with the boundaries of the foundation blocks, separated by a complex of geophysical data, which corresponds to the crustal fault zones. The block structure is most clearly manifested in the relief of the acoustic foundation and the gravitational field (Kulinich, Valitov, Proshkina, 2012). The basis for the second stage of research was the complex reinterpretation of all previously obtained geophysical and geological data and the construction of a new more de-tailed structural and geological scheme of the studied area (Proshkina, Kulinich, Valitov, 2017). Re-comparison, including statistical analysis of the connection of the fault-block structure of the area with Simushir earthquakes, their foreshocks and aftershocks, showed that more than 70% of the epicenters of all seismic events are concentrated on the boundaries of the selected blocks, or located near such boundaries and faults. Less than 15% of the epicenter is concentrated inside the blocks. Depressions between the blocks are almost aseismic.

Thus, the studies performed showed a well-defined spatial correlation of crust seismicity with block fragmentation of the basement of the studied area. In this case, the trigger of earth-quakes should be the impact of external geodynamic (tectonic) processes, the creation of gravitational instability in the block structure and its relocation until a new stable equilibrium is created.

References

1. Kulinich R.G., Valitov M.G., Proshkina Z.N. Geophysical fields, block structure, and seismic activity of the Central Kuril Islands //Russian Journal of Pacific Geology. 2012. Vol. 6,№ 6. P. 436-443.
2. Proshkina Z.N., Kulinich R.G., Valitov M.G. Structure, Matter Composition, and Deep Structure of the Oceanic Slope of the Central Kuril Islands: New Evidence // Russian Journal of Pacific Geology. 2017. Vol. 11,№ 6. P. 436-446.

The work was performed in the framework of the state task of the Institute: A - A - A 17-117030110032-3.

Key words:
Seismicity, zone of tectonic destruction, frontal slope of Central Kuril region.

Distribution of heavy metals in the bottom sediments of the Buor-Khaya Gulf (Laptev Sea)

Ruban A.S.[1*], Dudarev O.V.[1,2], Mazurov A.K. [1], Rudmin M.A.[1], Gershelis E.V.[1],Charkin A.N.[1,2], Semiletov I.P.[1,2]

[1]*National Research Tomsk Polytechnic University, Tomsk, Russia, 634050*

[2]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

**e-mail: ruban@tpu.ru*

Due to the toxicity, persistence and bioaccumulation in the environment, heavy metal contamination has attracted much attention and become a global problem in recent years. Bottom sediments reflect some characteristics of various sources such as geological matrix; land use, natural and anthropogenic inputs. They are an important carrier of contaminants in rivers, seas and other waters. Estuarine and coastal areas, a region of active land-sea interactions, are sensitive to impacts from natural processes and anthropogenic activities. Sediments in coastal and estuarine ecosystems, as a reservoir or sink for heavy metals, can act as a source of heavy metals for aquatic organisms when environmental conditions change. Thus, sediments in marine environments can play a great role in the deposition and transmission of heavy metals. A better understanding of how the sediment sources and sediment properties affect heavy metal enrichment and their bioavailability in different aquatic environments is needed.

All the heavy metals studied have a similar structure of their spatial distribution that indicates the similarity of their geochemical behavior in the process of water migration and diagenesis. Its main features are the increase in the content from the coasts of the gulf to its central part, which reflects the circumterrestrial character of the spatial distribution. In the same direction, the dispersion of the particles increases in the sediments, a sign of the expressed preferential accumulation of heavy metals in fine sediments. Obviously, the connection with the primary mineral matrix of terrigenous material is weakened (with the exception of the sand-silt sediments of the underwater coastal slope along the mountainous coast in the southwest of the gulf). Such elements as Cr, Co and Ni are closely related to Fe that indicates the possibility of sorption of these elements by colloidal iron hydroxide particles. The main mechanisms controlling the distribution of heavy metals in the system "water-bottom sediments" can be codeposition and change in the forms of migration as a result of sorption by clay particles, colloids of charged gels of iron and manganese hydroxides with the participation of bog and river humic substances of the water collection area. An important mechanism for increasing the content level of heavy metals is bioaccumulation, which is activated in the region of the hydrological front (biogeochemical barrier) in the central area of the Gulf.

Acknowledgements

This work at various stages was supported by the Russian Science Foundation (project no. 19-77-00016), the Government of the Russian Federation (project no. 14.Z50.31.0012), and. Laboratory investigations were carried out at Tomsk Polytechnic University within the framework of a Tomsk Polytechnic University Competitiveness Enhancement Program grant.

Key words

Arctic, Laptev Sea, bottom sediments, heavy metals.

Relation between formation of ooidal ironstones and Cretaceous-Eocene warming events on example Bakchar deposit, south-eastWestern Siberia

Rudmin M.A.[1*], Mazurov A.K. [1], Ruban A.S.[1]
[1] *Tomsk Polytechnic University, Tomsk, Russia, 634050*
**e-mail: rudminma@tpu.ru*

An integrated study involving petrographical, mineralogical and geochemical investigations proposes the origin of the Bakchar ironstone deposit by upward migration of a mixture of Fe-rich brine and hydrothermal fluid through marine sediments. Authigenesis of ferrimagnetic sulfide minerals (greigite and monoclinic pyrrhotite) occurred across the Paleocene-Eocene Thermal Maximum (PETM) within the Bakchar ooidal ironstone in southeastern Western Siberia. Co-occurrence of these minerals is associated with diagenetic environments that support anaerobic oxidation of methane, which has been validated by methane fluid inclusion analysis in the studied sediments. In modern settings, such ferrimagnetic sulfide formation is linked to upward methane diffusion in the presence of minor dissolved sulfide ions. The PETM was the most extreme Cenozoic global warming event and massive methane mobilization has been proposed as a major contributor to the globally observed warming and carbon isotope excursion associated with the PETM. The studied sediments provide rare direct evidence for methane mobilization during the PETM. Magnetic iron sulfide formation associated with methanogenesis in the studied sediments can be explained by enhanced local carbon burial across the PETM. While there is no strong evidence to link local methane venting with more widespread methane mobilization and global warming, the magnetic, petrographic, and geochemical approach used here is applicable to identifying authigenic minerals that provide telltale signatures of methane mobility that can be used to assess methane formation and mobilization through the PETM and other hyperthermal climatic events. Trace element concentrations of the ironstone deposits rule out continental derivation of Fe, while high REE concentrations indicate mixed hydrogeneous and hydrothermal source. Three main types of ironstone within the Bakchar deposit are characterized by distinct mineralogical assemblage of authigenic minerals corresponding to oxic, methanic and weakly sulfidic dysoxic conditions. Changing redox conditions of the depositional environment, methane seepage in warm seawater and availability of iron influx possibly determined the final mineralogy of three varieties of ironstones. The association of siderite with ferrimagnetic sulfides like greigite and pyrrhotite in ooidal ironstones indicate anaerobic oxidation of methane with limited bacterial sulfate reduction. The ironstone deposits of Narym, Kolpashevo and Bakchar are contemporaneous with geological events like ocean anoxic event 3, Cretaceous-Paleogene boundary and PETM, respectively, all corresponding to warm seawater conditions.

Acknowledgements
The authors acknowledge the financial support provided by Russian Foundation of Basic Research (18-35-00022). We carried out laboratory investigations at Tomsk Polytechnic University within the framework of a Tomsk Polytechnic University Competitiveness Enhancement Program grant.

Key words
Ooidal ironstones, geochemistry, mineralogy, Bakchar deposit, Western Siberia

Progress of Sino-Russian Marine Science and Technology Cooperation

Xinru Xue[1], Jianjun Zou[1], Xuefa Shi[1]*
[1]First Institute of Oceanography, MNR, China, No. 6 XianXiaLing Road, 266061, Qingdao, China,
*xfshi@fio.org.cn

Russia is a big coastal country and one of the arctic countries, has a strong strength in the field of marine and polar research and an important influence on international marine affairs. The Arctic Ocean and the subarctic marginal sea have great significance to the future waterway, trade, energy and military security of China. Therefore, the cooperation with Russia on the marine and polar research has been listed as a key plan for cooperation between the two governments. Over the past 20 years, both Chinese and Russian governments have actively promoted cooperation in the field of science and technology. FIO and POI have conducted effective and pragmatic cooperation in the field of marine geology and have achieved fruitful outcomes in cooperative research, joint investigations etc..

1. Cooperative research. The National Science Foundation of China (NSFC) approved the major international cooperation project between China and Russia in the field of marine geology in 2004, entitled “Sedimentary records of key sections of paleoenvironmental evolution of the marginal sea in the middle and high latitudes of the Northwestern Pacific” (2005-2008). Subsequently, the NSFC funded additional two major fund projects in 2007 and 2014, respectively: “Paleoenvironmental and productive changes in Sea of Okhotsk, Sea of Japan and East China Sea since the Late Pleistocene” (2008-2011), and “Paleoenvironmental and paleoclimatic evolution of Japan Sea since the Last Interglacial”. Besides these three projects, a joint exchange project entitled “Paleoceanography of subarctic sea and its margin sea in the Pacific and evolution of the intermediate water in the Northern Pacific since the Last Glacial” (2016-2017) is under implementation too.

2. Joint investigations. With great supports from both governments, FIO and POI have cooperated with the Russian research vessel to complete four joint cruises in the Japan Sea, Sea of Okhotsk, Bering Sea, the Northwestern Pacific and its marginal Seas. The first Sino-Russian joint cruise in the east Siberian seas was implemented from August to September 2016, which opened a new chapter for the maritime cooperation in the Arctic between China and Russia. A second China-Russia joint Arctic Expedition was conducted in the Laptev Sea and the Eastern Siberian Sea during September and October, 2018 on R/V “Akademik M. A. Lavrentyev”. Many fruitful outcomes and new findings were obtained.

Key words:

Sino-Russian, Science, Cooperation

The morphology and spatial distribution of chimney formation in the Shenhu area, northern South China Sea

Zhang Boda[1], Su Ming[1*], Yang Rui[2], Liu Fang[3], Liu Jie[4], Zheng Wenyi[1]
[1]*School of Marine Sciences, Sun Yat-sen University, Zhuhai, China, 519082*
[2]*Qingdao Institute of Marine Geology, Qingdao,China, 266071*
[3]*Guangzhou Marine Geological Survey, Guangzhou,China, 510075*
[4]*Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou, China, 510640*
**e-mail: suming3@mail.sysu.edu.cn*

Shenhu Area is located in the northern slope region of the South China Sea, and develops Pearl River Canyon. Through the analysis of the 2D and 3D seismic data provided by GMGS, 59 large-scale gas chimneys are identified in the study area. These gas chimneys can be divided into three categories according to the internal reflection characteristics. The type-A reflection features are blanking reflectors and low amplitude chaotic reflectors, the type-B reflection feature is push-down reflectors, and type-C reflection features are weak continuity of the push-down reflectors and small part of the chaotic reflectors. The morphological parameters and spatial distribution of these gas chimneys are described in detail. Morphological parameters include plane parameters and vertical parameters. And the spatial distribution of gas chimneys is combined with the canyon topography, faults distribution and magma distribution. The analysis results show that faults cause the chaotic reflectors inside the gas chimney, and faults affect the plane size of the gas chimney. Most of the gas chimneys develop at the Pearl River Canyon ridge area. So we think that the formation of the gas chimney is mainly controlled by the thickened sediments of the canyon ridge area, because the compaction induces higher overpressure. And while the faults make seal-weakening. In addition, the free gas-bearing sediments in the eastern part of the study area provide more fluid and overpressure for the formation of gas chimneys.

References

Cartwright, J., Santamarina, C.,*Marine and Petroleum Geology*, 2015,**65**, 126-140.
Su, M., Sha, Z., Zhang, C., Wang, H., Wu, N., Yang, R., Liang, J., Qiao, S., Cong, X., Liu, J., *ActaGeologicaSinica (English Edition)*, 2017, **91(1)**, 219-231.
Sun, Q., Cartwright, J., Wu, S., Chen, D., *Marine Geology*, 2013,**337**, 171-181.
Sun, Y., Wu, S., Dong, D.,Lüdmann, T., Gong, Y., *Marine Geology*, 2012,**311-314**, 32-40.
Yang, R., Su, M., Qiaom S., Cong, X., Su, Z., Liang, J., Wu, N., *Marine Geophysical Research*, 2015, **36(2-3)**, 253-261.

Acknowledgements

This work was supported bythe National Natural Science Foundation of China (No.41576048), the Pearl River S&T Nova Program ofGuangzhou (No. 201710010198), and the Guangdong Special Fund forEconomic Development (Marine Economy) (No. GDME-2018D001).

Key words

Fluid activities; Gas chimneys; Shenhu area.

Comparative transcriptomic analysis of two neighbouring Alvinocaridids shrimps in hydrothermal vent for micro-environmental adaptation

Fang-Chao Zhu[1,2], Jin Sun[3], Guo-Yong Yan[1], Jiao-Mei Huang[1,2], Chong Chen[4], Li-Sheng He[1,*]

[1] *Institute of Deep-sea Science and Engineering, Chinese Academy of Sciences, Sanya, Hainan, China*
[2] *University of Chinese Academy of Sciences, Beijing, China*
[3] *Department of Ocean Science, The Hong Kong University of Science and Technology, Hong Kong, China*
[4] *Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima-cho, Yokosuka, Kanagawa 237-0061, Japan*
**he-lisheng@idsse.ac.cn; Tel/Fax: +86-898-88380060*

Background: Diffusing fluid in the deep-sea hydrothermal vent creates rapid and acute physico-chemical gradientsthat correlate strongly with the distribution of the vent fauna. *Alvinocarislongirostris* and *Shinkaicarisleurokolos*are separately distributed around the hydrothermal vents and exhibit different thermal preferences. In this study, we investigated the possible molecular mechanisms of the niche separation and thermal adaptation by comparative transcriptomics.

Results: We obtained the transcriptomes of *A.longirostris* and *S.leurokolos*, and identified 11,002 pairs of single copy orthologs. The orthologousgenes related to chitin metabolism and extracellular matrix (including structural cuticular proteinsand collagens) were both highly expressed and positively selected in *S. leurokolos*, as both chitin and collagen were vital components of the exoskeleton. Genes involved in trehalose biosynthesis pathway, which was related to protein protection, were significantly overrepresented in highly expressed genes of *S. leurokolos*. In addition, significant higher proportion of ribosomes,translation initiation factors, elongation factors and globinsin *S. leurokolos*, as well as highly expressed ATP synthases and histones, indicated a more active aerobic respiration and protein synthesis, that often occurredunder elevated ambient temperature.

Conclusions: The current results indicated that the composition and modification of the exoskeleton were important for *S. leurokolos*environmental adaptation. Theneighbouringshrimps*A.longirostris* and *S.leurokolos*thrived in the same hydrothermal vent, but dwelled in different niches and expressed different protein patterns to adapt themselves to micro-habitats.

Keywords:
Hydrothermal vent; Alvinocarididae; transcriptome; thermal adaptation.

Research on the Liability and Compensation System of Sponsoring States Parties in the Area Development

Pei Zhaobin[1], Yan Tianmei[1]
[1]*Dalian Ocean University,No. 52 Heishijiao Street, Shahekou District, Dalian City, Liaoning Province,116023*
**e-mail: pzb@dlou.edu.cn; 279674573@qq.com*

Regarding the incident that occurred during the development of the Area, sponsoring States Parties are considered to be against the regulations and responsibilities that are stipulated in the Duty of Care. However, UNCLOS are blurred and unclear about the Duty of Care, not even to mention the stipulations of the compensation system, which are glided and in just a few words. The advisory opinion issued by the Sea-Bed Disputes Chamber of the International Tribunal for the Law of the Sea clearly referred that the impeccable elaboration and enforcement on domestic laws as well as administrative regulations and rules are the crucial points of sponsoring States Parties in their performing and exempting from liability. Considering the Law of the People's Republic of China on the Exploration and Development of Resources in Deep Seabed Areas is a conceptual legislation, it shall be followed with specific rules and regulations during its implementation process. What's more, the characteristics of the liability of States Parties should be fully taken into account in the formulation of rules and regulations and in the implementation of specific measures to distinguish the liability undertaken by sponsoring States Parties from that by the contractors, which is thought to be conducive to the development and implementation of China's "Area "development strategy.

Keywords:
Development of the Area, liability of States Parties, compensation system

T02-3: Sedimentology and paleoceanography of the Pacific Ocean

Morpholithodynamic processes, structure and development of the coasts of the contact zone of the subarctic sea and ocean (on the example of Iturup Island)

V.V. Afanasiev
Institute of Marine Geology and Geophysics, FEB RAS, 1 Nauki Str.Yuzhno-Sakhalinsk, Russia,
**e-mail:vvasand@mail.ru*

On the basis of the results of long-term studies of the shores of the Northern Pacific area, the definition of island territories as a contact zone of the seas of different types, as well as the seas and oceans was formulated. Attention is drawn to the fact that the geomorphologic structure of the coast is the result of a long and complex interaction of endogenous and exogenous processes of relief formation. For the development of the coast of the Kuril Islands, explosive volcanism is no less important than the features of neotectonic and modern movements, which caused the arrival of hundreds of millions of cubic meters of pumice-pyroclastic material and tephra to the zone of wave processing of the coastal zones of the neo- Pleistocene-Holocene[1].

Morphometric, georadar and paleogeographic studies of the coastal-sea relief of Iturup Island allowed to establish several abrasion and abrasion-accumulative terrace levels in pyroclastic deposits of the late Neo-Pleistocene-Holocene, as well as the presence of a buried bench composed of neogenicdacites of the Kamu Suite. Volcanic-tectonic deformation associated with the eruptions near the central part of the Vetrovoy isthmus, where the remains of a large caldera were observed, led to the collapse of the oldest packs of pumices in the basement of the section of the sea coastal ledge up to 60 m with a layer of beach material in their roof (LU-9223 - 6320±100, Cal. yr BP «IntCal 13»). The fall angles of the layers reach 80° with azimuths of falling towards the middle part of Vetrovoy isthmus. Thus, in the middle - late Holocene, after rising of sea level to marks close to modern, there was still, at least, the deposition of two large series of pyroclastic, the last of which is dated 1050±70Cal. yr BP «IntCal 13» - LU-8685.

The analysis of the hydrodynamic and ice regime of the ocean and sea coasts allowed to substantiate the morphoclimatic position of the Great Kuril arc (geospatial parameters and the differences in hydrometeoclimatic parameters connected with them) as a contact zone of the subarctic the sea of Okhotsk and the Pacific Ocean. The spatio-temporal features of eolianmorpholithogenesis in the late Holocene on the ocean and sea coasts were established. Morphometric studies of megascallops distribution of beach sediment along the shore showed that the period of megascallopic waves along the ocean shore in 1.5-2 times more than along the seashore.

References

Melekestsev, I.V., Neotectonic onshore and underwater volcanism at the Kuril island arc, in Neotectonic and Recent Volcanism in Russia, Laverov, N.P., Ed., Moscow: Nauka, 2005a, pp. 233–335

Key words
Pyroclastic, coastal evolution, coastal dynamics

The protection of cold seas shores

V.V. Afanasiev
Institute of Marine Geology and Geophysics, FEB RAS, 1 Nauki Str.Yuzhno-Sakhalinsk, Russia,
**e-mail:vvasand@mail.ru*

As the review of the problem shows, the protection is necessary first of all for the objects located on the Holocene sand-pebble accumulative formations (barrier Islands and bars). Only two protected settlements - Barrow and Wainwright - are located on 5-15 m terraces of the coast with a high content underground ice in the sediments of the coastal ledge. Nevertheless, the main attention of researchers is paid to the analysis of erosion of this type of coasts [Barnhart and oth., 2014].Due to the presence of permafrost, the specifics of the hydrodynamic regime and, seasonal frozen rocks in the beach zone, the erosion of coastlines in the subarctic and Arctic regions has significant differences [Are and al., 2002].

However, only recently when analyzing the dynamics of the Arctic coasts the morphogenetic type of coasts began to be taken into account. At the same time, it was found that the minimum displacements were noted for spits and bars, and the maximum erosion rates were observed on the banks of the plains formed during the descent of lakes [Gibbs, Richmond 2017]. It is interesting, the barrier Islands on the delta coasts are stable or growing [Jorgenson, Brown, 2005].The accumulation of sediment in the areas of inherited accumulation with increased coastal erosion observed since the forties years of the last century was established by us at the analysis of the dynamics of accumulative formations of Sakhalin. That is, bars and spits, that do not lose connection with the areas of nutrition, do not degrade, but only rebuild both in the conditions of subarctic and in the conditions of the Arctic coast. The most affected by the reforming of the shores - Shishmaref, Kivalina, Unalakleet, are located at the distal ends of the spits of the system of the lagoon strait.

Accordingly, coastal protection solutions should be based on the analysis of strait migrations, the shape and morphometry of the distal ends of the bars, the modification of the tidal prism and the possibilities of changes in the direction of growth of the bars. In addition, when solving the problem of protection and planning of activities on the coast of cold seas, the attention should be paid to the specifics of the erosion coastal process of the subarctic and arctic type; deformation of the underwater relief under fast ice, increasing of the steepness of the coastal profile at the formation of ice, as well as the decreasing of the wave-dampening properties of the beach during freezing.

References

1. Barnhart K.R., Anderson R.S., Overeem I., Wobus C., Clow G.D., Urban F.E. Modeling erosion of ice-rich permafrost bluffs along the Alaskan Beaufort Sea coast// J. of Geophysical Research Earth Surface. 2014. 119(5). P.1155-1179.
2. Are F.E., Grigoriev M.N., Hubberten H.W., Rachold V., Razumov S.O., Schneider W. Comparative shoreface evolution along the Laptev Sea coast. //Polarforschung. 2002. № 70. P. 135-150.
3. Gibbs A.E., Richmond B.M. National assessment of shoreline change – Summary statistics for updated vector shorelines and associated shoreline change data for the north coast of Alaska, U.S.–Canadian border to Icy Cape. U.S. Geological Survey Open-File Report 2017–1107, 2017.21 p.
4. Jorgenson M.T., Brown J. Classification of the Alaskan Beaufort Sea coast and estimation of carbon and sediment inputs from coastal erosion// Geo-Marine Letters. 2005. 25(2-3). P. 69-80.

Key words:
Coastal erosion, migration of lagoon straits, Shishmarev,

REACTION OF DIATOMS ON OCEANOLOGICAL CONDITIONS CHANGES IN THE SOUTH OF OKHOTSK SEA DURING THE LAST 100 THOUSAND YEARS

Antonina V. Artemova[1], Valentina V. Sattarova[1], Yurii P. Vasilenko[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
e-mail: artemova@poi.dvo.ru

The results of a complete analysis of modern and ancient deep-sea sediments, which were selected from an abyssal plain adjacent to the Okhotsk Sea, exhibit the chemical composition, quantitative content of diatoms and their species assembly. The character of the interrelation among chemical constituents is demonstrated via multi-component statistics.

Analysis of the diatom complexes shows that there were changes in the response of diatom flora due to abiotic factors. The reaction of diatoms is expressed in terms of the change in dominants, the change in the ratio of representatives from various environmental groups and the number of diatoms in the sediments.

Diatom assemblages reflect the present-day water masses characterized by high nutrient content, surface water circulation, and sedimentation conditions for different parts of study area.

The variability of diatom assemblages in the bottom sediments of the Sea of Okhotsk over the last 100 thousand years, updated by other methods, revealed a number of regional Okhotsk sea paleooceanological markers reflecting the climatic conditions of the period of their formation.

Key words
Diatoms, Deep-sea sediments, Geochemical composition

High resolution colour stratigraphy of the Japan Sea sediments

A. Bosin[1*], S. Gorbarenko[1], X. Shi[2], Y. Liu[2], J. Zou[2]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*First Institute of Oceanography, MNR, 6 Xianxialing Road, Qingdao, China, 266061*
**e-mail: bosin@poi.dvo.ru*

Four sediment cores from Yamato Rise and 3 sediment cores from Pervenets Rise were obtained during the joint Russian-Chinese cruise on the R/V "Akademik M.A. Lavrentyev" in 2010. All studied cores were photographed immediately after splitting and opening. The photo was taken in the supported constant conditions, such as uniform illumination, focal length, camera settings, etc. Each image from every 1-meter section was photographed with 10-cm overlap. Color standard was used to calibrate white balance. ImageJ software was used for analyzing of lightness of sediment cores. Lightness is a very close analogue of color L* in CIE L*a*b* chromaticity three-dimensional color space. In Japan Sea the sediment color is treated as essential proxy due to basinwide well-correlated dark-light cycles(Tada, 1994). Also Tada et al. (1999) established that a sequence of dark thin laminated layers is well-correlated with interstadials of the Dansgaard-Oeschger cycles during the last glacial period.

In our investigation we correlated records of lightness from seven cores with high resolution NGRIP record (Rasmussen et al., 2014). Obtained results show a good correlation. Digital image analysis has a high potential in high resolution stratigraphy.

References

Rasmussen, S.O., Bigler, M., Blockley, S.P., Blunier, T., Buchardt, S.L., Clausen, H.B., Cvijanovic, I., Dahl-Jensen, D., Johnsen, S.J., Fischer, H., Gkinis, V., Guillevic, M., Hoek, W.Z., Lowe, J.J., Pedro, J.B., Popp, T.J., Seierstad, I.K., Steffensen, J.P., Svensson, A.M., Vallelonga, P., Vinther, B.M., Walker, M.J.C., Wheatley, J.J., Winstrup, M., 2014. A stratigraphic framework for abrupt climatic changes during the Last Glacial period based on three synchronized Greenland ice-core records: refining and extending the INTIMATE event stratigraphy. Quat. Sci. Rev. 106, 14–28. doi:10.1016/j.quascirev.2014.09.007

Tada, R., 1994. Paleoceanographic evolution of the Japan Sea. Palaeogeogr. Palaeoclimatol. Palaeoecol. 108, 487–508. doi:10.1016/0031-0182(94)90248-8

Tada, R., Irino, T., Koizumi, I., 1999. Land-ocean linkages over orbital and millennial timescales recorded in late Quaternary sediments of the Japan Sea. Paleoceanography 14, 236–247. doi:10.1029/1998PA900016

Acknowledgements

This work was supported by the Russian Foundation for Basic Research (16-55-53048 GFEN_a), the Russian state budget theme No. 7 of POI FEB RAS (№AAAA-A17-117030110033-0), the international Taiwan-FEB RAS and Project of Ministry of Science and Technology, Taiwan 2017-2019 (17-MHT-003), the National Natural Science Foundation of China (U1606401, 41476056), the National Program on Global Change and Air-Sea Interaction (GASI-GEOGE-03, GASI-GEOGE-04), International cooperative projects in polar regions (201613), and the Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, grant No. MGQNLM-KF201702.

Key words

Age model, climate changes

Mid-late Holocene rainfall variation in Taiwan: A high-resolution multi-proxy record unravels the dual influence of the Asian monsoon and ENSO

J. Chen[1,2], T. Li[1,2], Q. Nan[2,3,*], X. Shi[1,2,**], Y. Liu[1,2], B. Jiang[4], J. Zou[1,2], K. Selvaraj[5], D. Li[6], C. Li[1,2]

[1] *Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, MNR, Qingdao, China, 266061*

[2]*Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China, 266061*

[3] *Key Laboratory of Marine Geology and Environment, Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China, 266071*

[4] *China Ocean Press, Beijing, China, 100081*

[5]*State Key Laboratory of Marine Environmental Science, Xiamen University, Xiamen, China, 361005*

[6] *Department of City Science, Ningbo University, Ningbo, China*

**e-mail: nanqingyun@qdio.ac.cn, xfshi@fio.org.cn*

Taiwan is particularly sensitive to changes in monsoonal precipitation and to typhoon-induced heavy precipitation events, however, rainfall variability in Taiwan on centennial and millennial time scales during the Holocene has not been well understood. This study describes mid-Holocene rainfall features of Taiwan based on pollen, total organic carbon (TOC), total nitrogen (TN), and C/N ratio records of core MD05-2908. The step-wise increase in sedimentation rate, fern spore percentage and concentration, TOC content, and C/N ratio suggests an increasing terrestrial material supply due to the intensified rainfall in Taiwan since 6800 cal. yr BP. This rainfall pattern shows an inverse pattern to the decreasing East Asian summer monsoon (EASM) strength represented by the multi-proxy records from North China. Variation of the East Asian summer circulation and associated moisture transport may account for the long-term rainfall changes in Taiwan. Superimposed on this trend, we interpreted three prominent rainfall changes, which focus on the periods of 6800–6600, 1090–880 and490–190 cal. yr BP. These centennial time scale rainfall variations in our records are linked to the intensity of El-Niño Southern Oscillations.

References

F. Chen, Q. Xu, J.Chen, J.Birks, J. Liu, S.Zhang, L.Jin, Z.An, R. Telford, X. Cao, Z.Wang,X. Zhang, K.Selvaraj,H. Lu, Y.Li,Z. Zheng,H.Wang, A. Zhou, G.Dong, J.Zhang, X. Huang,J.Bloemendal, Z.Rao. East Asian summer monsoon precipitation variability since the lastdeglaciation. *Scientific Reports*,2015, https://doi.org/10.1038/srep11186.

H.Li, P. Liew, O.Seki, T. Kuo, K.Kawamura, L.Wang, T. Lee.Paleoclimate variability in central Taiwan during the past 30 Kyrs reflected by pollen,$\delta^{13}C_{TOC}$, and n-alkane-δD records in a peat sequence from Toushe Basin. *Journal of Asian Earth Sciences*, 2013,**69**, 166-176.

K.Liu, C.Shen, K. Louie. A 1000-year history of typhoon landfalls inGuangdong, southern China, reconstructed from Chinese historical documentary records. *Annals of the Association of American Geographers*, 2001,**91**, 453-464.

C.Moy, G.Seltzer, D.Rodbell, D.Anderson. Variability of El Nino/Southern Oscillation activity at millennial timescales during the Holocene epoch.*Nature*, 2002,**420**, 162-165.

S.Xie, R. Evershed,X. Huang, Z.Zhu, R.Pancost, P.Meyers, L.Gong, C.Hu, J. Huang, S.Zhang, Y. Gu,J. Zhu. Concordant monsoon-driven postglacial hydrological changes in peat and stalagmite records and theirimpacts on prehistoric cultures in central China. *Geology*, 2013,**41**, 827-830.

H.Yan, L.Sun, Y. Wang, W.Huang,S. Qiu, C. Yang. A record of theSouthern Oscillation Index for the past 2000 years from precipitation proxies. *Nature Geoscience*, 2011,**4**, 611-614.

Z.Zhu, J.Feinberg, S.Xie, M. Bourne, C. Huang, C.Hu,H. Cheng.Holocene ENSO-related cyclic storms recorded by magnetic minerals in speleothemsof central China. *PNAS*, 2017,**114**, 852-857.

Acknowledgements

This study was supported by the NSFC-ShandongJoint Fund for Marine Science Research Centers (U1606401), NationalProgram on Global Change and Air-Sea Interaction (GASI-GEOGE-03,GASI-GEOGE-04), and the National Natural Science Foundation ofChina (41006036, 41576054, 41420104005).

Key words: La Niña, Tropical cyclone, Okinawa Trough

Magnetic stratigraphy of the last 1.9 Ma from Alaska Gulf: constraint for a drastic increase of erosion rate at mid-Pleistocene

S. Ge, X. Chen, J. Liu, X. Shi, Y. Liu
First Institute of Oceanography, Ministryof Natural Resources,6, XianXiaLing Str., Qingdao, China, 266061
**e-mail: shulange@fio.org.cn*

Detailed paleomagnetic work is undertaken for a 119 m composite core at site IODP 341-U1417 (56.57°N, 147.60°W, water depth 4200 m) from Gulf of Alaska. Discrete samples are routinely demagnetized by alternate field from 0 to 80 mT, and most of which obtained stable and single direction towards the projection origin. A shallow "normal" interval at the base of Brunhes Epoch is identified as disturbed sediment and fake inclination which belongs to Matuyama Epoch. With the shipboard continuous paleomagnetic scan(U1417A-D), Matuyama-Brunhes boundary (M/B: 780 ka) is determined at depth of 110.46 m, Jaramillo subchron (1070~990 ka) and an uncomplete Olduvai subchron (1900~1770 ka) were found at 139.91~133.28 m, 191.94~182.67 m respectively. Three times of increase in sedimentation rate since 1.2 Ma is observed (4cm to 12 cm/kyr) reflecting rapid erosion rate in source region-St. Elias mountain range, which timing closely matches the well-known mid-Pleistocene climate transition. These sediments from Gulf of Alaska thusare the potential climate archive with extremely high resolution.

Acknowledgements
This work was supported by Natural Science Foundation Committee Program(41376072) and samples provided by IODP sample repository from TAMU. S. Ge thanks China IODP office for supporting the travel fee for the Cruise in Alaska.

Key words
Gulf of Alaska site U1417, Matuyam-Brunhes polarity boundary, St. Elias Mountain Range

Recent geochemical records ofsediment organic matter along the asia coasal seas under thenatural climateforcingand anthropogenic impacts

Limin Hu[a,b], XuefaShi[a,b], YanguangLiu[a,b], Kirsten Fahl[c], XunGong[c], JianjunZou[a,b], AnatoliiAstakhov[d]

[a]*Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, Ministry of Natural Resources (MNR), China, 266061*

[b]*Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, 266061, China*

[c]*Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, D-27570 Bremerhaven, Germany*

[d]*V.I. Il'ichev Pacific Oceanological Institute, Far East Branch of Russian Academy of Science, (FEB of RAS) Vladivostok, 690041, Russia*

The accumulation of sedimentaryorganic carbon (OC) in the coastal margins plays an important role in the context of the global carbon cycle, as more than 80% of the global OC burial occurs in the these systems. Therefore, it is essential to understand the state and responses of OC burial in the context of global change in recent decades. The recent carbon sequestration in the coastal marine environment is influenced by coupling factors from the climate change and anthropogenic impact. In this work, the recent sedimentary OC burial under the natural climate change and recent extensive human impact were examined by several ^{210}Pb well-dated multi-cores located along the Asian continental margins from high latitude to moderate-low latitude shelf regions (the East Siberian Sea, the Bering Sea, the Bohai Sea) based on the geochemical proxies (e.g., TOC, TN, δ^{13}Corg, δ^{15}N) and typical lipid biomarkers. The results showed that the recent OC burial in the East Siberian Arctic shelf was largely impacted by the recent climate change with extensive land-based OC input through riverine input and coastal erosion; the terrestrial OC is dominated on the shallow arctic shelf with more contribution in the western part of this shelf system due to the coastal setting and change of the ice-complex permafrost deposit related OC input. While in the Bering Sea, it was found that the sea ice reduction may pose the regional ecological regime shift with increased marine OC burial and potential phytoplankton structure change, especially since the late 1970s; on the other hand, the OC burial in the moderate latitude shelf region of Bohai Sea revealed that the change of the sediment OC contribution was related to the river mouth relocation and human-induced eutrophication in recent decades. This work imply that the current status and future OC sequestration in the coastal margins will be altered by the natural forcing and increased human impact, which should be pose further concern on the comparative study on the OC burial in these coastal margins with different driving forces.

Local oxygenation in the midst of widespread regional anoxia during the last glacial maximum in the Japan Sea— the case ofTatar Trough

Y. Kakuwa[1*], R. Matsumoto[1], R. Shakirov[2], A. Obzhirov[2]
[1]*Gas Hydrate Research Laboratory, Meiji University, 1-1 Kanda-Surugadai, Tokyo, Japan, 1038301*
[2]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: kakuwa@meiji.ac.jp*

Deep water of the Japan Sea is oxygenated in present days, but waters deeper than 500 meters were anoxic or exilic during the last glacial maximum (LGM) due to the establishment of a stratified water column (Oba et al., 1991;Tada et al., 1992; Ikehara et al., 1994; and many others). Deep water anoxia is evidenced by the widespread occurrence of the thinly laminated sediment layer (TL 2) in almost all the areas of the Japan Sea from the Tsushima Basin in the south to regions west of the Japanese Archipelago including on the Yamato Rise and in the Yamato Basin, and extending northward to the Japan Basin.

During the expedition of R/V Lavrentyev belonging to the Pacific Oceanological Institute in 2018, sediment samples were collected by gravity coring at water depths up to 3000 meters in the northern margin of the Japan Basin and in the Tatar Trough, off Primorsky Krai. Diatom biostratigraphy reveals that fine lamination developed in muds during the LGM, as is typical of many parts of the Japan Sea. However, bioturbated structures consistently developed in muds during LGM extending from the slope to the bottom of the Tatar Trough. Although seawater in the Tatar Trough was not fully mixed, it remained weakly oxygenated.

We interpreted the supply mechanism of oxygen to the seabed of the Tatar Trough as follows. Sea ice is formed during winter seasons in the recent warm period of the Tatar Strait area situated in the north of the Tatar Trough, therefore the formation of sea ice would have been active during the LGM in the Tatar Trough. As a result, masses of heavy and chilled water rich in oxygen formed by brine rejection should have cascaded down to the seabed. It is also to be noted that laminations and thin beds of fine sand to coarse silt commonly occur with the bioturbated mud. Sea-level fall destabilized the continental slope and resulted frequent events of slope failure. Dissociation of gas hydrate in the Tatar Strait area brought on the decrease of pressure also contributed to slope failure. As a result, turbidity currents were formed disturbed the stratification of seawater and provided oxygen in the seabed of the Tatar Trough.

References

K. Ikehara, K. Kikkawa, H. Katayama, K. Seto, *Proc. 29th Intern. Geol. Congr. Part B*, 1994, 229-235.
T. Oba, M. Kato, H. Kitazato, I. Koizumi, A. Omura, T. Sakai, T. Takayama, *Paleoceanography*, 1991, **6**, 499-518.
R. Tada, I, Koizumi, A. Cramp, A. Rahman, *Proc. ODP, Sci. Results, **127/128**,**Pt. 1***, 1992, 577-601.

Acknowledgements

We express sincere gratitude to all crews and on-board Russian and Japanese scientists of the Lavrentyev expedition in 2018.

Key words

Japan Sea, LGM, oxygenated seabed

Initial paleoceanographic data of foraminifera and diatom fossils from the Tatar Trough in the northern part of the Japan Sea.

Takeshi Oi[1*], Fumio Akiba[2], Ryo Matsumoto[1]
[1]*Gas Hydrate Research Laboratory of Meiji University, 1-1 Kanda-Surugadai Chiyoda-ku Tokyo 101-8301 Japan*
[2]*Diatom Minilab Akiba, Co. Ltd., 632-12, Iwasawa Hanno-shi Saitama 357-0023 Japan*
**e-mail: take_oi@meiji.ac.jp*

According to the paleo-environmental studies since the LGM from the southern part of the Japan Sea (Oba et al., 1991), main three conditions were clarified. They are characteristic by the lower surface salinity and anoxic bottom conditions during the LGM, the inflow of Oyashio cold current during the de-glacial, and inflow of the Tsushima warm current during the post-glacial. On the other hand, there are not so many studies on the northern part of the Japan Sea.

In May 2018, the gravity coring (4m corer) were conducted by Lv81 (Lavrentyev cruise 81) in the Tatar Trough, Primorye. Our purpose is to establish the microfossil stratigraphy and discuss the paleoceanographic changes since the LGM. In this presentation, I will introduce the microfossil results of Lv81-14GC and 35GC, which collected around 1500m water depth from north and south area in the Tatar Trough from Lv81.

In 35GC, light and dark colored alternations and bioturbation in dark layers and three diatom zones (zone A-C; Akiba et al., 2014) are observed. These geological data and biozonation may support the stratified structure without lack of large sediments in this core. The age models of 14GC and 35GC are constructed from ^{14}C age of planktonic foraminifers and relative ages of the diatom zone boundary. The confirmed age with each diatom zone is about 6.8 ka at the A/B boundary and 15.5 ka at the B/C boundary, which is not significantly different from the diatom results of the southeastern part of the Japan Sea. Considering the age model of 14GC based on two ^{14}C age and diatom zone ages, the sedimentation rate changes greatly with the A-B diatom boundary.

Oxygen isotope ratios (δ^{18}O) of planktonic foraminifera of both cores change around 2.2 to 3.3, except for around 20 ka corresponding to LGM, which is somewhat lighter toward the upper core. Lightest peaks at middle parts indicate the low saline surface water by fresh water input, and upper lighter one is derived from the formation of warm surface waters originating by Tsushima warm current. δ^{18}O in the Tatar Trough are generally consistent with south results before 11 ka, but after 7 ka the δ^{18}O is heavier than the southeastern margin. From microfossil evidences, Tsushima Warm Current flows into the Japan Sea actively since around same time. So, the influence of this warm current of the Tatar Trough is very weak and surface temperature is lower than southeastern part.

One of the ‘Oyashio’ benthic species, *E. excavatum*, continue to occur after 11ka even if they become diatom zone A (occurrence of warm diatom species, *F. doliolus*). Lastly *E. excavatum* extinct northern part of the Japan Sea around 5-2ka, when surface water temperature slightly increase by influence of Tsushima Warm Current. The influence of warm surface current is weak

in Tatar Trough during middle MIS 1, so a cold water mass similar to the Oyashio water remained.

References

Akiba et al.2014: Diatom biostratigraphy and diatom-derived black grains of the uppermost Quaternary cores from the Japan Sea and their paleoceanographic implications. Jour of JAPT,79-2, 130-139 (in Japanese with English abstract).

Oba et al. 1991: Paleoenvironmental changes in the Japan Sea during the last 85000 years. Paleoceano. 6:499–518.

Acknowledgements

This work was supported by all of the scientists and crew of Lavrentyev cruise 81.

Key words

Benthic foraminifera, oxygen isotope, Japan Sea

The role of tectonics on evolution of the Red River Delta, North Viet Nam

Phung Van Phach[(1)*], Lobanov Viacheslav[(2)], Shakirov Renat[(2)], Yin Pin[(3)], Lai Vinh Cam [(4)]

[(1)]*Institute of Marine Geology and Geophysics, VAST, 18- Hoang Quoc Viet Street, Hanoi, Vietnam.*
[(2)]*V.I. Il'ichev Pacific Oceanological Institute, Far Eastern Branch, Russian Academy of Sciences, Baltiyskaya Str.43,Vladivostok, 690041 Russia.*
[(3)]*Institute of Marine Geology, Qingdao 266071, P.R. China*
[(4)]*Institute of Geography, VAST, 18- Hoang Quoc Viet Street, Hanoi, Vietnam.*
e-mail: pvphach@yahoo.com

The Red River Delta (RRD), North Viet Nam, has been forming since early Holocene (~9 k years ago) and is one of the most significant river deltas of the World. It occupies about 12,000-15,000 km^2, that equals the Nil river delta.

The evolution of the RRD was controlled by many factors, but the tectonic activity is the most special. In fact the RRD is situated on top of the Hanoi graben that presents the NW part of the large Red River-Tonkin basin (RRTKB). The RRTKB occupies an area of 150,000 km^2, with enormous volume of sediment, which can reach 4,500-5,000 km^3.

The RRD is situated in the tectonically active region, along the Red River Fault Zone (RRFZ) that is a boundary between two tectonic plates: the South China Plate in the NN and the Indo-China Plate in the SW. The central part of the RRD laid over the Ha Noi graben, which is controlled by Lo River fault in the NE and Chay River fault in the SW. Due to tectonic activity the relief of the RRD basement is differentiated and revealed as in-uniform distribution of Quaternary sediments.

Evolution of the RRD has been closely connected with the Pliocene-Quaternary tectonics, specifically during transgression period after Last Glacial Maximum (LGM). Sea had advanced along the NE and SW subsidence zones of the RRD and created two remarkable lagoons; meanwhile the central part of the RRD had somehow resisted transgression process and created a protrusive zone.

The Late Miocene tectonic compressive activity had created a reversed central block with the Tien Hai and Kien Xuong uplifted zones, while the Pliocene-Quaternary extension activity had produced several young graben structures, such as the Ninh Binh graben along Red River fault and Dong Quan sag along Lo River fault… Meanwhile the central sector of the RRD remained relatively stable or underwent a slight uplift.

Our study recognized that there were at least two tectonic movements have been occurred in the region since the Late Miocene, after a cessation of left-lateral strike slip of the Red River fault zone: those are NE-SW compression and then NE-SW extension according to the general right-lateral strike slip of the Red River Fault Zone (RRFZ).

This research was completed thank to two International Joint Projects: (1) The Project between Viet Nam and China "Comparative study of Holocene sedimentary evolution of the Red River Delta", coded as NĐT.01.CHN/15; (2) The project Between Viet Nam and Russia "Role of catastrophic processes in the formation, development of coastal complexes of South Pacific (Russia and Vietnam) and problems of coastal reasonable usage"; Coded as QTRU02.02/18-19. Joint research partially conducted by the Joint Vietnam-Russian Laboratory for marine geosciences (IMGG VAST – POI FEB RAS).

Sedimentation history and environment changes in the Oga Bay (Novaya Zemlya, Kara Sea) for the last millennium

V. Rusakov[1*], E. Taldenkova[2], T. Kuz'mina[1], T. Romashova[1]
[1]*V.I. Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, ul. Kosygina, 19, Moscow, Russia, 119991*
**e-mail: rusakov@geokhi.ru*
[2]*M.V. Lomonosov Moscow State University, Geographical faculty, Leninskie Gory, 1, Moscow, Russia, 119991*

Background: Sediment accumulation in the northern Novaya Zemlya bays is characterized by continuous "particle by particle" regime, i.e. without breaks in sedimentation (Murdmaa et al., 2004; Polyak et al. 2004). At the same time, the primary source of sediment material accumulated in the bays is suspension-rich meltwater discharged by glaciers that is strongly controlled by climate changes.

Material and methods: The paper presents original data on lithological and geochemical composition of sediments, as well as the abundance and species diversity of foraminifers, ostracods, and mollusks, in core AMK-5248 retrieved from the inner depression of the Oga Bay (Novaya Zemlya) during the 63rd cruise of R/V *Akademik Mstislav Keldysh* in 2015. Two sediment cores were collected with the help of both box-corer (26 cm long) and gravity-corer (402 cm long). The age model is based on AMS ^{14}C dating of benthic foraminifera from 4 levels. Sedimentation history in the bay was reconstructed for the time period since *ca.* 935 CE.

Results: It has been revealed that bottom sediment composition is determined by climate changes that control glacier movements, water circulation, sea ice cover extent and bioproductivity in the bay. Three major climatically controlled periods of environmental changes were established that correspond to the Medieval Warm Period (ca. 935-1280 CE), the early and late phases of the Little Ice Age (ca. 1280-1650 and 1650-1900 CE, respectively), and the recent warming (after *ca.* 1900 CE). These intervals are subdivided into 9 short-term intervals (sedimentation stages): 5 warm and 4 cold ones. Warm stages are characterized by degradation (retreat) of Goluboi glacier, ice melting, and extensive discharge of freshwater to the bay during relatively warm and long summers. It is evidenced by the peaks of ice- and iceberg-rafted debris, coarsening of bottom sediments due to enhanced water circulation, higher bioproductivity and benthic abundance. Cold stages are characterized by restricted water circulation due to extensive sea ice cover during cold and long winters and short summers promoting accumulation of clay fractions in bottom sediments. Bioproductivity and benthic abundance were low.

Conclusions: The established sedimentation stages only partially coincide with short-term climate changes in other Arctic regions (northern Canada, Greenland and Kola Peninsula), thus pointing to unique climate conditions on Novaya Zemlya. At the same time, although similar trends of environmental changes are revealed on the western and eastern coasts of the archipelago, climate conditions were more severe in the east.

References

I. Murdmaa, L. Polyak, E. Ivanova, Khromova N., *Palaeogeography, Palaeoclimatology, Palaeoecology*, 2004, **209**, 141-154.
L. Polyak, I. Murdmaa, E. Ivanova, *The Holocene*, 2004, **14(4)**, 638-644.

Keywords
Climate changes, Arctic

Evolution of the sedimentary environment and it's driving mechanism in the Sea of Japan since the last glaciation

Xuefa Shi[1,2]*, *Jianjun Zou*[1,2], *Sergey Gorbarenko*[3]

[1] *Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, MNR, Qingdao, China*

[2]*Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, , China*

[3.] *V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia*

**e-mail: xfshi@fio.org.cn*

The Japan Sea, one of the marginal seas of the North Pacific, connects with adjacent seas through four shallow straits (<130 m) and the present environment in the Japan Sea is affected mainly by the Tsushima Warm Current（TWC） and East Asia Monsoon (EAM). However, the spatial heterogeneity in environmental elements of the Sea of Japan may results in differential response to external forcing. Over the last few years, several China-Russia joint expeditions have been carried out to investigate the sedimentary processes and paleoenvironment changes in the Japan Sea. Based on selected sediment cores retrieved during these joint expeditions, we investigate the changes in terrigenous provenance and environment in the southern and western Sea of Japan over the last glaciation using a suite of proxies of sedimentology and geochemistry. We found the enhanced extent of seasonal sea-ice coverage coincided with the intensification of East Asian Winter Monsoon（EAWM） on orbital and millennial timescales during the last glacial - Holocene transition and the Last Glacial Maximum, which results in intensified deep water formation. We suggest these changes are closely related to an increase in solar radiation at high latitudes. At millennial timescales, perennial sea ice cover at investigated site might inhibit the formation of bottom current. Since 8 ka, increased deep ventilation and dampened sea ice coverage are closely related to enhanced EAWM and invasion of high salinity TWC into the Japan Sea. Sediment provenance also varied greatly since the last glaciation. During the last deglaciation, the contribution of river delivery is dominant in the southern Japan Sea, whereas sea ice delivers much terrigenous materials to the western Japan Sea. At orbital timescales, sea level is a primary factor controlling the sedimentary conditions of the Sea of Japan. During the low sea level and high sea level periods, the EAM and Kuroshio Current play a secondary role, respectively.

Acknowledgements

This study was supported by the National Natural Science Foundation of China (Grants No. 41420104005, U1606401) and National Program on Global Change and Air-Sea Interaction (GASI-GEOGE-04).

Key words

Sedimentary Environment; Last Glaciation; Sea of Japan

Reconstruction of the formation conditions of the sedimentary cover of the island slope of the Kuril-Kamchatka Trench (based on radiolarian analysis)

L.N.Vasilenko
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostok, Russia, 690041
**e-mail: lidia@poi.dvo.ru*

The Kurile – Kamchatka Trench is a transition zone from the Asian continent to the Pacific. Reconstruction of the environmental conditions in which the formation of a sedimentary cover took place is necessary to disclosure of the history of its development. One of the methods for determining the age of rocks and reconstructing the conditions of the formation of a sedimentary cover is radiolarian analysis.
In the present study, radiolarian analysis was applied to samples of dredging of the island slope of the Kuril-Kamchatka Trench, including the submarine Vityaz Ridge, the Outer Zone of the Lesser Kuril Ridge and the near-axial zone of the Kuril-Kamchatka Trench (88 samples from 38 stations).

In the area of the island slope of the Kuril-Kamchatka Trench in the sediments Late Eocene–Pleistocene, the rich fauna of radiolarians is found: Collodaria – 6 taxa from 3 genera, Spumellaria – 155 taxa from 80 genera and Nassellaria – 147 taxa from 79 genera (all 308 taxa). This work attempts to reconstruct sedimentation conditions based on the analysis of radiolarians-polycystin taxa of species and superspecies. The small total number of radiolarians and the prevalence in the complexes of Spumellaria, mainly taxa, characteristic for coastal areas of upwelling, assume shallow (shelf) conditions. The increase in the number of radiolaria, their taxonomic diversity and the dominance in the complexes of the species Nassellaria suggest a change in shallow water conditions to deep water. As a result, it is establish that the formation of a sedimentary cover on the northern and southern plateaus of the submarine Vityaz Ridge, as well as on the Pacific slope of the Lesser Kuril Ridge, during the Late Eocene – Pleistocene occurred in different sedimentary and tectonic modes. In the Late Oligocene, on the southern plateau of the submarine Vityaz Ridge, sedimentation conditions changed from shallow (offshore) to deepwater, whereas in the northern plateau, shallow water existed until the middle of the Middle Miocene. This is probably due to tectonic processes and the transgressive – regressive cyclicity of the World Ocean. In addition, in the Middle Miocene and at the border of the Pliocene and Pleistocene, the erosion of the pre-Cenozoic deposits is reveal, which contributed to their re-deposition, which confirms the activation of tectonic processes during these periods.

From the early Miocene, in the area of the island slope of the Kuril-Kamchatka Trench, there is an increase in the influence of the warm Kuroshio Current, which is likely due to climate warming in the North-West Pacific.

Acknowledgements
The work was performed in the framework of the state task of the Institute (No. AAAA-A17-117030110033-0)

Key words
Radiolarian analysis, the submarine Vityaz Ridge

Orbital-scale changes of IRD fluxesand sea ice conditions of theSea of Okhotsk during the Last Glaciation and the Holocene (MIS 4–MIS 1)

Yu. Vasilenko[1], A. Gorbarenko[1], A.Artemova[1], X.Shi[2], Y.-G.Liu[2], J.-J. Zou[2], E. Yanchenko[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, Ministry of Natural Resources, Qingdao,China,266061*
**e-mail: vasilenko@poi.dvo.ru*

In this paper, 6 schemes for reconstructing the ice conditions in the Sea of Okhotsk (the SO) during the marine isotope-oxygen stages (MIS) 4, 3, 2, 1.2, and 1.1 are presented. These schemes were constructed based on calculations of the ice rafted debris (IRD) flux in 16 sediment cores using previously developed age models. In addition, when constructing the schemes, we took into account the available mineralogical data (Derkachev et al., 2004). As a result, the key areas of ice formation and general direction of sea ice drift in the SO were established for each of the investigated MISs. During MIS 4, quite severe conditions existed in the SO with the ice cover preserved for much of the year. The ice formed predominantly along the northwestern and western coasts and drifted southeastward under the action of northwest geostrophic winds. During MIS 3, moderate, close to severe ice conditions were manifest. The sea ice actively formed along the northeastern and eastern coasts and extended towards the south and southwest under the action of the northeast geostrophic winds. During MIS 2, extremely severe ice conditions are noted. Under the influence of strong north geostrophic winds, ice formed along the northern coast, drifted southward and extended across the area of the sea. At that, the ice was of predominantly seasonal nature except for the northwestern and western coasts, where perennial ice fields were preserved over a period of several years. MIS 1.2 and MIS 1.1 had similar ice conditions. A difference lies in the fact that during MIS 1.2, severe ice conditions were more pronounced. However, during both MIS 1.1 and MIS 1.2, moderate and mild ice conditions are generally observed. The ice formed along the northern coast and drifted to the west and central parts of the sea. The central, southern and southeastern parts of the SO have experienced significant heating from cyclones coming from the Pacific Ocean. These variations of ice conditions in the SO attest to a particular type of baric field caused by changes in Asian-Pacific region atmospheric circulation prevailing over the sea area during different MISs. The secondary ice drift directions during practically all MISs points out that the predominant baric field at that time suffered changes rather than being constant. The baric field was only stable during MIS 2.

References

A.Derkachev, N.Nikolaeva, S.Gorbarenko, *Russian Journal of Pacific Geology*,2004, 23(1), 37-52.

Acknowledgements

This work was supported by the Russian Foundation for Basic Research (16-35-60019 mol_a_dk, 16-55-53048 GFEN_a), the Russian state budget theme No. 7 of POI FEB RAS (№AAAA-A17-117030110033-0), the international Taiwan-FEB RAS and Project of Ministry of Science and Technology, Taiwan 2017-2019 (17-MHT-003), the National Natural Science Foundation of China (U1606401, 41476056), the National Program on Global Change and Air-Sea Interaction (GASI-GEOGE-03, GASI-GEOGE-04), International cooperative projects in polar regions (201613), and the Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, grant No. MGQNLM-KF201702.

Key words

Ice rafted debris (IRD),IRD supply, sea ice drift.

Radiolarians as indictor paleo-environmental conditions of the Sea of Okhotsk in the Late Pleistocene and Holocene

E. Yanchenko, A. Gorbarenko, Yu. Vasilenko
V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041
**e-mail: yan@poi.dvo.ru*

This paper presents the results of a study of changes in the assemblages of radiolarians in the central part of the Sea of Okhotsk over the past 135 kyr. The age model of the core PC-7R is presented in [1, 2, 3]. The radiolarian assemblage was analyzed for a total of 296 core samples. In total 160 taxa of radiolarians (including 97 genera and 21 families) were recognized in sediments. Radiolarian fossil assemblages, including shallow and deep dwelling species, may indicate various habitat conditions throughout the water column. We categorized depth habitats of radiolarians as: 1) surface water species; 2) subsurface water species; 3) intermediate and deep water species. The changes of the relative abundance and fluxes of radiolarian taxa in core sediments were studied with additional data (IRD and paleo-productivity stack). Additionally, R-mode analysis of radiolarian assemblages identified some groups that depend to varying degrees on the availability of nutrients, inputs of terrigenous organic matter in the water column, and sea-ice conditions. As a result, we concluded that: 1) the radiolarians fluxes, regardless of their habitat depth, directly depends on the amount of nutrients (biomass of bacteria and phytodetrite), formed in a highly productive sea surface water mass, as well as nutrients supply in the water masses from the shelf areas in the terrigenous water suspension. 2) Relative abundance of radiolarian taxa depends not only on the amount of nutrients, but also on variations in the percentage of other species in the complex. Radiolarians following some strategies for survival and nutrition, inhabiting specific ecological niches, therefore, they abundance was determined by more complex relationships in the paleo-environment changes. 3) The complex study of radiolarian fluxes and percentage of radiolarian taxa provides information on variations within the radiolarian assemblages and major changes in the environment and climate of the Okhotsk Sea region.

References

1.S. Gorbarenko, N. Harada, M. Malakhov, T. Velivetskaya, Y.Vasilenko, A.Bosin, A. Derkachev, E. Goldberg, A. Ignatiev, *Deep-Sea Research II*,2012,61, 73–84.
2.E. Yanchenko, S. Gorbarenko,*Journal of Asian Earth Sciences*,2015,114 (3), 601-610.
3. S.Gorbarenko, T. Velivetskaya, M.Malakhov, A.Bosin,*Global and Planetary Change*,2017,152, 51–63.

Key words
Radiolaria,nutrients,Sea of Okhotsk.

Sea-level and climate signature recorded in the orbital-forced continental margin deposits over the last 1 Ma: New perspectives from the Bohai Sea

Zhengquan Yao[1,2,*], Xuefa Shi[1,2,*], Yanguang Liu[1,2], Shuqing Qiao[1,2], Xiaoyan Li[1,2]

[1]*Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, MNR, Qingdao 266061, China*
[2]*Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266061, China*
**e-mail: yaozq@fio.org.cn; xfshi@fio.org.cn*

Milankovitch orbital variations at precession, obliquity and eccentricity band have combined led to changes in solar radiation at different latitudes, thus driving changes in ice-sheet volume and consequently global sea-level. These changes at orbital-scale are clearly expressed in oxygen isotope records of benthic foraminifera in deep-sea sediments), while in continental margin area, sedimentary rhythm of transgression-regression cycles have been preserved. Though the timing and amplitude of the Pleistocene eustatic sea-level, as well as global climate condition are generally known, the response of sedimentation in continental margin to these changes remains to be resolved. Furthermore, recognition of orbital cyclicity in shelves deposits has long been impeded due to the scarce of high-resolution, almost continuous records at orbital timescale, which make it difficult to correlate $\delta^{18}O$-derived deep-sea stratigraphy with the sea-level shaped deposits on continental margin. In this study, we carry out Principal components analysis on the grainsize data of core BH08 retrieved from the Bohai Sea, combined with previously published color reflectance and total organic carbon (TOC) proxies 1) to extract the signals of climate and sea-level recorded in core BH08, 2) to evaluate the response of sedimentation to sea-level and climate, and to provide a reference for shallow continental margin area influenced by monsoonal climate. The results indicate that Milankovitch-scaleclimate modulate sediment supply whereas eustatic sea-level changes redistribute the sediments. In most cases, however, the effect of eustatic sea-level fluctuations overshadows the signal of Milankovitch-scale sediment supply.

Acknowledgements
This work was jointly supported by the National Natural Science Foundation of China (NSFC; No. 41476055, U1606401).

Key words
Bohai, Middle Pleistocene, Sea-level, Climate, Orbital-forcing

Alkenone reconstructions of the subarctic Northwestern Pacific surface hydrography and upper ocean stratification since the last glacial

Pai-Sen Yu[1], Chia-Ju Liao[2], Min-Te Chen[2], Jian-Jun Zou[3], Xuefa Shi[3], A. A. Bosin[4] and Sergey A. Gorbarenko[4]

[1]*Taiwan Ocean Research Institute, National Applied Research Laboratories, Kaohsiung 801, Taiwan*
[2]*Institute of Earth Sciences, National Taiwan Ocean University, Keelung 20224, Taiwan*
[3]*First Institute of Oceanography, State Oceanic Administration, Qingdao, China*
[4]*Pacific Oceanological Institute FEB RAS, Vladivostok, Russia*
Corresponding author: Pai-Sen Yu (menardii@mail2000.com.tw)

In order to reconstruct subarctic Northwestern Pacific surface hydrography and sea surface temperature from the last glacial, we investigated alkenone-based records in the marine sediments of a piston core recovered off the east coast of the Kamchatka Peninsula, Russia during the R/V *Akademik M. A. Lavrentyev* 2013 cruise. Core LV 63-41-2 (52.56°N, 160.00°E; water depth 1924 m) retrieved from a high sedimentation site, in which the interactions of the Bering Sea and the warm water mass from the NW Pacific are highly dynamic. In this study, high-resolution last glacial alkenone-based records from Core LV 63-41-2 are reported. Prior to 27-16 ka BP high glacial $C_{37:4}$ alkenone concentrations indicate large amount of fresh water influencing the surface water of the NW Pacific with a reaching to the Site LV 63-41-2. We further inferred that during the last glacial the low salinity water may be formed from riverine input from the Kamchatka Peninsula, the ice-melting water on site and/or brought by the surface current from the Bering Sea, and are efficient in producing strong water stratification condition. The stratification weakens vertical mixing of the upper water column, that in turn decreases the nutrients upwelled from deep to the surface therefore causes low productivity of coccolithophorids. During the early Bølling-Allerød (B/A) period, a gradual increasing of alkenone-SST and associated with high $C_{37:4}$ alkenone concentrations, implying that a weakened stratification and much stronger nutrient upwelling of the early B/A period than that of the last glacial. The late B/A period is characterized by an abrupt warming with possibly more melting sea ices in the Bering Sea and the coast near the Kamchatka Peninsula. The large amount of fresh water lens formed during the ice melting might have ceased vertical mixing and upwelling in the upper water column as evidenced by a decline of biological productivity of both calcareous and siliceous organism during late B/A. We suggest an early warming and low productivity in the NW Pacific that is coincident with a rapid cooling in most of the Northern Hemisphere high latitudes during the Younger Dryas.

Acknowledgements
The research was supported by the joint programs of MOST/FEBRAS and FIO, China

Key words
Alkenone, Sea Surface Temperature, Glacial, Holocene

Millennial-scale variations in intermediate water ventilation of the western subtropical North Pacific

Jianjun Zou[1,2]*, Xuefa Shi[1,2], Aimei Zhu[1]

[1] *Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, MNR, Qingdao,China*
[2]*Laboratory for Marine Geology, Qingdao National Laboratory for Marine Science and Technology, Qingdao, , China*
**e-mail: zoujianji@fio.org.cn*

Variations in atmospheric CO_2 levels at orbital and millennial timescales are dominated by both ocean circulation and biological productivity, which also exert great effects on concentration of oxygen in deep ocean and sediment. However, the role of voluminous subtropical North Pacific in modulating atmospheric CO2 levels and the ocean oxygen concentration changes are poorly constrained. In this study, we use a suite of geochemical proxies to investigate the ventilation variations in the subtropical North Pacific over the last glaciation. Our data support the enhanced ventilation at intermediate-depth site during cold intervals whereas dampened ventilation in the warming intervals. Coherent pattern in change with those of the Bering Sea and the Eastern North Pacific, it may reflect broad effects of North Pacific Intermediate Water (NPIW) on ventilation of the North Pacific. On the other hand, we found out-of-phase relationship between changes in deglacial sedimentary oxygenation in the OT and Atlantic Meridional Overturning Circulation bridged by NPIW. The mechanisms behind deglacial Atlantic-Pacific ventilation seesaw pattern seem to be attributed to the perturbation of sea ice formation and sea surface salinity oscillation in high latitude North Pacific through atmospheric and oceanic teleconnection.

Acknowledgements
This study was supported by the National Natural Science Foundation of China (Grants No. 41476056, 41876065) and National Program on Global Change and Air-Sea Interaction (GASI-GEOGE-04).

Key words
Ventilation in Intermediate water; subtropic North Pacific; Last Glaciation

Mechanism for Late Pleistocene paleomagnetic variations in subarctic North Pacific sediments: Dipole vs non-dipole fields

Yi Zhong [1, 2], Yanguang Liu [3, 4], Xiaoqiang Yang [5], Andrew P. Roberts [6], Aleksandr Bosin [7], Sergey Gorbarenko [7], Jian Zhang [2], Xuefa Shi [3, 4], Ting Chen [1], Yu-Min Chou [1], Wei Liu [1], Haosen Wang [1], Congcong Gai [6, 8], Jianxing Liu [3, 4], Aleksandr Derkachev [7], Xiaoke Qiang [9], Qingsong Liu[1,2*]

[1]*Center for Marine Magnetism (CM2), Department of Marine Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, P. R. China*

[2] *Key Laboratory of Computational Geodynamics, University of the Chinese Academy of Sciences, Beijing 100049, P. R. China*

[3] *Key Laboratory of Marine Sedimentology and Environmental Geology, First Institute of Oceanography, Ministry of Natural Resourses, Qingdao 266061, P. R. China*

[4]*Laboratory for Marine Geology, Qingdao National Oceanography Laboratory for Marine Science and Technology, Qingdao 266061, P. R. China*

[5] *Department of Earth Science, Sun Yat-Sen University, Guangzhou 510275, P. R. China*

[6] *Research School of Earth Sciences, Australian National University, Canberra, ACT, Australia*

[7] *V.I.Il'ichev Pacific Oceanological Institute, Far East Branch of Russian Academy of Science, Vladivostok 690041, Russia*

[8]*State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, P. R. China*

[9] *State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi' an 710061, P. R. China*

**e-mail: gsliu@sustech.edu.cn*

High-resolution paleomagnetic records from the subarctic North Pacific Ocean are scarce because this deep-ocean setting lies largely below the carbonate compensation depth, which compromises development of conventional $\delta^{18}O$-based chronologies for long sediment cores. In this study, an age model was developed using an integrated dating approach for a 5.25 m-long (~140 ka) core (Lv63-4-2) from Detroit Seamount, which includes radiometric dating, sporadic oxygen isotope determinations, paleoproductivity proxies (carbonate content, color reflectance), and high-resolution paleomagnetic studies. Mineral magnetic analyses indicate that vortex state magnetite is the dominant magnetic carrier. A relative paleointensity (RPI) curve was developed, which generally mimics global RPI stacks, particularly including a minimum during the Laschamp excursion (~41 ka). However, apparent localized features are also evident, particularly in the younger part of the record, such as a directional anomaly and RPI peak at ~12 ka, which is attributed here to a short-lived flux patch instability on the core-mantle boundary below East Asia. In addition to conventional RPI variations due to global-scale dipole features, non-dipole features due to localized large RPI and paleo-directional changes need further study to understand regional geomagnetic variations.

Acknowledgements

We thank Qiang Zhang for helpful suggestions. This work was supported financially by the National Natural Science Foundation of China (41806063, 41874078, and U1606401), the Open Fund of the Key Laboratory of Marine Geology and Environment, Chinese Academy of Sciences (No. MGE2018KG05),SIGEPAX (No. 03F0704A) and State Key Laboratory of Marine Geology, Tongji University (No. MGK1826).

Key words

Relative paleointensity; Geomagnetic excursion; Non-dipole-filed; Flux lobes; Chronostratigraphy; Subarctic North Pacific.

T03: Ocean environment and ecosystem

T03-1: Marine pollution

Ice covers influence on pollutant transfer process in wastewater disposal through marine outfalls

S. Bezborodov, N. Zemlyanaya
Far Eastern Federal University, 8 Sukhanova Str., Vladivostok, Russia, 690090
e-mail: bezborodov.sa@dvfu.ru

Background. The research of pollutant transfer process in ice-covered marine water areas has a great practical interest [1, 2, 3, 4]. The understanding of pollution transfer and transformation processes in freeze-up period is necessary in conditions of active development of the Arctic Coast and in design a long-term prediction of water quality.

Results. The detailed research of wastewater transfer in ice-covered marine water areas in Russia factually not been produced despite of the fact, that in practice all type of coastal outfalls realized in the Far Eastern seas, which freeze-up period during from 4 to 6 months. The submitted research shows the results of field studies of wastewater outfall which located in the northern part of the Amur Bay. The field studies results was compared with results of wastewater transfer calculations, making by engineering methods and results of simulation, produced by CFD (Computational Fluid Dynamic) models which implemented in the Ansys Fluent application software package.
Conclusions. A comparison of field research and numerical simulation data found that the results of theoretical calculations do not always coincide with the field research data.

Key words
Wastewater, ice covers, marine outfall.

References
1. J. Stark, P. Corbett, G. Dunshea, G. Johnstone, C. King, J. Mondon, M. Powerd A. Samuel, I. Snape, M. Riddle The environmental impact of sewage and wastewater outfalls in Antarctica: An example from Davis station, East Antarctica // *Water Research*, 2016, **105**, p.602-614
2. T. Bleninger Coupled 3D Hydrodynamic Models for Submarine Outfalls: Environmental Hydraulic Design and Control of Multiport Diffusers // Univ.-Verlag Karlsruhe, 2007. - 219 p.
3. P. Roberts, H. Salas, F. Reiff, M. Libhaber, A. Labbe, J. Thomson Marine Wastewater Outfalls and Treatment Systems // IWA Publishing. 2010. - 520 p.
4. S. Hamza, S. Habli, N. Saïd, H. Bournot, G. LePalec. Simulation of pollutant dispersion of a free surface flow in coastal water // *Ocean Engineering* 2015, **108**, p. 81-97

Marine litter and its influence on marine ecosystem

Ya. Blinovskaya
Far Eastern Federal University.8 Sukhanova Str., Vladivostook, Russia, 690003
e-mail: blinovskaya@hotmail.com

Background. Marine litter also known as marine debris is human-created waste that has deliberately or accidentally become afloat in a sea. Marine litter tends to accumulate on coastlines. Some forms of marine litter such as wood, food waste and other decomposes in sea water but most marine litter forms don't biodegrade especially it concern as plastic. Waterborne plastic poses a serious threat to fish, seabirds, marine mammals and other animals and its habitat including acidification processes. Ocean dumping, accidental container spillages, litter washed into storm drains, and wind-blown landfill waste are all contributing to this problem.

Material and methods. The researches have demonstrated that despite the shared severity of the problem throughout, the sources of pollutant introduction into the marine coastal environment of Japan, Korea, China, and Russia are quite different. In the Russian Far East the "land originated" litter is prevailing. It is mainly coming from the enterprises and companies doing their business on the coast, as well as tourism, represented as a rule by unmanaged tourist camps. Along with traditional plastic waste it is a so-called microplastic that is of interest. Russia is no exception in this respect. Active research into microplastics in southern Russian Far East marine environment has been done since 2014. There are 13 monitoring stations within the Peter the Great Gulf waters (Sea of Japan) to include recreational and industrial areas differing in hydrodynamic behavior, at five of which plastic items are encountered on a regular basis.

Results. In samples taken from the Bosporus of the East Strait and Golden Horn Bay microplastic particles of approximately 2-3 mm in size are regularly observed. Quality analysis of all the samples collected was carried out using spectrophotometric method and that of infrared microscopy. It has been found that the chemical constitution of the samples studied is represented mostly by polyethene, polypropylene, particles of polystyrene and polyvinylchloride. Coastal samples frequently contain cellulose. A certain amount of methylaniline, formaldehydes, and monocarbozides was detected.

Conclutions. Monitoring results analysis shows: an increase in the amounts of plastics and other waste entering coastal marine zone, connected, in particular, with plastics production growth; presence of toxic chemicals, including persistent organic pollutants, within the composition of plastics entering marine waters; particular impact of microplastics, both of primary origin (e.g. microparticles incorporated into detergents and cosmetic products), and of secondary one (generated through macroplastics destruction) on coastal marine ecosystems.

Key words
Marine litter, microplastic, monitoring

Threshold concentration of heavy metals in organisms and bioaccumulation factor

E. Chernova
Pacific Geographical Institute of FEB RAS, Radio 7, Vladivostok, Russia 690041
e-mail: elena@tigdvo.ru

Background. Assessment of the environment requires standards of quality: threshold or maximum permissible concentrations of harmful substances in its components. As the threshold concentration of metals in biomonitors, it is proposed to use the median value plus its confidence interval, the median of absolute deviations (Med+2MAO) [1]. The other methodology for calculating the threshold concentrations in biomonitors has developed with the use of the standard of element content in water and bioaccumulation factor for algae (BAF = ratio of metal concentration in the body (μg/g of dry weight) to its content in water (μg/ml))[3]. There is a negative linear correlation between Log-transformed values of BAF for metals in organisms and content in water [2]. The aim of this work was to establish a correspondence between the threshold concentrations of metals in brown algae from the Sea of Japan and the value of BAF.

Material and methods. Concentrations of Zn, Cu, Cd, Pb, Ni, Fe, Mn (μg/g of dry mass) in the mass species of algae were determined by atomic absorption spectrophotometry. To determine the threshold concentrations of metals in algae (Med+2MAO), we used literature and own data on the trace element composition of macrophytes from the coastal waters of the Russian part of the Sea of Japan. The BAF values were calculated on the basis of literature and own data, and the curve of BAF variability depending on the element content in the medium was constructed.

Results. An analysis of the BAF curve showed that the highest and most variable BAF values of metals in algae are observed in the water with concentrations in the background range and belong to algae containing metals in concentrations from the background range (not exceeding the threshold ones). With increase of concentrations of elements in the environment and exceeding the background range, the BAF values in algae reduce exponentially. This allows us to believe that the organisms accumulate elements from the background environment for their physiological needs with higher intensity and come to active regulation after the appearance in the environment of excess metal above the background range. When the concentrations go beyond the background range, there is a positive linear correlation between the contents of the element in the medium and organisms. Under the background conditions, the relationship between the concentrations of elements in the medium and organisms is not observed, which should be borne in mind when interpreting biomonitoring data.

Conclusions. To the background range of concentrations (Med±2MAO) of metals in algae, the greatest and most variable BAF values and the environment with background values of dissolved elements correspond. Under the background environment, the organisms accumulate metals for their physiological needs with a higher intensity than in the environment with their excess. In this range of concentrations, there is no relationship between the contents of element in water and organisms.

Key words
Brown algae, threshold concentrations of metals, Bioaccumulation Factor.

References

1. Reinmann C., Filzmoser P., Garrett R.G., Sci. Total Environ., 2005, V. 346, P. 1–16.
2. Zalewska T., Danowska B., Mar. Pollut. Bull., 2017, V. 118, P. 281–288.
3. DeForest D.K., Brix K.V., Adams W.J., Aquat. Toxicol., 2007, V. 84, P. 236–246.

Distribution of Polychaeta in the western and northern Barents Sea

D. Dikaeva, E. Frolova
Murmansk Marine Biological Institute KSC RAS, 17, Vladimirskaya Str., Murmansk, Russia 183010
**e-mail:dikaeva@mmbi.info*

Modern species composition and abundance of polychaetes are researched in the northern Barents Sea including the South Cape Trench, Bear-Hope Islands flat, and Storfjord Strait. Bottom relief significantly affects distribution of bottom sediments, circulation and distribution of water masses, as well as distribution and composition of bottom fauna. The surveyed areas are subjected to the warm South Spitsbergen Current and cold East Spitsbergen and Bear Currents, which affect species composition and structure of benthic communities. Previously the polychaete worms were not investigated enough in this area. In total, 61 quantitative samples from 21 stations were collected during the expedition of Murmansk Marine Biological Institute aboard RV 'Dalnie Zelentsy' in July and November 2017 using Van Veen grab (capture area 0.1 m^2) in 3-fold repetition. Increasing of biomass and density of polychaetes was detected for silty-clay soils in the South Cape Trench, Bear Island Bank, Storfjord Strait, and adjacent deep-water areas. Detritophage *Spiochaetopterustypicus* was a dominant species by biomass and metabolic rate, but *Galathoweniaoculata* had the highest abundance. The hollows of the bottom with weakened hydrodynamics where sedimentation process of suspension prevailed over its transfer are more favorable for detritophages (Kuznetsov, 1970).In the survey, the biomass and population density of polychaetes had decreased with the depth decreasing, as well, both at the western slope of Bear Island Bank and in the northern areas, where *Nothriahyperborea* dominated. The most unfavorable conditions for detritophages were found on hard soils with a predominance of coarse clastic material, in the zone of active hydrodynamics, where transfer prevailed over sedimentation. Previously there were found that *Spiochaetopterustypicus*, *Galathoweniaoculata* dominated over Bear Island – Spitsbergen Plateau and in the open part of the sea and *Spiochaetopterustypicus* dominated in Bear Island Trench and on St. Anne slopes (Frolova, Dikaeva, 2017). So, new data confirm the results of Kuznetsov's study.

References

A. Kuznetsov,*Trudy IO AN SSSR*, 1970, **88**, 5-80.
E. Frolova, D. Dikaeva.*Transactions of Kola Science Centre.Oceanology*, 2017, **4**(2),81-88.

Key words
Polychaeta, Annelida, Barents Sea, benthos community

Distribution of ^{137}Cs in the surface mixed layer of the Black Sea Distribution of ^{137}Cs in the Surface Mixed Layer of the Black Sea in summer 2017

I. Dovhyi[1*], D. Kremenchutskii[1], O. Kozlovskaya[1], N. Bezhin[2], V. Milyutin[3], E. Kozlitin[3]
[1] *Marine Hydrophysical Institute of RAS, 2 Kapitanskaya Str., Sevastopol, Russia, 299011*
[2] *Sevastopol State University, 33 Universitetskaya Str., Sevastopol, Russia, 299053*
[3] *Frumkin Institute of Physical Chemistry and Electrochemistry of RAS, 31 Leninsky Prospect, Bldg. 4, Moscow, Russia, 119071*
**e-mail: dovhyi.illarion@yandex.ru*

Background. Contamination of the Black Sea with technogenic radionuclides was one of the Contamination of the Black Sea with technogenic radionuclides was one of the consequences of the Chernobyl accident, ^{137}Cs with the half-life of about 30 years being of the primary concern[1].

Material and methods. Field observations data on the spatial-temporal variability of the ^{137}Cs specific activity field in the surface mixed layer of the Black Sea obtained in the cruise 95 R/V Professor Vodyanitsky (June 14 – July 7, 2017) were obtained. There were 22 samples of seawater at 11 stations sampled and processed for the period of studies. Data on the vertical distribution of the radionuclide in the active layer of the sea were obtained on 6 stations. For the first time ever, ^{137}Cs was separated from seawater on a ferrocyanide sorbent of the FSS brand, intentionally developed for selective recovery and separation of ^{134}Cs and ^{137}Cs radionuclides from technological solutions and radioactive waste.

Results. Ferrocyanide sorbent of the FSS brand based on potassium-nickel ferrocyanide and silica gel was used for separation of ^{137}Cs from seawater samples for the first time. High ^{137}Cs recovery values (over 60 %) by this sorbent were demonstrated.

No effect of the depth (0-65 m) on the specific activity of ^{137}Cs in seawater was detected within the activity measurement error limit.

The ^{137}Cs specific activity values in the surface mixed layer of the aquatic area of the Crimean Peninsula and pelagic zone of the Black Sea varied within the range of 5.7 – 8.8 Bq m^{-3}, amounting 6.86 ± 0.15 Bq m^{-3} at average. Actually, almost twofold decrease of the average specific activity value of ^{137}Cs in the surface mixed layer from 16[2,3] to 8 Bq m^{-3} was observed from 2013 to 2017.

The elevated values of the ^{137}Cs specific activity were observed in the western part of the Crimean Peninsula aquatic area and deep-water part of the Black Sea, whereas the lower specific activity values were observed in the Crimean South Coast area.

References

[1]T.V. Chudinovskikh, V.N. Eremeev, G.F. Batrakov, Physical Oceanography, 2001, 11(5), 439-446.
[2]S.B. Gulin, N.Yu. Mirzoyeva, V.N. Egorov, G.G. Polikarpov, I.G. Sidorov, V.Yu. Proskurnin, Journal of Environmental Radioactivity, 2013, 124, 50-56.
[3]S.B. Gulin, V.N. Egorov, M.S. Duka, I.G. Sidorov, V.Yu. Proskurnin, N.Yu. Mirzoyeva, O.N. Bey, L.V. Gulina, Journal of Radioanalytical and Nuclear Chemistry, 2015, 304,779-783.

Acknowledgements
This work was conducted under the State Assignment of the FASO of the Russian Federation, the "Oceanological Processes" topic No. 0827-2019-0003.

Key words: ^{137}Cs, Black Sea, selective sorbent.

Sorption of Radium and Thorium isotopes from seawater by MnO_2 impregnated fiber

I. Dovhyi[1*], D. Kremenchutskii[1], Ya. Tovarchii[2], Yu. Shibetskaya[2], N. Bezhin[2], A. Egorin[3,4], E. Tokar[3,4], I. Tananaev[4]

[1] *Marine Hydrophysical Institute of RAS, 2 Kapitanskaya St., Sevastopol, Russia, 299011*
[2] *Sevastopol State University, 33 Universitetskaya St., Sevastopol, Russia, 299053*
[3] *Institute of Chemistry, Far Eastern Branch of the Russian Academy of Sciences, 159 100th anniversary of Vladivostok ave., Vladivostok, Russia, 690022*
[4] *Far Eastern Federal University, 8 Sukhanova St., Vladivostok, Russia, 690003*

**e-mail: dovhyi.illarion@yandex.ru*

Background. Natural radionuclides are widely used as tracers for studying many natural processes [1]. Radium isotopes (^{223}Ra, ^{224}Ra, ^{226}Ra, ^{228}Ra) make it possible to quantify the submarine groundwater flow – an important source of fresh water in many water-deficient regions[2]. The isotope ^{234}Th is a common tracer, allowing the particulate organic matter fluxes assessment [3].

Material and methods. It was used W. Moore's [4] method for preparing the sorbent by which radium and thorium radionuclides have been sorbed from 200 l seawater samples by two sequel adsorbers with 5 g of fiber. The efficiency of the sorbent was shown (recovery more than 80% for ^{226}Ra, ^{228}Ra, ^{234}Th).

Results. This thesis discusses the use of manganese dioxide-based acrylate fiber for sorption of radium and thorium isotopes from seawater. Seawater is a difficult object of this study, due to its high salinity and low specific activity of natural radionuclides. Therefore, it is actual obtaining effective sorbents for the recovery of radionuclides from sea water.

Conclusions. The main difficulty when measuring the activity of individual radionuclides is the use of various methods. For the short-lived ^{223}Ra, ^{224}Ra isotopes measurement, specialized RaDeCC system is used. For ^{226}Ra, ^{228}Ra, the daughter decay products in the sorbent's ash are measured by γ-spectrometry with or without radiochemical preparation. It is possible the measurement of the short-lived ^{234}Th isotope from samples of small volume (several tens of liters) by β-radiometry with the following measurement of residual activity after 5 months, or from samples of large volume (several hundred liters) by direct γ-spectrometry.

Acknowledgements
The reported study was funded by RFBR and Sevastopol according to the research project №18-33-50001 («Tutor» project), the state assignment of FASO of Russian Federation (theme «Oceanological processes» No. 0827-2019-0003) and FEFU Foundation, under the contract of January 28, 2019, No. D-38-19, and supplementary agreement No. 1 of March 19, 2019 (project No. 18-04-0027).

Key words
Submarine groundwater discharge, Radium, Thorium.

References
1. J.K. Cochran, H. Feng, D. Amiel, A. Beck, *Journal of Geochemical Exploration*, 2006, 88(1-3), 376–379.
2. M. Mejías, B.J. Ballesteros, C. Antón-Pacheco, J.A. Domínguez, J. Garcia-Orellana, E. Garcia-Solsona, P. Masqué Journal of Hydrology, 2012, 464-465, 27–40.
3. K.O. Buesseler, C.R. Benitez-Nelson, S.B. Moran, A. Burd, M. Charette, J.K. Cochran, Marine Chemistry, 2006, 100(3-4), 213–233.
4. W.S. Moore, *Deep Sea Research and Oceanographic Abstracts*, 1976, 23(7), 647–651.

Synthesis of magnetically controlled sorbents based on iron-cobalt spinel to extract uranyl ions from aqueous media

A. Drankov[1,2*], E. Papynov[1,2], I. Tkachenko[1], I. Tananaev[2]
[1]*Institute of Chemistry, Far East Branch, Russian Academy of Sciences, Vladivostok Russia, 690022*
[2] *Far Eastern Federal University, Vladivostok, Russia, 690922*
**e-mail: Artur.drankov@gmail.com*

Background. In the past few years there has been considerable interest in the use of spinel ferrites for use in the environment, primarily for the removal of toxic pollutants from aqueous media.

Material and methods. The stability of spinel-ferrite sorbents at different values (pH 2.0–8.0) is an advantage, since they can be used in a wide pH range as adsorbing materials for water purification.

Results. Therefore, this paper presents an integrated approach for the synthesis of magnetic sorbents of composite composition ($CoFe_2O_4$ spinel) and their reduced forms, developed original techniques of sol-gel, template and thermo-synergistic synthesis [1] of argon-hydrogen gases in the medium to restore nanoscale iron and cobalt metal phases. The laws governing the influence of the conditions of syntheses on the physicochemical characteristics of the obtained nanostructured magnetic systems are studied. The conditions of the synthesis methods have been optimized, taking into account the establishment of regularities in the series "synthesis conditions – composition – structure – properties" for each type of sorbent. The optimal paths for heat treatment of materials at the stage of template removal for the formation of the required phase composition of the sorbent with a defect-free macroporous framework are proposed. Magnetic characteristics (saturation magnetization Ms and coercive force Hc) were studied depending on the magnitude of the applied magnetic field and temperature susceptibility, and the magnetic nature of the sorbents was determined, taking into account the chosen method of their synthesis.

Conclusions. Sorption efficiency was evaluated, kinetic curves of sorption of uranium(VI) extraction from aqueous media were obtained at different pH values of the medium for the obtained sorbents. Sorption mechanisms ("reductive deposition" or "sorption-reagent interaction") of uranyl ions in the presence of synthesized sorbents of different composition are proposed.

Acknowledgements
This work was supported by The Ministry of Education and Science of the Russian Federation, State Order № 0265-2019-0002 of the Institute of Chemistry FEBRAS (development of new methods for the synthesis of sorbents). The use of Shimadzu equipment was financially supported by the Genzo Shimadzu scholarship.

Key words
Magnetic sorbents, sol–gel technology, uranyl ions

References
1. Papynov E., Mayorov V., Modin E., Kaplun E., Sokol'nitskaya T., Avramenko V., (2015) Fundamental investigations, 2015, №12, 505-510.

Selenium in the food chain of Peter the Great Bay (Sea of Japan) ecosystems

N.V. Ivanenko[1], O.N. Lukyanova[2], L.T. Kovekovdova[2], N.E. Struppul[3]
[1] *Vladivostok State University of Economics and Service, 41Gogolya Str., Vladivostok, Russia, 690014*
[2] *Pacific branch of the Federal State Budget Scientific Institution "Russian Federal Research Institute of Fisheries and oceanography"(TINRO), 4, Shevchenko Alley,Vladivostok, Russia, 690090*
[3]*Far Eastern Federal University, 8 Sukhanova St., Vladivostok, Russia, 690090*
e-mail: Natalya.ivanenko@vvsu.ru

Background. The levels of chemical elements in living organisms are determined primarily by the conditions of existence, the trophic status of the species and their physiological need for the elements.

Materials and methods. The paper covers the features of the accumulation of an element by marine organisms of various trophic levels. *Se* content was determined in 21 species of algae and grasses, 27 species of bivalve mollusks, 4 species of echinoderms, 22 species of fish, bottom sediments, also taking into account the background content of *Se* in seawater. As a criterion, the coefficient of *Se* accumulation in separate links of trophic chains was used (the ratio of the absolute *Se* concentration in the subsequent trophic link to its concentration in the previous one). *Se* was found using a flameless atomic absorption method.

Results. For the waters of Primorsky Territory, it has been established that at the first trophic level (water / algae), *Se* accumulation coefficients are high and reach 7,000 [1]. Despite this, the level of *Se* content in algae and sea grasses is low and comparable to *Se* concentrations in algae from open regions of the World Ocean (does not exceed 0.8 μg / g dry weight)[2, 3]. *Se* concentrations in organs of invertebrates are similar to known values in commercial mollusks living in other parts of the World Ocean with moderate and low elemental content in the environment. The maximum values of the accumulation factors at the second level (algae / echinoderma, algae / mollusks) are 11.4. The average *Se* concentration in the soft tissues of mollusks from Peter the Great Bay is 4 μg / g dry weight. The level of *Se* concentrations in fish of the northwestern part of the Sea of Japan (1–6 μg / g dry weight) makes it possible to assign this region to selenium-deficient provinces. At the third trophic level (fish / crustacean, starfish / mollusks), the *Se* accumulation coefficient is about 1.0. In the transformation of Se in marine waters, an important role is assigned to biogenic detritus [4]. However, for highly productive ecosystems of the Peter the Great Bay, *Se* remains unexplored in the composition of the detritus formed during the death of marine organisms. In the literature, biogenic detritus is considered as a depot of a number of chemical elements and as a nutrient substrate for the bacterial community.

Conclusions. There are significant differences in the accumulation of *Se* by organisms of different trophic levels. Analysis of selenium migration in marine ecosystems requires an understanding of the role of organic sediments in the transfer of an element along the food chain.

Key words: Selenium, marine ecology, Sea of Japan.

References

1. Arsenic and selenium in commercial aquatic organisms from the coastal waters of Primorsky Krai. L.T. Kovekovdova, N.V. Ivanenko, M.V. Simokon, V.V. Shcheglov. *Izv. Tikhookean. Nauchno–Issled. Inst. Rybn. Khoz. Okeanogr.*, 2001, **129**. 3-8.
2. Selen v morskikh organizmakh (Selenium in Marine Organisms). O.N. Lukyanova, Kovekovdova, N.E. Struppul, N.V. Ivanenko. Vladivostok: TINRO-Tsentr, 2006.
3. Trace elements in marine macrophytes of the Russian Far East. L.T. Kovekovdova, N.K. Khristoforova, *Achievements in the life Sciences*, 2011, **(3)**, 41-60.
4. The role of microorganisms in transformation of selenium in marine waters. N.V. Ivanenko. Russian Journal of Marine Biology, 2018. **44(2)**. 87-93.

Space-Time Characterization and Risk Assessment of Nutrient Pollutant Concentrations in China's Near Seas

Qutu Jiang[1], Junyu He[1], Jiaping Wu[1], Mingjun He[1], Evan Bartley[2], Guanqiong Ye[1*], George Christakos[1, 2*]

[1] *Ocean College, Zhejiang University, Zhoushan 316021, China*

[2] *Department of Geography, San Diego State University, San Diego, CA 92182, USA*

email: homer_qtj@zju.edu.cn

Background. The combination of land-sea water interaction and human activity discharge large amounts of nutrient loading to the sea causing severe pollution events. In this context, a comprehensive quantitative characterization of the spatiotemporal variation of nutrient pollutant concentrations is a key component of any reliable seawater quality assessment and integrated coastal management plan.

Material and methods. The present work combines the Bayesian maximum entropy (BME) method with stochastic site indicators (SSI) to estimate monthly nitrate and phosphate concentrations in China's near seas during 2015, explore their spatiotemporal variation and provide an explicit quantitative assessment of seawater quality in conditions of in situ uncertainty. This makes it the first study of space-time nutrient pollutant characterization at a national-scale coastal seawater environment.

Results. The results show that nitrate and phosphate distributions exhibit the same spatial trends in near seas, whereas high nutrient pollution levels are found in the Yangtze River, Liaohe River and Pearl River estuaries. Local differences of temporal trends exist between nitrate and phosphate distributions, which suggest that distinct remediation strategies are needed to properly satisfy the required seawater quality standards.

Conclusions. The average nitrate and phosphate concentrations across space-time were found to be equal to 0.271 and 0.015 mg/L, respectively. The nitrate and phosphate concentrations exceeding the 4th grade seawater quality standard during 2015 were about 11% and 2.6%, respectively, and the percentages of joint locations with nitrate and phosphate concentrations exceeding the same standard were 6% and 0.6%, respectively. Human activities along the coastal cities during different seasons have a great effect on water quality near the coast, whereas the temporal marine hydrodynamics played an important role in the biochemical processing of nutrient transport and distribution.

Main References

Christakos G., Hristopulos D.T., 1996b. Stochastic indicators for waste site characterization. Water Resour. Res. 32 (8), 2563–2578.

Conley D.J., Paerl H.W., Howarth R.W., Boesch D.F., Seitzinger S.P., Havens, K. E., Lancelot C., Likens G.E. 2009. Ecology. controlling eutrophication: nitrogen and phosphorus. Science, 323(5917), 1014

Jiang, Q., He, J., Wu, J., Hu, X., Ye, G., Christakos, G. 2019. Assessing the severe eutrophication status and spatial trend in the coastal waters of Zhejiang province (China). Limnol. Oceanogr. 64, 3-17

Acknowledgements

This research work was supported by a grant by the National Natural Science Foundation of China (Grant NSFC 41671399).

Key words

Nutrient pollutants, China's near sea, Bayesian maximum entropy

Purification of high salt-bearing solutions from heavy metal and radionuclide contaminants by the method of nanofiltration

V. Kaptakov, V. Milyutin, E. Kozlitin.
Frumkin Institute of Physical Chemistry and Electrochemistry of RAS, 31 Leninsky Prospect, Bldg. 4, Moscow, Russia, 119071
e-mail:V.Kapt@yandex.com

Background. In the experiments, we determined the retention capacity (R,%) of the NFs membrane with respect to Ca^{2+} and Mg^{2+} hardness salts as well as to heavy metal Ni^{2+}, Zn^{2+}, Cu^{2+}, Fe^{2+}, and Pr^{2+} ions.

Results. Generalized results on extraction of the above-listed ions from solutions of their nitrates with metal concentration of 0.5-5.0 g/dm^3 and pH=2-3 were given in Table 1.

Table 1. Values of the retention capacity (R) of NF membrane in relation to various metal ions

Ion	Ca^{2+}	Mg^{2+}	Ni^{2+}	Zn^{2+}	Cu^{2+}	Fe^{3+}	Pr^{3+}
R, %	80-88	90-94	80-86	88-94	94-96	96-98	96-98

The results suggested that the NF process was highly efficient in extracting double- and triple-charged ions due to the increased influence of the electrostatic retention mechanism.
The retention ability of $NaNO_3$ was also studied, which, in the concentration range from 0.1 to 20 g/dm^3, did not exceed 20%.

High salt-bearing liquid radioactive waste includes solutions with a salt content of more than 10 g/dm^3. Therefore, the retention capacity was determined in relation to the trace amounts of ^{137}Cs, ^{90}Sr, and ^{60}Co radionuclides from a solution with $NaNO_3$ concentration of 10 g/dm^3 and pH=6.0. The results obtained were shown in Table 2.

Table 2. Values of the NF membrane selectivity (S) and decontamination factor (D_f) of the solution from various radionuclides

Process indicator	Radionuclide		
	^{137}Cs	^{90}Sr	^{60}Co
R, %	45±5	95±1	> 99.5
D_f	1.8±0,2	20±3	> 200

The presented results showed the higher retention efficiency of the membrane in relation to ^{60}Co radionuclide as compared to ^{90}Sr and especially ^{137}Cs. Apparently, the high retention rates for ^{60}Co were related to the fact that in neutral solutions cobalt can be found not only in the ionic but also in the colloidal state.

Conclusions. Thus, the nanofiltration process was very promising for extracting multiple charged ions from solutions, with a rather high throughput rate for the single-charged ones, and could be used to decontaminate high-salt wastewater and technological solutions from radioactive and heavy metal impurities.

Key words
^{137}Cs, ^{90}Sr, ^{60}Co, polymer membrane, purification, nanofiltration

Recent changes in the upper epipelagic nekton community in the North-West Pacific off Kuril Islands in relation to abundant migrations of chub mackerel and Japanese sardine in summer

A. A.Khoruzhiy
Russian Research Institute of Fisheries and Oceanography, Pacific branch (TINRO), Vladivostok, Russia 690091
e-mail: alex.khoruzhiy@gmail.com

Recruitment intensity and biomass of chub mackerel (*Scomberjaponicus*) and Japanese sardine (*Sardinopsmelanostictus*) increase recently in the Kuroshio region (Sakuramoto, 2013; Kamimura et al., 2015), that subsequently promotes their feeding migrations expanding northwards. Changes of nekton species composition are analyzed on the data collected by 14 trawl surveys (1270 stations in total) conducted in the North-West Pacific off Kuril Islands in June-July of 2004-2018. There is revealed that chub mackerel and Japanese sardine occur more frequently and in higher abundance in the upper epipelagic layer of this area since 2014 till nowadays. As the result, structure of the nekton community changed significantly by seasonal dominance of these species. The integral characteristics of community as index of poly-domination (Williams, 1964) and Pielow index (Ricotta, Avena, 2003) have decreased from 6.3 and 0.6 in 2004-2013 to 3.7 and 0.3 in 2014-2018, respectively, while Margalef index (Margalef, 1958) was almost stable with slight fluctuations from 4.6 to 4.0 for the entire period. These noticeable shifts influenced on rank of some species: the former dominant groups as salmons (mostly pink salmon) and mesopelagic fish (mostly myctophids) are replaced in 2014-2018 by more abundant chub mackerel and Japanese sardine. Generally, structure of the upper epipelagic nekton community inhabiting the oceanic waters off Kuril Islands has switched from a poly-dominant to a bi-dominant state.

References

R.Margalef.Information theory in ecology,*Gen. Syst.*, 1958,**3**, 36-71.

Y. Kamimura, M. Takahashi, N. Yamashita, C. Watanabe, A. Kawabata. Larval and juvenile growth of chub mackerel *Scomberjaponicus* in relation to recruitment in the western North Pacific,*Fisheries Science*, 2015, **81** (3), 505-513.

C.Ricotta, G.Avena. On the relationship between Pielou's evenness and landscape dominance within the context of Hill's diversity profiles,*Ecological Indicators*, 2003, **2** (4), 361–365.

K.Sakuramoto. A recruitment forecasting model for the Pacific stock of japanese sardine (*Sardinopsmelanostictus*) that does not assume density-dependent effects. *Agricultural Sciences*, 2013,**4,** 1-8.

C.B. Williams. Patterns in the balance of nature and related problems in quantitative ecology, L., N.Y.: Academic Press, 1964, 324 p.

Acknowledgements

I sincerely thank my colleagues from TINRO who took part in the expeditions and collected the material.

Key words

Upper epipelagic nekton community, North-West Pacific, chub mackerel, japanese sardine

Wind stress water recirculation in the Peter the Great Bay (Sea of Japan)

T. Kilmatov[1], I. Zabin[2], I. Mokrousov[1]
[1] *Far Eastern Federal University, FEFU, 8 Sukhanova Str., Vladivostok, Russia, 690090*
[2] *V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041*
e-mail: kilmatov.tr@dvfu.ru

Background. The social, economic and tourist development of Vladivostok city implies some steady increase in the environmental impact of pollution to the Bay of Peter the Great. There are many observations and modeling studies showing the general role of the wind stress and drift component for the bay water circulation. The integral time for which the waters of the bay could be replaced by clean waters of the open sea was estimated. The classical approximation of Ekman's transfer in “deep” and “shallow” water was supplemented by the approximation of “intermediate depth” of water. In last case the integral water flow deviates from the direction of the wind stress by 45^0 to the right. The application of “intermediate depth” model for Peter the Great Bay was used in the water areas of 30–70 meters deep.

Results: The volumetric inflow of clean sea water to the bay for a fixed time depends on the wind direction. The favorable wind is the North wind (plus - minus two compass points). This wind of the order of 10 m/s for 10 days long is able to provide the cleaning effect of bringing the open sea waters to the bay. In particular there is the full replacement of the Amur Bay water with the clear open sea waters for two weeks long. During the autumn - winter cooling and vertical water instability can enhance the recirculation. The south wind (plus minus two compass points) creates the surge effect and this factor makes some difficult to replace the bay waters. During the summer warm-up period the stable vertical stratification produces difficulties for mixing and to replace the water in the bay.

Conclusions. Any activity associated with the threat of the Peter the Great Gulf pollution should be started the autumn – early winter period due to the seasonal monsoon activity and the prevalence of the northern winds. In this time period there is no ice cover and wind stress provides the kinetic energy of the drift flow and bringing the clean water from the sea

Key words
Peter the Great Gulf, pollution, modeling

The mollusk *Glycymeris yessoensis* as an indicator of the sea pollution

T.O. Mizgina[1,2], I. V. Chikalovets[1,2], V. I. Molchanova[2], O. V. Chernikov[2]
[1.] *Far Eastern Federal University, School of Natural Sciences, Vladivostok, Russian Federation*
[2.] *G. B. Elyakov Pacific Institute of Bioorganic Chemistry, Far East Branch, Russian Academy of Sciences, Vladivostok, Russian Federation*
e-mail: tanya.tasha@mail.ru

Background. Bivalves as near-bottom filter feeders have proved to be adequate bio indicators of sea contamination. It is no mere coincidence that mussels have been chosen as an object for the monitoring of coastal waters. The existence of a huge number and diversity of mollusks indicates the presence of effective systems for the protection of their own organism. Important role in nonspecific immune reactions such as agglutination, phagocytosis and lysis, play carbohydrate-binding proteins – lectins.

Results. In our previous study, novel lectin was identified and characterized from the hemolymph of the mollusk *Glycymeris yessoensis* (GYL). This bivalve inhabit in the Troitsy Bay, Sea of Japan. It is widespread Pacific bivalves. We investigated the lectin activity in response to anthropogenic contaminants using the method of the enzyme-linked immunosorbent assay. We revealed significant changes in lectin activity in response to effect of diesel fuel as a toxic agent. It was found, that GYL content increased 2.8 times after 3 hours clams treatment with aliquot of diesel fuel in aquarium. After that, its concentration drops sharply, which is associated with a rapid expenditure of lectin in response to the fight against pollution and in a day it drops to almost zero. The maximal activity of lectin was recorded at 48 h after the exposure of the animals to the influence of diesel fuel. This is probably connected with activation of the process of GYL synthesis. Obviously, the similar change reflects the adaptive compensatory processes that to occur in mollusks subjected to intoxication.

Conclusions. Thus, the determination of the level of lectins of bivalves can be used both to assess the biological state of invertebrates when they adapt to various ecological and anthropogenic influences and to be one of the indicators of the pollution of the marine aquatorium.

Key words
Lectin, Bivalve mollusks, bio indicators

Chemical contamination of coastal areas off Vladivostok: more than 35 years history and effects on benthic population

A.V. Moshchenko*, T.A. Belan, B.M. Borisov, T.S. Lishavskaya, A.V. Sevastianov
Far Eastern Regional Hydrometeorological Research Institute, 24 Fontannaya Str., Vladivostok, Russia. 690091
**e-mail: avmoshchenko@mail.ru*

Background. Coastal zone off Vladivostok is exposed to heavy anthropogenic impact, and chemical pollution is one of the most important components of this influence. Changes of total chemical contamination were shown to explain more than 50 % of variance of *AMBI* and *M-AMBI*, the indices that describe ecological status of macrozoobenthic populations, but these effects are local and observed clearly at the most polluted regions of Peter the Great Bay [1]. The aim of the work is to consider the history of contamination and its biological consequences at these areas.

Material and methods. Samples of sediments were collected in Amursky and Ussurisky Bays, Golden Horn Inlet and East Bosphorus Strait since 1982 at 16 monitoring stations using van Veen grab. Besides, data obtained during the special survey of 2016 (50 stations) were used. Total level of chemical contamination is estimated by *TPF* index: *TPF*=(PHC+PHE+Pb+Cu+ΣDDT)/5, where abbreviations are 5-range estimations (*log*-scale) of contents of hydrocarbons, phenols, lead, copper, and sum of DDT and its metabolites [2]. To characterize effects of contamination on benthos, a method for quantitative appraisal of disturbances of benthic communities, was used [3]. It is based on changes of Shannon-Wiener index for bivalve mollusks (H_b') along *TPF* gradient; measures of these disturbances are ERL_q and ERM_q that limit the area of progressive degradation (linear drop of H_b').

Results. According to pollutant contents, cluster analysis and EM algorithm, the stations surveyed (data of 2016) were grouped in 5 clusters that show different levels of contamination, from low in the 1st group to extreme in the 5th one. Changes of *TPF* follow similar two phase pattern in all groups. *TPF* showed progressive growth in the 1st phase (up to the beginning of the 1990s), and then become relatively stable in the 2nd phase (up to 2018, most stations), but evident *TPF* fluctuations were observed during the whole period of observations. The 1st phase was shorter notably at the most polluted sites than that of the areas with low contamination level. *TPF* was less the ERL_q in the 1st and 2nd groups, varied within ERL_q–ERM_q in the 3rd group and exceeded ERM_q in other ones during the 2nd phase. Benthos existing under heavy pollution is presented by poor degraded communities, populations of the 3rd group are unstable and change notably under additional negative environmental effects, and those of the 1st and 2nd ones are similar to communities of clear areas. Probably, such a situation occurred there during last 30 years.

Key words
Contamination, changes, macrozoobenthos

References

1. Moshchenko A.V., Belan T.A., Borisov B.M., Lishavskaya T.S., Sevastianov A.V., *Izvestiya TINRO*, 2019, **196**, 155-181.
2. Belan T.A., Moshchenko A.V., *Ocean Science Journal*, 2005, **40(1)**, 1-10.
3. Moshchenko A.V., Belan T.A., *Russian Journal of Marine Biology*, 2008, **34(4)**, 279-292.

Temporal variation of radiocesium concentration in surface marine sediments at coastal area off Fukushima Prefecture, Japan

S. Nagao[1*], S. Terasaki[2], S. Ochiai[1], K. Fukushi[1], M. Asami[3]
[1]*Institute of Nature and Environmental Technology, Kanazawa University, Kakuma-machi, Kanazawa, Ishikawa, Japan, 9211192*
[2]*Graduate School of Natural Science and Technology, Kanazawa University, Kakuma-machi, Kanazawa, Ishikawa, Japan, 9211192*
[3]*National Maritime Research Institute, 6-38-1 Shinkawa, Mitaka, Tokyo, Japan, 1810004*
**e-mail: nagao37@staff.kanazawa-u.ac.jp*

Background: After the accident, Kusakabe *et al*. [1] have shown that concentrations of ^{137}Cs in the surface sediments varied spatially by two orders of magnitude from 1.7 to 580 Bq kg^{-1}dry off Miyagi, Fukushima, and Ibaraki Prefectures during May 2011-March 2012. Temporal variations were reported for the surface sediments off Miyagi, Fukushima, and Ibaraki Prefectures during 2011-2016 [2]. For better understanding the variation of radiocesium concentration, it is important to investigate the spatial and temporal distribution at some restricted coastal area including river systems. This study investigated the spatial distribution of ^{134}Cs and ^{137}Cs in the coastal marine sediment off the Fukushima Dai-ichi NPP and Niida River in 2015-2016.

Materials and methods: The radioactivity of ^{134}Cs and ^{137}Cs was measured for the packed samples using gamma-ray spectrometry with low background Ge detectors equipped with a multichannel analyzer at the Low Level Radioactivity Laboratory and the Ogoya Underground Laboratory of Kanazawa University during 1–3 days. The cascade summing effect was corrected for ^{134}Cs using a contaminated soil sample from Fukushima. Decay correction of radioactivity for ^{134}Cs and ^{137}Cs was done at each sampling date.

Results: Radiocesium deposited onto the coastal marine sediments exhibited temporal variation of radioactivity at surface sediments off Fukushima Dai-ichi NPP and Niida River in a period of October 2015 to January 2016. Total radioactivity of ^{134}Cs and ^{137}Cs ranged from 3 Bq/kg-dry sed. to 549 Bq/kg-dry sed. and from 10 Bq/kg-dry sed. to 2480 Bq/kg-dry sed., respectively. Water content also varied spatially and temporality. There is a positive correlation between the radioactivity and water content. The results suggest that sediments with fine particle size are associated with radiocesim, and are re-suspended and remobilized by heavy rain and stormy events.

Conclusions: Radioactivity variation of radiocesium associated with marine sediments is controlled by resuspension and deposition of surface marine sediments at coastal area with water depth less than 72 m.

Acknowledgements
This study was performed by the contract research on accumulation of radionuclides in coastal marine area off Fukushima Prefecture funded by the Nuclear Regulation Authority in 2015.

Key words
Coastal marine sediments, Cs-134, riverine suspended solids

References
1. Kusakabe M., Oikawa S., Takata H., Misonoo J., *Biogeosciences*, 2013, **10**, 5019-5030.
2. Kusakabe M., Inatomi N., Takata H., Ikenoue T., *J. Oceanography*, 2017, **73(5)**, 529-545.

POC Export Regulated by Plankton Community Structure in a Subtropical Marginal Sea

Yong Qiu[1], Yuyuan Xie[1], Edward Laws[2], Xin Liu[1], and Bangqin Huang[1*]

[1] *State Key Laboratory of Marine Environmental Science, Fujian Provincial Key Laboratory of Coastal Ecology and Environmental Studies, College of the Environment and Ecology, Xiamen University, Xiamen 361102, China.*
[2] *Department of Environmental Sciences, College of the Coast and Environment, Louisiana State University, Baton Rouge, Louisiana, USA.*
[*] *Corresponding author: Bangqin Huang (bqhuang@xmu.edu.cn)*

Floating sediment traps were deployed to study POC flux and composition of sinking particle in contrast shelf, slope and basin ecosystems in the 5 summers during 2014 and 2018in the South China Sea, the largest marginal sea in western Pacific. Results showed that average integrated euphotic POC flux decreased, while the composition of sinking particles changed significantly from the shelf to slope and basin systems. Contribution of sinking phytoplankton cell decreased while zooplankton fecal pellets increased from the shelf to slope and basin systems. Diatoms were main contributors in the sinking phytoplankton in the three contrast ecosystems although diatoms-*Prochlorococcus* dominated in the shelf while *Prochlorococcus*-Haptophytes (T8) in the slope and basin water column systems. The cylindrical fecal pellets were the main contributor of zooplankton fecal pellets POC fluxes in the shelf, slope and basin systems. For the different layers of composition of sinking particles, contribution of diatoms increased from upper to depth layers. Overall, phytoplankton community regulated POC flux and composition of sinking particle via aggregation and repackaging, while influencing zooplankton fecal pellets production and sinking export in marginal sea ecosystems.

Acknowledgments: This work was supported by grants from the National Key Research and Development Program of China(No.2016YFA0601201), the China NSF Key Project (No. 41330961) .

Keywords:

POC flux; plankton community; marginal sea ecosystems

Identification of dissolved and particulate carbonyl compounds produced by marine harmful algal bloom species

Lixia Shang[1,2,3], Zhangxi Hu[1,2,3], Ying Zhong Tang[1,2,3*]

[1]*CAS Key Laboratory of Marine Ecology and Environmental Sciences, Institute of Oceanology, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao, China, 266071.*

[2]*Laboratory for Marine Ecology and Environmental Science, Qingdao National Laboratory for Marine Science and Technology, 7 Nanhai Road, Qingdao, China, 266071.*

[3]*Center for Ocean Mega-Science, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao, China, 266071.*

**e-mail: yingzhong.tang@qdio.ac.cn*

Background. Carbonyl compounds, especially polyunsaturated aldehydes (PUAs), are increasingly reported as teratogenic to grazers and deleterious to phytoplankton [1]. While PUAs have been considered to be mainly produced by diatoms after cell wounding, little is known about whether or not microalgae other than diatoms, particularly harmful algal bloom (HAB)-forming species, produce carbonyl compounds also.

Material and methods. In this study, we analyzed the carbonyl compounds from eight common HAB-forming species (*Akashiwo sanguinea*, *Karenia mikimotoi*, *Karlodinium veneficum*, *Margalefidinium polykrikoides*, *Prorocentrum donghaiense*, *P. minimum*, *Scrippsiella trochoidea* and *Heterosigma akashiwo*) using gas chromatography-mass spectrometry with full scan and selected ion monitoring (SIM) modes.

Results. Our results showed a ubiquitous presence of carbonyl compounds both in dissolved and particulate forms in all species examined in the study. In the full scan mode, 133 chromatographic peaks were detected from fifty-one samples altogether. Both the varieties of carbonyl compounds and their quantities were algal species dependent, although most of the carbonyl compounds could not be fully identified according to the mass spectral database only due to the unavailability of enough standards for all analytes. Aided with nine standards and using SIM mode, we further identified and quantified all nine aldehydes (2-methyl-2-pentenal, trans-2-nonenal, cis-6-nonenal, 2,6-dimethyl-5-heptenal, trans-2-hexenal, trans-2-decenal, 2,4-heptadienal, trans-trans-2,4-octadienal, and trans-trans-2,4-decadienal). Four of these nine aldehydes that were detected in particulate form confirmed that trans-2-nonenal could be produced by *K. mikimotoi*, *Karl. veneficum*, *P. donghaiense*, *P. minimum*, *S. trochoidea* and *H. akashiwo*, 2,4-heptadienal and trans-trans-2,4-decadienal by *A. sanguinea*, *M. polykrikoides* and *S. trochoidea*, and trans, trans-2,4-octadienal by *S. trochoidea*, respectively.

Conclusions. This study proved that some dinoflagellate and raphidophyte species could contribute to the pool of carbonyl compounds including PUAs in marine ecosystem. Some carbonyl compounds, particularly those with high cell quota and/or dissolved concentration, may be related to fish-killing or allelopathy and need further identification and quantification.

Acknowledgements

This work was supported by the NSFC-Shandong Joint Fund for Marine Ecology and Environmental Sciences (Grant No. U1606404), the National Science Foundation of China (Grant Nos. 41476142, 61533011, 41606126, and 41506143).

Key words

Aldehyde; dinoflagellate; harmful algal blooms (HABs)

References

1. Miralto A, Barone G, Romano G, Poulet S A, Ianora A, Russo G L, Buttino I, Mazzarella G, Laabir M, Cabrini M, *Nature*, 1999, **402**, 173-176.

Trends of the marine litter distribution on the southern coastal zone of the Primorsky region

M. Vysotckaia[1], V. Okhotkina[1], Ya. Blinovskaya[2]
[1] *Ecostart L.L.C, Saratovskaia Str., Vladivostok, Russia, 690065*
[2] *Far Eastern Federal University.8 Sukhanova Str., Vladivostook, Russia, 690003*
e-mail: starteco@yandex.ru

Background. The amount of human-caused environmental impact can be evaluated by the degree of pollution. Centuries-long highly intensive strain on the coastal marine environment has given rise to another problem: marine litter. This problem is becoming more and more urgent for coastal states. Marine litter can be found virtually in any sea, whether involved in anthropogenic activities on the large scale or geographically remote from the apparent sources of pollution. The sources of its introduction into coastal waters are not only land-based objects (ports, coastal sanatorium-and-spa institutions), but some sea-based objects as well (marine transport, sea farms, etc.), where currents and winds carry it over great distances. Development of measures for the reduction and prevention of polluting the shoreline and coastal waters with marine litter it is necessary to determine the degree of pollution of its constituent parts first.

Material and methods. The region under research is one of the most dynamic zones of the geographical envelope where land and sea interact. The region under research covers the shoreline with city beaches and sanatorium-and-spa zones, beaches, industrial zones (Slavyanka, Vladivostok, Nakhodka); recreational zones, for both unorganized and organized tourism (Khasansky district). The period of time allowing evaluating the change in the degree of the shoreline pollution with litter is that from 2007 till 2018. To facilitate the monitoring of litter in shoreline and coastal waters the shoreline division scheme was developed based on the analysis of the physiographic processes occurring in land and sea interaction.

Results. During a research nearly 88,000 square meters of coastal zone were studied and collected 2600 kg of marine litter including 641 kg of plastics, 293 kg of metal, 580 kg of glass and 545 kg of other waste. The main sources of pollution are revealed. These are recreation activity, fishery, and estuary areas. Plastic is the overriding type of waste [1]. As for localization in the environment the marine litter is presented by the following categories: floating (tends to pollute a surface of the water and the coastline), submerged (tends to pollute a seabed, including regions of sea farms and fishery) and dissolved (tends to change physical and chemical properties of water and grounds).

Conclusions. When planning shoreline cleaning-up activities for the south-western coast of Primorye the following should be taken into account: the distance from the polluted areas to the utilization sites officially established by local authorities, the extent of the shoreline involvement into the economic activities, as well as supervision of pollution sources within the coastal waters. Prevention of pollution by marine litter can be reached by two practical decisions: drawing attention of administrative structures (development of regional programs, measures and actions, international cooperation) and ecological education of the population (organization of actions, exhibitions, seminars, etc) [2]. Thus the system approach to a solution of the pollution problem

by marine litter will promote management, will allow preventing, lowering and localizing consequences.

Key words
Marine litter, coastal water, monitoring

References

1. Blinovskaya Ya.Yu., Okhotkina V.E., Vysotskaya M.V. International coastal clean-up (ICC) as the methods of marine litter monitoring. The priority directions of the science and the education development: II International science and practical conference articles digest, 2018. Pages 380-383 (in Russian).
2. Okhotkina V.E. Environmental safety of Primorsky region coastal zone recreational environmental management. St. Petersburg, 2015. 27 p. (in Russian)

Photocatalysis for degradation of organic pollutants in seawater

Wu Di, Ye Ying, Wu Jianbo*
Ocean College, Zhejiang University, China, 310018
**e-mail: 1131958232@qq.com*

Background. Using activated carbon fiber felt as the carrier and ferric oxalate as the carrier to construct fenton system, a heterogeneous catalytic system with organic dye Reactive Red M-3BE (RR M-3BE) as the target pollutant was constructed to activate persulfate to generate strong oxidant free radicals to degrade wastewater under visible light. In addition, the effects of chloride ion and carbonate ion on the reaction system were investigated. The reactivity was studied by using EPR (electronic paramagnetic resonance) technology mixed with free radical scavenger (methanol) [1, 2, 3, 4, 5, 6, 7, 8, 9, 10].

Results. The results showed that hydroxyl (•OH) and sulfate radical(•SO^4-) were generated and played an important role in the reaction. The catalytic oxidation efficiency of the system was more than 3 times that of the traditional system. The degradation rate reached 99.4% after 30 minutes of illumination.

Conclusions. The results of this study provide a feasible way to efficiently activate PMS in Marine wastewater treatment, and also open up a broad prospect for the study of non-homogeneous catalytic systems in the field of environmental catalysis.

Acknowledgements
This work was supported by Zhejiang Provincial Natural Science Foundation of China (No. LY14E030015, LQ15E030005)

Key words
Photocatalysis; degradation; environment

References
1. Khail LB,Mourad WE,Rophad MW. Appl. Cata B:Environmental, 1998, 17: 267 -273.
2. Adamson A.W, Waltz, W.L, Zinatoe, et al.Chem.Rev. 1968, 68: 541 -543.
3. Faust B.C, Zepp R.G.Enwiron.sci.technol, 1993, 27: 2517 -2522.
4. Zuo Y.G., Hoigne J. Atmospheric Environment, 1994, 38:1231 -1239.
5. Ferguson GM.Polym.Int, 1992. 28(1):35 -40
6. Deng N.S, Wu F, Luo F, et al.Chemosphere, 1998, 36:3101 -3112.
7. Deng N.S, Wu F, Luo F, et al.Chemosphere, 1997, 35:2697 -2706.
8. Hug S J, Laubscher HU.Environ.sci.technol, 1997, 31,160 -170.
9. Wu F, Deng N.S,ZuoY.G. Chemosphere, 1999, 39 (12), 2079 -2085.
10. Zhang Z, Wu F, Deng US. toxicol Environ Chem, 2001, 82, 129 -137.

Investigating resilient coral reefs to climate change and anthropogenic disturbances in the Gulf of Thailand

T. Yeemin*, M. Sutthacheep, S. Pengsakun, C. Chamchoy, W. Klinthong
Marine Biodiversity Research Group, Faculty of Science, Ramkhmahaeng University, Huamark, Bangkok, Thailand
**e-mail: thamasakyeemin@hotmail.com*

Coral reefs in tropical countries are degrading because of the synergistic effects of natural and anthropogenic disturbances, although their high economic values and benefit to society. Increasing frequency and severity of climate change related stresses, particularly coral bleaching, along with human stresses including coastal development, pollution, sedimentation, destructive fishing and unmanaged tourism have declined the live coral cover and generally its health. Anthropogenic disturbances had also reduced coral recovery and reef resilience. Highly resilient coral reefs in the Gulf of Thailand are explored after three severe coral bleaching events in 1998, 2010 and 2016. The coral reef resilience was assessed by live coral cover, coral recruitment, population densities of reef fish and macroinvertebrate grazers, macroalgae and water quality. The high resilient coral reefs were observed at several reef sites, particularly a dive site in Mu Ko Chumphon, Ko Ngam Noi where the live coral cover was 77.3%. The dominant corals were *Acropora muricata*, *Pavona decussata*, *Porites lutea*, *Cyphastrea microphthalma*, *Galaxea fascicularis*, *Pocillopora acuta*, *Plerogyra sinuosa*, *Symphyllia radians*, and *Platygyra sinensis*. The mass coral bleaching event in 2016 caused high percentages of bleaching in *Acropora* spp. but they completely recovered after the bleaching. The dominant reef fish species included *Neopomacentrus anabatoides*, *N. cyanomus*, *Dascyllus reticulatus*, *Parioglossus philippinnus*, and *Pomacentrus moluccensis*. Sea urchin *Diadema setosum* was abundant on the reefs, as well. These high resilient coral reefs will provide larval supply to other reef sites in the Gulf of Thailand. This study implies that the human impacts at the high resilient coral reefs should be minimized in order to enhance their resistance, tolerance and recovery rates after coral bleaching events.

Acknowledgements
We would like to thank staffs of the Department of National Parks, Wildlife and Plant Conservation and Marine Biodiversity Research Group, Faculty of Science, Ramkhamhaeng University for their field work assistance. This study was funded by a budget for research promotion from the Thai Government awarded to Ramkhamhaeng University and research grant from the National Science and Technology Development Agency (NSTDA).

Key words
Climate change, coral reef, resilience

Decontamination of Sea Water from ^{137}Cs and ^{90}Sr by Sorption Methods

P. Zelenin*, V. Milyutin, N. Nekrasova, E. Kozlitin
Frumkin Institute of Physical Chemistry and Electrochemistry of RAS, 31 Leninsky Prospect, Bldg. 4, Moscow, Russia, 119071
**e-mail: p.zelenin@outlook.com*

Background. The problem of sea water decontamination from radioactive pollution, primarily from ^{137}Cs and ^{90}Sr radionuclides, became of the high priority after the Fukushima Daiichi nuclear accident in 2011.

Results. The results of sorption removal of ^{137}Cs and ^{90}Sr from a model solution simulating the seawater composition on the sorbents listed below were presented in this research.

- **MDM** – modified manganese dioxide-based sorbent (IPCE RAS, Russia);
- **IE-95** – synthetic zeolite with the structure of chabazite (Dow Chemical, The USA);
- **SRM-Ba** – barium silicate sorption-reagent material (Institute of Chemistry of the Far Eastern Branch of RAS, Vladivostok, Russia);
- **SB-1** – barium-containing inorganic sorbent (IPCE RAS, Russia);
- **FND** – highly-dispersed nickel ferrocyanide sorbent on the diatomite carrier (IPCE RAS, Russia);
- **FNS** – granulated nickel ferrocyanide sorbent on the silica carrier (IPCE RAS, Russia).
- The model solution contained 30 g/dm^3 of dissolved salts and ~10^5 Bq/dm^3 of ^{137}Cs and ^{90}Sr. Sorption was carried out in the batch mode with 1/200 solid-to-liquid ratio and 48 hours contact time. The distribution coefficient value (K_d) of ^{137}Cs and ^{90}Sr as well as the decontamination factor (D_f) for sorption on different sorbents were presented in Table 1 and 2.

Table 1. The distribution coefficient value (K_d) of ^{137}Cs in sea water and the decontamination factor (D_f) of sea water from ^{137}Cs for sorption on different sorbents

Sorbent	**FNS**	**FND**
K_d **^{137}Cs, cm^3/g**	**$(6.1\pm0.6)\times10^4$**	**$(1.1\pm0.3)\times10^5$**
D_f	**305**	**550**

Table 2. The distribution coefficient value (K_d) of ^{90}Sr in sea water and the decontamination factor (D_f) of sea water from ^{90}Sr for sorption on different sorbents

Sorbent	**IE-95**	**MDM**	**SB-1**	**SRM-Ba**
K_d **^{90}Sr, cm^3/g**	**70±5**	**590±30**	**3100±200**	**6400±330**
D_f	**1,35**	**4,0**	**16,5**	**33,0**

The results showed that SRM-Ba and SB-1 sorbents were more effective for decontamination of sea water from ^{90}Sr, while ferrocyanide sorbents FND and FNS – from ^{137}Cs.

Key words
^{137}Cs, ^{90}Sr, inorganic sorbents, sea water, decontamination

Impact of copper nanoparticles on protein oxidation in *Mytilus trossulus*

A. Zhukovskaya[1], A. Chesnokova[2], V. Chelomin[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*Far Eastern State Technical Fisheries University, 52B Lugovaya Str., Vladivostok, Russia, 690087*
**e-mail: avianna@poi.dvo.ru*

Background. The invention and use of nanoparticles for new technologies and industries gives rise to them in the environment [1]. Today is the actual problem of revealing the consequences that can cause nanoparticles in having got into the organism of marine hydrobionts [2]. In order to assess the toxicological effect of nanoparticle to marine hydrobionts we conducted study the impact of some concentrations of CuO nanoparticles (CuO NP) on protein oxidation (protein carbonyl) in digestive gland and gills of mussel *Mytilus trossulus*.

Material and methods. *M. trossulus* were obtained from Alekseeva Bay of the Peter of the Great Bay the Sea of Japan. And were exposed by CuO NP (<50 nm, cat. # 544868, SigmaAldrich) to 10, 40 and 100 μgL^{-1} during 5 days in 100 L tanks. After experimental conditions mussels were transfer in natural habitat for restored. Protein carbonyl contents were measured by an alkaline method [3] in tissues (digestive gland and gill) in control animals, exposed and restored mollusks after 1, 3 and 5 days' depuration.

Results of this study showed that level of protein carbonyl can serve to confirm toxic effect of nanosize particle metals on marine hydrobionts on the example of mussel *M. trossulus*. The increase of protein oxidation under CuO NP exposure according to the concentrations in digestive gland and gill were observed. It is important to note that during incubation with different concentrations of CuO nanoparticles the proteins of the digestive gland *M. trossulus* are oxidized to a greater extent than proteins of gills. And nevertheless, the process of "cleansing" from the effects of Np CuO, yet it turns out easier for the digestive gland. The results also showed a general decrease in protein oxidation after a period of depuration 1, 3, and 5 days. During the period of depuration, a decrease in the concentration of protein carbonyl in the studied tissues indicates the sensitivity of the biochemical adaptation system of mussel *M. trossulus* to the high concentration CuO NP.

Conclusions. The fact of recovery of the protein carbonyl level to the one of in control indicates the ability of the mussel biochemical system to adapt well to the short-term impact of high concentrations of nanosize copper.

Acknowledgements
The work was performed as part of the state assignment program of the Far East Branch of the Russian Academy of Sciences on the theme "The Effect of Natural and Anthropogenic Factors on Biogeochemical Processes and the State of Biota in Marine Ecosystems" (No: AAAA-A17-117030110038-5).

Key words
Nanoparticles, Protein Carbonyl, *Mytilus trossulus*.

References
1. V. D.Rajput et al. *Environmental Nanotechnology, Monitoring & Management*,2018, vol. 9, pp. 76-84 https://doi.org/10.1016/j.enmm.2017.12.006
2. S.R. Tangaa, H. Selck, M. Winther-Nielsen, M-N. Croteau. *NanoImpact*, 2018, vol. 11, pp. 33-41. https://doi.org/10.1016/j.impact.2018.01.002
3. C. S. Mesquita, R. Oliveira, F. Bento, D. Geraldo, J. V. Rodrigues, J. C. Marcos. *Analytical Biochemistry*, 2014, vol. 458, pp. 69-71. doi.org/10.1016/j.ab.2014.04.034

T03-2: Ocean environment and ecosystem

Assessment of the phytoplankton state and ecosystem bio-productivity by the methods of mathematical modeling using satellite data

A. Abakumov, S. Pak*
Institute of Automation and Control Processes FEB RAS,. 5 Radio Str., Vladivostook, Russia, 690041
**e-mail: packsa@iacp.dvo.ru*

Climate change influence on integrated biomass of phytoplankton in the whole euphotic layer in a certain water bodies is assessed on the base of mathematical modeling techniques using satellite data. The model of the phytoplankton biomass profile is developed and verified with the data available in scientific literature and provided by Centre for Regional Satellite Monitoring of Environments (IACP FEB RAS, Vladivostok). The water areas topography is digitized and assimilated in the computer graphic laboratory of IACP FEB RAS. The phytoplankton biomass dynamics is modeled for Lake Issyk-Kul (Kyrgyzstan) and Japan Sea, the annual primary production is estimated for the Japan Sea. The main result of the modeling experiments is that stability of the modeled values of phytoplankton biomass and production to variations of the parameters and environmental inputs is found.

The presented model is suitable for predicting the phytoplankton biomass and primary production in any geographic area available for satellite monitoring. The model solution is adequate to the source information about the water bodies and has a level of accuracy comparable to the original satellite information.

Acknowledgements
The reported study was funded by RFBR according to the research project № 18-01-00213.
The reported study supported by a grant of Comprehensive program of fundamental scientific research «Far East» (project № 18-5-051).

Key words
Satellite sensing, phytoplankton, mathematical modeling

The Okhotsk Sea de-oxygenizing influence on deep-water fishes

N. Aseeva*, V. Matveev
Russian Research Institute of Fisheries and Oceanography, Pacific branch (TINRO), Vladivostok, Russia 690091
**e-mail: aseeva_n@hotmail.com*

Distribution of some deep-water species in the Okhotsk Sea is considered for the period since 1963 on the data of scientific surveys and observers aboard fishing vessels on the continental slope at the depth from 200-400 to 1300-2000 m. The deep-water fauna is very diverse and includes several hundreds of species, belonged mostly to families *Macruridae, Zoarcidae, Pleuronectidae, Sebastidae, Moridae*, and *Cottidae* (Andriyashev,1954; Novikov, 1974; Borets, 1988). Changes in bathymetric distribution of commercial species are analyzed. The most of flounders and other species which inhabits the depths above 300 m did not change their distribution, in general, whereas the densest concentrations of adult greenland halibut *Reinhardius hippoglossoides* were located at 600-700 m depth until 2000s but shifted to 500-600 m recently. This shift could be reasoned by lowering of dissolved oxygen content in the intermediate layer below 500 m because of limited ventilation in condition of warm winters – the recent lowering reached 0.6 mL/L per decade. However, the upper part of the intermediate layer is still well-ventilated, so the de-oxygenizing is not dangerous for mass commercial species of the upper continental slope.

References

A.P. Anfriyashev. Fishes of boreal seas of the USSR, Moscow: Nauka, 1954, 566 p.
L.A. Borets. Stocks of bottom fishes on the West Kamchatka shelf, *Fisheries*, 1988, **3**, 29-31.
N.P. Novikov. Commercial fishes of the continental slope of the Pacific Ocean, Moscow: Pishchepromizdat, 1974, 308 p.

Key words
Deep-water species, halibut, Okhotsk Sea

Features of the pebble beaches formation at the Southern Coast of Crimea

A. Boguslavsky, S. Kazakov*, I. Berzova, N. Khamitsevich
FSBSI Black Sea Hydrophysical Proving Ground of RAS, Katsiveli, Rep. Crimea, 298688
**e-mail: science@bshpg-ras.ru*

Southern coast of Crimea (SCC) is characterized by abrasion-bay coasts with few pebble beaches in the bays. Absence of sandy beaches is determined by features of contact between a mountainous country and the sea – deep banks with steep slopes, which are subjected to active abrasion (Zenkovich, 1960). In the 1980s, intensive shore protection was conducted with construction of buns and creation of artificial bulk beaches between the buns. Currently, these facilities cover approximately 50 % of SCC coastline. Now more than 100 buns from their initial number about 600 are destroyed or half-destroyed by storms and artificial beaches are partially preserved only in few dozens of inter-bun gaps (Goryachkin, Ivanov, 2010).

Preliminary assessment of income and removal of pebbles at SCC beaches in the annual cycle is presented using an example of Katsiveli section of the coastline that includes the Limensky Bay, the natural coast of Cape Kikineiz, and the artificially protected coast between Katsiveli and Ponizovka settlements. Regular observation data on the sea level at stationary Katsiveli sea level station, wind rate and direction, and near-shore wave height are analyzed, as well. There is preliminary concluded that in temporal scale of days-months the most influential factor in forming and degradation of SCC pebble beaches is the regime of changing storm winds direction from eastern to western and vice-versa. Active removing of pebbles from the beaches into the sea occurs during and soon after the eastern storm winds. On the contrary, return of pebbles to the beaches proceeds during and soon after the western storm winds. The key mechanism of the pebbles movements is related with the prevalent direction and rate of the near-bottom flow in the sea close to the shore line. It changes from the off-shore to the on-shore at changing the prevalent storm winds from eastern to western (Shuleikin, 1968).

References

V.P.Zenkovich. Morphology and dynamics of Soviet coasts of the Black Sea, Moscow: USSR Ac.Sci., 1960, 215 pp.
Y.N.Goryachkin, V.A. Ivanov. Modern state of the Black Sea coasts in Crimea, *Rep.Ukraine Natl.Ac.Sci.*, 2010, **10**, 87-92.
V.V. Shuleikin. Physics of the Sea, Moscow: Nauka, 1968, 1084 pp.

Key words
Beach, bottom sediment transport, shore protection

Molecular cloning of cold shock domain-containing protein (CSP), heat shock protein 60 (Hsp60) and 10 (Hsp10) genes from the cosmopolitan and harmful dinoflagellate*Scrippsiellatrochoidea*and their differential transcriptions responding to temperature stress and alteration of life cycle

Yunyan Deng, Zhangxi Hu, Zhaoyang Chai, Ying-ZhongTang*
CAS Key Laboratory of Marine Ecology and Environmental Sciences, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China
**e-mail: yingzhong.tang@qdio.ac.cn*

CSPs, cold shock domain containing proteins, are demonstrated to be involved in low temperature responses and various cellular processes under normal growth conditions. Heat shock protein 60 (Hsp60) and Hsp10 are two chaperones important to both stressresponses and cellular metabolisms in most organisms. We used the cosmopolitan, toxic, and resting cyst-producing dinoflagellate *Scrippsiellatrochoidea* as a representative HAB-forming dinoflagellate to investigate the transcription patterns of *CSP*, *Hsp6*0 and *Hsp10* in vegetative cells in response to temperature shocks and in resting cysts, with an objective to preliminarily probe their possible functions in dinoflagellates. The full-length cDNAs of a *CSP*, a*Hsp60* and a *Hsp10* gene from *S. trochoidea* (*StCSP*,*StHsp60* and *StHsp10*) were obtained via rapid amplification of cDNA ends (RACE) (Accession Nos.MF964217, MG014188 and MG014187). The real-time PCR results together indicated *StCSP* expression was not modulated by temperature at the transcriptional level and implied this gene may not be associated with temperature stress responses in *S. trochoidea* as the gene's name implies. The results also revealed that *StHsp60* and *StHsp10* exhibited highly similar mRNA accumulation patterns in response to temperature stresses. Their mRNA amounts, compared to that at 20°C (control), were rapidly up-regulated upon exposure tooth lower (15°C, 10°C, 5°C) and higher (25°C, 30°C)temperatures and showed a clear time-dependent manner, suggesting a possible involvement of *StHsp60* and *StHsp10* in the urgent adaptation of *S. trochoidea* to drastic temperature stress. Furthermore, significantly elevated mRNA levels of all the three genes were detected in resting cysts (newly formed and that maintained in dormancy for different durations)relative to that in vegetative cells(at exponential and stationary stages), indicating the three genes are actively expressed during dormancy of *S. trochoidea.* Taking together our recent transcriptomic work on *S. trochoidea* into consideration, we postulate that the three molecular chaperone genes may play roles during encystment and cyst dormancy of the species.

Acknowledgements
This work was supported bythe National Science Foundation of China (Grant No. 41606126), the NSFC-Shandong Joint Fund for Marine Ecology and Environmental Sciences (Grant No. U1606404), and National Science Foundation of China (Grant Nos. 41476142, 41506143, 61533011, and U1301235).

Key words
Cold shock domain-containing protein (CSP); Heat shock protein 60 (Hsp60); Heat shock protein 10 (Hsp10)

Dynamics of hydrological regime of the Sivash lagoon (Sea of Azov) in context of water use system changes in the region

E.S. Eremina*, E.E. Sovga
Marine Hydrophysical Institute of Russian Academy of Sciences, 2 Kapitanskaya Str., Sevastopol, Russia 299011
**e-mail:shchurova88@gmail.com*

Sivash is a hypersaline lagoon with unique natural recoverable mineral salt deposit that plays a significant role in the regional economy and is a wetland of international importance. The Sivas was included in the Ramsar List in 1978. The lagoon is located in the western part of the Azov Sea, and is almost fully isolated from the sea by natural sand bar. The narrow strait connects the lagoon with the sea. The lagoon has a special hydrological regime. It can be divided into 4 parts: the western and middle parts are the shallowest areas (depth < 1 m) separated by man-made dikes which maintain the required hydrological regime and the eastern and southern parts (depth up to 3 m)are not affectedly significant anthropogenic changes. Since 1970s, the Sivash water balance was maintained through the following water input and output processes: water inflow from the Sea of Azov through the strait, precipitation, drainage and waste water of the North Crimean Canal (which was opened in the1970s), surface water supply and underflow of Sivash basin, evaporation, and outflow of the Sivash waters through the strait into the Sea of Azov. In 2014, the North Crimean Canal, supplying water to Crimea, was closed, and the amount of fresh water coming from irrigated fields to the Sivash decreased by 0.63 km^3/year. The observations show that salinity in the southern Sivash (far from the strait) increased in four years from 54to 82psu. In the Eastern Sivash, located closer to the strait, salinity increased from 26 to 29 psu in its northern part and from 34to 52psuin its southern part. Reservoirs separated by dikes were not affected by the reduction of fresh water supply. Such changes in the hydrological regime of the lagoon caused a decreasing of the water level, and an increase of the water inflow from the Sea of Azov. Under new conditions, the lagoon ecosystem is subjected to large-scale transformation and restructuring, the species diversity is changing both in the lagoon and on its coasts.

Acknowledgements
This work was supported by Russian Federation State Task № 0827-2019-0004

Key words:
Lagoon, Sivash, Sea of Azov

Mesozooplankton prey preference and dynamics of plankton population in the model

E. Giricheva[1,2]
[1]Institute of Automation and Control Processes FEB RAS,.5Radio Str., Vladivostok, Russia, 690041
[2]Far Eastern Federal University,8, Sukhanov Str., Vladivostok, Russia, 690091
e-mail: evg.giricheva@yandex.ru

Usually mesozooplankton (e.g. copepods) is considered as the main grazer in models of plankton systems (Wroblewski et al., 1988; Franks and Walstad, 1997). However, numerous studies have appeared recently that microzooplankton, not copepods, is the primary grazers in oceanic ecosystems (Verity et al., 1993). Life cycles of microzooplankton are very different from those of copepods that requires another model responds when the zooplankton is parameterized to represent either microzooplankton or mesozooplankton. From the other hand, the microzooplankton is a trophic link between phytoplankton and copepods (Sherr and Sherr, 1988). Grazing impact of microzooplankton on phytoplankton is decreased because of itself grazing by mesozooplankton, i.e. the microzooplankton is both competitor and prey for copepods. Its portion in the diet of mesozooplankton varies depending on species, growth stage, and abundance of food in the system. Mathematical modeling allows one to estimate the influence of micro- and mesozooplankton on the plankton community dynamics.

Spatiotemporal dynamics of plankton community in a vertical column of water is considered. The model describes interactions between phytoplankton, microzooplankton and copepods, taking into account the phytoplankton and microzooplankton portions in the copepod diet. The modeling without space heterogeneity has revealed that competition between micro- and mesozooplankton for prey is an essential factor for the system dynamics. Two variants of the system dynamics are observed. In the case of weak grazing by mesozooplankton, the system demonstrates either stable coexistence of both zooplankton groups with significant impact of microzooplankton on phytoplankton, or extinction of mesozooplankton with increasing of the phytoplankton portion in its diet. In the case if microzooplankton protists are ineffective grazers – they are displaced by copepods or survive in a small number if their portion in the copepods diet is insignificant. Allowing for spatial dependence in the modeled plankton community causes spatial structures appearance induced by Turing instability. It means that the system with diffusion only is able to induce stationary vertical profiles of plankton biomass. Such system state is possible if both predators are effective grazers and the phytoplankton portion in the copepods diet does not exceed 20%.

References

P.J.S. Franks, L.J. Walstad L.J. *Journal of Marine Research*, 1997, **55(1)**, 1-29.
J. Wroblewski, J.L. Sarmiento, G.R. Flierl, *Global Biogeochemical Cycles*, 1988, **2**, 199-218.
P.G. Verity, et al., *Deep Sea Research Part I: Oceanographic Research Papers*, 1993, **40(9)**, 1793-1814.
E.B. Sherr, B.F. Sherr, *Limnology and Oceanography*, 1988, **33**, 1225-1227.

Key words
Plankton community, mathematical model, prey preference

Temperature variability and response in fish communities in the Bering and Okhotsk Seas, 1950-2018

G. Khen*, Y. Sorokin
Russian Research Institute of Fisheries and Oceanography, Pacific branch (TINRO), Vladivostok, Russia 690091
**e-mail: gennady.khen@tinro-center.ru*

The Bering and Okhotsk Seas are among the highest productive regions in the World Ocean. Their huge stocks of commercial species provide up to 60% of the Russian overall catch. However, many populations of commercial species are subjected to significant fluctuations related to both intra-population and environmental reasons. Long-term changes of temperature conditions in the Bering and Okhotsk Seas since 1950 till nowadays are presented on the background of large-scale processes in the atmosphere and ocean and their possible influence on fish communities dynamics is discussed.

During these seven decades, sea surface temperature (SST) in both seas has been gradually increasing. The positive trend is statistically significant in all seasons, its mean value is 0.018°C per year, and finally the water temperature on the surface of both seas has become 1.2°C higher, twice exceeding average SST increase in the Pacific (http://ds.data.jma.go.jp/tcc/tcc/index.html). Since 1950, there have been two shifts towards higher SST, related to PDO shifts: in the late 1970s and in the mid 2000s, and three periods when SST had no trend: the rather cold period of 1950-1976, the period of moderate SST from 1977 till 2013, and the warm period since 2014 till nowadays.

Dynamics of walleye pollock year-classes strength in the eastern Bering Sea are in good agreement with these large-scale environmental changes: all strong year-classes appeared within the second moderate period when the most abundant generations were formed in the years with temperature below the average value for this period (5.2 °C). These strong year-classes provided a growth of the East-Bering pollock stock in early 1980s which is still high. However, no strong year-classes were appeared in the modern warm period, so if the warming continues the strong-year classes of pollock will be less available.

The walleye pollock dynamics in the Okhotsk Sea is poorly related to changes of water temperature. Strong year-classes of this population had formed both in cold and moderate years. In 1986-1989, when SST had increased in the Okhotsk Sea on the background of the Arctic Oscillation (AO) switching from negative to positive phase (the positive AO phase still continues), the pollock year-classes in the Okhotsk Sea were strong.

This switch of AO phase coincided with changes in the fish community structure in the eastern Okhotsk Sea. Until the switch (in 1970-1985), high species diversity of nekton was observed in this area, but the number of fish species had decreased since 1990 and continues to decrease because of rare species disappearance, while all high abundant fish species, such as walleye pollock, pacific herring, pacific cod, capelin, and some gobies are quite numerous.

Key words
Water temperature, walleye pollock, fish community.

Genotoxic monitoring of the coastal waters of Peter the Great Bay

S.Kukla, V. Slobodskova*, A.Mazur, N. Dovzhenko, V. Chelomin
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: slobodskova@poi.vo.ru*

Coastal areas are subjected to many anthropogenic factors, including pollution. Because of complex interaction of biogeochemical and hydrodynamic processes, the bulk of pollutants concentrates in the bottom sediments and near-bottom water layer that could cause a violation of physiological functions of benthic and planktonic organisms. Laboratory of marine ecotoxicology of Pacific Oceanological Institute monitored in several years the changes in structure of the DNA molecule for mass commercial species of bivalve mollusks in Peter the Great Bay (Japan Sea) and assessed stability of the DNA molecule integrity and its resistance to environmental changes and anthropogenic pollution [1, 2]. The water areas with unfavorable ecological conditions are determined. The unfavorable habitat can initiate serious disturbances in structure of the DNA molecule that lead to mutations and malignant transformations of a cell. Potential consequences of this impact are able to influence on populations dynamics and communities structure and distribution.

Acknowledgements
This work was supported by a research theme № AAAA-A17-117030110035-5 sponsored by the government of Russian Federation

Key words
Monitoring, DNA, bivalve mollusk

References
1. Slobodskova V., Kukla S., Chelomin V. An analysis of the quality of the marine environment based on determination of the genotoxicity of DNA in the gill cells of yesso scallop *Mizuhopecten yessoensis* (Jay, 1856). *Russian Journal of Marine Biology,* 2015, **41**(6), 495–498.
2. Slobodskova V., Zhuravel E., Kukla S., Chelomin V. Evaluation of DNA damage in marine mussel *Crenomytilus grayanus* as a genotoxic biomarker of pollution. *J. Ocean Univ. China,* 2019, **18**(1), 159-164.

Vertical Change of the Deep-sea Sedimentary Microbial Community Composition in West Philippine Basin

Lin Genmei[1], Su Ming[1], Lu Jianguo[1*], Hu Bangqi[2]
[1]*School of Marine Sciences, Sun Yat-sen University, Zhuhai, China, 519082*
[2]*Qingdao Institute of Marine Geology, Qingdao,China, 266071*
**e-mail: lujianguo@mail.sysu.edu.cn*

Microbial communities play an important role in carbon and nutrients cycling. As 72% of prokaryotic cells representing in marine subsurface which make up more than half of total Earth's prokaryotic cells exists in deep ocean (Edwards et al., 2012), it's very important to explore microbial life beneath the seafloor in rocks and sediments. Philippine Sea is located between continental plate (Eurasian Plate) and oceanic plate (Pacific Plate). Till now, very few studies investigated deep-sea microbes around this place.

One 4.01-meter-long core was taken from West Philippine Basin (15.32° N, 133.23° E) at a water depth of 4941.9 m in 2018 summer. Samples were collected every 50 cm and flash frozen and stored at -80 °C. Community DNA was extracted and quantified, followed by the amplification of hypervariable V4 region of 16S rRNA gene. After the quantification and purification of amplicons, 16S rRNA gene libraries were constructed and sequenced using ION S5^{TM} XL platform. The quality-controlled sequences were clustered into bacterial taxa and identified as operational taxonomic units (OTUs) based on the distance at 3% or less dissimilarity cutoff. OTUs were classified to corresponding taxonomy information using SILVA132 database. The dataset was then used for diversity and richness calculation, Bray-Curtis-based non-metric multidimensional scaling (NMDS) analysis, as well as FAPROTAX functional prediction (Louca et al., 2016).Initial analysis represented the vertical change of microbial community composition from the surface (0 mbsf) of seafloor to deeper sediment (4 mbsf). The presence and relative abundances of bacterial taxa varied significantly. At phylum level, Phylum Proteobacteria were dominant on the seafloor surface, while Phylum Actinobacteria had higher relative abundance in microbial community from deeper sediment. Consistently, at order level, the most abundant groups on the seafloor surface were Pseudomonadales and Xanthomonadales from Class γ-Proteobacteria and Rhizobiales from Class α-Proteobacteria, compared to deeper communities, which had higher abundance of Order Spirochaetales from Phylum Actinobacteria. For functional prediction, chemoheterotrophy and nitrogen cycle were found in all depth but by different specific processes. It's also noteworthy that aromatic compound degradation exclusively appeared in the bacterial community from 4mbsf.

This study described the deep-sea sedimentary microbial community composition. Further analysis will focus on network analysis between bacteria and chemical elements composition, aiming to elucidate how subseafloor microbes coordinate with biogeochemical cycles.

References

Edwards, K.J., Becker, K., Colwell, F., *Annual Review of Earth and Planetary Sciences*, 2012, **40**, 551-568.
Louca, S., Parfrey, L.W., Doebeli, M., *Science*, 2016, **353(6305)**, 1272-1277.

Acknowledgements

This work was supported bythe Pearl River S&T Nova Program ofGuangzhou (No. 201710010198).

Key words

Microbial community composition; West Philippine Basin.

Mapping the distribution of *Karenia mikimotoi* cyst along the coast of China

Yuyang Liu[1,3], Zhangxi Hu[1,2,4], Ying Zhong Tang[1,2,4,*]
[1]*CAS Key Laboratory of Marine Ecology and Environmental Sciences, Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China, 266071*
[2]*Laboratory for Marine Ecology and Environmental Science, Qingdao National Laboratory for Marine Science and Technology, Qingdao, China, 266071*
[3]*University of the Chinese Academy of Sciences, Beijing, China, 100049*
[4]*Center for Ocean Mega-Science, Chinese Academy of Sciences, Qingdao, China, 266071*
**e-mail: yingzhong.tang@qdio.ac.cn*

The unarmored dinoflagellate *Karenia mikimotoi* has been well known for causing extensive harmful algal blooms (HABs) and massive kills of fish and shellfish along marine coastal waters. While the species has been investigated from many aspects of its ecology and particularly the blooming mechanism, little has been known about its life history and possible presence of resting cysts in marine sediments. Based on our recent discovery of resting cyst production by *K.mikimotoi*, here we present our quantitative detection of its resting cysts in the sediments of coastal waters of China using a combined approach of quantitative PCR (LSU rDNA-targeted) and fluorescence in situ hybridization (FISH) using species-specific oligonucleotide probe which targets the LSU rDNA D2 domain of *K. mikimotoi*. The sediment samples were pretreated with the SPT cyst-concentrating method to remove DNA debris prior to DNA extraction and real-time PCR. The copy number of rDNA in the diploid resting cysts was measured and taken into consideration for the cyst enumeration. Our investigation of 126 samples demonstrated that *K.mikimotoi* cysts widely present in the sediment of all four seas of China, covering a latitude range from 18.29°N to 39.85°N. Our FISH detections for 40 representative samples further confirmed the presence and observed the morphological variation of *K. mikimotoi* resting cysts in marine sediments. While the qPCR-based abundance of cysts was generally low (< 20 cysts kg^{-1} of wet sediment) in most of the samples, higher abundance (4 to 1012 cysts kg^{-1}) was detected in the sediment samples collected from those areas where blooms of the species have frequently occurred during the last 20 years (e.g. Sansha Bay of Fujian Province). The germination of cysts with an abundance of 70 cysts kg^{-1} was calculated to be enough to initiate a bloom with a cell density of 1×10^7 cells L^{-1} within 50 days. Our results proved a wide geographic distribution of *K. mikimotoi* resting cyst along the coast of China and thus provide important insights into the mechanisms of frequent bloom outbreaks and a global distribution of *K. mikimotoi*.

Acknowledgements
This work was supported bythe NSFC-Shandong Joint Fund for Marine Ecology and Environmental Sciences (Grant No. U1606404), the National Science Foundation of China (Grant Nos. 41476142, 61533011, 41606126, and 41506143), the Scientific and Technological Innovation Project Financially Supported by Qingdao National Laboratory for Marine Science and Technology (Grant No. 2016ASKJ02), and Creative Team Project of the Laboratory for Marine Ecology and Environmental Science, Qingdao National Laboratory for Marine Science and Technology (Grant No. LMEES-CTSP-2018-1).

Key words
Kareniamikimotoi; Resting cyst; Fluorescence in situ hybridization (FISH)

Remote Sensing based Algorithms of Net Community Production in the Atlantic Ocean

P. Lobanova[1*], G. Tilstone[2], A. Koldunov[1]
[1]*Saint Petersburg State University, Saint Petersburg, Russia, 199034*
[2]*Plymouth Marine Laboratory, Plymouth, United Kingdom, PL1 3DH*
**e-mail: p.lobanova@spbu.ru*

Net community production (NCP) and primary production (PP) are the principal parameters in the World Ocean marine ecosystem that drive the carbon cycle. NCP can be a quantitative measure of phytoplankton community absorption of dissolved carbon and carbon flows from the atmosphere to the ocean via "biological pump" (Stanley et al., 2010). It is important to develop algorithms for NCP estimation to characterize variability over spatio-temporal scales. NCP can be estimated from remotely sensed PP and sea surface temperature (Tilstone et al, 2015). The aim of this study is to develop and validate regional NCP algorithms for the Atlantic Ocean.

To develop NCP algorithms as a function of PP we used both *in situ* and modeled PP data for 30 stations in the Atlantic Ocean in seven biological provinces in 1998-2011 years. Modeled PP was retrieved using two satellite-derived models: Vertically Generalized Productivity Model (VGPM), and Platt and Sathyendranath Model (PSM), which showed significant correlation with *in situ* PP in the Northeast Atlantic (Lobanova et al, 2018). To retrieve daily water column PP we used ocean colour data from ESA CCI OC database, version 3.1, MODIS-Aqua data of Sea Surface Temperature and Photosynthetically Active Radiation from NASA OceanColour Web. A Power Law between PP (both modeled and *in situ*) and NCP was developing to estimate NCP in different Atlantic basins, which was validated using data from 50 stations.

The power law between NCP and VGPM PP and *in situ* PP were similar. With the same values of NCP, values of PSM were lower than VGPM in average 110-130 mg C m^{-2} d^{-1}. Validation of new NCP algorithms showed that three models in most cases underestimated *in situ* NCP. While with NCP values more than -50 mmol O_2 m^{-2} d^{-1} they greatly overestimated it (RPD = 118 - 129%). Inclusion of additional parameters such as temperature, which in turn influences photosynthetic activity of phytoplankton, to the models can improve their performance.

References

Lobanova P., G.H. Tilstone, I. Bashmachnikov, V. Brotas. Accuracy assessment of primary production models with and without photoinhibition using Ocean-Colour Climate Change Initiative data in the north east Atlantic ocean, *Remote Sensing*, 2018, **10(7)**, 1116; doi:10.3390/rs10071116

Stanley, R.H.R., J.B. Kirkpatrick, N. Cassar, B.A. Barnett, M.L. Bender. Net community production and gross primary production rates in the western equatorial Pacific, 2010, *Global Biogeochemical Cycles*, **24**, GB4001, doi:10.1029/2009GB003651.

Tilstone G.H., Yu-yuan Xie, C. Robinson, P. Serret, D.E. Raitsos, et al. Satellite estimates of net community production indicate predominance of net autotrophy in the Atlantic Ocean, *Remote Sensing of Environment*, 2015, **164**, 254–269

Acknowledgements

PL and AK were supported by Russian Foundation for Basic Research (RFBR) grant 18-35-00543. GT was supported by the UK Natural Environment Research Council (NERC) International Opportunity Fund Grant 'Satellite estimates of marine net community production in the South Atlantic from Sentinel-3 (SemSAS) (grant number NE/P00878X/1) and the NERC National Capability the Atlantic Meridional Transect.

Key words

Net community production, models, remote sensing

Some results of four deep-sea Russian-German expeditions in the NW Pacific, 2010-2016

M.V. Malyutina[1], A. Brandt[2,3]
[1]*National Scientific Center of Marine Biology, FEB RAS, Palchevskogo Str., 17, Vladivostok, Russia 690041*
[2]*Senckenberg Res. Inst. and Natural History Museum, Senckenberganlage 25, Frankfurt am Main, Germany 60325*
[3]*Goethe University of Frankfurt, FB 15, Max-von-Laue, 13, Frankfurt am Main, Germany 60439*
**e-mail: m_malyutina@mail.ru*

Abyssal plain is the largest ecosystem on our planet occupying > 70% of the World Ocean, but it is still the least studied one - only 5% of the ocean floor has been surveyed. The northwest Pacific is highly productive and diverse region with several deep-sea basins differing in depths, hydrology, and degree of isolation: the Kuril-Kamchatka Trench (KKT), the abyssal plain adjacent to the trench from the east, and the marginal seas adjacent to it from the west. One of the goals of the Russian-Germany expeditions was to inventory biodiversity and biogeography of benthic organisms of all size classes in these abyssal basins. Since RV *Vityaz* expeditions in 1949-1966, it was the first extensive biological studied in the region with using modern sampling gears and methodology. SoJaBio expedition in 2010 investigated the relatively young and isolated basin of the Japan Sea (500-3700 m depth). The open, non-isolated ancient abyssal plain eastward from KKT was studied in KuramBio expedition in 2012. SokhoBio expedition in 2015 sampled benthos from the deepest part of the Okhotsk Sea in the Kuril Basin with similar depths (max. 3372 m) as in the Japan Sea, but less isolated, linking to the Pacific with the Kuril Straits with the deepest Bussol Strait (2318 m). KuramBio II expedition in 2016 studied the KKT hadal benthos to test whether the Trench serves as a barrier for distribution of abyssal fauna around it. The first time the hadal zone with the depths up to 9584 m was successfully sampled by epibenthic sledge. In total, four expeditions yielded: >5000 collected samples, >11500 underwater pictures, >1100 min. recorded video. More efficient sampling methods revealed that diversity of the deep-sea benthic fauna in the NW Pacific was significantly underestimated. As the result, the species list for the studied areas becomes in 6-20 times longer: from ~600 species known after 10 *Vityaz* expeditions to ~4500 species. About 50% of the species were new to science or new found for the NW Pacific. The deepest records and new data on species distribution were obtained. In SoJaBio, 620 species were sampled and the number of species known for the Japan Sea was extended in 6 times; in KuramBio ~1800 species were found that was in 6 time more than it was known for KKT, SokhoBio expedition extended number of species in the Kuril Basin in 20 times and revealed close relation of its fauna with the abyssal fauna of the NW Pacific. It was revealed that the KKT hadal fauna is poorer than the abyssal fauna, though some common species were found in the abyssal and hadal of KKT and in the Kuril Basin. Most of these species are eurybathic ones, widespread in the NW Pacific, possibly such eurybionticity allows them to overcome the barriers. Results of the first three Russian-German expeditions are published in three issues of Deep-Sea Research II. Results of KuramBio II expedition to the hadal KKT are preparing for publishing – 51 species 9 genera and 2 families will be described. Besides the new data obtained in the expeditions, biogeographic data collected from Russian scientific literature are transferred to the OBIS database increasing five-fold its data for the North-West Pacific region: from 1936 to 7050 records. New expedition is planning in the near future to the northern Pacific areas bordering with the Arctic Ocean as the Aleutian Trench and Bering Sea.

Key words:
Abyssal fauna, benthos, North-West Pacific

Hypoxia in the seawater wedge at the bottom of the Razdolnaya River estuary (the Amursky Bay, Japan Sea)

P.Yu. Semkin*, P.Ya. Tishchenko, V.B. Lobanov, Yu.A. Barabanshchikov, T.A. Mikhailik, G.Y. Pavlova, S.G. Sagalaev, P.P. Tishchenko, M.G. Shvetsova, E.M. Shkirnikova
V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041
**e-mail: pahno@list.ru*

Hypoxia is a state of ecosystem when the dissolved oxygen content is so low that it causes quantitative and qualitative changes biochemical processes. Mechanism of the hypoxia developing in the internal part of the Razdolnaya River estuary is investigated. The Razdolnaya basin area is 7300+9500 km^2 in Russia and China, respectively, its mean annual water discharge is 72 m^3/s, changing seasonally from 2–12 m^3/s in the ice-covered period to 800 m^3/s (sometimes up to 2000 m^3/s) during floods that could happen in spring, summer or autumn. The dissolved oxygen content, as well as currents, water level, depth, temperature, salinity, photosynthetic active radiation, turbidity, pH, total alkalinity, ice thickness, concentrations of nutrients, chlorophyll *a* and humic substances, major element content, and meteorological parameters were observed at the stations located along the river stream in different seasons in 2011–2018 and pCO_2 and DIC were calculated for the same sites and times. In conditions of low water run-off, when the river discharge does not exceed 20 m^3/s, the wedge of seawater penetrates into the river channel up to 28/20 km from the river mouth bar in winter/summer, respectively, the reverse currents of tidal nature occur in the estuary with the velocity up to 25 cm/s. This seawater wedge is fully displaced from the river channel when the freshwater discharge increases to approximately 400 m^3/s. The two-layer water circulation, typical for microtidal estuaries, is impeded in the Razdolnaya estuary by vast shallows at its mouth, particularly in winter, when the ice makes an additional barrier for the water exchange. That's why hypoxia develops in the bottom layer in the internal estuary under the low run-off regime, both in winter and summer, accompanied by anomalies of carbonate system parameters and nutrients. The hypoxia is caused by microbial oxidation of Diatomea organic matter in the bottom layer in conditions of limited photosynthetic radiation. It is promoted by high primary production in the estuary due to its density stratification with a strong pycnocline. Thus, phytoplankton bloom goes above the pycnocline simultaneously with active destruction of sunk phytoplankton cells beneath the pycnocline. The oxygen content is the maximum at the estuary surface (300 μM) and minimum at its bottom (< 60 μM). High pCO_2 values (> 5000 μatm) were observed in depressions of the estuary relief because of water stagnation and huge accumulation of organic matter. General background of hypoxia is a strong flux of nutrients with the Razdolnaya River flow, partially of anthropogenic origin. The ice itself is not a reason of hypoxia; in winter the hypoxia is formed only if the ice is covered by snow that prevents penetration of photosynthetic active radiation into the water.

Key words
Estuary, eutrophication, hypoxia

Studies of bacterioplankton and chlorophyll *a* in the Polar frontal zone region

T. Shirokolobova*, M. Venger, A. Vashchenko, V. Vodopyanova, P. Makarevich, T. Maximovskaja, P. Vashchenko
Murmansk Marine Biological Institute, Russian Academy of Sciences KSC, Murmansk, Russia 183010
**e-mail: shirokolobova@mmbi.info*

Results of the first study of bacterioplankton seasonal dynamics in the Polar Front zone separating the cold Arctic and warm Atlantic waters in the north-western Barents Sea are presented. The survey was conducted during polar night (in November 2013 and November-December 2015) and in transition period between polar night and polar day (in April 2016 and 2018). The samples were taken from the depths of 0-50, 0-55 m. Bacterial cells were collected on nuclear filters with a pore diameter of 0.2 μm and stained by DAPI dye. Chlorophyll *a* (Chl) was extracted by Vladipor filters with a pore diameter of 0.6 μm. Concentration of Chl in the Atlantic waters in November-December gradually decreased from 0.11±0.01 mg/m^3 to trace amounts, the abundance and biomass of bacteria decreased from (0.51±0.03) ·10^6 cells/ml and 74.57±13.86 mg/m^3 to (0.20±0.02) ·10^6 cells/ml and 6.01±0.65mg/m^3. In the ice-free Arctic waters, Chl concentration in November was below the detection limit, the bacteria values were low: (0.11±0.03) ·10^6 cells/ml and 4.21±1.27 mg/m^3. In April, the concentration of Chl increased from 0.33±0.01 mg/m^3 (middle April) to 0.58±0.05 mg/m^3 (late April) in the Atlantic ice-free waters and varied from 0.79±0.10 mg/m^3 to 3.49±0.48 mg/m^3 in the ice-covered Arctic waters. The abundance and biomass of bacterioplankton in the Atlantic waters increased from (0.24±0.03) ·10^6 cells/ml and 7.79±1.35 mg/m^3 to (0.28±0.02) ·10^6 cells/ml and 15.33±1.22 mg/m^3 and were (0.27±0.01) ·10^6 cells/ml and 16.63±1.47 mg/m^3 in the Arctic waters in late April. The results indicate that in conditions of photosynthetic processes attenuation at the end of autumn season, bacterioplankton is more abundant in the Atlantic waters than in the Arctic waters. In conditions of increasing solar activity in April, Chl concentration in the Atlantic waters corresponds to a pre-bloom state, while the abundance of bacterioplankton is still the same low as in winter. On the contrary, transition from polar night to polar day in the Arctic waters is accompanied with sharp activation of phytoplankton and increasing abundance of bacterioplankton, which values approach to the level of the Atlantic waters. The bacterioplankton growth in spring in the Arctic waters is provided by autochthonous organic matter produced by phytoplankton, but its growth in Atlantic waters is probably supported with allochthon organic matter brought to the Barents Sea by the Atlantic Current.

Acknowledgements
This research was performed with federal funding (state project topic 9-17-01 (133) Г30228-2019-0003 and 9-18-02 (133, 137) Г30228-2019-0029), and partially funded by the Russian Science Foundation. Grant project No. 17-14-01268

Key words
Bacterioplankton, chlorophyll, Barents Sea

Seasonal, inter-diurnal and diurnal variability of thermohaline conditions and chlorophyll *a* studied by WQM Wet Labs in the coastal area of the Japan Sea

V. Shulkin[1*], P. Semkin[2], T. Orlova[3], V. Kachur[4], E.E. Borisovets[5]
[1]*Pacific Geographical Institute FEB RAS, 7 Radio Str., Vladivostok, Russia, 690041*
[2]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[3] *National Scientific Center of Marine Biology FEB RAS, Palchevskogo 17, Vladivostok, Russia 690041*
[4]*Institute of Automation and Control Processes FEB RAS, 5 Radio Str. Vladivostok, Russia, 690041*
[5]*Russian Research Institute of Fisheries and Oceanography, Pacific branch (TINRO), Vladivostok, Russia 690091*
**e-mail: shulkin@tigdvo.ru*

Seasonality of phytoplankton is a key factor controlling the productivity of marine ecosystems. Short-term negative consequences of the phytoplankton proliferation (HABs, hypoxia) also concern to certain seasons. That's why sampling with frequency 1-2 times per month, usually used for studies of seasonality, is not enough to reflect the dynamic of plankton succession with cells life time 1-3 days, but the data with temporal resolution of hours and days are necessary to elucidate the mechanisms of the plankton succession, in particular in very variable coastal areas. The data of long-term (1.5 years) regular (every 3 hours) observation on temperature, salinity, turbidity, and chlorophyll *a* concentration are presented collected with WQM Wet Labs device in the coastal area of the northwestern Japan Sea (Peter the Great Bay, Amur Bay). The WQM has been mounted at 7 m depth on the bottom within the photic layer and exploited from February 2017 until July 2018 with a 2-week break for service in February 2018. During the period of measurements, the chlorophyll *a* and turbidity did not have any trends, confirming effective work of the antifouling system of the device. The day-to-day variability of temperature and salinity during the ice cover period was determined mainly by rather slow hydrological processes with the time scale of 10-12 days. In spring, these parameters fluctuated mostly in the time scale of 3-4 days, which corresponded with the scale of atmosphere processes and sharp changes of temperature and salinity were conditioned by strong difference between the surface and bottom layers. Temperature was less variable in summer, but salinity variations had increased due to increasing influence of the river runoff. Variations of thermohaline conditions in autumn corresponded again to the periods of stormy weather but they were rather stable between the storms. The main pattern of chlorophyll *a* concentration by WQM data was a prominent maximum (12.4 mg/m^{3}on average) in the period from late April to early June that was not coherent with the chlorophyll *a* concentration observed at the sea surface by spectrophotometric analysis of water samples and satellite observations. However, the chlorophyll *a* concentrations by WQM data were close to those at the sea surface for the periods without stratification in late autumn and winter. Diurnal variability of chlorophyll *a* concentration was insignificant. Variations of turbidity were driven by weather events (storms and swells) at all time scales.

The data on cross-scale temporal variability of temperature, salinity, and chlorophyll *a* obtained by WQM give a fresh look to functioning of phytoplankton community in such changeable coastal area as the Amur Bay. Besides, the use of WQM device provides a proof of weather factors dominance in dynamics of shallow waters, with minor role of diurnal processes, as tides.

Acknowledgements
This work was supported by RFBR 16-05-00166a

Key words
WQM Wet Labs, phytoplankton, Amur Bay

Phytoplankton primary production at the northeastern Sakhalin shelf in summer 2016

P.P. Tishchenko, P.Y. Tishchenko
Pacific Oceanological Institute, Far-Eastern branch of Russian Academy of Science, Vladivostok, Russia
**e-mail: eq15@poi.dvo.ru*

The northeastern shelf of Sakhalin Island is a feeding area for gray whales and petroleum deposits are exploited in the same area. This overlapping of a short trophic chain "phytoplankton/phytobenthos – zooplankton/zoobenthos (shrimps) – grey whale" and oil production requires more knowledge about primary production processes in this area. The survey in the northeastern part of Sakhalin shelf was conducted in July 2016 with measuring of vertical profiles of temperature, salinity (conductivity), dissolved oxygen, chlorophyll fluorescence, and PAR and collecting the water samples for determining concentrations of phosphate, nitrate and chlorophyll *a*. Phytoplankton assimilation number was calculated using the oxygen sensors of Rinko profiler and primary production was calculated by Zvalinsky method. The mean value of the phytoplankton assimilation number in the surveyed area was 9.66 mgC/(mgChl·day). Spatial distribution patterns of chlorophyll *a* and primary production were similar. The highest values of primary production were observed in the northern part of the shelf where the Amur River impact was significant. Both chlorophyll *a* concentration and primary production decreased southward and to their minimums in the southeastern part of the surveyed area. Large quantity of phytoplankton cells was found after sedimentation, accumulated at the bottom at the latitude of the Piltun Bay, probably they were originated in the north and transported to the south by the southward current. The Amur River discharge provided nutrients into the euphotic layer of the surveyed area and provided the stratification necessary for photosynthesis. High phytoplankton assimilation number confirmed an intensive photosynthetic activity. The maximum value of the phytoplankton production as 11.17 gC/(m^2·day) was detected in the area with the highest influence of the Amur River. However, better feeding conditions for gray whales were formed southward from this area, where the phytoplankton cells were accumulated at the bottom.

Key words
Primary production, phytoplankton assimilation number, northeastern shelf of Sakhalin

Presumption of Distribution and Behavior of *Sebastes Thompsoni* Using Stable Isotope Ratio

Shinsuke Tosha[1*], Yasushi Ito[1], Tomoya Aoki[2**]
[1]TheJapanese Institute of Fisheries Infrastructure and Communities, 3-4-6,Iwamotocho,*Chiyoda, Tokyo, Japan*
[2]*Chateau Marine Survey Co. Ltd., 3-2-5,Shintera,Wakabayashi, Sendai,Miyagi, Japan*
[**]*present address: JapanMicrobiological Laboratory Co. Ltd., 2-3-36,Ogimachi,Miyagino, Sendai, Miyagi, Japan*
**e-mail: tosha@jific.or.jp*

Background

Based on the previous research, methods for appropriate capture and treatment of *Sebastes thompsoni* inhabiting in the deep continental shelf and attaching a transmitter thereto to carry out biotelemetry research has been developed. Biotelemetry research based on the development enables us to directly grasp the distribution and behavior of *S. thompsoni* in fish reef and its peripheral areas, and therefore it becomes possible to obtain the most effective data for considering improvement of fishing ground. As the size of a transmitter restricts the age of traceable *S. thompsoni*, grasping the behavior of those less than three years using a biotelemetry is difficult.Thereupon this study attempts to indirectly grasp the behavior of *S. thompsoni* using the stable isotope ratio of oxygen, carbon and nitrogen.

Material and Method

We employed microscale sampling and microscale analytical techniques to analyze the oxygen stable isotope ratio ($\delta^{18}O$) of the otoliths of *S. thompsoni*caught in Sea of Japan. We also analyzed the carbon and nitrogen stable isotopes ratio ($\delta^{13}C$ and $\delta^{15}N$) of muscle tissue of *S. thompsoni*, small zooplankton, large zooplankton and small fish. The empirical temperature of *S.thompsoni* including those less than three years old was found by the$\delta^{18}O$ of otolith, and the contribution ratio of different food sources by age was found using$\delta^{13}C$ and $\delta^{15}N$.

Results

The $\delta^{18}O$ values, correlated with the empirical temperature of *S. thompsoni*, increased from0-year-old to2-year-old and did not change much over 3-year-old.
The $\delta^{15}N$ values, as an index of trophic level, increased as they grew older. The mean $\delta^{15}N$ values were 10.4, 10.6 and 10.7 to 11.0‰ at 2 to 3, 4and 5 to 8-year-old.

Conclusion

This paper reports that these analyses by stable isotope ratio are suggested to be an effective method for considering the distribution and behavior of *S. thompsoni*.

References

Høie H, Otterlei E, Folkvord A. Temperature- dependent fractionation of stable oxygen isotopes in otoliths of juvenile cod (*Gadusmorhua* L.). *ICES J.Mar.Sci.*, 2004, 61, 243−251.
Phillips DL, Gregg JW. Sources partitioning using stable isotopes: coping with too many sources. *Oecologia*, 2003, 136, 261–269.

Key words
Oxygen/carbon/nitrogen stable isotope ratio, empirical temperature, analysis of feeding habit

A study on coral habitat evaluation and impact prediction of ocean thermal energy conversion

M. Uchida[1], S. Tabeta[1*]
[1]*Graduate School of Frontier Sciences, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Japan,2778563*
**e-mail: tabeta@k.u-tokyo.ac.jp*

Ocean thermal energy conversion (OTEC) is one of the electric power generation technologies that utilizes temperature difference between the surface water and deep-sea water in the ocean. Tropical seas with high temperature at the surface are the main target of OTEC. In Japan, a 50 kW demonstration plant of OTEC technology is working at Kume Island, Okinawa Prefecture, and its expansion to 1 MW is studied. The discharged water released from OTEChas deep-sea origin, so has higher nutrients concentration and lower temperature comparing to the surface water. Therefore, this water could have a negative influence on corals adapted to the surface environment of tropical sea. On the other hand, it slow temperature might make a positive effect for the corals, because recent temperature rising is one of the reasons of coral bleaching.

The influence of discharge water from OTEC on coral habitat around Kume Island is assessed. To evaluate quantitatively the influence, Habitat Suitability Indexes (HSIs) for water temperature and nutrients concentration are developed. Relationships between the coral habitat and other environmental factors such as topography are also investigated using Maxent, which estimates species distributions by maximum entropy modeling through a machine-learning technique.

Changes in water temperature and nutrients concentrations caused by the water discharge from 1 MW OTEC are modeled by hydrodynamic simulations and interpreted using HSI. Rather small impact from 1 MW OTEC on the coral habitat is found. Among the bottom topography factors, the water depth and slope inclination are important for the coral habitat.

References

M.T. Burrows, R. Harvey, L Robb. Wave exposure indices from digital coastlines and the prediction of rocky shore community structure. *Mar EcolProgrSer*, 2008, **353**, 1-12.
B.M. Costa, M.S. Kendall, J. Rooney, et al.Prediction of mesophotic coral distributions in the Au‘au Channel, Hawaii, NOAA Technical Memorandum, 2012, 149 pp.
Z. Wang, S. Tabeta.Numerical simulations of ecosystem change due to discharged water from ocean thermal energy conversion plant. In: OCEANS 2017, Aberdeen: IEEE, 2017, 1-5.

Acknowledgements

This work was partially supported by JSPS Kakenhi (15H04210).

Key words

Coral reef, habitat evaluation procedure, Maxent

Preliminary remote sensing observation of sea surface temperature increase during *Ulva prolifera* blooms

S. Wang*, D. Tang
Guangdong Key Lab of Ocean Remote Sensing, South China Sea Institute of Oceanology, Guangzhou, China.
**e-mail: sufenwang1976@126.com*

Background. The sea surface temperature could be affected by microalgae blooms (Wang and Tang, 2010). Possible similar effect of macroalgae blooms is investigated for a massive bloom of green macroalgae *Ulva prolifera* occurred in the Yellow Sea (Liu et al., 2009).
Material and methods. The data on sea surface temperature (SST) and chlorophyll *a* concentration at the sea surface were acquired from MODIS satellite scanner by NASA data distribution system (http://ocean-color.gsfc. nasa.gov). Wind data were obtained from SeaWinds satellite scatterometer (Remote Sensing Systems in Santa Rosa, California, USA, http://www.ssmi.com/qscat/) and averaged weekly.

Results and Conclusions. A massive bloom of green macroalgae *Ulva prolifera* occurred in the Yellow Sea in June of 2008, resulting in perhaps the largest "green tide" event in history. The area covered by "green tide" was about 1200 km^2 and it impacted the area up to 40,000 km^2. Other blooms of this species occurred in 2009 and 2010. SST increased in 1-3^oC in the area of *Ulva prolifera* blooms, obviously because of increased radiation absorption at the sea surface. However, further understanding of the macroalgae blooms influence on the sea surface conditions is necessary.

References

S. Wang, D. Tang. Remote sensing of day/night sea surface temperature difference related to phytoplankton blooms. *Int. Journal of Remote Sensing*, 2010, **31**, 4569–4578.
D. Liu, J.K. Keesing, G. Xing, P. Shi. World's largest macroalgal bloom caused by expansion of seaweed aquaculture in China. *Marine Pollution Bulletin*, 2009, **58**, 888–895.

Acknowledgements

This work was supported by the National Natural Sciences Foundation of China (41876136 and 41430968), the Collaborative Innovation Centre for 21st Century Maritime Silk Road Studies (2015HS05).

Key words

Remote sensing, sea surface temperature, Ulva prolifera bloom

Genomic insights into metabolic diversification of methanotrophic archaea in cold seep sediments in the South China Sea

Yong Wang*
Institute of Deep Sea Science and Engineering, Chinese Academy of Sciences, Sanya, Hai Nan, China
Email: wangy@idsse.ac.cn

Methane assimilation by anaerobic methanotrophic (ANME) archaea is an important way to regulating the effectiveness of the greenhousein deep-sea cold seeps. Subsurface microbes have very low mutation rates, and their evolution is likely controlled by selection of different environmental settings. In this study, a total of 13ANME genome bins representing five ANME types were obtained from the Jiaolong cold seep in the South China Sea. This includes the first report of ANME-1b, -2b and -2c genomes. Despite>50% genomic reduction of our ANME bins, compared with the reference genomes for the cultivated strains in bioreactors, the pathways of methane assimilation and carbon dioxide fixation were all identified in the bins. Our genomic bins lack the genes for TCA cycle and most of those for carbohydrate and inorganic ions transport and metabolism in the cultivated strains. We also identified the genes involved in utilization of alkane sulfonate in our ANME genomes perhaps for adaption to sulfur starvation. All the genes related to reduction of nitrogen and sulfur oxides were absent from the bins, indicating their syntrophic dependence on partner organisms. Acquisition and loss of the genes in the ANME genomes exhibited a momentous role in shaping genetic diversity and ecological divergence among sympatric microbes in the cold seep. Our study also detected *in situ* transcriptional activities of the ANME types in four subsurface layers, which provides further evidence for the critical role of the ANME in the carbon and nitrogen cycles.

Mapping of Underwater Landscapes in Coastal Shallow Waters in the Peter the Great Bay Using Remote Sensing

V. V.Zharikov, K. Yu. Bazarov*, E. G.Egidarev
[1]*Pacific Geographical Institute FEB RAS,7Radio Str., Vladivostok, Russia, 690041*
**e-mail: kbazarov@mail.ru*

The Sea of Japan has the highest biodiversity abundance in Russia. Its coastal area is notable for active production and diversity of ecosystems, habitats, and landscapes. Natural coastal geosystems of PrimorskyKrai, being exposed to growing human press of local and transboundary origin, require complex research of their structure and detailed insight to the dynamics of nature resource potential (Preobrazhenky et al., 2001).

Current studies of benthic natural complexes are based on resource consuming and expensive underwater activities, which could be optimized by remote sensing (RS) data (Hossain et al., 2015). The basic restriction in RS application is the depth of sunlight penetration (Klemas, 2013) which depends on water transparency and weather conditions, therefore our study refers to water areas with maximum depth of 20 meters.

For mapping an underwater landscape studies in shallow waters of the Peter the Great Bay we used RS data from LANDSAT-8 and IKONOS-2, as well as data collected in field (echo sounding, diving routes with description etc.) and orthophotographs obtained with Phantom-4 proUAV.
The most detailed information was received for coastal shallow water in the eastern part of Far Eastern Marine Biosphere Reserve. The basic results of our research are the series of underwater landscape maps for several areas of the Peter the Great Bay and method of their compiling.
Use off data from LANDSAT-8 satellite provides seasonal and long-term monitoring. It can be useful to forecast development of coastal communities and ecosystems in the coastal area of the Sea of Japan, including areas under anthropogenic impacts.
Monitoring with RS data will promote finding regularities in natural land anthropogenic dynamics of underwater landscapes as a source of valuable information for marine nature use planning and management in the coastal areas. Application of UAVs for surveying coastal shallow waters provides more efficient mapping of underwater landscapes and detailed description of relief and vegetation, bringing the research to a higher level.

References

Klemas V. Airborne remote sensing of coastal features and processes: an overview, *Journal of Coastal Research*.,2013, Vol. 29 (2), P. 239–255.
PreobrazhenskyB. V., ZharikovV.V., Dubeikovsky L.V. The basics of underwater landscape science. Vladivostok, Dalnauka, 2000, 360 p.
Hossain M. S., Bujang J. S., Zakaria M. H., Hashim M. The application of remote sensing to seagrass ecosystems:an overview and future research prospects,*International Journal of Remote Sensing*, 2015, Vol. 36 (1), P. 61–113.

Key words:
Underwater marine landscapes, monitoring, remote sensing.

T04: Ocean and sustainability of human life

Human factor of maritime navigation

S. Fadyushin[1]
[1]Far Eastern Federal University, 8 Sukhanova St., Vladivostok, Russia, 690090
e-mail: fadyushin.sg@dvfu.ru

In modern science and practice of moving objects management the term “human factor” is widely used. It is called the main cause of accidents on various types of transport: according to average data, this factor accounts for about 70 – 80% of accidents [1]. In water transport, the accident rate due to human factor reaches 90% [2].

The term “human factor” is usually interpreted in a psychological aspect. It does not take into account the fact that “The control system of a moving object (ship, vessel, plane) is man-machine and consists of a regulator, which also includes an operator (watch navigator, pilot), and a control object, which is a moving object as an engineering structure "[3].
This research was conducted in the aspect of a cybernetic approach. The basis of this approach is a probabilistic view of the human factor, for the evaluation of which the basic concept of information theory – entropy, is used. The aim of the study is to develop a probabilistic model of human factor rationing. The basis of the research hypothesis is the principle of the activity approach in psychology, which consists in the unity of consciousness and human activity. Consciousness is an area of the human psyche that is difficult to formalize. Human activities, on the contrary, are available for formalization. From this it follows that through the study of human activity, one can understand the laws of human natural behavior and the role of the human factor in the control of moving objects.

In the study, the control system “navigator – vessel – object of maneuver” was considered. As an estimated parameter of the state of the control system, the basic concept of information theory, entropy, was used. Rationing entropy allows one to quantify the human factor and take into account its impact on the control system.

The main conclusion of the study is as follows. In the aspect of the cybernetic approach, the human factor of navigation is a statistical parameter of the Poisson distribution of a random variable, which measures the average amount of entropy of the probable state of the system “navigator – vessel – object of maneuver” per one decision made by the navigator.

References

1. V. Pazovskiy The accident rate for the world fleet. Proc. Int. Conf. on Safety of Navigation in the Far Eastern Basin (Vladivostok: Maritime State University Press). 2007, pp 108–113.
2. The number of accidents on water transport in 2015 increased by 62%, the majority of which accounted for fishing vessels. [Electronic resource]. – Available at: http://portnews.ru/top_news/216552/ (last retrieved on: 08.28.2018).
3. A. Sazonov Human factor and safety of moving objects management. Sbornik materialov XVI Obshchego sobraniya akademii navigatsii i upravleniya dvizheniyem. 2003, pp 6–8.

Key words
Navigation, cybernetics, entropy

An Evaluation of Electrospray between the Charge Density and various Electrode Distances from Water/Biodiesel Emulsion

C-H. Fu[1], I. Osamu[2*], K. Akihama[2], H. Yamasaki[2]
[1] *Graduate School of mechanical engineering, College of Industrial Technology, Nihon University, Chiba, Japan*
[2] *Department of sustainable engineering, College of Industrial Technology, Nihon University, Chiba, Japan*
**e-mail: imamura.osamu@nihon-u.ac.jp*

Nowadays, the global warming is the most important issue to solve the carbon dioxide emission around the world. To satisfy the emission of carbon dioxide and climate change, the Kyoto protocol and Paris agreement are being the major platform to give the policies on solutions between the countries. In this investigation, biodiesel is expected as the carbon neutral fuel and be added the water to make water containing emulsified fuel which contains the large electric conductivity. By this point of view, using the electrostatic energy is an efficiency method to atomize the water containing emulsified fuel into the particles. However, the water containing emulsified fuel is expected as non-Newtonian fluid and its physical characteristics give some difficulties to atomize the fuel into particles by using the electrostatic energy application. In order to atomize and observe the water containing emulsified fuel under the electrostatic energy, we set the ultra-high-speed camera, which has the maximum 120000fps, to observe the mechanism of electrospray and analysis the video to figure out the particle size distribution by ImageJ software. In this paper, not only the mechanism of electrospray and particle size distribution are discussed but also the distortion of electric field and charge density will be discussed mathematically to elucidate the key factor which control the spray mode. As the result, the electric current seems to be the key factor to determine the spray mode and the knowledge of relationship between the charge density and electric potential supplied with various electrode distances will be given to fundamental scientific research for future work.

References

1) IPCC. Climate change 2007: synthesis report. In: Team TCW, Pachauri RK, Reisinger A, editors. Geneva, Switzerland: IPCC; 2007
2) Baruch JJ. Combating global warming while enhancing the future. Technol Soc 2008; 30: 111-21
3) Lord Rayleigh, Philos. Mag., 14 (1882) 184-186
4) J. Zeleny, Proc. Camb. Phil. Soc., 18 (1915) 71-83
5) J. Zeleny, Phys. Rev., 10 (1917) 1-6
6) Ghannam MT, Selim MYE. Stability behavior of water-in-diesel fuel emulsion. Petrol Sci Technol 2009; 27: 396-411
7) Huo M, Lin S, Lin H, Lee C-fF. Study on the spray and combustion characteristics of water-emulsified diesel. Fuel 2014; 123: 218-29

Key words
Electrostatic atomization, Biodiesel fuel, Emulsion

Commercial resources brown algae in coastal zone Sakhalin and Kuril Islands and their use

Galanin D.A., Prokhorova N.Yu.
Russian *Research Institute of Fisheries and Oceanography (Sakhalin branch)*

Background: Macrophyte brown algae are an important component of coastal hydrobiont communities. Stability of macrophyte communities is provided by availability of rock habitats in the coastal zone. In the Sakhalin-Kuril region (SKR), this type of substrate can be found in 70% of bottom landscapes. Algae species able to withstand waving activity (limiting factor) inhabit open water areas at depths up to 3-5 m. Macrophytes sensitive to illumination inhabit waters at the depths up to 12-15 m, less sensitive organisms - 16–25 m. Below 30 m, brown algae are seldom observed in the SKR.

The objective is to monitor the resources of macrophyte brown algae in the Sakhalin-Kuril Region and determine the prospects for their commercial use.

Material and methods: Studies of the brown algae resources have been carried out in the course of inventories and biological monitoring using diving equipment. Algae communities have been studied at depths of 1–20 m; over 4,000 stations have been investigated; several thousand samples of brown algae have been collected and measured. During the expeditions, we have collected material on indicators of abundance and biological characteristics of commercial brown algae. Targeted commercial macrophytes in the SKR include *Saccharina japonica, S. bongardiana, S. angustata, Alaria marginata, Costaria costata*. The materials used in the preparation of the report cover the period from 2001 to 2014.

Results: Estimated total biomass of macrophyte brown algae in the SKR is approximately 1 million tons. The volume of explored commercial biomass of algae of the Saccharina genera in 2014 was 400 thousand tons. Most of the biomass of brown algae is located in the southern Kuril Islands (83.4%). Of 173.4 thousand tons of algae recommended for catch in the region, only 5 thousand tons (less than 3%) were caught. A low level of brown alga catches was noticed in the southern and northern Kuril Islands as well as in Aniva Bay (0-3% of allowable catch). Good kelp removals were registered near the southwestern coast of Sakhalin Island (63%). The level of available catch in a specific fishing ground is connected with its distance from the processing sites. Long distances increase the prime cost of algae production. The main direction of the brown algae uses in the region is its export to the western part of the country and abroad in the form of raw materials with minimal processing.

Conclusions: The resources of macrophyte brown algae in the SKR are distributed extremely unevenly due to a great diversity of habitat conditions in the coastal zone of the islands. The demand for brown algae resources depends on a distance between the fishing and processing sites. Kelp fishing off the Sakhalin Island southwestern coast has been successful for over 100 years. Reducing the cost of fishing may increase the catch volume of brown algae to 20,000 tons.

Keywords:
Macrophyte brown algae, commercial resources, Sakhalin-Kuril region.

Beneficial effects of seaweeds and seaweed compounds on human health: Toward popularization and establishment of habit of eating seaweeds in the Western countries

Juro Hiromi[1)] ,Tatiana T. Kalenik[2)], Elena Dobrynina[2)], Svetlana M. Minenko[2)]

1) College of Bioresource and Sciences, Nihon University, Japan;
e-mail: hiromi.juro@nihon-u.ac.jp
2) Department of Biotechnology and functional nutrition, FEFU, Russia

One of the subjects in the Joint Research Project "Kelp Project" conducted from 2014 to 2016 between College of Bioresource and Sciences, Nihon University (Japan) and Far Eastern Federal University (Russia) was how to disseminate the kelp-eating habit in Russia for the sake of extending their life span. One resolution obtained against this subject was to act educational campaigns, for example, by means of the publication of a new-typed recipe book for cooking ingredients from seaweeds and containing pages where scientific evidences showing the beneficial effects of seaweeds and seaweed compounds on the human health are described. Such a recipe book will be expected to contribute to the popularization and establishment of habit of eating seaweeds in Western countries including Russia.

Intake of seaweeds has been related to a lower incidence of chronic diseases such as cancer, hyperlipidemia and coronary heart diseases, mainly on the basis of epidemiological studies comparing Japanese and Western diets. In supporting those findings, recent research has focused on identifying compounds in seaweeds and the role of seaweeds in reducing the risk of chronic diseases, such as cardiovascular diseases and cancer, diabetes and obesity using results mainly from cellular and animal studies to propose potential mechanism behind the observed effects. Nobel and/or characteristic bioactive compounds of seaweeds, such as fucoxanthin of carotenoids, phlorotannins of algal polyphenol, alginic acid, fucoidan of polysaccharides, and fucosterol of algal lipid that are not found in the terrestrial plants may provide the human health promoting properties. This review briefly describes many evidences of beneficial effects of unique bioactive compounds in seaweeds on human health and disease status. In this review, however, it is necessary to take notice that a huge number of literature on seaweeds associated with the human health is not covered comprehensively, because this work is aimed principally at ordinary people who are not experts including medicine, pharmacy and nutrition, and who still have no habit to intake seaweeds but take interest in functional foods and improving human health.

References

Hiromi, J. (2018) Summary of the general discussion in the International Symposium, pp.263-265. In*" Popularization of "Kombu"-Eating Culture in Russia and Outlook toward the Promotion of Kelp Industries in Asia-Pacific Region"* (ed. RRIAP of Nihon University), Keiryu-Shosha, Tokyo.

Acknowledgement

This work was partly supported by International Research Project (2014-2016) in RRIAP (Regional Research Institute of Agricultural Production) of Nihon University.

Key words:

Seaweeds, bioactive effects, human health

Copper complex for the removal of Biofilm

Urara Ishizaki[1*], Kazuaki Yoshimune[1]
[1]*Department of Applied Molecular Chemistry, College of Industrial Technology, Nihon University, Japan,*
**e-mail: urara-i@lion.co.jp*

The bacterium *Legionella pneumophila* is a ubiquitous in soil water, and inhaling the bacteria by people with weakened immune systems often causes lung inflammation [1]. *L. pneumophila* can colonize and grow in biofilm which is formed by multicellular communities to confer their advantages, such as physical and mechanical resistances and chemical protection. Efficient removal of biofilms in the circulating water system is required for improving their safety. For the removal of biofilms in tubes, oxidant such as hydrogen peroxide is often used. Recently, disodium carbonate compound with hydrogen peroxide (DCHP) is substituted for hydrogen peroxide, since it is more cheap and easy for handling and preserving. Metal ion catalyzes oxidation by the oxidants and thus, metal complex increases their capability of oxidation. To provide an efficient washing detergent, it is important to evaluate the effect of metal complex on the control of biofilms and bacterial growth by the oxidants.

The complex (Cu-MGDA) of Cu(II) with methylglycinediacetic acid was used as metal complex. Treatment of *L. pneumophila* ATTC 33153 (10^8 CFU/ml) with 0.5 wt% DCHP for 5 min decreased its populations to 10^3 CFU/ml. The living cells was further decreased by 90% by the addition of 0.001 mM Cu-MGDA.

A biofilm-forming bacteria, *Pseudomonas aeruginosa* synthesizes an exopolysaccharide called alginate to form biofilm [2]. The addition of 0.003 mM Cu-MGDA significantly decreased the viscosity of 2 wt % alginate in the presence of 1 wt% DCHP.

The addition of DCHP should increase the washing efficiency against biofilms.

References
[1]Hoepelman IM, 143 (23), 1192 (1999)
[2]Laverty G *et al.*, Pathogens, 3 (3), 596 (2014)

Key words
Biofilm, Metal complex, Alginate

"Kombu" a traditional edible seaweed in Japan, its processed foods and health functions

Toshiaki Kamitani[1], Yuka Tojo[1], Kazunaga Yazawa[2], Toshiya Toda[3], Seiichiro Aoe[4], Toshio Suzuki[1*]

[1]*Fujicco Co., Ltd. R&D Laboratory, 6-13-4 Minatojima-nakamachi Chuo-ku, Kobe 650-8558, Japan*
[2]*Neutraceuticals and Functional Foods Science, Waseda University Research Organization for Nano & Life Innovation, 513 Waseda-tsurumaki-cho, Shinjuku-ku, Tokyo 162-0041, Japan.*
[3]*Department of Food Function, School of Human Environmental Science, Mukogawa Women's University, 6-46 ikebiraki,Nishinomiya,Hyogo 663-8558, Japan*
[4]*Department of Food Science, Faculty of Home Economics, Otsuma Women's University, 12 Sanban-cho, Chiyoda-ku, Tokyo 102-8357, Japan*
**e-mail:t-suzuki@fujicco.co.jp*

Kombu is Japanese name for tangle, a kind of seaweed native to the Japanese isles. The most major kind of Kombu in Japan is "Ma-Kombu", the scientific name is *Saccharina japonica*. In our country, we eat processed Kombu by several ways of processing. We introduce some kinds of processed Kombu and their features on health functions, along with our studies.

(1) Kombu extract is called "Kombu-dashi" in Japan. Its taste is very important for Japanese cuisine using as soup stock. Glutamic acid is well known as "UMAMI" component, but the taste of Kombu-dashi is thought to be expressed by not only glutamic acid but also mannitol and potassium. From a nutritional view point, one of the key features of "Kombu-dashi" is some minerals, containing Potassium, Magnesium, Calcium and so on. Although it contains a large amount of minerals, the amount of Potassium is larger than that of Sodium in Kombu. It is thought to be good for preventing from a high blood pressure. And it also contains minor minerals such as Zinc, Manganese and Iron in higher quantity than any other foodstuff.

(2) "Tororo-Kombu" is a traditional Japanese food made from Kombu, which is minimally processed by "shaving", seals in and retains the nutrient components found in raw Kombu, such as minerals and dietary fibers. We examined the possibility that the characteristic processing affects the elution of nutrient components and the expression of physiological functions. Firstly, we observed "Tororo-Kombu" by SEM and found that the most of cells in cellular tissue were fractured by shaving. Secondly, we compared the amounts of components, that is five minerals, fucoidan, and water-soluble alginate, eluted into artificial digestive fluid from "Tororo-Kombu" vs. non-shaved material and found that much larger amounts of components eluted from "Tororo-Kombu". This finding is might be caused by fracturing cells. The increase of eluted components in "Tororo-Kombu" could be expected to enhance the functionality of the components in intestinal tract *in vivo*.

(3) "Kombu-Tsukudani" is also a traditional Japanese food cooked with soy-souse and seasonings. It contains several dietary fibers in both soluble and insoluble types. They are reported to have some physiological health functions such as improvement of intestinal condition and inhibition of fat absorption. In our recent study, we found that Kombu processed at higher temperature has stronger effect of anti-obesity than non-heated Kombu. The mechanism is now under investigation.

Key words
Kombu processing foods, Saccharina japonica, heath functions

Studies on the Mechanism of Alzheimer's Disease in Early Diagnosis and Targeting Immunotherapy including preclinical phase medicine

H. Kohno[1], T. Shimizu[2], T. Komoriya[2], K. Yoshimune[2]
[1]*Hoshi University, Ebara 2-4-41, Shinagawa Tokyo, Japan, 142-5801*
[2]*Nihon University, Izumicho 1-2-1, Narashino, Chiba, Japan, 275-8575*
**e-mail: h-kohno@hoshi.ac.jp*

Nowadays, Alzheimer's disease is the most threatening neural disorder in human life because of the losing memory and humanity. In addition to the disaster, the population is expected to grow in numbers of nine to ten million patients in Japan. These disorders are characterized as the phase of clinical events of the specific feature in tau protein tangle and senile plaque hippocampus region in the brain.

In order to overcome the disaster, we set the strategy for early detection and stage oriented medical treatment which is effective to control and to recover neural cellular net work system.
For decades as indicated in reference, we have researched and reported for early detection of cerebrospinal fluid analysis and blood based serum assay for highly specific biomarkers of this type of disease. In the first, stage the work on immunoassay in cerebrospinal fluid testing to investigate the phosphorylated tau proteins. However, later it was also suggested that the $A\beta_{1\text{-}42}$ short peptide is accumulated and it was aggregated, then these event cause of the death of neuron cells in hippocampus region of the patient brain.

Based on the fact, it is identified that the aggregated $A\beta_{1\text{-}42}$ forms the senile plaque which was followed by the formation of insoluble phosphorylated tau protein which destructive in memory system.

In this report we are reporting the recent advancement in highly sensitive immunoassay for diagnosis of the disease and recent approach of targeting medical treatment for Alzheimer's disease including preclinical stage of medical drugs.

References

1) K. Ishiguro, H. Kohno et.al., *Neuroscience letter*, 1999, **270,** 91-94.
2) T. Shimizu, H. Kohno et.al., *Journal of Bioscience and Bioengineering*, 2013, **115**, 216-220.
3) T. Shimizu, K, Yoshimune, H. Kohno et.al., *Advances in Bioscience and Biochemistry*, 2013, **4**, 63-66.

Key words
Alzheimer's disease, Aβ1-42 Aggregation Immunoassay, Vaccination

Addition effects on *Marinobacter* sp. and *Alcaligenes* sp. to give to ocean sludge decomposition using circulation-type purification system

T. Komoriya[1], K. Okamoto[2]
[1] *Nihon University, Izumicho 1-2-1, Narashino, Chiba, Japan, 275-8575*
[2] *Nihon University, 1-8 Kanda-surugadai, Chiyoda-ku, Tokyo, Japan, 101-8308*
**e-mail: komoriya.tomoe@nihon-u.ac.jp*

It is important to reduce and control the formation of sedimentary sludge in the ocean. Plans to reduce the sludge are usually based on dredging or sand covers. Dredging is a simple method whereby the sludge is physically removed. However, the dredged sludge needs to be treated after removal. Sand covers, in general reduce contamination from ocean sludge, but they too can stress living organisms and ecological systems and are not ideal in places where navigation is a major concern. Hence, better and more efficient sludge management options are needed. Here, the use of fine-bubble technology was investigated for applications involving the purification of sludge. The principle of this technology is that bacteria can degrade sludge are activated by the aerobic conditions induced by the fine-bubbles. A fine-bubble decomposition system with circulation-type has been developed for ocean sludge. We identified the useful two bacteria (*Marinobacter* sp. and *Alcaligenes* sp.) for sludge decomposition from Manila Bay and Funabashi ports in Japan. Then we tested the performance of this system when added bacteria. The results showed that effects on purification seem to be well when additional bacteria are added directly to the process.

References

K. Tomoe, O. Kyoichi, T. Takashi *at al*., *International Journal of GEOMATE*, 2019,**17(59)**, 51-59.

Key words
Marinobacter sp., Circulation-type Purification System, Fine-bubble

Study of residence space corresponding to environmental transformation seen in Tonle Sap Lake in Cambodia

Akio Kuroyanagi, Ryo Sugahara
College of Science & Technology,
Department of Oceanic Architecture & Engineering, Nihon University
7-24-1narashinodai,Funabashi-shi,Chiba,274-8501 Japan
e-mail:kuroyanagi.akio@nihon-u.ac.jp

Cambodia Tonle Sap Lake is the largest freshwater lake in Southeast Asia[1)]. In this lake, the scale of the lake surface is largely different between the dry season and the wet season, and in the wet season, the surface area of the lake surface changes by more than five times the dry season. On the other hand, in the dry season, the amount of water decreases and the earth becomes dry, the daytime temperature is high, and the solar radiation is intense. These environmental changes foster a diverse biological ecosystem around the lake's coast. That places the fishing village on the shore of the lake.

The coastal settlements of Tonle Sap Lake have roughly two types of locations, and the settlements located on land are located in floodplains where mangrove forests flourish in order to cope with water level changes due to seasonal fluctuation and dry solar radiation. This mitigates the effects of changes in water level and dryness and strong sunlight. On the other hand, settlements located in water areas move to the mouth of a mangrove forest near the land area in the rainy season when the lakes are flooded. When the lake is in a drought season, water settlements will be formed at a depth of about 1 to 2 m. And the dwelling which forms each settlement of land area and water area shows different residence forms for every location location. Also, the arrangement of residences shows a characteristic configuration. The result of having investigated the habitation space corresponding to water level change of Cambodia Tonle Sap[2)].

Result of investigation,

1) 4commune, existence of the colony located ashore and the colony located on water surface was caught.
2) A colony form shows a linear array.
3) The form of the dwelling has been classified into four.
4) The way, functional separation, and plane composition which are used for the space composition of a dwelling had the feature.
5) There were three move forms in a dwelling.

In order to conserve the lake environment, it is important to maintain the life of the coastal fishing village.

References
1) Colin Poole:Tonle Sap,RIVER BOOKS,2) Akio Kuroyanagi(2018):Disappearing Asian floating culture,Kajima-publishing.

Key words
Environmental transformation, Water village, Dwelling form

Social Vulnerability Assessment in the Coastal Zone of China

Lin Lin, Yizhe Zhang, Xuchao Yang
Ocean College, Zhejiang University, China, email: linlin1995@zju.edu.cn

Social vulnerability assessment has been recognized as a reliable and effective measure to inform coastal hazard management. Although significant advances have been made in the study of social vulnerability over two decades, China's social vulnerability profiles are mainly based on the administrative unit, which can't provide detailed distribution and hinder the ability to diagnose human risks. In this study, we established social vulnerability index (SoVI) in 2000 and 2010 at a spatial resolution of 250m for China's coastal zone combining the potential exposure index (PEI) and social resilience index (SRI). Fitting the census data and multi-source remote sensing data of NTL, Land Use, NDVI, GHSL and DEM in Random Forest model, PEI with 250m resolution was obtained, and the county-level SRI was evaluated through principal component analysis (PCA) relying on 33 socioeconomic variables. For identifying the spatiotemporal change, we used global and local Moran's I to map clusters of SoVI and SoVI percent change in the decade. The results suggest that: (1) ignoring several small hot spots, counties in the Yangtze River Delta, Pearl River Delta and eastern Guangzhou have the most vulnerability especially in urban areas, while counties in Hainan and southern Liaoning contain the least vulnerability, and (2) notable increases emphasize in Tianjin, Yangtze River Delta and Pearl River Delta. Through this analysis, the spatiotemporal variation and heterogeneity in social vulnerability provide decision makers a scientific basis to focus risk mitigation effort in the most important locations.

References

1. Cutter, S.L., B.J. Boruff, and W.L. Shirley, Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, 2003, **84(2)**, p. 242-261.
2. Cutter, S.L. and S. Derakhshan, Temporal and spatial change in disaster resilience in US counties, 2010–2015. *Environmental Hazards*, 2018, p. 1-20.
3. Ge, Y., W. Dou, and N. Liu, Planning Resilient and Sustainable Cities: Identifying and Targeting Social Vulnerability to Climate Change. *Sustainability*, 2017. **9(8)**, p. 1394.
4. Ho, H.C., et al., Spatiotemporal analysis of regional socio-economic vulnerability change associated with heat risks in Canada. *Applied Geography*, 2018, **95**, p. 61-70.
5. Nguyen, C.V., et al., Assessment of social vulnerability to climate change at the local scale: development and application of a Social Vulnerability Index. *Climatic Change*, 2017, **143(3-4)**, p. 355-370.
6. Tavares, A.O., et al., Decennial comparison of changes in social vulnerability: A municipal analysis in support of risk management. *International Journal of Disaster Risk Reduction*, 2018, **31**, p. 679-690.
7. Ye, T., et al., Improved population mapping for China using remotely sensed and points-of-interest data within a random forests model. *Science of The Total Environment*, 2019. **658**: p, 936-946.
8. Zhou, Y., et al., Local spatial and temporal factors influencing population and societal vulnerability to natural disasters. *Risk Anal*, 2014, **34(4)**: p. 614-39.

Acknowledgements
This work was supported by the Fundamental Research Funds for the Central Universities.

Key words
Social vulnerability; potential exposure; social resilience

An Assessment of the Marine Eco-civilization Performance in Oujiang River Estuary Area, Zhejiang, China

Ying Lin[1], Huawei Zhang[2], Guanqiong Ye[1*], Jingang Jiang[1]
[1]*Ocean College, Zhejiang University, Zhoushan, China. 316000*
[2]*Zhejiang Institute of marine aquaculture, Wenzhou, China, 325000*
**email : gqy@zju.edu.cn*
Ying Lin's email:21734011@zju.edu.cn

Background: An estuary area usually experiences the most intensive anthropogenic influence of the coastal areas due to its geographical and physical attributes. It takes an important part of the "marine eco-civilization construction" in China. It is thus necessary to assess the performance of marine eco-civilization in the estuaries. There are, however, very few methodologies or cases studies related to marine eco-civilization assessment.

Material and methods: Taking the Oujiang River Estuary area as a research area, this study aims to formulate an index system and an evaluation model for assessing the performance of marine eco-civilization in the estuary areas. The index system consists of six angles including coastal community, economy, resources, ecology, culture and governance based on the requirements of "marine eco-civilization construction" as well as the attributes of the estuary area. The evaluation model is developed based on the 3-D space state model.

Results: The preliminary results of the case study shows that the overall performance of marine eco-civilization construction in Oujiang River Estuary was getting better, but the developments of six angles were not balanced.

Conclusions: The local government could focus on the development of marine culture and the restoration of marine ecological environment in the future.

References

World Bank. The Logframe Handbook. A Logical Framework Approach to Project Cycle Management. 2000.
NOAA. Coastal Zone Management Act Performance Measurement System:Contextual Indicators Manual. 2010.
UNEP.. Green is Gold: The Strategy and Actions of China's Ecological Civilization.2016
Gao Shan, Huang Xianjin. Index System on Performance Evaluation of Ecological Civilization in Province Administrative Areas—A Case in Jiangsu Province. *Economic Geography*, 2010,30(5), 823-828.(in Chinese)
Sun Qian, Yu Datao, Ju Maowei, et al. Construction of Index System for Performance Evaluation of Marine Ecological Civilization. *Ocean Development and Management*, 2017, 34(7):3-8.(in Chinese)

Acknowledgements

This work was supported by Zhejiang Institute of marine aquaculture and Department of Natural Resources of Zhejiang Province .

Key words

Assessment; Indicators; Marine eco-civilization

Changes in ORP (Oxidation Reduction Potential) of oxidative stress marker reflecting the in-body change by antioxidants using by electrochemistry measurement method

H. Saito[1], M. Nishio[2],
[1*]*BMD Inc. 2-7-5-604 Nihonbashi Nigyocho, Chuo-ku, Tokyo, 103-0013, Japan,*
[2]*Bio Research Center Co., Ltd, Segi Build 2F, 1-7-1 Iwamotocho, Chiyoda-ku, Tokyo, 101-0032, Japan*
[1]**e-mail: hsaito@bmdjapan.com*

Background and aim: The ROS (Reactive Oxygen Species) is supposed to be one of the causes of cell damages. There are many methods to measure the oxidative stress inducing the damage to lipids, proteins and nucleic acids caused by ROS.[1)] The electrochemistry measurement system provides two distinct parameters of ORP to exactly understand redox potential, and provides a complete view of oxidation across a biological system. ORP is an integrated balance between total oxidants and total reductants, which provides a real time snapshot of oxidative stress in a biological system, such as animal and human body. An above-normal sORP (static ORP: mv) value indicates a higher state of redox imbalance. A higher cORP (capacity ORP: μC) indicates a higher capacity of antioxidant reserving in a biological sample. The increase of sORP by the brain injury are known.[2)] sORP of sperm is widely measured in reproductive medicine clinics, because seminal oxidative stress is associated with MOSI (male oxidative stress infertility).[3)] The aim of present study is to examine those differences of ORP value among mammalian species, ORP changes occurring in body fluids by antioxidant, and ORP changes of saliva in daily life habit.

Material and Method: High fat diet with 20% lard was fed to rats for a week. Supplements as antioxidant were vitamin C, vitamin E, coenzyme Q10, alfa-lipoic acid, lycopene, and astaxanthin. The changes in ORP of fresh serum and saliva were measured using by RedoxSYS$^{\bigcirc,R}$ of electrochemistry system. As samples, fresh saliva after rinsing mouth was measured.

Results: Generally, human serum showed lowest sORP and highest cORP among human, rat and monkey. Monkey serum showed highest sORP and lowest cORP. Serum of rats showed significantly higher sORP by high fat diet. Higher fatty feed may cause oxidative stress. A decrease of sORP and an increase of cORP were suggested in human serum by the intake of antioxidant supplements. It took around six months for aged male to decrease oxidative stress from high sORP to average level in serum. As a result, antioxidant supplements indicated an active oxygen inhibitory effect in a body. Generally, saliva showed higher sORP than serum. Impacts on sORP and cORP in saliva by difference of life habit such smoking and alcohol drinking were observed

.

References:

1) Alessandra Buico, Claudio Cassino, Mauro Ravera, Pier-Glacomo Betta, and Domenico Osella, *Redox Report, 2009, 14(3), p125~131*
2) Leonard T. Rael, Raphael Bar-Or, Michael T. Kelly, Mathew M. Carrick, and David Bar-Or, *Electroanalysis 2015, 37, p2567~2573*
3) Ashok Agarwal, and Albert D. Bui, *Oxidants, Antioxidants and Impact of the Oxidative Status in Male Reproduction, 2019, p217~224*

Key words:
Oxidative stress, ORP of serum and saliva, antioxidant supplement

Perspective of Russian seaweeds as new and sustainable bioresource: An outline of the Russia-Japan collaborative research project.

Yasuyoshi Torii[1]
[1]*College of Bioresource Sciences, Nihon University, Kameino 1866, Fujisawa City, Kanagawa, Japan*
**e-mail: torii.yasuyoshi@nihon-u.ac.jp*

[Backgrounds] Kelp (*Laminaria japonica*, "Konbu" in Japanese) grows in coastal area in the northern part of Japan (Hokkaido and Tohoku area). 90 % of Japanese aquaculture production of kelp is from Hokkaido. Dried kelp is used to prepare "Dashi" (basic soup stock in Japanese cuisine), for its richness in L-Glutamate, a major *umami* component in foods. Thus, this is the most important aspect of utilizing Kelp in the Japanese cuisine. Kelp is also known to be rich in alginate, fucoidan and other polysaccharides. These contents are suggested to have many roles in health promotion in many reports. Alginate is also used as multi-purpose food additives in wide variety of processed foods nowadays.
[Material & Methods] Natural kelp also grows in the coastal area of the far-east Russia, including Primorskiy Krai and Sakhalin Island. Kelp harvesting and processing has been industrialized in these areas. There are some companies manufacturing certain kinds of kelp products. The amount of the seaweed resources in the area is presumed to be enough to cover its demand in Russia. However, consumption of kelp and other seaweeds is not going well these days. Meanwhile Russian people are paying more attention to healthy life style and longevity of Japanese people. With a kind and generous support from the Far Eastern Federal University (FEFU), Russia, Nihon University RRIAP Kelp project has been carried out since 2014 to 2016. Within the framework of this collaborative project, Japanese members visited FEFU in Vladivostok city for three times to hold meetings, tasting events and lectures to the University students and Russian citizens to prevail information about seaweeds and promote kelp consumption in Vladivostok, Russia. We brought some food samplers which contain Kelp processed in a factory in Nihon University. Additionary, FEFU and Nihon University School of Bioresource Sciences signed the collaboration Agreement in 2015.
[Results & Conclusions] Here in this article, the outline of this Russia-Japan collaborative project is going to be reported and the perspectives of the Russian Kelp utilization as a new bioresource is going to be discussed.

References

Yasuyoshi TORII: "Actions for the dissemination of kelp-eating culture in Vladivostok during the Kelp Project." in RRIAP monograph vol. 32 "Popularization of "Kombu"-Eating Culture in Russia and Outlook toward the Promotion of Kelp- Industries in Asia-Pacific Region" (Ryukei-shosha Books, Japan) (2018)
Yasuyoshi Torii, Koji Miyauchi, Juro Hiromi, Elena Dobrynina, Svetlana Minenko, and Tatyana Kalenik: "Perspective of Russian seaweed as a new bioresource; An outline of the Russia-Japan collaborative research project. *New Food Industry*, vol.60 (9), p.72-80 (2018)

Acknowledgements

This work was supported by Nihon University's RRIAP (Regional Research Institute of Agricultural Production) International Research Project (2014-2016).

Key words

Kelp, Seaweeds, Food innovation

The Application and New Development of the Principle of Inheritance of Human Common Property in the International Seabed Area Legal System

Wang Yan[1], Liu Xiaochen[2], Pei Zhaobin[1]

[1]*Dalian Ocean University, No. 52 Heishijiao Street, Shahekou District, Dalian City, Liaoning Province,116023;*[2]*Dalian Maritime University,1 Linghai Road, Ganjingzi District, Dalian City, Liaoning Province,116026*

**e-mail:1120658722@qq.com*

The principle of inheritance of human common property has been put forward as early as the 1960s, but its controversy has never stopped. In recent years, facing the new situation of changes in the international community, the principle of inheritance of human common property has appeared new application and development in the legal system of the international seabed region. This paper will start with the theoretical basis of the principle of inheritance of human common property, introduce the application and development experience of the principle in the international seabed region, analyze the causes of the application and development dilemma of the principle, put forward the concept of solutions, and introduce the efforts and obstacles of the developing countries represented by China in the principle of inheritance of human common property. In order to promote the application and new development of the principle of inheritance of human common property in the international seabed legal system on the basis of finding out the shackles and solving the difficulties.

Keywords:
International Seabed Area, Human common inheritance, International Seabed Authority

Discovery of new marine natural products by cross-talk of hydrothermal vent fungal-bacterial community

Bin Wu
Ocean College, Zhejiang University, China

We performed a metabolomics survey of the secondary metabolism of a hydrothermal vent fungal-bacterial community comprising Aspergillus sclerotiorum DX9 and Streptomyces sp. WU20. The fungal strain was found to increase the secretion of notoamides and cyclo(Pro-Trp) produced by the actinomycetes was discovered to be the responsible molecule, which led to the hypothesis that the fungi transformed cyclo (Pro-Trp) synthesized by the actinomycetes as the biosynthetic precursors of notoamides in the cross-talk. Further analysis showed Streptomyces sp. WU20 was efficient in transforming amino acids into cyclo (Pro-Trp) and adding tryptophan as well as proline into the cross-talk could enhance the induction of the notoamide accumulation.

Research on the Mechanism of Profit Distribution of the Common Inherited Property of Mankind

Xu Chang[1], Yang Siting[1], PeiI Zhaobin[1]

[1]*Dalian Ocean University, No. 52 Heishijiao Street, Shahekou District, Dalian City, Liaoning Province,116023*
**e-mail: pzb@dlou.edu.cn;907403245@qq.com;xuchangdlou@163.com*

As the common heritage of mankind, the monetary and non-monetary benefits of the international seabed area should be enjoyed by all mankind. However, the vast majority of countries can not directly benefit from it, and they can only indirectly realize their due rights to the common heritage of mankind by distributing the interests of exploration and development subjects. In order to achieve substantial fairness in distribution, it is suggested to adopt the mode of combination of legislation and contract to distribute interests, that is, on the basis of the minimum distribution of interests stipulated by law, each subject determines other matters concerning the distribution of interests through consultation. When determining the amount of legally distributed benefits, necessary relevant factors should be taken into consideration, such as the balance between the exploration and development rights of investors and the obligation to share interests, the substantive equality between developed and developing **countries**, and the appropriateness of payment matters. In addition, in order to rationalize the distribution mechanism, it is suggested that the population base and level of development should be taken into account in the negotiation of distribution, and the existing parallel development system, exploration priority, technology transfer and the tax provisions of the authority should be standardized and improved.

Key words:
common heritage of mankind, profit distribution,equitable principle

Conformational change of salt-tolerant glutaminase from marine bacterium

Kazuaki Yoshimune[1*], Hayato Ohashi[1], Masaru Goto[2]
[1]*Department of Applied Molecular Chemistry, College of Industrial Technology, Nihon University, Japan*
2 Department of Biomolecular Science, Graduate School of Science, Toho University
**e-mail: Yoshimune.kazuaki@nihon-u.ac.jp*

Most enzymes show little activity under high salt conditions, such as 4 M NaCl. Some enzymes show activity both in the presence and absence of high concentrations of NaCl, and they are known as salt-tolerant enzymes. Salt-tolerant enzymes are useful for fermentation and food process which contains high concentrations of salt. However, their salt-tolerant mechanisms are little understood. Previously, we determined the crystal structure of salt-tolerant glutaminase (Mglu) from marine *Micrococcus luteus* K-3 to investigate its halo-adaptation mechanisms. A comparison of the structures in the presence and absence of 4.3 M NaCl revealed that Mglu alters the conformation of a part (242-248 aa; salt loop) by the addition of 4.3 M NaCl. Among amino acid residues of the salt loop, Tyr243 is located near the catalytic nucleophile Ser64. On the other hand, salt-labile glutaminase from *Bacillus subtilis* maintain its conformation both in the presence and absence of NaCl. These facts suggest the conformational change contributes for the salt-tolerance. The suppression of the conformational change by site directed mutagenesis could reveal the effect on the salt-tolerance. Aspartate 244 and Alanine 244 of the salt-loop were substituted by alanine and serine, respectively. Their salt-tolerance of the two mutants are reported.

References

[1]Yoshimune K *et al.*, FEBS J, 277, 738 (2010)
[2] Yoshimune K *et al.*, Biochem Biophys Res Commun, 346, 1118 (2006)

Key words
Glutaminase, salt-tolerance, marine bacterium

Interpretation of the Principle of Human Common Inheritance of Property in International Law

Pei Zhaobin[1] Qu Yanan[1] Li Jia[1*]

[1]*Dalian Ocean University Law School, No. 52, Heishijiao Street, Shahekou District, Dalian City,,Liaoning province,China,116023*

*email：709117713@qq.com；jia7998814@foxmail.com

The principle of the common heritage of mankind is an important legal principle stipulated in the United Nations Convention on the Law of the Sea. It is an important application of the law of the sea in the international seabed area, It is of great significance to resolve the attribution of international seabed areas and resource rights and promote the fair and rational distribution and utilization of marine resources. Starting from the definition and legal attributes of the common heritage of mankind, it traces back to the principle of the common heritage of mankind, and explains the main content and scope of the principle of the common heritage of mankind in the framework of international law. In combination with the concept of the human destiny community proposed by China, it puts forward feasible suggestions for the development and practice of the principle of human common inheritance, and explores the development path of the principle of the common heritage of mankind from the perspective of international law.

Keywords:
International seabed area; principle of common heritage of mankind; United Nations Convention on the Law of the Sea

T05: Polar ocean research and explorations

T05-1: Carbon cycle in the Arctic land-shelf system

Last millenniums ice conditions in the East Siberian and Chukchi Seas: reconstruction on sedimentary proxies

A.S. Astakhov[1*], A.A. Bosin[1], Shi Huefa[2], Hu Limin[2], A.V.Darin[3], I.A.Kalugin[3], V.V.Plotnikov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2] *First Institute of Oceanography China. 6 Xianxialing Road, Qingdao 266061*
[3] *V.S. Sobolev Institute of Geology and Mineralogy SB RAS, pr. Ak. Koptuga 3, Novosibirsk, Russia, 630090*
**e-mail: astakhov@poi.dvo.ru*

The main tasks of adapting the approach and computing reconstructions of the paleoenvironment conditions were solved on the base of transfer functions obtained by comparing observed data of the ice conditions and elemental composition of sediments accumulated over the calibration period [1]. The data on the elemental composition of sediments, measured at resolution 0.5–1.2 mm and converted to the time scale according to the results of isotope analysis (^{210}Pb, ^{137}Cs, AMS^{14}C), were compared with the observed data on the duration of the ice-free period (IFP). For these time series, transfer functions were computed using the multiple regression equations and applied for reconstruction of ice.

Performed regional reconstructions of ice conditions with decade resolution for the last centuries have shown good correlation with global reconstructions of area of the Arctic ice cover [2]. Common features of the observed and reconstructed variations of IFP for the studied cores of the East Siberian and Chukchi Seas in recent centuries are:

- the maxima of ice cover spreading in the last centuries were in the 19th century and the first half of the 20th;
- in recent decades, the ice cover has decreased dramatically; this is in general terms coincides with the observed increase in average annual air temperature; many researchers explained this phenomenon by anthropogenic activity;
- in the certain stages of the Little Ice Age (LIA) and, especially, in the Maunder Minimum, the IFP increased, which does not coincide with changes in the average annual air temperature.

Calculated reconstructions of the ice-free period based on transfer functions for the last 4-5 thousand years using the long cores from the Chukchi and East Siberian Seas revealed cycles of variability with a period of 1.6–1.9 thousand years and very close to duration of 1800-year cycles of lunar tides. The periods with the most severe ice conditions occurred 0.1–0.3, 1.8–2.2, 3.8–4.1 thousand years ago. The rapid increase in the duration of the IFP in recent decades, noted in our reconstructions and in worldwide observations, cannot be associated with 1800–year cycle of changes in IFP. According to this cyclicity, the duration of the IFP should be minimal, but tends to increase. The amplitude of observed increase in duration of IFP in recent decades is much higher than predicted. This may be caused due to imposing of growing trend of natural cyclicity and processes determined by global anthropogenic warming.

References

1. Astakhov, A.S., Akulichev, V.A., Dar'in et al., Doklady Earth Sciences, 2018, 480(2), 768–773.
2. Kinnard, C., Zdanowicz, C.M., Fisher, et al.., Nature, 2011, 479, 509–512.

Acknowledgements: This work was supported by the Russian Foundation of Basic Research [grant 18-05-60104)

Key words:
Sediment chemistry, East Siberian Shelf, ice reconstruction

Submarine ground-water discharge in the coastal waters of the Arctic seas

A.N. Charkin[1,2,]*, O.V. Dudarev[1,2], M.S. Cherepnev[1], A. Ovsenev[1], I.P. Semiletov[1,2]
[1]*National Research Tomsk Polytechnic University, 30 Lenin Avenue, 634050 Tomsk*
[2]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: charkin@poi.dvo.ru*

As of today, the shelf groundwater systems as well as the particularities of the submarine ground-water discharge SGD have been very poorly studied. At the same time, groundwater systems of deep-seated subsurface aquifer systems have developed under the bottom, which are similar to those on land. In these systems, the migration of infiltration water is possible from the land, and the reverse, the migration of saline water from the submarine watershed to the land. The origin and functioning of local SGD zones on the shelf is tightly connected via structural, lithological and geomorphological features to the shelf regions. In different climatic zones, these features are complicated by additional factors. For the Arctic shelf, with boundaries of widely developed permafrost, these subsurface land-sea interactions are complicated by the geocryological conditions.

Our research shows that SGD does exist in the Siberian-Arctic shelf seas, but its dynamics may be largely controlled by complicated geocryological conditions such as permafrost. The field-observational approach in the southeast Laptev Sea used a combination of hydrological (temperature, salinity), geological (bottom sediment drilling, geoelectric surveys), hydrochemical (measurement of concentrations of biogenic elements, alkalinity, pH, dissolved oxygen, macrocomponent analysis (Cl, SO4, Na, Mg, Ca, K)) and geochemical (radiogenic isotopes ^{224}Ra, ^{223}Ra, ^{228}Ra, ^{226}Ra and stable isotopes ^{18}O, ^{2}H) techniques.

Active SGD was documented in the vicinity of the Lena River delta with two different operational modes. In the first system, groundwater discharges through tectonogenic permafrost talik zones was registered in both winter and summer. The second SGD mechanism was cryogenic squeezing out of brine and water-soluble salts detected on the periphery of ice hummocks in the winter. The proposed mechanisms of groundwater transport and discharge in the arctic land-shelf system is elaborated. Through salinity versus ^{224}Ra and ^{224}Ra/^{223}Ra diagrams, the three main SGD-influenced water masses were identified and their end-member composition was constrained. Based on simple mass balance box models, discharge rates at site in the submarine permafrost talik zone were $1.7 \times 10^{6} m^{3} d^{-1}$ or $19.9 m^{3} s^{-1}$, which is much higher than the April discharge of the Yana River.

Acknowledgements
This work was supported by the Russian Science Foundation (grant no. 15-17-20032 and 19-17-00058).

Key words
Submarine ground-water discharge, Arctic shelf, talik zones.

Export of Suspended Particulate Matter to the East Siberian Shelf: Mesoscale of Interannual Variability

O. Dudarev[1.2*], A. Charkin[1,2], A. Ruban[2], V. Vonk[4], O. Gustafsson[3], L. Sánchez-García[4], T. Tesi[5], I. Semiletov[1,2], N. Shakhova[2], A. Mazurov[2]

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

[2]*Tomsk Polytechnic University, Tomsk, Russia*

[3]*Stockholm University, Stockholm, Sweden*

[4]*Utrecht University, Netherlands*

[4]*Institute of Environmental Sciences, Zaragoza University, Spain*

[5]*Institute of Marine Sciences, National Research Council, Venezia, Italy*

**e-mail: dudarev@poi.dvo.ru*

We present the data obtained in the International Russia-US and Russian-Sweden-US cruises of 2000, 2003-2005, 2008, 2011, 2014 and 2016, which characterized a spatial and interannual variability in distribution of suspended particulate material (SPM), and its organic carbon (POC) and stable isotopes content.

The role of the coastal zone in lateral transport and fate of terrestrial organic carbon in the East Siberian Arctic Shelf (ESAS) is still not studied well because most recent activities were focused on onshore geomorphologic and geochemical features, while biogeochemical and sedimentation consequences of coastal erosion and riverine runoff in the sea were not studied sufficiently.

Spatial-time dynamics of SPM composition (POC and isotopes) along with its material composition is considered in connection with changing river runoff and wind patterns. It has been found that not the rivers Indigirka, Kolyma (of East Siberian Sea) as Lena and Yana (of Laptev Sea), but the coastal erosion is a dominant source of terrestrial POC into the ESAS. The SPM concentration sharp gradient was found across the frontal zone between "freshened/high SPM" and "Pacific/low SPM" waters. Position of the frontal zone varies significantly from year to year. It is mainly attributed to the difference in atmospheric circulation patterns driven the Arctic Ocean circulation. During storms and surges the SPM concentration in the same area increased up to 10-times and higher.

Acknoledgements

This work was financial supported by the Russian Government grant (№ 14Z50.31.0012), the Wallenberg Foundation and from the Swedish Polar Research Secretariat and the Arctic Co-Op Program of the Nordic Council of Ministers (№ 331080-70219), grants of Russian Science Foundation (№ 15-17-20032; 19-17-00058) and Ministry of Science and Higher Education gov. assignment AAAA-A17-117030110039-2), grants of NOAA and NSF.

Key words

East Siberian Shelf, suspended particulate matter, organic carbon and isotope

Patterns of Terrestrial Organic Carbon Distribution in the Modern Sediments of East Siberian Shelf

O. Dudarev[1,2*], A. Charkin[1,2], A. Ruban[2], V. Vonk[4], O. Gustafsson[3], L. Sánchez-García[4], T. Tesi[5], I. Semiletov[1,2], N. Shakhova[2], E. Panova[2], A. Grinko[2], A. Mazurov[2]

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

[2]*Tomsk Polytechnic University, Tomsk, Russia*

[3]*Stockholm University, Stockholm, Sweden*

[4]*Utrecht University, Netherlands*

[4]*Institute of Environmental Sciences, Zaragoza University, Spain*

[5]*Institute of Marine Sciences, National Research Council, Venezia, Italy*

**e-mail: dudarev@poi.dvo.ru*

East Siberian Shelf (ESS) is clearly important region for storing and processing material that derives from the land and the sea. Here synthesize the lithological and biogochemical data obtained in the ESSS by Laboratory of Arctic studies of Pacific Oceanological Institute in cooperation with Stockholm University and International Arctic Research Center (University of Alaska-Fairbanks, USA) during the last 20 years (1999-2018).

Highest organic carbon content in the surface sediment (SOC) was found near mouths of ESS major rivers Lena, Yana, Indigirka, Kolyma (up to 4w/w%) and near highly eroded coast (1-2 w/w%). .However, sedimentation over the major portion of shallow ESS is dominated by coastal erosion not riverine runoff. It has been shown that contribution of terrestrial organic carbon is up to 100% in areas strongly impacted by coastal erosion. Lowest SOC values (~0.1-0.5 w/w %) were found in the sediments of relic shoals.

New detail maps of distribution of sediment organic carbon, terrestrial organic carbon and C/N ratio value are considered along with the sediment sizing and mineralogical data.

Acknoledgements

This work was financial supported by the Russian Government grant (№ 14Z50.31.0012), the Wallenberg Foundation and from the Swedish Polar Research Secretariat and the Arctic Co-Op Program of the Nordic Council of Ministers (№ 331080-70219), grants of Russian Science Foundation (№ 15-17-20032; 19-17-00058) and Ministry of Science and Higher Education gov. assignment AAAA-A17-117030110039-2), grants of NOAA and NSF.

Key words

East Siberian Shelf, sediment organic carbon, terrestrial organic carbon

Mineralogical surface sediment properties and their influence on TerrOC distribution across the East Siberian Arctic Shelf

E. Gershelis[1*], A. Ruban[1], O. Dudarev[2], I. Semiletov[2]
[1]*Tomsk Polytechnic University, 30 Lenina Av., Tomsk, Russia, 634050*
[2] *V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: elenapanova@tpu.ru*

Background. The East Siberian Arctic shelf (ESAS) is heavily affected by high terrestrial input from the Great Russian Rivers and from coastal erosion. Therefore, the fate of terrigenous organic carbon (TerrOC) across the ESAS is of increasing interest in environmental research.

Material and methods. Grain size measurements were performed using a laser diffractometer. Specific surface areas were measured using the standard Brunauer-Emmett-Teller method. Total organic carbon (TOC) concentrations, δ13 C isotopic composition analyses as well as alkaline CuO oxidations were performed as described earlier by Tesi et al. (2014, 2016).

Results. Grain size and corresponding surface area distributions are believed to be one of the key determinants affected the OC composition of continental margins sediments. In the present study, we observe strong prevailing of fine-silt surface sediments across the ESAS that can be explained by stable subglacial sedimentation environment. The variations in grain-size distribution observed across the Buor-Khaya bay are in direct accordance with previous results reported for this area. Nevertheless, the grain-size distribution results showed up two unusual coarse-grained areas. Those are 1) in the central part of the LS and 2) to the north of the New Siberian Islands, ESS. The grain size distributions of the sediments are expressed as bimodal distribution diagrams indicating on different sedimentation mechanisms. General pattern of lignin loadings over the ESAS shows that of TerrOC loss starts immediately after reaching several meters depth. Variations in lignin loadings values indicate fine-grained sediments as TerrOC transport agents for the entire margin.

Conclusions. We have suggested several external factors directly affecting sediment sorting in the coarse-grained areas. Those include modern and paleo ice scouring in the early Holocene; intensive gas venting accompanied by removal of fine-grained sediment; or lateral brine injections occurring in this region. Preliminary results also unraveled the processes of general net loss of TerrOC and replacement of TerrOC with marine organic matter across the entire ESAS. The carbon loading values are generally even, while extension of the enriched δ 13C signatures from coast to the deep sea reflects a decreasing role of TerrOC.

References

Bröder, L., Tesi, T., Salvadó, J. A., Semiletov, I. P., Dudarev, O. V., and Gustafsson, Ö. *Biogeosciences*, 2016, 13, 5003-5019 pp.

Tesi, T., Semiletov, I., Hugelius, G., Dudarev, O., Kuhry, P., and Gustafsson, O. Geochimica Et Cosmochimica Acta, 2014, 133, 235-256 pp.

Tesi, T., Semiletov, I., Dudarev, O., Andersson, A. and Gustafsson, Ö. Journal of Geophysical Research: Biogeosciences, 2016, 121(3), 731–752 pp.

Acknowledgements

This study was supported by Russian Foundation of Fundamental Research (Project #18-35-00572 Mol_a).

Key words

Organic carbon, Arctic shelf, sediments

The experience of using automatic degassing device for seawater to determine methane concentrations

D. A. Kosmach[1*], D. V. Chernykh[1], N. E. Shakhova[2], E. A. Spivak[1], A. V. Kurilenko[1], A. V. Koshurnikov[3], A. N. Salyuk[1] and I. P. Semiletov[1,2],

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

2 National Research Tomsk Polytechnic University, 30 Lenina pr., Tomsk, Russia, 634050

3 Lomonosov Moscow State University, GSP-1, Leninskie Gory, Moscow, Russia,119991

**e-mail: den-kosmach@mail.ru*

Since atmospheric methane is thought to contribute up to 20% of the greenhouse gas effect, accurate determination of dissolved methane (CH_4) concentrations is vital for the study of methane dynamics in a variety of natural aqueous environments. The Arctic is warming dramatically, with potentially catastrophic impacts on climate through release of CH_4 via rapid mobilization of the labile reservoirs of carbon sequestered in permafrost [1-4]. Top candidate to move substantial amounts of carbon from land and ocean to the atmosphere on decadal-century timescales is thawing permafrost in the Arctic [2-4]. Thus CH_4 concentrations in the arctic aquatic ecosystems should be measured continuously over long time periods and large spatial scales. In this report we present the selected results of continuous dynamic head-space measurements ("stripping" technique) [5] performed in the Siberian Arctic seas as well as the Far Eastern seas including the Bering Sea and sea of Okhotsk. The CH_4 data in the surface waters were obtained during three full scale expeditions accomplished in 2011 - 2012, 2015. In total, more than 17500 measurements were made. Results of our investigations demonstrate that concentrations of dissolved CH_4 measured in the surface water in all eight Seas were supersaturated regards to the atmosphere. However, anomalously high concentrations of dissolved CH_4 in the surface water were found in the East Siberian Arctic seas (ESAS), which is composed of the Laptev Sea, the East Siberian Sea and the Chukchi Sea. The CH_4 distributions in surface waters indicate the increasing gradient between low latitudes to high-latitudes. Because the ESAS average depth is only 45 m, the water column provides a short conduit for bottom-released CH_4 to be vented to the overlying atmosphere. This distinguishes CH_4 venting in the ESAS from sedimentary releases in deeper waters, in which the bulk of CH_4 would be oxidized before reaching the sea surface. New data supports the previous results showing the dominance of the ESAS – as a source of atmospheric methane of global significance.

References

1. N. Shakhova, I. Semiletov, A. Salyuk, V. Yusupov, D. Kosmach, Ö. Gustafsson, *Science*, 2010, vol. 327, page 1246 - page 1250.

2. N. Shakhova, I. Semiletov, I. Leifer, V. Sergienko, A. Salyuk, D. Kosmach, D. Chernykh, C. Stubbs, D. Nicolsky, V.Tumskoy, Ö. Gustafsson, *Nature Geosci.*, 2014, vol. 7 (1), DOI:10.1038/NGEO2007.

3. N. Shakhova, I. Semiletov, V. Sergienko, L. Lobkovsky, V. Yusupov, A. Salyuk, A. Salomatin, D. Chernykh, D. Kosmach, G. Panteleev, D. Nicolsky, V. Samarkin, S. Joye, A. Charkin, O. Dudarev, A. Meluzov, O. Gustafsson, *Phil. Trans. R. Soc. A.*, 2015, vol. 373, 20140451. DOI:10.1098/rsta.2014.0451

4. N. Shakhova, I. Semiletov, Ö. Gustafsson, V. Sergienko, L. Lobkovsky, O.Dudarev, V. Tumskoy, M. Grigoriev, A. Mazurov, A. Salyuk, R. Ananiev, A. Koshurnikov, D. Kosmach, A. Charkin, N. Dmitrevsky, V. Karnaukh, A. Gunar, A. Meluzov, D. Chernykh, *Nature Communications*, 2017, vol. 8:15872, DOI:10.1038/ncomms15872.

5. D. Kosmach, V. Sergienko, O. Dudarev, A. Kurilenko, Ö. Gustafsson, I. Semiletov, N. Shakhova, *Doklady Chemistry*, 2015, vol. 465, part 2, page 281– page 285.

Acknowledgements

This work was supported by Russian Science Foundation (grants No 15–17–20032 and 18-77-10004).

Key words

Arctic shelf, dissolved methane, long-term observations

Matched-field localization in the typical Arctic environment

Chonglei Liu, Haining Huang*, Jiyuan Liu, Yuquan Wu, Chunhua Zhang, Qihu Li
Institute of acoustics, Chinese academy of science, 21, west of north 4th ring Str., Beijing, China, 100190
**e-mail:hhn@mail.ioa.ac.cn*

Background. The Arctic marine regions are of significant economic values, posessing abundant natural resources. Moreover, the Arctic has a crucial influence on global climate and ecology. Acoustic method for researching and exploiting Arctic are a topic of great interest. Researchers have utilized acoustic propagation properties such as modal group velocity to predict and monitor seasonal variability of sea ice thickness in the Arctic. Matched-field processing (MFP) takes the advantage of the physical characteristics of ocean waveguide, and can be used to determine the source localization or the parameters of the waveguide with super resolution and accuracy. In this paper, we construct an under-ice MFP localization scheme and conduct some preliminary analyses of the performance of the proposed algorithm in the typical under-ice Arctic environment.

Material and methods. In August, 2018, we conduct a low frequency acoustic propagation experiment during the ninth Chinese national Arctic research expedition. The sea is 3000m depth with an approximately 2.7m thick ice plate above and an upward refracting sound speed profile. The source locating in XUELONG vessel transits 650-800Hz LFM sweep with 2s duration repeated every 30s by a fish-lap transducer at a depth of 70m under the ice cover. The receiving site situating at a floe camp consists of a 10-element vertical line array (VLA) with an element spacing of 30m, 4.5km away from the source. To account for the effects to the acoustic property by ice cover, we utilize the coupled full-field acoustic propagation model called OASR-Kraken to generate the replicas in a frequency band from 650Hz to 800Hz with an increment of 2Hz. Then conduct single frequency and incoherent wideband MFP to examine the localization performance by the detection ratio (difference in dB between maximum and the highest side lobes in ambiguity surface) and range/depth localization error.

Results. Totally, we get 12 consecutive ambiguity surfaces using Bartlett and MV method, respectively. In each case all the ambiguity surfaces are almost identical with a stable range/depth estimation of (63m, 4430) which indicates an estimated error of 7m in depth and 70m in range in comparison with the true position. As anticipated, the performance of the MV method is superior to the Bartlett method, while the broadband method overmatches single frequency likewise.

Conclusions. The MFP results are promising with high resolution and low sidelobes which indicates the feasibility of MFP localization in under-ice environment.

References

[1] A. N. Gavrilov and P. N. Mikhalevsky. "Low-frequency acoustic propagation loss in the Arctic Ocean: Results of the Arctic climate observations using underwater sound experiment". J. Acoust. Soc. Am., 2006, **119(6)**, 3694-3706.
[2] H. Schmidt, A. B. Baggeroer, W. A. Kuperman, and E. K. Scheer, "Environmentally tolerant beamforming for high-resolution matched field processing: Deterministic mismatch," J. Acoust. Soc. Am., 1990, **88(4)**, 1851-1862.
[3] A. B. Baggeroer, W. A. Kuperman, and P. N. Mikhalevsky, "An overview of matched-filed methods in ocean acoustics," IEEE J. Ocean.Eng., 1993, **18(4)**, 401-424.

Acknowledgements

This work was supported by Chinese national Arctic research expedition, we show our appreciation to scientists for their extraordinary work in the real acoustic data acquisition.

Key words: Arctic acoustics, Matched-field processing, Source localization

Spatio-temporal changes in the chemical composition of the Ob River (Western Siberia)

J.A. Moiseeva[1*], O.G. Savichev[1], A.K. Mazurov[1]
[1]*National Research Tomsk Polytechnic University, Tomsk, Russia, 634050*
**e-mail: jamoiseeva@mail.ru*

The Ob River is one of the largest rivers in the world. It flows into the Gulf of Ob of the Kara Sea and has a significant impact on the ecological and geochemical state of the Arctic basin. An analysis of the chemical composition of the Ob River in the middle and lower reaches during different periods of time was performed. The authors carried out sampling of the water of the Ob River and chemical analysis on the sections of the middle (from the mouth of the Tom to the Irtysh rivers in 1991, 1999, 2016) and lower (Irtysh River – Gulf of Ob in 2016) reaches. In addition, scientists of the Tomsk Polytechnic University, the Institute of Geology and Geophysics of Oil and Gas of the SB RAS and JSC Tomsk geomonitoring conducted research on the Ob River and its tributaries within the Tomsk Region 1994-2018. In addition, the data of long-term observations of Roshydromet on the Ob River in the sections of Kolpashevo, Prokhorkino, Aleksandrovskoye, Belogorie, and Salekhard were analyzed in collaboration with other scientists [1-4].

The waters of the Ob River, on average, correspond to freshwaters with low and medium mineralization, pH values range from slightly acidic in spring to slightly alkaline in summer-autumn, contain a large amount of organic substances and their transformation products. Concentrations of these and a number of other indicators almost everywhere exceed the established standards, which is often associated with anthropogenic impact, as well as with the arrival of swamp waters into the river drainage. It should be noted and the influence of tributaries, the flow of which is formed in different natural conditions, which leads to a change in the ratio of conditionally surface and underground components along the Ob river. [1, 2, 5]
In general, the effect of various factors on the chemical composition of the Ob River manifests itself in a general decrease in salinity and pH, and an increase in the concentration of organic matter from sources to the mouth. A significant impact on the chemical composition of the waters of the Ob River has: Tom, Chulym, Irtysh - on the total content of dissolved salts; smaller flat tributaries with more wetland watersheds - on the content of organic substances, iron compounds, pH. This influence is generally non-linear and can be traced mainly on average over a period of many years.

References

1. V.A. Zemtsov, O.G. Savichev R., *International Journal of Environmental Studies,* 2015, **volume** 72 (3), page386-page396.
2. O.G.Savichev, A.K. Mazurov, I.I. Pipko, V.I. Sergienko and I.P. Semiletov, *Doklady Earth Sciences,* 2016, **volume** 466 (1), page47-page51.
3. S.L. Shvartsev, O.G. Savichev, G.G. Vertman, R.F. Zarubina, N.G. Nalivaiko, N.G. Trifonova, Yu.P. Turov, L.F. Frizen, V.V. Yankovskii, *Water Resources,* 1996, **volume** 23 (6), page673– page682.
4. S.L. Shvartsev, O.G. Savichev, *Water Resources*, 1997, **volume** 24 (6), page707– page 13.
5. S.L. Shvartsev, *Geochemistry International*, 2008, **volume** 46(13), page1285– page1398.

Acknowledgements
This work was supported by the Government of the Russian Federation (project no. 14.Z50.31.0012) and Russian Science Foundation grants (No 18-55-80015).

Key words
Ob River, Arctic basin, chemical composition.

Marine CO_2 system patterns in the Gulf of Anadyr during fall season

I. Pipko[1*], S. Pugach[1], N. Savelieva[1], V. Luchin[1], O. Dudarev[1], I. Semiletov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskays Str., Vladivostok, Russia, 690041*
**e-mail: irina@poi.dvo.ru*

The Bering Sea (BS) shelf is one of the most productive marine ecosystems in the global ocean. On the extensive continental shelf, seasonally high rates of pelagic phytoplankton primary production support large populations of marine mammals and seabirds, and coastal fisheries. The continental shelf of the BS is a region that has demonstrated remarkable variability in recent decades in response to climate forcing. Over the last few decades, many studies have been conducted on the physical, biological and hydrochemical character of the eastern Bering Sea, but its western part is poorly investigated.

The Gulf of Anadyr (GA) is one of the largest gulfs of the western (as and a whole) BS, where the most saline and productive branch of the Bering Sea waters entering the Arctic is formed. The main goal of the research is to determine the modern carbonate characteristics of the GA waters, to identify the main processes and factors controlling the dynamics of the seawater CO_2 system, the degree of water acidification and CO_2 fluxes between ocean and atmosphere in this poorly studied area. It is also important to assess the level of corrosivity of transformed Pacific waters flowing onto the Arctic shelf from the western part of the Bering Sea during fall season.

Marine carbon dioxide (CO_2) system data (pH and total alkalinity) has been collected in discrete seawater samples in the GA during October 2011. Hydrological parameters of seawater, as well as the concentrations of nutrients (silicates, phosphates, inorganic nitrogen), oxygen, colored dissolved organic matter (CDOM) and chlorophyll-a also were measured. Continuous measurements of meteorological parameters and CO_2 content in the atmosphere have been performed. Partial pressure of CO_2 (pCO_2), dissolved inorganic carbon (C_T), aragonite saturation state (Ω_{Ar}), relative fractions of mixed waters and CO_2 fluxes between the ocean and the atmosphere were calculated.

It was established that during this period the gulf waters absorbed CO_2 from the atmosphere at a rate of -22.5 mmol m^{-2} day^{-1}, which determined the "classical" mechanism of acidification of water due to uptake of excess atmospheric CO_2. In general surface waters of the gulf were supersaturated with respect to aragonite. The exception was the highly dynamic region of Anadyr Strait, where the vertical distribution of the investigated parameters was homogeneous, the surface waters were close to equilibrium with respect to aragonite, and CO_2 flux was directed to the atmosphere. Bottom waters of the gulf, in contrast, were characterized by significant seasonal corrosivity with respect to aragonite primarily due to remineralization of organic matter to CO_2. It was shown that during the late fall relatively salty and acidic, quasi-equilibrium with respect to aragonite, and oxygen-depleted waters with high concentrations of nutrients and CO_2 have been entered the Arctic Ocean with the Anadyr current.

Future long-term monitoring of the region is critical for assessments of the contribution of the western Bering Sea shelf to regional carbon budgets and evaluation of seasonal and interannual variability in response to natural and anthropogenically influenced climate change.

Acknowledgements
This work was supported by Russian Foundation for Basic Research (grant No. 18-05-00559a).

Keywords: carbonate system, acidification, CO_2 fluxes

A study of radon and thoron activity in the Siberian Arctic seas

S.A. Plastun[1*], M.S. Cherepnev[1*], A.N. Charkin[1,2*], I.P. Semiletov[1,2]
[1]National Research Tomsk Polytechnic University, 30 Lenin Avenue, 634050 Tomsk
[2]V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
*e-mail: corresponding@poi.dvo.ru, xheracl@gmail.com, maxcherepnev@tpu.ru, charkin@poi.dvo.ru

Radon and thoron is a natural radioactive gas that evolves from the radioactive decay of radium. The radium content of the soil, bottom sediment and suspended particulate matter is considered to be constant due to its long half-life. Radon and thoron has centered on human health effects after inhalation and ingestion, however it also provides many useful geophysical and hydrologic tracer applications. For example, considerable efforts have been made over the years to use radon measurements in soil gas and groundwater for earthquake predictions. Radon has been used as a tracer of ground-water/surface-water mixing and matrix diffusion in fractured-rock aquifers.

In the course of the 73rd cruise of the RV "Akademik Mstislav Keldysh" in the autumn of 2018, a radiometric analysis of water samples taken from the "flow-through" system and at twenty hydrological stations from different horizons using bathometers was conducted. Sampled water was measured on a Rad7 radiometer.

High thoron activity were found in the Kara Sea and coincided with a river plume of the Ob and Yenisei rivers. High values are due to the high concentration of suspended particulate matter in river waters, which in turn contains in excess parent isotopes of thorium. Thorium is a continuous source of short-lived thoron. Also, the maximum values of radon and thoron were obtained in the vicinity of the Lena river delta. This station was located near the previously discovered place for submarine groundwater discharge, which are sources of radium parent isotopes (Charkin et. al., 2017), which explains the high values.

The obtained results show a strong relationship between the radon and thoron activity and the source of parent isotopes, primarily sedimentary material and submarine groundwater discharge.

References

Charkin, A. N., Rutgers van der Loeff, M., Shakhova, N. E., Gustafsson, Ö., Dudarev, O. V., Cherepnev, M. S., et al. Discovery and characterization of submarine groundwater discharge in the Siberian Arctic seas: A case study in the Buor-Khaya Gulf, Laptev Sea. The Cryosphere, 11(5), 2017, pp. 2305–2327.

Acknowledgements

This work was supported by the Russian Science Foundation (grant no. 15-17-20032 and 19-17-00058).

Key words

Radon, thoron, submarine groundwater discharge.

Dissolved organic matter and its optical characteristics on the ESAS

Svetlana P. Pugach[1*], Irina I. Pipko[1], Igor P. Semiletov[1,2]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskays Str., Vladivostok, Russia, 690041*
[2] *National Research Tomsk Polytechnic University, Tomsk, Russia*
**e-mail: pugach@poi.dvo.ru*

The East Siberian Arctic Shelf (ESAS) is the broadest and shallowest continental shelf in the World Ocean. It is characterized by both the highest rate of coastal erosion and a large volume of riverine input of terrigenous dissolved organic matter (DOM). DOM plays a significant role in marine aquatic ecosystems. The colored (chromophoric) fraction of DOM (CDOM) directly affects the quantity and spectral quality of available light, thereby impacting both primary production and UV exposure in aquatic ecosystems.

A multi-year study of DOM optical parameters and the spectral characteristics of the DOM chromophoric fraction was carried out in the vast ESAS during the summer-fall seasons. The spectral characteristics of CDOM were applied to identify different biogeochemical provinces in the surveyed area.

The analysis of CDOM spectral characteristics showed that the major part of the Laptev and East Siberian Sea shelf (making up the ESAS) is influenced by terrigenous DOM with high aromaticity, stemming from riverine discharge. The atmospheric circulation regime is the dominant factor controlling CDOM spatial distribution on the ESAS. A western and an eastern regime of ESAS, separated around 165-170° E, were identified with distinctly different DOM optical properties.

Strong correlation between dissolved organic carbon (DOC) and CDOM concentrations in surface shelf waters influenced by terrigenous discharge indicates feasibility of estimating DOC content from the CDOM assessed in situ using a WETStar fluorometer. The direct estimation of optical characteristics of DOM in the surface ESAS waters provided by this study will also be useful for validation and calibration of remote sensing data. Employing optical techniques can increase the temporal and spatial coverage of DOM measurements across the ESAS and help to more accurately estimate the amount of terrigenous DOM; this estimation is necessary for understanding how carbon budgets and fluxes will be altered under future climate change scenarios.

Acknowledgements
This work was supported by Russian Foundation for Basic Research (grant No. 18-05-00559a).

Keywords:
Arctic, dissolved organic matter, CDOM

The shipboard observations of atmospheric methane concentration in the East Siberian Arctic seas during 2006-2018 years

A. N. Salyuk[1*], D. A. Kosmach[1], D. V. Chernykh[1], E. A. Spivak[1], A. V. Kurilenko[1], N. E. Shakhova[2], and I. P. Semiletov[1,2]

[1] *V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

[2] *National Research Tomsk Polytechnic University, 30 Lenina pr., Tomsk, Russia, 634050*

** e-mail: san@poi.dvo.ru*

The East Siberian Arctic Shelf (ESAS) extensive methane release was recently reported to be an important atmospheric source of methane [1-5]. A comprehensive data set of shipboard continuous CH_4 mixing ratio measurements in the lower part of the atmospheric boundary layer (ABL) during 2006-2018 was collected with a high-accuracy fast CH_4 analyzer system. The numerous areas with elevated methane concentration were revealed and mapped. Slow mixing ratio elevations (typical observed values were of about 10-100 ppm per day and occasionally more) in the lower part of ABL in stationary conditions are very sensitive to mean in time and space methane flux from the water to atmosphere. This fact in despite of significant location uncertainties of methane sources can be used for independent Large-scale and Mesoscale spatial and time estimates of methane flux to the atmosphere. Huge fast methane mixing ratio elevations (about 0.1 - 30 ppm and more occurring at time intervals of about 1 -100 s) were regularly detected in the areas of active methane bubble venting from the bottom caused by permafrost degradation, decomposing of methane gas hydrates in the depth of sediment, or deep fluid discharge in the areas of geological faults. The observation of fast methane anomalies in the lower part of ABL appears to be a valuable tool for observation, mapping and monitoring of the active methane bubble sources at the bottom in addition to acoustic monitoring.

References

1. N. Shakhova, I. Semiletov, A. Salyuk, V. Yusupov, D. Kosmach, Ö. Gustafsson, *Science,* 2010, vol. 327, page 1246 - page 1250.

2. N. Shakhova, I. Semiletov, I. Leifer, V. Sergienko, A. Salyuk, D. Kosmach, D. Chernykh, C. Stubbs, D. Nicolsky, V.Tumskoy, Ö. Gustafsson, *Nature Geosci.*, 2014, vol. 7 (1), DOI:10.1038/NGEO2007.

3. N. Shakhova, I. Semiletov, V. Sergienko, L. Lobkovsky, V. Yusupov, A. Salyuk, A. Salomatin, D. Chernykh, D. Kosmach, G. Panteleev, D. Nicolsky, V. Samarkin, S. Joye, A. Charkin, O. Dudarev, A. Meluzov, O. Gustafsson, *Phil. Trans. R. Soc. A.*, 2015, vol. 373, 20140451. DOI:10.1098/rsta.2014.0451

4. N. Shakhova, I. Semiletov, Ö. Gustafsson, V. Sergienko, L. Lobkovsky, O. Dudarev, V. Tumskoy, M. Grigoriev, A. Mazurov, A. Salyuk, R. Ananiev, A. Koshurnikov, D. Kosmach, A. Charkin, N. Dmitrevsky, V. Karnaukh, A. Gunar, A. Meluzov, D. Chernykh, *Nature Communications*, 2017, vol. 8:15872, DOI:10.1038/ncomms15872.

5. D. Kosmach, V. Sergienko, O. Dudarev, A. Kurilenko, Ö. Gustafsson, I. Semiletov, N. Shakhova, *Doklady Chemistry*, 2015, vol. 465, part 2, page 281– page 285.

Acknowledgements

This work was supported by Russian Science Foundation (grants No 15–17–20032 and 18-77-10004).

Key words

Arctic shelf, methane, atmospheric boundary layer

Thawing permafrost-related methane and carbon dioxide emissions from the East Siberian Arctic Shelf (ESAS)

I. Semiletov[1,2]*, N. Shakhova[2,3] , I. Pipko[1] , O. Dudarev[1,2], A. Salyuk[1], D. Chernykh[1], D. Kosmach[1], S. Pugach[1], E. Panova[2], A. Mazurov [2], Örjan Gustafsson[4], Leif Anderson[5]

[1]V.I. Il'ichov Pacific Oceanological Institute FEB RAS, 43 Baltiiskaya Street, Vladivostok, Russia, 690041
[2]National Tomsk Research Polytechnic University, 30 Prospect Lenina, Tomsk, Russia, 634034
[3]University of Alaska Fairbanks, International Arctic Research Center, Akasofu Building, 99775-7320, Fairbanks, USA
[4]Stockholm University, Department of Applied Environmental Science and Bolin Centre for Climate Research, 10691, Stockholm, Sweden
[5]University of Gothenburg, Department of Marine Sciences, 40530 Goteborg, Sweden
**e-mail: ipsemiletov@alaska.edu*

Improved understanding of the global carbon cycle and potential responses of climate system requires better knowledge about key processes that control global biogeochemical cycles, an assessment of the complex interactions and feedbacks, and a better understanding of the vulnerabilities that impact carbon pools in the Earth's system. On the large part of the ESAS, surface water are source of carbon dioxide (CO_2) into the atmosphere [1-3]. The high pCO_2 values can be attributed primarily to the remineralization of organic matter (OM) introduced from the coastal erosion and Siberian Rivers. Our results show that the acidifying effect of eroded OM decomposition at the erosion-dominated site was more than 5 times stronger than that of estuary freshening [1-4]. Persistent and potentially increasing aragonite undersaturation of ESAS water has already far exceeded projected levels for the year 2100 (AMAP, 2013), which are based only on atmospheric CO2 uptake. Methane (CH_4) release from thawing Arctic subsea permafrost and from failing hydrates are two climate-related mechanisms that could substantially change projected greenhouse gas forcing within this century. Atmospheric venting of CH_4 from the ESAS was recently reported to be at least on par with flux from the Arctic tundra [5]; however, the future scale of these releases remained unclear. We suggest that the coastward progression of subsea permafrost thawing in a warming Arctic could potentially result in a 3-5 orders of magnitude increase in CH_4 emissions from the ESAS.

References

[1]Semiletov, I., Pipko, I., Gustafsson et al., Acidification of East Siberian Arctic Shelf waters through addition of freshwater and terrestrial carbon. *Nature Geoscience* **2016**, 9, 361-365, doi: 10.1038/ngeo2615.
[2]Semiletov I.P., Shakhova N. E., Sergienko et al., On Carbon Transport and Fate in the East Siberian Arctic Land-Shelf-Atmosphere System, *Environment Research Letters* **2012**, 7, doi:10.1088/1748-9326/7/1/015201
[3]Semiletov, I., I.I. Pipko, I.A. Repina, and N. Shakhova, (2007), Carbonate dynamics and carbon dioxide fluxes across the atmosphere-ice-water interfaces in the Arctic Ocean Pacific sector of the Arctic, *Journal of Marine Systems*, 66 (1-4), 204-226.
[4]Semiletov, I., O. Dudarev, V. Luchin et al., The East-Siberian Sea as a transition zone between Pacific-derived waters and Artic shelf waters, *Geophysical Research Letters* **2005**, *32*, L10614/2005GL022490.
[5]Shakhova, N., I. Semiletov, I. Leifer et al., Ebullition and storm-induced methane release from the East Siberian Arctic Shelf, *Nature Geosciences* **2014**, vol. 7, No. 1, doi: 10.1038/NG

Acknowledgements
This work was supported by Russian Science Foundation (grants No 15–17–20032 and 18-77-10004), the Russian Government (No. 14, Z50.31.0012), Headquarters FEB RAS, and the International Siberian Shelf Study Project.

Key words
East Siberian Arctic Shelf, coastal and subsea permafrost thawing, carbon dioxide and methane release

Methane potential of the East Siberian Arctic Shelf as a factor of global significance

N. Shakhova[1*], V. Sergienko[2], I. Semiletov[1,3] , D. Kosmach[3,1], D. Chernykh[1,3], R. Ananiev[4], L. Lobkovsky[4]

[1] *Federal Independent Educational Institution «National Research Tomsk Polytechnic University», 30 Lenin Avenue, Tomsk, Russia, 634034*

[2]*Headquarters of the Far Eastern Branch of the Russian Academy of Sciences (FEB RAS), 50 Svetlanskaya Str., Vladivostok, Russia, 690091*

[3]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS.,43 Baltiyskaya Str., Vladivostook, Russia, 690041*

[4] *P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*

**e-mail: NataliaFletcher@yahoo.com*

Geologic evidence provides insight into possible climate change effects from a warmer Arctic, suggesting that enhanced Arctic methane (CH_4) emissions during warm periods played a key role in past rapid climate change. Here we report selected results of our multi-year complex study (1994-2018) in the East Siberian Arctic Shelf (ESAS) –the broadest and shallowest shelf in the World Ocean. The ESAS is a unique area for a range of reasons: 1) The ESAS is the area, where more than 80% of sub-sea permafrost is currently located ; 2) Sub-sea permafrost has been experiencing continuous warming during the last 8-10 kyrs since it was inundated; 3) The ESAS is most significantly affected by global warming - during the first 5 years of 21-st century, mean surface air temperature above the ESAS increased by up to 5˚C; 4) The ESAS holds a major reservoir for *shallow Arctic hydrates* and *sub-sea permafrost*; 5) No comparable region has such an *extensive* continental shelf area (>50% of the ESAS); the ESAS shelf accounts for ~10% of the global continental shelf area; 6) The ESAS is very shallow (mean depth is less than 50 m), which provides a *short conduit* for seabed CH_4 transfer to the atmosphere . 7) ESAS seabed CH_4 emissions are geologically *controlled*; specifically, failure of subsea permafrost to further restrict methane release from seabed deposits uncorks the huge gas reservoirs, leading to *large-scale releases; 8)* As a marine ecosystem, the ESAS is markedly oligotrophic, which could limit microbial methane consumption (or production). Based on 43 all-seasonal full-size marine expeditions (including drilling of 17 boreholes) we document that CH_4 emissions from the ESAS manifest transformation of methane potential to CH_4 source of Global significance [1-4].

References

[1]Shakhova, **N.,** Semiletov, I., Gustafsson et al., O., (2017): Current rates and mechanisms of subsea permafrost degradation in the East Siberian Arctic Shelf. *Nature Communications* **2017**, 8, 15872 doi: 10.1038/ncomms15872.

[2]Shakhova, N.; Semiletov, I.; Sergienko et al., The East Siberian Arctic Shelf: towards further assessment of permafrost-related methane fluxes and role of sea ice. *Philos. Trans. R. Soc. A-Math. Phys. Eng. Sci.* **2015**, *373*, 13, doi:10.1098/rsta.2014.0451.

[3]Shakhova, N., I. Semiletov, I. Leifer et al., Ebullition and storm-induced methane release from the East Siberian Arctic Shelf, *Nature Geosciences* **2014**, vol. 7, No. 1, doi: 10.1038/NG

[4]Shakhova, N.; Semiletov, I.; Salyuk, A. et al., Extensive Methane Venting to the Atmosphere from Sediments of the East Siberian Arctic Shelf. *Science* **2010**, *327*, 1246-1250, doi:10.1126/science.1182221.

Acknowledgements

This work was supported by the Russian Science Foundation (No 15–17–20032 and 18-77-10004), the Russian Government (No. 14, Z50.31.0012), FEB RAS, NSF, NOAA, and the International Siberian Shelf Study Project.

Key words

East Siberian Arctic Shelf, subsea permafrost and hydrates, methane release

T05-2: Polar ocean research and explorations

Dynamic of single seep: From bubbles stream to seepage area

D. Chernykh[1,2*], N. Shakhova[2], D. Kosmach[1], R. Ananiev[3], A. Salomatin[1], O. Gustafsson[4], A. Saluk[1], N. Dmirtevsky[3], L. Lobkovsky[3], S. Silionov[1], I. Semiletov[1,2]

[1] *V.I. Il'ichev Pacific Oceanological Institute FEB RAS.,43 Baltiyskaya Str., Vladivostook, Russia, 690041*

[2] *Federal Independent Educational Institution «National Research Tomsk Polytechnic University», 30 Lenin Avenue, Tomsk, Russia, 634050*

[3] *P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*

[4] *Department of Environmental Science and Analytical Chemistry (ACES), Bolin Centre for Climate Research, Stockholm University, Stockholm 10691, Sweden.*

**e-mail: denis.chernykh.vl@gmail.com*

Seep – bubble discharge areas of greenhouse gases (including methane) from bottom sediments into water and atmosphere are detected in each ocean of Earth. Depth of detection from 10 meters to 2 kilometers and deeper [1]. Shallow seep significant portion of which is located in the widest and shallow shelf of World Ocean – East Siberian Arctic Shelf [2] is the most interest. First detection of seeps in Laptev Sea was in 2007 [3] and confirmed in 2011, 2014, 2016, 2018 years. Methane estimation in rising bubbles was done by method which is described in paper [4] Working area of Laptev Sea south-west part of Northern polygon represents the seabed area of 1.9 km^2. On territory of that area at depth of 52 meters was detected 32 seeps. Sizes of those seeps are from 20 to 300 meters. Acoustic survey set that seep's quantity in Laptev Sea chosen area is growing continuously and reached the maximum value in 2018. Seep which was detected in 2007 not only kept its activity through 12 years of observation but evolved into vast area covering the area of 0.23 km^2. The average methane flow from study area in 2018 was $20.1 \cdot 10^6$ g/d.

References

[1]Judd, A. *The global importance and context of methane escape from the seabed*; 2003; Vol. 23, pp. 147-154.

[2]Shakhova, N.; Semiletov, I.; Sergienko, V.; Lobkovsky, L.; Yusupov, V.; Salyuk, A.; Salomatin, A.; Chernykh, D.; Kosmach, D.; Panteleev, G., et al. The East Siberian Arctic Shelf: towards further assessment of permafrost-related methane fluxes and role of sea ice. *Philos. Trans. R. Soc. A-Math. Phys. Eng. Sci.* **2015**, *373*, 13, doi:10.1098/rsta.2014.0451.

[3]Shakhova, N.; Semiletov, I.; Salyuk, A.; Yusupov, V.; Kosmach, D.; Gustafsson, O. Extensive Methane Venting to the Atmosphere from Sediments of the East Siberian Arctic Shelf. *Science* **2010**, *327*, 1246-1250, doi:10.1126/science.1182221.

[4]Chernykh, D.V.; Yusupov, V.I.; Salomatin, A.S.; Kosmach, D.A.; Konstantinov, A.V.; Silionov, V.I.; Mazurov, A.K.; Salyuk, A.N.; Shakhova, N.E.; Gustafsson, O., et al. New acoustical technique to quantify methane ebullition in sediment water column: a case study in the Laptev sea, the Arctic ocean. *Bull. Tomsk Polytech. Univ.-Geo Assets Eng.* **2018**, *329*, 153-167.

Acknowledgements

This work was supported by Russian Science Foundation (grants No 18-77-10004 and 15–17–20032).

Key words

East Siberian Arctic Shelf, methane seep, Laptev Sea

Development of underwater gamma ray spectrometer for Environmental Research of the Arctic shelf

R.E.Kelsingazina[1,*], M.S. Cherepnev[1], A.N. Charkin[1,2,*], I.S. Sobolev[3]
[1]National Research Tomsk Polytechnic University, 30 Lenin Avenue, 634050 Tomsk
[2]V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
[3]Limited Liability Company "Geo Service", 5-21 Uchebnayastreet, Tomsk 634028, Russia
*e-mail: ruziya_95@mail.ru, charkin@poi.dvo.ru

In the recent decades, underwater gamma ray spectrometry has been widely used in environmental studies. Marine gamma-ray spectrometers have been used for a range of applications including the mapping of rocks and unconsolidated sediments, mineral exploration (mainly for heavy minerals and phosphorites), sediment transport studies and investigations in relation to discharged and dumped nuclear wastes and at nuclear weapon test sites (Jones, 2001). Gamma spectrometry measurement in situ has advantages over laboratory measurements since they allow continuous mapping of large areas of the seabed. Gamma rays are rapidly absorbed by sea water. Therefore, when measuring radionuclides in seabed sediments the gamma-ray detector needs to be in contact with or very close to the sea floor. We developed a vibration-proof container made of composite materials with three scintillation detectors inside, which slides directly along the bottom of the sea. Such an approach makes it possible to measure gamma activity in bottom sediments with maximum efficiency.

For the first time in the Arctic region, we carried out continuous underwater gamma ray spectrometry at the test site with previously detected submarine groundwater discharge in Buor-Khaya Bay (Charkin et. al., 2017). The obtained results clearly localize the geochemical anomalies over the place of submarine groundwater discharge and the associated tectonic faults. This circumstance suggests a high potential of this method in the study of the Arctic shelf.

References

Jones D.G. Development and application of marine gamma-ray measurements: a review. Journal of Environmental Radioactivity 53, 2001, pp. 313-333.
Charkin, A. N., Rutgers van der Loeff, M., Shakhova, N. E., Gustafsson, Ö., Dudarev, O. V., Cherepnev, M. S., et al. Discovery and characterization of submarine groundwater discharge in the Siberian Arctic seas: A case study in the Buor-Khaya Gulf, Laptev Sea. TheCryosphere,11(5),2017, pp. 2305–2327.

Acknowledgements

This work was supported by the Russian Foundation for Basic Research (project№ 18-05-70047).

Key words

Gamma ray spectrometry, Arctic shelf, mapping seabed.

Nonferrous, Noble, and Rare Metal Grains in the Chukchi Sea Bottom Sediments

O. Kolesnik*, A. Kolesnik
V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041
**e-mail: kolesnik_o@poi.dvo.ru*

An electron microprobe analysis revealed the Chukchi Sea surface sediments to contain numerous particles of nonferrous, noble, and rare metals: Cu, Zn, Sn, Pb, Ni, Bi, Mo, Ag, Au, Pd, and Pt. Those usually occur as 1–5 μm grains among the fragments of rock-forming minerals, the latter being mainly quartz and feldspar.
Nonferrous metal grains are generally represented by intermetallic compounds and oxides of Cu and Zn, Sn and Pb, and sometimes Ni. Native brass and cassiterite seem to be mostly abundant. Unlike nonferrous metal grains, noble and rare ones are less found. Oxidized silver dominates among them.

Nonferrous, noble, and rare metal grains have highly unequal distribution. The most enriched sediments cover seabed areas near the Alaska and Chukotka Peninsula coasts (primarily the western shoal) stretching to the southern Chukchi Sea, as well as Herald Canyon area. The most probable grain source is represented by metalliferous geological land formations which extend off shelf (e.g., Flerov et al., 2011). Earlier studies detected similar grains in the Chukchi Sea ferromanganese nodules, cementation of sediment particles by iron and manganese oxides, hydroxides, and hydrous phosphates (diagenesis processes) being responsible for that (Kolesnik and Kolesnik, 2013, 2015).

References

I. Flerov, O. Dundo, E. Gusev, V. Sukhoroslov, *Rudy i Metally (Ores and Metals)*, 2011, Nos. 3–4, 165–166 [in Russian].
O. Kolesnik, A. Kolesnik, *Lithology and Mineral Resources*, 2015, **50** (3), 181–191.
O. Kolesnik, A. Kolesnik, *Russian Geology and Geophysics*, 2013, **54** (7), 653–663.

Acknowledgements

The FIO-POI Joint Research Center of Ocean and Climate was instrumental in done this study funded by the Far Eastern Branch of the Russian Academy of Sciences (Grant no. 18-1-008).

Key words:

Chukchi Sea; bottom sediments; nonferrous, noble, and rare metals.

COMPOSITIONAL VARIATION OF GLAUCONITES IN UPPER CRETACEOUS-PALEOGENE SEDIMENTARY IRON-ORE DEPOSITS IN SOUTH-EASTERN WESTERN SIBERIA

Mazurov A.K. [1*], Rudmin M.A.[1]
[1]*National Research Tomsk Polytechnic University, Tomsk, Russia, 634050*

The present study of shallow marine glauconite within Upper Cretaceous-Palaeocene sediments leads to the following conclusions. Studied glauconites are divided into two types, altered and unaltered. Unaltered glauconite reflects an overall increase of K_2O at a more or less fixed Fe_2O_3(total).It exhibits predominantly greenish appearance and belongs to ordered type with ≤10% expandable layers. The glauconite pellets are restricted to shaley and silty sediments with abundant organic matter and pyrite framboids in Lower Coniacian, Upper Santonian and Campanian. major element composition of glauconites is affected by subaerial exposure similar micro-inclusions in both varieties is related to the immobile nature of REE and trace elements.

Acknowledgements
The investigations were supported by Russian Foundation of Basic Research and Tomsk Oblast Administration within the framework of the research project 16-45-700090. Many geologists and geochemists have contributed to the material presented in this paper and who kindly helped in this investigation. D. Usoltsev (Tomsk Polytechnic University) is acknowledged for technical assistance with X-ray diffraction analysis. Authors are thankful to the anonymous reviewer and the editor for constructive criticisms and useful suggestions on earlier version of the manuscript.

Key words
Glauconite. Geochemistry, Micro-inclusions, Upper Cretaceous, Palaeocene, Western Siberia.

Lithological features and organic matter of sediments in the south-eastern Laptev Sea (Muostakh cape)

Perevertaylo T.G.[1*], Kazhumukhanova M.Z.[2], Nedolivko N.M.[1], Shakhova N.E.[1], Dudarev O.V.[1,3], Gershelis E.V.[1],Mazurov A.K. [1], Semiletov I.P.[1,3]

[1]*National Research Tomsk Polytechnic University, Tomsk, Russia, 634050*

[2]*KazZinc, Kokshetau, Kazakhstan, 020000*

[3]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

**e-mail: ptg@tpu.ru*

The present study seeks to improve current understanding of modern climate changes, which are considered as the consequences of the greenhouse effect caused by increasing content of the main greenhouse gases - carbon dioxide and methane. Complex studies in the land- shelf-atmosphere system across the Arctic shelf, including biogeochemical and lithological analyses of sediments across Eastern Arctic seas, are needed.

The **research aims** to study both lithological and mineralogical sediment compositions, variability of the organic matter content (Corg), molecular and isotopic composition of carbon (δ13C) contained in the ice complex deposits (ICD) along the Laptev Sea coast (Cape Muostakh).

Samples of modern bottom sediments obtained during the expedition of 2015 in the south-eastern part of the Laptev Sea were investigated.

Methods used in the present study include GC-MS analysis, pyrolysis, isotope analysis, X-ray phase analysis followed by further numerical processing and interpretation.

Research results. The mineralogical composition of the clay fraction has been studied, and the distribution of clay minerals has been established. The features of molecular and isotopic Corg composition are revealed. Initial results on the hydrocarbon source of ICD- Corg, which dominates in the shallow part of the East Siberian Arctic shelf, are obtained. Pyrolysis and GC-MS data are highly correlated reflecting complex biogeochemical processes occurring during the Corg transformation at the various stages of lithogenesis. In addition, study provides preliminary estimates of the light hydrocarbons generation potential for the Corg contained in the sediments.

Acknowledgements

This work at various stages was supported by the Government of the Russian Federation (project no. 14.Z50.31.0012), the Russian Science Foundation (project no. 15-17-20032), and. Laboratory investigations were carried out at Tomsk Polytechnic University within the framework of a Tomsk Polytechnic University Competitiveness Enhancement Program grant

Keywords:

Organic matter, bottom sediments, isotope analysis, GC-MS, mineralogical composition, Laptev Sea, Cape Muostakh.

Assessing the response of the atmosphere-sea ice-ocean system to severe weather events during freeze-up in the Chukchi Sea

M. Pichugin[1*], I. Gurvich[1], E. Khazanova[1], E. Zabolotskikh[2]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*Russian State Hydrometeorological University, Malookhtinsky prospect 98, St. Petersburg, Russia, 195196*
**e-mail: pichugin@poi.dvo.ru*

Many studies show significant changes in the Arctic climate system over recent decades, manifesting in the sea ice cover reduction and enhancement of the atmospheric meridional circulation. The East part of the Eurasian Arctic (EEA), including the Chukchi Sea, is understudied compared to other areas in the Northern hemisphere. However, the sea ice decline is also observed in the EEA area creating favorable conditions for severe marine weather systems development. Moreover, the thermal contrast between sea and ice surfaces is likely favorable to cyclogenesis with an identical life-cycle to that at mid-latitudes that is consistent with a projected northward shift of the cold-air outbreaks associated with storm winds and intense air-sea heat fluxes.

This study assesses impacts of prolonged cold-air outbreak (CAO) events on surface heat flux and sea ice conditions in the Chukchi Sea during low sea ice extent of the basin in autumn-winter period (November-December) 2014–2017. An analysis of the structure, characteristics and evolution of extreme cold events was performed using multisensor satellite measurements in the optical and microwave wavelength ranges, the National Centers for Environmental Prediction (NCEP) Climate Forecast System, version 2 (CFSv2) and Arctic System Reanalysis, version 2 (ASR2) data sets.

Generally, the extreme cold events over the sea were caused by a system of extratropical cyclones over the Bering Sea and the Gulf of Alaska, which deepened the Aleutian Low, and the growing Arctic anticyclone. It has been shown that the CAOs were developed during 5–7 days and accompanied by the near sea surface wind speed $W \geq 20$ m/s and rapid formation and drift of sea ice. Analysis of sea ice response to the extreme cold events showed an increase in the open and very open ice areas. We assume that these areas were exposed to the significant cold atmosphere releasing heat and moisture into the atmosphere. However, the magnitude and variations of surface turbulent heat fluxes are poorly known due to the lack of observations and uncertainties in coupled atmosphere-sea ice-ocean model parameterizations. Estimates of surface turbulent sensible and latent heat fluxes from the NCEP-CFSv2 analysis and ASR2 showed intense heat transfer to the atmosphere (more than 600–700 W/m^2) off the ice edge as a result of the cold dry air advection over the open sea and strong winds (more than of 22 m/s). Also, local zones of oceanic heat loss with flux values exceeding 500 W/m^2 were allocated over large leads and narrow areas of open water near the northwestern coast of Alaska.

Acknowledgements
This work was supported in part by the program "Dalniy Vostok" of the Far-Eastern Branch of the Russian Academy of Sciences (project No. 18-I-010) and by the POI FEB RAS program (project No. AAAA-A17-117030110037-8)

Key words
The Chukchi Sea, Severe weather events, surface heat flux, sea ice

Bubbles in ice

Yu. Polovinka[1*], A. Maksimov[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: yrivlad@poi.dvo.ru*

The hydrocarbon seeps emitting buoyant bubble plumes from seafloor vents have been actively investigated in different regions of the World Ocean. In winter, rising bubbles, which have reached the sea surface, freeze in ice. These clouds of the frozen bubbles are observed in Arctic seas. Acoustic manifestations of bubbles frozen in ice and gas hydrate are the subjects of the current study. It is a problem to distinguish the bubble contribution against the wide variety of sea ice in homogeneities in remote sensing in the Arctic seas. However, the search for hydrocarbon sources and their manifestations in Arctic seas demands development of remote methods for detecting methane inclusions in an ice sheet.

On the basis of the general solution of the elastic wave scattering problem for the sphere, the scattering cross section for a bubble frozen in an ice has been found [1]. The derived expressions coincide in the limiting cases with known results. The results of Ref. [1] are developed in the present study for the case of two closely located inclusions, which is the simplest model describing the interaction between bubbles. The possibility of an analytical solution of this problem is related with the use of specific coordinates reflecting the presence of the internal symmetry [2]. As the second step the structure of low-frequency resonances of bubbles clouds of the simplest geometry has been investigated. There are defined four classes of bubble clusters trapped in ice representing distinct types of bubbling seeps that differed in flux rate: isolated bubbles in multiple ice layers; merged bubbles in multiple ice layers; single gas pockets stacked in ice; relatively open holes in winter ice. The simplest bubble cloud model in the form of a lens with effective elastic parameters located in an ice plate resting on a liquid base has been analysed. It provided insight in the details of an interaction of this object with the three types of waves, namely, the flexural wave, the longitudinal wave, and the horizontally polarized shear wave, which can propagate in such a waveguide. The peculiarities of radiation in liquid at the Mach angle have been investigated for the longitudinal wave as it transects the bubble cloud.

The required elements for the development of remote methods for gas plume detection in winter season in Arctic seas have been derived. We ascertained the peculiarities of sound scattering by individual ice inclusions and derived the self-consistent field equations describing multiple scattering processes. These equations allow the inclusion distribution parameters to be correlated with the effective elastic and density characteristics of the medium, which, in turn, makes possible study of the acoustic manifestation of bubbles in real conditions.

References

[1] A.O. Maksimov, *Acoustical Physics*, 2011, **57** (3), 391–400.
[2] A.O. Maksimov, Y.A. Polovinka, *Physics of Fluids*, 2013, **25** (6), Article Number 062104.

Acknowledgements

This study was supported by RFBR, project no. 19-02-00317.

Keywords

Bubble, ice, remote sensing

Distribution of heavy metals in the bottom sediments of the Buor-Khaya Gulf (Laptev Sea)

Ruban A.S.[1*], Dudarev O.V.[1,2], Mazurov A.K. [1], Rudmin M.A.[1], Gershelis E.V.[1], Charkin A.N.[1,2], Semiletov I.P.[1,2]

[1]*National Research Tomsk Polytechnic University, Tomsk, Russia, 634050*

[2]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

**e-mail: ruban@tpu.ru*

Due to the toxicity, persistence and bioaccumulation in the environment, heavy metal contamination has attracted much attention and become a global problem in recent years. Bottom sediments reflect some characteristics of various sources such as geological matrix, land use, natural and anthropogenic inputs. They are an important carrier of contaminants in rivers, seas and other waters. Estuarine and coastal areas, a region of active land-sea interactions, are sensitive to impacts from natural processes and anthropogenic activities. Sediments in coastal and estuarine ecosystems, as a reservoir or sink for heavy metals, can act as a source of heavy metals for aquatic organisms when environmental conditions change. Thus, sediments in marine environments can play a great role in the deposition and transmission of heavy metals. A better understanding of how the sediment sources and sediment properties affect heavy metal enrichment and their bioavailability in different aquatic environments is needed.

All the heavy metals studied have a similar structure of their spatial distribution that indicates the similarity of their geochemical behavior in the process of water migration and diagenesis. Its main features are the increase in the content from the coasts of the gulf to its central part, which reflects the circumterrestrial character of the spatial distribution. In the same direction, the dispersion of the particles increases in the sediments, a sign of the expressed preferential accumulation of heavy metals in fine sediments. Obviously, the connection with the primary mineral matrix of terrigenous material is weakened (with the exception of the sand-silt sediments of the underwater coastal slope along the mountainous coast in the southwest of the gulf). Such elements as Cr, Co and Ni are closely related to Fe that indicates the possibility of sorption of these elements by colloidal iron hydroxide particles. The main mechanisms controlling the distribution of heavy metals in the system "water-bottom sediments" can be codeposition and change in the forms of migration as a result of sorption by clay particles, colloids of charged gels of iron and manganese hydroxides with the participation of bog and river humic substances of the water collection area. An important mechanism for increasing the content level of heavy metals is bioaccumulation, which is activated in the region of the hydrological front (biogeochemical barrier) in the central area of the gulf.

Acknowledgements

This work at various stages was supported by the Government of the Russian Federation (project no. 14.Z50.31.0012), the Russian Science Foundation (project no. 15-17-20032), and. Laboratory investigations were carried out at Tomsk Polytechnic University within the framework of a Tomsk Polytechnic University Competitiveness Enhancement Program grant.

Key words

Arctic, Laptev Sea, bottom sediments, heavy metals.

Geochemistry of rare earth elements in bottom sediments of the Arctic seas

V. Sattarova*, A. Astakhov, K. Aksentov, A. Alatortsev
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: sval_80@poi.dvo.ru*

The investigate of the REE distribution in the surface and Holocene sediments from the shelves of the East Siberian and Chukchi seas indicated that REE in these sediments predominantly occur in sand- and silt-size detrital mineral grains sourced from the adjacent coasts.
The REE are associated with other elements common for stable heavy clastic minerals in bottom sediments, i.e., Zr, Nb, Hf, Th, and Ti. These associations are most typical for the western East Siberian Sea, where terrigenous material is supplied from the East Siberian platform area. The total lanthanide concentrations in the East Siberian Sea sediments increase from east to west that indicates their supply from the erosion of the mainland coast and the New Siberian Islands ice complex as well as from river discharge, primarily from the Lena River. Shale normalized REE patterns similar to the Lena River SPM but at low concentrations persists in the entire East Siberian Sea and traces to the Chukchi Sea. REE distributions from the southeastern Chukchi Sea and the Gulf of Anadyr (Bering Sea) (Anikiev et al., 1997) differ markedly by the depletion in light lanthanides. The area of propagation of the western branch of the Pacific water entering through the Bering Strait is distinguished by low LREE/HREE values. Changes in the REE concentrations in a core from the SW Chukchi Sea with the age of slightly over 2 kyr may indicate a migration of the current system and a supply of the sedimentary material by the Pacific waters.

References

Anikiev, V.V., Dudarev, O.V., Botsul, A.I., Kolesov, G.M., Sapozhnikov, D.Yu., *Geochemical International*, 1997. **35**(3), 274–283.

Acknowledgements

This work was supported by the Russian Science Foundation, Project no. 16-17-10109, by RFBR according to the research Project no. 18-05-60104, by the governmental Grant of POI FEB RAS (№ АААА-А17-117030110033-0).

Key words

Rare earth elements; geochemistry; bottom sediments

Synoptic spreading and mixing dynamics of the Lena plume

E. Spivak[1*], A. Osadchiev[2,3],
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*P.P. Shirshov Institute of Oceanology RAS, 36, Profsoyoznaya Str., Moscow, Russia, 117218*
[3]*Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, RAS, Moscow, Russia, 119017, *e-mail: stilo@poi.dvo.ru*

This paper investigates the dynamics of spreading and mixing of the Lena River plume at the synoptic time scale. The work includes field data collected in early October 2018 during the 73rd cruise of the RV *Akademik Mstislav Keldysh* in the Laptev Sea, located in the east of the Lena Delta and in the north of the Buor-Khaya Bay. We used data collected by underway system. These data include temperature and salinity in the surface layer along the course of the vessel, as well as vertical profiles of temperature and salinity at hydrological stations. Based on these measurements we investigated the submesoscale structure of the Lena plume during the low autumn runoff with high spatial resolution, as well as its response to the synoptic wind variability.

Vertical measurements were carried out in the plume areas where surface salinities were different. Vertical thermohaline structure was obtained for different stages of transformation of the continental runoff in the process of mixing with more saline waters. We came to the conclusion that increases in surface salinity as a result of mixing of the Lena plume is accompanied by an increase in the plume thickness and, increases the mass content of salt in the freshened surface layer. A joint analysis of new and archived vertical thermohaline measurements in the study area, carried out in 2008 and 2016. It showed a direct relation of surface salinity on the mass content of salt in the river plume, which is fairly well approximated by a linear function. Based on the constructed linear dependence, we obtained estimates of the mixing rate of the Lena plume in the near-delta area.

In the course of the expeditionary work, the response of the boundary of the Lena plume to the variability of the local wind was recorded. As a result of the wind, freshened near-delta part of the plume was pressed to the shore, the plume front moved to a distance of 20 km in less than a day. This effect shows a high spatial variability of the less saline and most stratified part of the Lena plume on the variability of wind exposure.

Acknowledgements
This research was funded by the Ministry of Science and Education of Russia, theme 0149-2019-0003 (collecting of in situ data); the Russian Foundation for Basic Research, research projects 18-05-60069 (collecting of satellite data) and 18-05-00019 (study of river plumes); the Russian Science Foundation, research project 18-17-00089 (processing of satellite data); the Grant of the President of the Russian Federation for state support of young Russian scientists – candidates of science, research project MK-6168.2018.5 (study of freshwater transport).

Key words
Arctic, Lena River, stratification

Phytoplankton studies in the Polar Front region in April 2018

V. Vodopyanova, V. Larionov, P. Vashenko*, A. Bulavina
Murmansk Marine Biological Institute Russian Academy of Sciences KSC, Murmansk, Russia, 183010
**e-mail: pavelvashenko@gmail.com*

In April 2018, in the northwest of the Barents Sea in the region of the Polar Front, the distribution of chlorophyll *a* concentration of pelagic microfitoplankton in a layer of 0-50 m was studied. Sampling of seawater was carried out with standard hydrobiological methods. The concentration of chlorophyll *a* was measured by spectrophotometric method [1]. Species composition and quantitative characteristics of phytoplankton were determined in Najott's chamber in samples concentrated by the reverse filtration method. The temperature and salinity were measured by SEACAT SBE 19 plus. Temperature and salinity (T,S) analysis was made according to Mamaevs methodology [2].

The research site (74.8°-76.2° N, 23°-33.3° E) was located in the Polar Front zone, which clearly separates (in 0-50 m layer) the Arctic Basin waters and the Atlantic waters of the Spitsbergen bank from the Atlantic waters of the Bear island Trough coming from the North Cape Current. The phytoplankton community on both sides of the Polar Front was represented by the early spring complex. The biomass (90%) of it formed by diatoms (*Achnanthes taeniata, Fragilariopsis oceanica, Thalassiosira cf. gravida*). However, the level of development of microplankton was much higher in Arctic and Atlantic waters of the Spitsbergen bank. The highest chlorophyll concentrations (3.13 ± 0.43 mg/m^3) were detected at stations located in the water mass of the Arctic Basin. The Arctic surface water reached a latitude of 75.8° N. The stations located to the south were under influence of the Atlantic waters of the Spitsbergen bank, the concentration of chlorophyll in these waters was 2.04 ± 0.29 mg/m^3. At the stations which are located in Atlantic waters related to the Bear island Trough, the concentration of chlorophyll (0.38 ± 0.03 mg/m^3) was an order of magnitude lower than in the Atlantic waters of the Spitsbergen bank. Several stations within this water mass were located in quasi-homogeneous (in temperature and salinity) layer of water, which indicates of intense convective mixing. The concentrations of chlorophyll at this layer were 0.68 ± 0.05 mg/m^3.

Thus, the Polar Front zone, which expressed in the early spring period, is a powerful boundary that limiting exclusively the level of development and quantitative indicators of the early spring of microphytoplankton complex. The front line separates the more productive Arctic and Atlantic of the Spitsbergen bank, with concentrations of chlorophyll 2-3 mg/m^3 in it, from the Atlantic waters of the Bear island Trough, in which the pigment concentrations are less than an order of magnitude.

References

1. Water. Spectrophotometric determination of chlorophyll-a (State standard: 17.1.4.02-90). (Moscow: Standards) 2001. 10 pp.
2. Mamaev O.I. Thermohaline analysis of the World Ocean waters. – Leningrad: Hydrometeoizdat, 1987. 296 pp.

Acknowledgements

Research was funded by the Russian Science Foundation. Grant project No. 17-14-01268

Key words

Polar front, chlorophyll, Barents Sea

T06: Ocean engineering, marine constructions and renewable energy

T06-1: Marine engineering

The justification of the hull shape and the characteristics of the rudder propeller unit of the cargo-passenger ferry class Ars5

J. Bondarenko
Postgraduate student, Maritime State University named after Admiral G.Nevelskoy, 50a Verkhneportovaya Str., Vladivostook, Russia, 690003
e-mail: Julia_Bond1993@mail.ru

Background. The purpose of the study is to justify the shape of the hull and the characteristics of the rudder propeller unit of the cargo-passenger ferry class Arc5. In the course of solving the tasks set in this paper, it was determined: dependence of water resistance on ship speed; ice resistance; hydrodynamic characteristics of the steerable thrusters in the autonomous mode of operation; mutual influence of the elements of the ship-steerable thruster system.

Material and methods.The object of the research was a ferry of the Sakhalin type, project 1809, the operating steam on the line of Vanino-Kholmsk. As well as a new concept of an ice-breaking ferry-type ferry-boat of the unrestricted navigation area of the CNF11CPD project, designed by the Marine Engineering Bureau. The following tasks were set for the purpose of the study:
- Justification and choice of the calculated characteristics of the ferry;
- Development of a standard version of the vessel;
- Determination of resistance on clean water, ice resistance;
- Designing the propeller of the ice-going ship;
- Creation of a 3D model of the ship's hull and rudder propeller.

The solution of the problem was carried out using the Flow Simulation SolidWorks module with parametric study elements. For this purpose, a ship's surface of a cargo-passenger ferry was created, and also a three-dimensional model of a propeller, and also a three-dimensional model of the steerable thruster type Azipod was constructed, using the 3D modeling program of SolidWorks.

Result. Investigation of the mutual influence of the ship's surface with steerable thruster. As a basic study, we accept the basic operating mode of the vessel, speed 8 m / s. And also the main rotational speed of the steerable thruster is 150 rpm. The next step was to conduct a parametric study, in order to build a ship's passport, from which it is possible to judge the mutual influence of the ship's surface with the steerable thrusters.
Conclusion. It can be argued that the designed screw works well both on the front and back, i.e. the designed passenger-and-freight ferry will have sufficient maneuverability. Considering the interaction of the screw with the pod, one can come to the conclusion that the presence of a pod leads to an increase in the efficiency, which can be clearly seen from the curves of the action of the screw.

References

A. Aksenov, V. Pokhilko, and A. Dyadkin, *Proceedings of ASME PVP, COMPUTATIONAL TECHNOLOGY (CFD)*. Hyatt Regency, Atlanta, Georgia, USA, July 22-26, 2001.

Key words: Hull shape of the cargo-passenger ferry class Ars5, rudder propeller unit, ship-steerable thruster system.

The numerical modelling of hydrodynamic characteristics of the propeller-rudder complex and turning capacity of the fishing vessel

V.G. Bugayev[1], Dam Van Tung[1], Fam Chung Hiep[2], Ya.R. Domashevskaya[1*]
[1]*Far Eastern Federal University 8 Sukhanov St., Vladivostok, Russia, 690091*
[2] *Astrakhan State University 16 Tatischeva Str., Astrakhan, Russia, 414056*
**e-mail: 100-70-100dom@mail.ru*

Adequate assessment of the vessel's turning capacity requires a thorough and detailed analysis of the hull shape and characteristics of the propeller-rudder system, as well as their interaction in the process of fishing operations. Using of experimental and numerical methods is extremely relevant and convenient solution to assess the vessel's turning capacity. An important advantage of numerical methods in comparison with traditional methods, field tests and model experiments is the possibility of studying both the hull-nozzle-propeller system as a whole and each element separately, paying particular attention to its characteristics.

The purpose of the research is to substantiate, using numerical methods of the hull shape and the characteristics of the propeller-rudder system (propeller in the nozzle) of the fishing vessel of the project 70133, which is intended for manufacturing and operation in Vietnam. The influence of the hull and the propeller on the hydrodynamic characteristics of the nozzle is due to the following factors: a) the presence of a propeller wave behind the hull; b) the presence of downwash of water flow when the vessel drifts; c) the presence of a free surface; d) increasing the flow rate, which runs on the nozzle, is made by the propeller. The speed of the vessel, the speed of rotation of the propeller and the angle of the nozzle rotation have also a significant influence on the hydrodynamic characteristics of the nozzle, and, consequently, on the propulsion and turning capacity.

The results of calculations of the transverse and the resistance force acting on an isolated nozzle, a nozzle with a rotating propeller and with a rotating propeller behind the hull, have been presented.

References

1. Antonenko S.V., Kitaev M.V., Novikov V.V.: Calculation of water resistance to the vessel's movement. Methodical instructions. Vladivostok, FEFU, 2012, 48 p.
2. OST 5.4129-75. The complex propulsion propeller-guide nozzle. The method of calculation and design rules: - M.: Standards publishing house, 1975, 202 p.
3. Rakov A.I. Features of the fishing vessel design. L.: Shipbuilding, 1966. - 144 p.
4. Rakov A.I. Optimization of the main characteristics and elements of fishing vessels. L.: Shipbuilding, 1978, 232 p.
5. Russian Maritime Register of Shipping. Ships Register. St. Petersburg, 2015, 926 p.
6. Turbal V.K., Shpakov V.S., Shtumpf V.M. Designing the contours and propulsion of sea transport ships. - L.: Shipbuilding, 1983, 304 p.
7. Voitkunsky Ya. I. Handbook on the ship's theory: book 3. Manageability of displacement vessels. Hydrodynamics of ships with dynamic principles of maintenance. L.: Shipbuilding, 1985, 539 p.

Key words:
Fishing vessel, propeller-rudder system, hydrodynamic characteristics of the nozzle, the vessel's turning capacity.

The necessity of a system approach to the development of the Far Eastern fishing fleet

L. Chekhranova[1], Ya. Domashevskaya[1],
[1]*Far Eastern Federal University 8 Sukhanov St., Vladivostok, Russia, 690091*
**e-mail: 100-70-100dom@mail.ru*

The development of the fishing fleet of the Far Eastern Basin is particularly relevant in the context with the need for increasing using level of primary commodities in the exclusive economic zone of the Russian Federation. The efficiency of fishing fleet using is directly related to its updating.

The report provides an analysis of the current composition and age of the fishing fleet vessels. Implementation of the Strategy for the Fishing Fleet Development in the Far East has been considered, and the problems associated with its implementation have been analyzed. The contradictions between the composition of the fleet, operational areas and primary commodities bases that have arisen with the enactment of the Russian Federation law dated December 20, 2004 “About Fishing and Conservation of Aquatic Biological Resources” have been considered.

The features of the transition from the order for the construction of ships abroad to the construction of new generation fishing vessels in domestic shipyards have been described, which make possible increasing their operation efficiency.

The main factors that must be considered during designing ships for the Far Eastern basin have been identified. The current situation in the developing of the fishing fleet requires a systematic approach, allowing one to eliminate the contradictions that have arisen and improve the quality of their operation.

References

1. Vasilenkova N. V. Problems of the Russian fishing fleet and their solutions // Young Scientist. - 2011. - №7. T.1. - p. 75-78.
2. Domashevskaya Ya.R., Chekhranova L.I. Damages caused to the bulwarks of reefer ships. Bulletin FEFU School of Engineering, 2018. volume 3 (36) p. 53-64.
3. Ishaev V.I. About the development of fisheries in the Far East. URL: http://fishnews.ru/ (appeal date: 04/10/2019).
4. About quotas on catch (extraction) of aquatic biological resources. Resolution of the Government of the Russian Federation dated 11/20/03. Number 704. URL: www.sistema.ru (appeal date: 04/10/2019)
5. Press release conference "New approaches in the construction of the fishing fleet." Suggestions for improving the RS Rules for fishing vessels. URL: https://www.setcorp.ru/main/ (appeal date: 04/10/2019).
6. Order of the Ministry of Agriculture of Russia, dated April 20, 2017 N 189 Approval of the Development Strategy for Marine Terminals for the integrated maintenance of the fishing fleet, taking into account the coastal logistics infrastructure for the transportation, storage and distribution of fish products. URL: http://rulaws.ru (appeal date: 04/10/2019).
7. Sergeev A.S., Chelyadin M.G. Problems of implementation of the development concept for the Coastal Fisheries in the Far East of Russia. Bulletin PSEE, 2006, № 3, p. 10-16
8. Construction of fishing vessels in Russia, August 2018. URL: http: // news- Russia.ru-an.info/ (appeal date: 10.04.2019).
9. Federal Law "About Fishing and Conservation of Aquatic Biological Resources" dated 12/20/2004 N 166-FZ URL: http://www.consultant.ru/document/ (appeal date: 04/10/2019).

Key words:
System approach, the composition of the fishing fleet, coastal and ocean fishing.

Radio-hydroacoustic sound probing system for remote sensing of the atmosphere, ocean and Earth crust, monitoring their fields of different physical nature

M.V. Mironenko[1], V.I. Korochentsev[2]

We consider scientific engineering design and measurement technologies in the non linear sounding hydroacoustics to produce the radio-hydroacoustic sound probing system for remote sensing of the atmosphere, ocean and earth crust, to monitor their fields of different physical nature, having been formed by natural and artificial sources including dangerous phenomena. The practical way of the system generating and exploitation was founded basing on the stationary and autonomous radio-hydroacoustics equipment for marine device design including radio-location and radio-connection equipment.

Key words:
Marine environment, non-linear sounding hydroacoustics, non-linear interaction and parameters transformation of different physical nature waves, hydroacoustic system of monitoring.

Distant parametric reception of source fields and phenomena in the atmosphere, ocean and Earth crust by technologies of the non linear sonic hydroacoustics in marine environment

M.V. Mironenko[1], V.I. Korochentsev[2], A.M.Vasilenko[3]

The pattern and measurement technologies of non linear sonic hydroacoustics including their realization in the sonic systems of monitoring were considered in this article. Possibility of their fulfillment in the sonic radio-hydroacoustic systems of monitoring of information fields that were generated by natural sources, by processes and by phenomena in the atmosphere, ocean and Earth crust was based.

System testing demonstrated that the range of measured frequencies embraced tens and ones of kHz, also, hundreds, tens and ones, shares of Hz.

Key words:
Non-linear sonic hydroacoustics, sounding radio-hydroacoustic system of monitoring, measured information fields, sources and phenomena in the atmosphere, ocean and Earth crust, marine environment.

Effects of Arrangement of Mooring Tethers on Response Characteristics of a Floating Structure in Deep Sea with Steep Bathymetry

K. Omura[1], T. Ikoma[2*], Y. Aida[2], K. Masuda[2] and H. Eto[1]
[1]*Yashiyo Engineering Co., Ltd., CS Tower, 5-20-8 Asakusabashi, Taito-ku, Tokyo, Japan, 111-8648*
[2]*DOAE, CST, Nihon University, 7-24-1 Narashinodai, Funabashi, Chiba, Japan, 274-8501*
**e-mail: ikoma.tomoki@nihon-u.ac.jp*

In very deep ocean fields offshore, when ocean resources and ocean spaces are developed and utilized, design technologies of a floating structure and design of mooring systems are very important. There are some sea areas with very steep bathymetry around offshore small islands. Length of mooring tethers should be very different for each. Thus, characteristics of tether tensions and motion of a floating system would be complex. We need to amount of its influence.

The object of this study is to investigate the influence and the characteristics of motion and tensions in ocean waves. The study used a theoretical calculation method and an in-house computer programme code and WAMIT® applying the linear potential theory. Also the calculations were carried out in frequency domain so that a linear spring was modeled for the mooring system. Then, we considered strict effects which were direction of each tether and initial length. The formulation can take into account of positions where the mooring tether was attached on a floating structure and also anchored. The method provides effects of different of water depth at anchoring positions for each tether. As a floating structure, we applied a semi-submersible type floating structure with four circular cylinder columns.

As a result, motion of a floating structure was not affected by the difference of tether length of the four lines. However, mooring tension was affected by the influence very much. Although the calculations were done only in linear assumption, we investigated very long period range corresponding to the slow drifting motion due to nonlinear wave forces. The results suggested a possibility of strong effects in the tension with the slowly varying wave drifting motion. The study concludes that we need more investigation and consideration of the length and arrangement of the tethers to moor a floating structure in the steep bathymetry ocean fields.

References

WAMIT®, Ver.7.2, WAMIT, Inc.
Koichi Masuda, Tomoki Ikoma and Takashi Nagai, “Fundamental Study on Springing Responses of A Taut-Moored Column-Footing Type Floating Body,” *Journal of the Society of Naval Architects of Japan*, 1994, **volume 1994 (176)**, pp. 163-173

Key words
Floating structure, Mooring system, Steep bathymetry

Energy-resource saving materials based on nanodispersed polytetrafluoroethylene

A. Tsvetnikov[1*], L. Matveenko[1], V. Kuryaviy[1], S. Maslennikov[2], V. Egorkin[1], D. Mashtalyar[1], A. Golub[1], A. Pavlov[1], S. Gnedenkov[1]

[1]*Institute for Chemistry of Far Eastern Branch of Russian Academy of Science, Stoletiya Vladivostoka prospect 159, Vladivostok, 690022, Russia*

[2]*National scientific center for marine biology of Far Eastern Branch of Russian Academy of Science, Palchevskogo str. 17, Vladivostok, 690041, Russia*

**e-mail: tsvetnikov@ich.dvo.ru*

For the first time nanodispersed polytetrafluoroethylene (NPTFE) was created in Institute for chemistry FEB RAS by means of thermogradient method[1] which subsequently was implemented for developing production technology[2] of NPTFE. PTFE molecules were separated according their molecular weights[3] using the method of chromatomass-spectrometry. As the result, it was discovered that is case of temperature growth up to 400^{o} C, molecules with weights from 338 Da to 3000 Da are sublimated. NPTFE molecules condense in form of 5-10 nm thick nano-films and, depending on condensation conditions, congregate in gas phase into bundles of different shapes (micro-films, micro-pipes, micro-spheres) and sizes (0,2-15 μm). Films are weakly linked with each other and are easily released during mechanical action applied on a particle, which allows creating stable coatings on any surface due to the nano-effect.

Method of extracting different temperature fractions from NPTF was developed, and their physic-chemical properties were analyzed. Low-molecular fraction NPTFE was successfully used as the ski lubricants, and high-molecular fraction NPTFE was used to protect metal surfaces against sludging and scale formation. Methods of creating multifunctional composite layers on titanium, aluminum, magnesium alloys and steel, including structural and functional materials – which are widely used in aviation, shipbuilding, ship repair and marine engineering – by means of plasma electrolytic oxidation with subsequent application of NPTFE, were developed[4].

Created composite coatings protect metals and alloys against various types of corrosive damage in the air and in the seawater (coatings increase the resistance against charge transfer by 5-6 orders of magnitude, as compared to unprotected metal/alloy without coating), as well as against physical deterioration and bio fouling. They greatly decrease the surface wettability and the friction coefficient. The properties of metals' coatings based on NPTFE in pure form as well as in the form of a component of composite polymer compositions were investigated. It was shown that coatings' wetting angle increases up to 130 ^{o} , friction coefficient decreases in 3-5 times, deposit decreases in 5-7 times, chemical durability along with the anti-icing and anti-fouling characteristics increase in several times[5]. Researches of NPTFE oil-compositions influence to an internal-combustion engine and different types of mechanisms have proved the decrease in vibration, rubbing parts wear-out and fuel consumption as well as increase of engine oil lifetime.

References

1. A.K. Tsvetnikov, Vestnik FEB RAS, 2009, **2**, p. 18-22.
2. A.K. Tsvetnikov, patent 2035308 Russian Federation, 1995.
3. A.D. Pavlov, S.V Suhoverhov., A.K. Tsvetnikov, Vestnik FEB RAS, 2011**, 5**, p. 51-55.
4. S.V. Gnedenkov, S.L Sinebryukhov., D.V.Mashtalyar, V.S. Egorkin, A.K. Tsvetnikov, A.N. Minaev, Protection of Metals, 2008, **44(7)**, p. 704–709.
5. A.K. Tsvetnikov., L.A. Matveenko, A .V. Puz, V.S Egorkin, A.V. Golub, S.I. Maslennikov, A.D. Pavlov, S.V Gnedenkov, Russian Coatings Journal, 2016, **1-2**, p. 63-67**.**

Acknowledgements: This work is funded by the program "Dalniy Vostok", project 18-3-014.
Key words: polytetrafluoroethylene; nano-films; coatings; composite.

T06-2: Ocean renewable energy

Behaviours of OWC Devices Installed on a Large Floating Structure and PTO Performance

S.Furuya[1], T.Ikoma[2*], H.Eto [2],Y.Aida[2], K.Masuda[2]

[1] *Nihon University, CST, Department of Oceanic Architecture and Engineering, Chiba, Japan*
7-24-1 Narashinodai, Funabashi, Chiba 274-8501, Japan
[2]*Depertment of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: ikoma.tomoki@nihon-u.ac.jp*

Pontoon type very large floating structures are effective for offshore ocean space utilization. Although semi-submersible types are better to install extreme sea areas than pontoon types, pontoon types should be able to reduce cost to design, install, and make maintenances because of simple configuration. Some researchers have tried to install oscillating water column type wave energy converters to use as damper devices as well as to harvest wave power. Our research group has also studied such as a very large floating structure of a pontoon type and showed theoretical calculation results. However the prediction method which calculates hydrodynamic forces including effects of OWC behaviours and air pressure in an air chamber has not been validated sufficiently.

The objective of this study is to prove validity of the prediction method and the in-house programme code developed already. To do that, calculation results with the present method were compared with air pressures, air flow rate, and the primary conversion characteristics obtained by model experiments and other prediction methods. The present method could predict the physical values and hydroelastic motion behaviours of large floating structures with several hundred in length.

The study concluded the approach to develop the prediction method was correct and useful in order to estimate amount of power harvested from ocean waves and to reduce elastic motion behaviours.

References

Tomoki Ikoma, Koichi Masuda, Yuka Watanabe, Hiroaki Eto, Chang-kyu Rheem and Takeshi Kinoshita
"Power Generation Potential of a VLFS Equipped With OWC Type WECs and Damper Effects on Elastic Motion",
OMAE2015-41960, pp. V006T05A018; 8 pages,2015

Hisaaki Maeda, Taishi Onishi, Masaaki Hayashi, Tomoki Ikoma, Yukihisa Hagio, Hirotaka Osawa, Mamoru Arita
"Research on response reduction effect of elastic floating body by oscillating water column"
Journal of the Society of Naval Architects of Japan, **volume2000(188)**, pp.279-285, 2000

Key words
OWC Type WECs, Hydroelastic, Large Floating Structure

Effects of the Scale and Airchamber Volume of OWC Type WECs on air pressure and Flow Rate

Shota Hirai[1], Tomoki Ikoma[2*], Hiroaki Eto[2], Yasuhiro Aida[2], Koichi Masuda[2]
[1]*Department of Oceanic Architecture and Engineering, CST, Nihon Univercity*
7-24-1, Funabashi, Chiba, Japan, 274-8501
e-mail: cssh19030@g.nihon-u.ac.jp
[2]*Department of Oceanic Architecture and Engineering, CST, Nihon Univercity*
[2*]*e-mail: ikoma.tomoki@nihon-u.ac.jp*

Oscillating water column (OWC) type wave energy converters (WECs) have been studied by a lot of researchers and demonstrated as a full-scale sea test for practical use. However, some problems have remained in putting OWC type WECs into practical use. As one of the problems, it is pointed that difference in scale affects the behavior in characteristics of an air chamber between a full-scale model and a small scaled experimental model, especially in the primary conversion efficiency of WECs. It is still unclear which the cause of effects of the difference in scale is because of the viscosity or the air compressibility. The objectives of this study are to quantitatively investigate how the difference affects the air chamber characteristics such as air pressure, relative water level, and after all the primary conversion efficiency. This study made experimental models of three scales which were S = 1/1, 1/2, 1⁄4 and carried out forced oscillation tests in still water. From the relative water level, we can know air flow rate and we can predict the primary conversion at the air chamber from the flow rate and the pressure. As a result, it was confirmed that the difference in the scale affected the air chamber characteristics.

References

Ikoma T, Masuda K, Eto H and Shibuya S, "Basic Characteristics of the Primary Conversion of an OWC Type WEC Installed on a Wave Dissipating Double-Caisson", 2018,*Proceedings of the ASME 2018 37th International Conference on OMAE2018*, ASME, OMAE2018-77020.

Kinoshita T, Masuda K, Miyajima S and Kato W, "Effects of air compressibility in an air-chamber on a performance of a fixed O.W.C. Type Wave Energy Absorber", 1985, *Journal of the Society of Naval Architects of Japan*, **Vol.157**, pp.211-216

Acknowledgements

This study was carried out as a part of the study as the JSPS KAKENHI Grant-in-Aid for Scientific Research (B) 18H01646.

Key words

OWC Type WECs, Scale Effect, Airchamber

Applicability of the MPS Method to Performance Analysis of the OWC-WEC

Mitsuhiro Masuda[1*], Yutaro Sasahara[2], Kiyokazu Minami[1]
[1]*Tokyo University of Marine Science and Technology, 2-1-6 Etchujima, Koto-ku, Tokyo, Japan 135-8533*
[2]*Japan Oil, Gas and Metals National Corporation, 2-10-1 Toranomon, Minato-ku, Tokyo, Japan 105-0001*
**e-mail: masuda@kaiyodai.ac.jp*

Background

In the recent years, ocean renewable energy has been increasingly in the spotlight due to global warming and energy issues etc. Research on ocean renewable energy devices is being carried out by many researchers, companies and countries. Authors focus on an oscillating water column type wave energy converter (called below OWC-WEC). It is considered that the OWC-WEC is useful because it has few movable parts and it can also be used as a breakwater device. The OWC-WEC has been thoroughly studied and it has a long history. [1], [2] However, the OWC-WEC still need further research about energy conversion efficiency and costs etc.

Material and methods

The MPS (Moving Particle Semi-implicit) method which is a kind of a particle method in a computational fluid dynamics (called below CFD) is applied to the performance analysis of the OWC-WEC. The MPS Method was first published by Koshizuka and Oka in 1996 [3] and has been used in research in various areas of engineering and science since then. In this study, these following items are conducted; 1) the development of analysis program code which can simulate the multiphase flow by three phases of gas, liquid and solid, 2) the development of air duct model.

Results

This improved MPS program code was applied to verification of the applicability to the performance analysis of the OWC-WEC. The reproducibility of the primary conversion efficiency of the fixed type OWC-WEC by this program code was verified and discussed by comparison with experimental results.

Conclusions

It was found that this improved MPS program code can accurately calculate the flow of the air in the air chamber. And, the reproducibility of the experimental results was shown. Finally, the usefulness and applicability of this program code were discussed and recommendations for future work were made.

References

[1] Washio, Y., Osawa, H., Ogata, T., Nakagawa, H., Okayama, S. and Nagata, Y., A Study on Characteristics of Generated Output of the Offshore Floating Type Wave Pert Device “Mighty Whale”, *Journal of the Society of Naval Architects of Japan*, 190, pp. 395-405, 2001-12.
[2] The Queen’s University of Belfast: Islay LIMPET Wave Power Plant Publishable Report, 2002.
[3] Koshizuka, S. and Oka, Y., Moving-Particle Semi-implicit Method for Fragmentation of Incompressible Fluid, *Nucl. Sci. Eng.*, 123, pp. 421-434, 1996.

Acknowledgements

This research was made possible by the Grant in Aid for Scientific Research B of the Ministry of Education, Culture, Sports, Science and Technology.

Key words

Ocean renewable energy, OWC type wave energy converter, MPS method

Effects of Moon pools on Motion Responses of Barge-Based Floating Structures

S. Moritsu[1], M. Nakamura[2], T. Ikoma[3*], K. Masuda[3], Y. Aida[3], H. Eto[3]
[1] *Department of Oceanic Architecture and Engineering, CST, Nihon University*
7-24-1 Narashinodai, Funabashi, Chiba 274-8501, Japan
[2] *Department of JGC PLANT INNOVATION CO., LTD.*
[3] *Department of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: ikoma.tomoki@nihon-u.ac.jp*

A pontoon type which can be constructed with shallow draft is effective when a floating offshore wind turbine system is installed in shallow seas. However, motion responses of it in ocean waves would be enlarged comparing with semi-submersible and SPAR types. A concept was proposed in which the responses could be reduced in waves and a moon pool was provided. The moon pool was called as the damping pool but motion reduction effect was not clear. Besides, it is interesting to apply a moon pool to reduce motion responses of a floating structure.

An objective of this study was to investigate fundamental effects of a moon pool on motion responses of a floating system to be used for an offshore wind turbine system.

At first, the study carried out a model experiment in a wave tank using a scaled model on which twin-vertical wind turbine models were set. After proving validity of a prediction method based on the linear potential theory, we conducted system calculations to investigate influence of moon pools to wave exciting forces, radiation forces, and motion responses of a floating body with four moon pools. In the calculations, we varied areas and draft of moon pools although the displacement of the model was kept constant.

As a result, it was confirmed the reduction effects on wave exciting forces and radiation dumping coefficients comparing with them of a conventional pontoon with same displacement. The effects were confirmed especially in relatively high frequency range and the reduction seemed as very wide wave-less condition. The results suggested that motion responses could be reduced by arranging moon pools and we could change the frequency range to be reduced by varying draft of moon pools. The study concluded possibility of the motion reduction effect due to moon pools arrangement and it was made because of reducing wave exciting forces on heave and roll.

References

Effects of the Projecting Wall and the End Wall to OWC Type WEC in Shallow Water,
T Ikoma, K Masuda, H Omori, H Taguchi, H Osawa and T Miyazaki, *The Japan Society of Naval Architects and Ocean Engineers (JASNAOE), and The Royal Institution of Naval Architects (RINA),* **volume No. S8-3** CD-ROM, 2013.

Key words
Moon-pool, Wave Response, Hydrodynamic Force

Effects of Projecting-Wall Thickness on Primary Conversion Performance of PW-OWC Type WECs

K. Sugo[1], T. Ikoma[2*], H. Eto[2], Y. Aida[2], K. Masuda[2]
[1] Department of Oceanic Architecture and Engineering,School of Science and Technology Nihon University, 7-24-1 Narashinodai, Funabashi, Chiba 274-8501, Japan.
*e-mail:ikoma.tomoki@nihon-u.ac.jp
[2] Department of Oceanic Architecture and Engineering, CST, Nihon University

An oscillating water column (OWC) type is one of wave energy converters (WECs) and many researches on it have been conducted in the world. A method to improve primary conversion performance of an OWC WEC has been proposed and studied, in which projecting walls are installed in front of inlet-outlet of OWC. The method is very effective to improve the primary conversion performance indeed. However, it is not easy to install the projecting walls on the device because of structural problems. Besides, we would need to consider floaters to obtain buoyancy when it is a floating system. Then it is necessary to understand influence of thickness of the projecting walls to the performance as well as hydrodynamic pressure and so on.

This study conducted with objectives of understanding the influence of the thickness of projecting walls to the performance and effects of water depth on characteristics of the performance with several variations of the thickness.

The study applied a calculation method based on the linear potential theory which could take into account of wave power absorption by OWC-airchamber feature. We calculated and discussed characteristics of air pressure and airflow rate of an airchamber and the primary conversion using five calculation models. Each model had different thickness of projecting walls.

At first, influence of water depth was not clear so that characteristics of the performance would be dominated by wavelength. The thickness of projecting walls affected on the performance a little but it was not changed qualitatively. Wider and wider thickness, the performance was reduced but air pressure and the flow rate increased when the thickness was wider.

The study concluded that the thickness of projecting walls affected on the primary conversion performance of OWC WECs with projecting walls. The thing should be important in design floating systems because of buoyancy regions.

References

Tomoki Ikoma,Koichi Masuda,Hikari Omori,Hiroki,Hisaaki Maeda
Improvement of Wave Power Take-Off Performance due to The Projecting Walls for OWC Type WEC, *Proceedings of the ASME 2013 32nd International Conference on Ocean,Offsyore and Arctic Engineering OMAE2013*,2013,OMAE2013-10384

Tomoki Ikoma,Koichi Masuda,Hikari Chang-Kyu Rheem,Hisaaki Maeda,Yuta Watanabe
Primary Conversion Efficiency of OWC Type WECs Installed on a Floating Structure, *Proceedings of the ASME 2012 32nd International Conference on Ocean,Offsyore and Arctic Engineering OMAE2012*,2012,OMAE2012-83337

Acknowledgements

This study was financially supported by the research grant of the Japanese Institute of Fisheries Infrastructure and Communities in 2017 and 2018. We very thank the organization for the support.

Key words

Wave energy converters, projecting wall, primary conversion

T06-3: Ice field engineering

Seaworthy all-terrain vehicles on air-supported tracks for effective construction and functioning of bases in the Arctic

Azovtsev A. I., Ogai S. A.
Maritime State University named after G. I. Nevelskoy,
50a, Verkhneportovaya St., Vladivostok, Russia, 690003
email: Azovtsev@msun.ru
email: Ogay@msun.ru

With the intensive development of the Russian Arctic application of non-specialized all-terrain vehicles damages the soil of tundra. Floating vehicles on wheels and caterpillar tracks are unable to operate in the broken ice. Air-supported amphibian ships lose their passibility on the rugged terrain and have excessively high power imputs. Searching exploration grounded the unique universality of road performance, sparing pressure upon the tundra soil and effective cutting of power imputs of vehicles on air-supported tracks, including those of 150 tons carrying capacity.

Air-supported caterpillar tracks are produced from a broad conveyer track, on the outer side of which there are plenty of large diameter inflatable soil catchers. Air cushions are employed instead of a suspension bracket. Large area of resting provides passability on poorly bearing soil, snow and marshland without damaging the tundra turf in summer. Seaworthy all-terrain vehicle on those tracks will go over 20° slope and can operate on a shore slope. With small slopes its efficiency is 1.5 times higher than that of the air-cushioned ships. The effectiveness of suggested tracks during glissading is 2 times more than that of the best glissading ships.

Demonstrating tests of a self-propelled model at the exhibition “Spetstrans” received a gold medal for developing a new principle of motion on air-supported tracks. It is shown that the all-terrain vehicle operates reliably on the broken ice with going out of water onto the ice, provides seaworthiness at force 4 gale, operates in the surf sea, goes out of the water onto the ice, is capable of operating on stumps of the wood-cutting area, successfully gets over snow and marshland. And the most effective way of reducing resistance of motion of ship’s sheathing to the meeting current is put into practice on the water.

The drafts of seaworthy all-terrain vehicles for transport provision of the Arctic bases for operation on freezing shelf and utmost lack of roads including the rugged terrain within the wide range of unfavourable weather conditions have been worked out according to the Federal purposeful program. High effectiveness during salvage operations is also forecast considering high weather dependability of aviation in the region.

G. I. Nevelskoy Maritime State University is willing to cooperate on research and development of seaworthy all-terrain vehicles on air-supported tracks.

References: Engineering offer on creation of a seaworthy all-terrain vehicle on air-supported tracks of raised carrying capacity // СПб: SRC Maritime intellectual technologies, 2018. – № 4 (42), vol.5 – p. 39 – p. 44

Key words:
Seaworthy all-terrain vehicles, ecology, power effectiveness

Ekranoplan - a transformer for coastal waters

E.A. Galushko[1], K.V. Gribov[2], .Y. Zhurenko[3], S.M. Krivel[4], G.A. Fedoreev[5]
[1] *Irkutsk State University, 1Karl Marx Str., Irkutsk, Russia, 664003*
[2] *Far Eastern Federal University, 8 Sukhanova Str., Vladivostok., Russia, 690091*
[3] A *Soyuzmortrans Ltd., 10 Semenovskaya Str., Vladivostok., Russia, 690090*
[4] *Irkutsk State University, 1Karl Marx Str., Irkutsk, Russia, 664003*
[5] *Soyuzmortrans Ltd., 10 Semenovskaya Str., Vladivostok., Russia, 690090*
**e-mail: gribov.kv@dvfu.ru*

The aim of the work is to create a lightweight 2-seater speed, amphibious, boat - wig - transformer for year-round individual and professional use in the absence of transport infrastructure in the coastal waters. The developed vehicle will combine several principles of movement adapted to different operating conditions: over ice, snow, water, over water through its constructive transformation into a snowmobile, airboat and ekranoplan to ensure a competitive advantage in the consumer market for individual water transport.

Scientific background on the subject of the project is formed on the basis of:

- studies of aero-hydrodynamic characteristics of the model of the RT-6 ground effect vehicle at KSTU. A.N. Tupolev;
- results of aerotube tests of the ET-2 model in the wind tunnel of the Samara State Aerospace University (SGAU) named after. ac S.P. Korolev and the model - an analogue of MT1 in the Krylov State Research Center. ac A.N. Krylov;
- research and optimization of the dynamics and aerodynamics of mathematical 3D models of ET-2, held at the Irkutsk State University.

At the first stage, studies were carried out to optimize the basic aerohydrodynamic scheme by developing, manufacturing, and full-scale tests of the prototype surface-effect vehicle - transformer. Were obtained preliminary values of aerodynamic quality and formed the flight-technical and tactical-technical characteristics of the project being developed.

The characteristics of the longitudinal stability of the ground effect vehicle and its transform modifications (aerogliser and snowmobiles) will be determined after the end of the tests at the second stage of research. A prototype model of ground effect vehicle of the first stage of research will help to remove the risks and doubts of future investors in the subsequent commercialization of the project results.

References

1. Fedoreev G.A., Znatkov A.S., Kizilov D.I., Schaub P.A., Moskovkina S.V. Ekranoplans today // Morskoy Vestnik, 2015, No. 4 - p. 26-28;

2. Konstantin V. GRIBOV, Gennady A. FEDOREEV. The concept of selection of aerodynamic schemes of ekranoplanes for transport corridors of the Arctic. The paper on TEAM-2018. The 32nd Asian-Pacific Technical Exchange and Advisory Meeting on Marine Structures. Wuhan, China, 2018. - p. 9-23

Acknowledgements
The authors would like to thank the Russian Scientific and Technical Society of Shipbuilders named after Academician A.N. Krylova for support and assistance in the implementation of this work

Key words
Aerohydrodynamic scheme, ekranoplan - transformer, a model sample

Improving the efficiency of ships in Russian ice conditions

V. Kulesh[1], T. Bessonova[1], N. Pets[1*]
[1]*Far Eastern Federal University. 8 Sukhanova St., Vladivostok, Russia, 690091*
**e-mail: pec_85@mail.ru*

Ice conditions in the Arctic and the Russian seas of the Pacific Ocean are the biggest obstacle to navigation and other activities aimed at the development of resources and regional development. The paper discusses three areas of possible development and increase the efficiency of the fleet in ice conditions.

Operation of the fleet in difficult ice conditions is associated with the capabilities of escort and support of icebreakers. An important feature of the operation is also the replenishment of the fleet by ships of different ice categories interacting with each other. For planning fleet replenishment in the first part of the work, the interrelations of the most important characteristics of icebreakers and ice navigation ships, such as displacement, power, deadweight, and light-ship weight are considered. These relationships are different for ships of different purposes, ice categories and determine their ice passability. It is shown that the combination of power and the light-ship weight may not be rational. The work takes into account the entire range of Russian ice categories of ships - from Ice1 to Icebreaker 9.

Replenishment of icebreakers and ice navigation ships needed to improve fleet efficiency, but it is the most expensive way. Increasing the competitiveness and capacity of Russian ports during ice navigation periods is impossible without the participation of foreign-built ships, which often have no ice reinforcement. In the second part of the work, the issues of a relatively new procedure are considered - ice certification of such ships. The safe and relatively efficient operation of these ships in the ice is possible if the captain observes a number of operational limitations related to the speed of movement in the ice, the landing of the ship, the technical condition of the hull and other factors. Examples of solving these problems for ships and floating objects for various purposes are showing.

Considering that the replenishment of the Russian fleet is largely provided by foreign ships already in service in the third part of the work, questions of increasing their effectiveness in the ice are considered. Modernization and ice reinforcement of such ships to the level of Russian ice categories are expensive and not widely used. Restrictions on ice certifications limit the effectiveness of the work of ships in the ice. The way of partial ice hull reinforcement is promising. The paper discusses options for such reinforcements. Particular attention is paid to the minimum labor intensity of implementation and a slight increase in weight. Such reinforcements increase not only the strength and safe speeds of the ship in ice, but also the hull durability under wear conditions. Examples of such solutions are considered.

Keywords:
Icebreakers, ice navigation ships, efficiency, ways to increase.

Features of the side framing navigation ships (INS) under the action of ice loads

M. Moskaleko*, I. Druz**, V. Moskaleko
Maritime state university named admiral G. I. Nevelskoy. 50a, Verkhneportovaya Str., Vladivostok, Russia, 690059,
**e-mail: asmsh@rambler.ru, ** e-mail: druz_i_b@mail.ru*

Development of the Arctic and its resource potential is one of the main strategic objectives of Russia. Winds drive the old ice of great thickness towards North America, increasingly opening the Northern sea route (NSR) for navigation, in conditions of global warming. According to forecasts, the volume of traffic on the NSR will reach 30 million tons by 2021. The passage of vessels through the Northern sea route by 2030 should be year-round.

Given the continuous extension of navigation periods and the operation of Arc7 vessels in the Eastern sector of the Arctic, an increase in the number of ice damage is expected in the corning years, both for new vessels and for vessels with a significant age of operation.

Material and methods
We have analyzed, by methods of mathematical statistics, data on the damage of INS hulls on the results of repairs at ship repair plants in the Far East, since 1980. The planned factor experiments on steel models for the supercritical deformation of the ship's set beams are carried out.

Results
It was found that in most cases the ice damage is of a plastic nature, with the supercritical deformation of the set together with the attached skin belts. INS fatigue and brittle damages are practically absent. In the last 5 years, the main type of ice damage remains damage to the side slabs. At the same time, the developed cylindrical insert begins to play a negative role for ships longer than 120 m, especially when moving along the channel behind the icebreaker. At small angles of inclination of the side, combined with high speeds of movement when breaking the edges, the destruction of the ice occurs by the crushing and the local pressure is equal to the small contact area within 3–5 space. Especially dangerous is loading with increasing load during periods of ice contraction that is typical with the closing of the channel by ice for vessels longer than 150 m. Determining critical link in the strength characteristics of on-Board overlap, the action of ice loads, are supporting the attachment of the frames where stresses from bending and shear are able to exceed limits of the yield strength of the material.

Summary
1. Ice damage to side overlaps INS is of a plastic nature. It is expedient to carry out calculations of overlapping, methods of limit equilibrium, on action of the concentrated loading.
2. In the rules of classification societies there is по uniform approach to the purpose of the calculated span of the beams onboard set, taking into account the design of the end nodes of fastening on the support circuit.

Knee joints cannot be considered absolutely rigid, since in the area of extremes of concentrated deformations they can lose the stability of the flat shape of the bend much earlier than the limit state in the middle of the span of the frame. Therefore, taking into account the risks of collapse at the ends of the span, the INS cannot be considered as a crumpling element, from the standpoint of protection against damage to the beams of the set.

3. The control parameters of the deformation process revealed by us, under the action of ice load, allowed us to obtain adequate mathematical models and develop safe relations in the height of the wall, the reduced length of the free span of the beam depending on the flexibility and the type of connection at the nodes. The obtained dependences also allow to estimate the residual life of the overlap strength and to develop criteria for defecation of the beams onboard set in сазе of ice damage.

Keywords
Ice navigation ships (INS), ice load, set beams.

Finding of optimal characteristics at the initial steps of designing of multifunctional icebreaker

S.A. Ogai, A.I. Azovtsev, M.V. Voyloshnikov
Admiral G.I. Nevelskoy Maritime state university

The characteristics and the particulars in the design of multipurpose ship for ice navigation (multifunctional icebreaker) are determined systematically, given the large size of investments in the construction of the ship. The design constraints in finding of the characteristics and particulars of ship serve the characteristics of the general system, which in the ship enters as the subsystem. In accordance with the specified design constraints are determined design characteristics of the multifunctional icebreaker, which determine ship size. For finding of ship optimal characteristics the mathematic model is worked out and used. The set of sought characteristics of the multifunctional icebreaker size of includes: the design deadweight, the displacement at the summer load line, the gross and the net tonnage and etc. As a rule, only one or couple parameters are usually defined at the initial design stages as an independent. To find them, the economic criterion of the present worth is used. The criterion is defined in the dependence of multifunctional icebreaker efficiency on the design constraints, on the values of the required characteristics and on the particulars of the ship, which would be determined at the subsequent design stages. The design particulars of multifunctional icebreaker, which includes the proportions of the dimensions, as well as the characteristics of the definite ship devices and it systems, are determined at the subsequent design stages, taking into account its own constraints, which are the characteristics of the ship found at the previous design stages.

Key words:
Multipurpose ship, ice navigation, icebreaker, project optimization, efficiency criterion, objective function, constraint, ship characteristics, ship particulars

T06-4: Port and harbor engineering

The stability problem of dry dock

S. Antonenko[1], M. Kitaev[1], R.Vignesh[1]
[1]Far Eastern Federal University,8 Sukhanova Str., Vladivostok, Russia, 690090
*e-mail: kitaev.mv@dvfu.ru

Zvezda Shipbuilding Complex is being built as part of an expansion to the existing Zvezda shipyard owned by United Shipbuilding Corporation. The complex is located in the town of Bolshoi Kamen in the far-east of Russia. Now the construction of the dry dock is being completed. In the spring 2020, it is planned to install the dry dock gate in the dock. Earlier in Russia, dry docks of this size were not built. The dock is designed by Chinese specialists and built under their supervision, followed by Chinese regulations.

During the operation, the dry dock gate act as a hydraulic structure, but it is afloat during dock operations and in this aspect it does not differ from the vessel. According to the rules [1], clause 7.2.3.2, the initial metacentric height of a Dry-Dock Gate with the length of more than 30 m (length of the dry dock gate considered as 114 m) with a minimum draft of not less than 1.0 m. To ensure the required stability, permanent solid ballast of 2400tons is added along with the 2600tons of total mass of the structure.

The Russian side proposed replacing permanent solid ballast with liquid, motivating it with the fact that solid ballast is undesirable because of difficulties in examining hull structures, in operation and during repairs. They point out that according to the British norms [2] the required metacentric height at least 30cm, and in the French [3] should be positive. In this case, an independent invigilator was appointed. One of the authors of the publication was an expert.

The stability calculation of the dry dock gate were carried out both in the absence and in the presence of variable water ballast in ballast tanks, whose width is 12 m and the volume is almost 1600 m3. The double bottom tanks are located in the bottom of the Dry-Dock Gate, which occupies the entire width of the tank and it also communicate between left and right side of the tank. During the operation analysis, the actual operation condition and the restriction of wind speed is taken in to an account. The stability analysis for the towing operation is also carried out according to the Russian Register [4]. The stability of the dry dock gate during the ballasting process depends on the ratio of the time of the ballast flowing from one side to another (the period of water oscillation in tanks) and its own natural period. A preliminary assessment was made of these periods. In addition with this, an approach was made to change the design of tanks to improve the stability in the intermediate stage of ballasting.

The results of the analysis are communicated to the interested parties and taken into account in the final draft of the Dry-Dock Gate.

References

Code for design of dry dock CB/T 8524-2011, China.
British standard BS 6349-3:2013
Bureau Veritas.Rules for harbor equipment.Chapter 3. Floating door
Правила классификации и постройки морских судов. Часть IV Остойчивость. Российский морской регистр судоходства, 2018. 63 с.

Key words
Basin dry dock, dry dock gate, water ballast, ship stability

Fundamental study on the characteristics of the movement of ships and the characteristics of mooring cable tension in non-berth mooring

Hiroaki Kihara[1], Tomoki Ikoma[2*], Kouchi Masuda[3*],
Yasuhiro Aida[4*], Hiroaki Eto[5*], Nanae Miyashita[6*]

[1] *Graduate student, Department of Oceanic Architecture and Engineering, CST, Nihon University*
[2] *Professor, Department of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: ikoma.tomoki@nihon-u.ac.jp*
[3] *Project Professor, Department of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: masuda.koichi@nihon-u.ac.jp*
[4] *Assistant Professor, Department of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: aida.yasuhiro@nihon-u.ac.jp*
[5] *Associate Professor, Department of Oceanic Architecture and Engineering, CST, Nihon University*
**e-mail: eto.hiroaki@nihon-u.ac.jp*
[6] *MILIT Kanto Regional Development Bureau, Japan*
**e-mail:csnn16021@g.nihon-u.ac.jp*

The exclusive economic zone of Japan is 4.47 million square kilometers, and the development of remote islands as an activity base capable of transportation and replenishment has attracted attention in order to make effective use of these vast waters. Offshore breakwaters are difficult to maintain for remote islands with steep submarine topography. Therefore, non-berth mooring of ships by connecting four mooring posts on the quay side and two mooring buoys on the offshore side is adopted. However, since non-berth mooring involves a greater amount of ship movement than berth mooring, there is room for improvement of the mooring method to improve cargo handling efficiency. In the present study, nonlinear interaction between waves and floating bodies and nonlinear phenomena of waves in the vicinity of the quay wall are assumed. Therefore, numerical simulation was carried out using the moving particle semi-implicit method. In addition, non-berth moored vessels in regular waves were examined in order to clarify the ship movement characteristics and mooring cable tension characteristics. In addition, the effectiveness of the mooring method was clarified for the purpose of improving the cargo handling rate. Furthermore, we investigated a mooring method to improve the cargo handling efficiency and proposed setting up a floating breakwater in order to ensure the calmness of the front of the quay.

References

A study on calculation methods of allowable wave heights of a moored ship in remote island ports, Yoneyama, H, Minemura, T, Moriya, journal of JSCE B3, Vol.73, No.2, I_803-I_808, 2017

A Study on Applicability of Particle Method to Floating Body Behavior Analysis in Tsunami, Masuda, M ,Nihon University PhD thesis, 148p, 2009

Floating-fluid coupled analysis method during tsunami action in MPS method, Architectural Institute of Japan, Aida ,Y, Masuda ,K , Ikoma ,T, Eto H, 10018, 2013

A fundamental research on the behaviors of floating vessles moored to floating pier in tunami, Masuda K, Masuda M , Ikoma T, Murata K and Minami K, journal of JSCE B3, Vol.69, No.2, I_85-I_90, 2013

Key words

Non-berth mooring, mooring cable tension, movement characteristics

Online biomonitoring and immediate bioindication technology: Two years testing in the coastal area of the Barents Sea

E. Komarova[1], A. Gudimov[2*], A. Burdygin[3]
[1] *Research Institute of Physics at Southern Federal University, 194 Stachki Av., Rostov-on-Don, Russia, 344090,*
[2]*Murmansk Marine Biological Institute of KSC of RAS, 17 Vladimirskaya Str., Murmansk, Russia, 183010*
[3]*Sechenov Institute of Evolutionary Physiology and Biochemistry RAS, 44 Toreza Av., Saint-Petersburg, Russia, 194223*
**e-mail: alexgud@mail.ru*

Online control of the environmental safety in marine ecosystems is absent because the only sampling methods of the standard biomonitoring are just applied so far. Nothing is known about the current water quality at any given time point. Thus it is impossible to detect environmentally hazardous situations in good time and then promptly take the necessary measures, especially when toxic pollution or other dangerous environmental changes occur. The best solution is adoption of new eco-technologies such as online biomonitoring for continuous ecological control of the environment (Massabuau et al., 2015).

Our system of online biomonitoring with bivalves is the first in Russia a complete and full-blown system for automatic biosensor monitoring and online bioindication of the natural environment. The key point of the system is online bioindication with biosensor – bivalve behavior, which allows us to detect environmentally dangerous (toxic) changes in the environment within 1-6 hs. Initially, the main goal of our research was to record and mathematically treat bivalve behaviour data and to investigate their current adaptations to the fluctuated coastal environment. Our system and technology are the result of long-term fundamental research (1985-2017).

For the applied ecology and protection of the environment the main aim and a challenge of our biosensor monitoring research was to detect the effect of any harmful or toxic pollution in the near-real time. On the one hand, the effects of copper, cadmium, synthetic detergent, diesel oil, crude oil, as well as ammonia, drilling muds, fluids and solutions, inorganic matter and other substances on the behavior of mussels from Barents Sea (*Mytilus edulis*) and Black Sea (*M. galloprovincialis*) and other costal bivalves were estimated in our experiments. In some experiments (2007 only) the responses of mussel cardiac activity and behavior were simultaneously recorded. On the other hand, devices of the system were developed and for the recording device unit some magnetoresistive sensors were successfully selected and applied.

The online biomonitoring system has been tested under natural conditions of the Barents Sea for two years (2016-2018), and then the online biosensor monitoring of the coastal water proceeds successfully so far.

References

Massabuau, J.-C, Gudimov A. and Blanc P. Environmental Monitoring of Arctic Waters with Unmanned Bivalve Biosensor Technology: One Year of Background Data Acquisition in the Barents Sea // Proc. SPE Russian Petroleum Technology Conference, (October 26, 2015, Moscow). - Paper SPE - 176681-MS: https://www.onepetro.org/download/conference-paper/SPE176681MS?id=conferencepaper%2FSPE-176681-MS.

Acknowledgements

We are grateful to the Total company (France) for partial support of the research.

Key words

Online biomonitoring, bivalve behavior, magnetic sensors

THE INFLUENCE OF COATING ON CORROSION SHELL PLATES SHIPS AND STRUCTURAL ELEMENTS OF THE UNDERWATER PART STATIONARY FLOATING STRUCTURES

M. Moskaleko*, I. Druz**
Maritime state university named admiral G. I. Nevelskoy. 50a, Verkhneportovaya Str., Vladivostok, Russia, 690059,
**e-mail: asmsh@rambler.ru, ** e-mail: druz_i_b@mail.ru*

As is known, the wear of hull structures of ships and stationary floating structures depends on a number of technical and operational factors. The determining effect on the corrosion rate gives paint protection. Poor-quality paint increases wear and consequently the level of stress concentration in the structure, which leads to the development of cracks in the welded joints. Since the entry into force of the International Convention on the control of harmful anti fouling systems on ships in 2001. (AFS), with the prohibition to apply the system of paint protection containing tin compounds after January 1, 2008. Due to the rise in price of paints and the appearance on the market of inefficient paints to protect the underwater part, the situation with the quality of paint protection has become even more urgent.

Material and methods

We, by methods of mathematical statistics, investigated the processes of wear homogeneous groups connections of the hull structure and cladding for ships, and stationary floating structures for 10 years, since 2008. The wear rates, safety of the paint coating (its scheme – layers/soil-paint, the types and basis of the coating) and the volume of repair work were studied.

Results

A stable relationship between quality of the paint coating and wear rates in the structure is revealed. The residual critical parameters of the area of paint coatings for the purposes of operation are determined, with a decrease in which the corrosion rate increases sharply, increasing more than 2.5 times against the average values. The color schemes for different types of coatings are analyzed and the objective function for controlling the process corrosion protection various homogeneous groups of bonds is constructed.

Summary

1. For each type of paint, using the created target function, you can choose the equilibrium point at the minimum permissible (for operation) scheme of painting – the thickness and number of layers soil/paint.

2. The use of expensive paints, increasing the thickness (against the minimum) and the number of layers coating soil/paint and improving the quality preparation surfaces of the structure above the category SA2 does not lead in practice to a tangible result in reducing the wear rates of the structural bond groups.
3. In practice, it is advisable to use a simplified color scheme for the preparation of the surface above the level of SA2. The best results (with a guarantee of paint protection for 2.5 years) gives the use of simplified schemes, using domestic vinyl-based soils and compatible imported antifouling paints.

Keywords
Paint coating, the rate of wear, the paint scheme.

THE DEVELOPMENT OF E-LOGISTICS SYSTEM WEIGHT OF THE SEA CONTAINERS IN PORTS

M. Moskaleko*, I. Druz**, V. Moskaleko
Maritime state university named admiral G. I. Nevelskoy. 50a, Verkhneportovaya Str., Vladivostok, Russia, 690059,
**e-mail: asmsh@rambler.ru, ** e-mail: druz_i_b@mail.ru*

Today, more than 90 % of the goods in world trade are shipped by sea, most of the expensive goods are sent in containers, which are in operation there are about 400 million units in 20 feet equivalent. The container, as the main element of the material flow of supplies in the logistics scheme of world trade, acts as a universal measure of the balance of ships and ports in the marine industry. The main criterion is the speed of container handling, while maintaining a balance between the ship and the port becomes possible only on the basis of modern digital technologies.

Material and methods

Today, there are по universal technologies based on common digital standards or unified digital equipment in the industry. Each private container owner independently develops e-logistics platforms. With the introduction of amendments to SOLAS 74 Convention on the confirmation of the gross tested mass of containers ("VGM Certificate" according to IMO resolution MSC.380(94)) increased time of cargo handling and violated the logistics scheme of the port economy. To optimize cost and time management of cargo-handling logistics in the modified scheme, was the issue of digitization of the data on the weight of loaded containers, they comply with the safe plan of loading and rotation of the ports. We have developed an e-logistics system for the weight of sea containers based on distributed Petri networks, which allows one to reduce risks and transaction costs in the implementation of unmanned technologies in ports.

Results

To solve the logistics tasks, control the weight of loaded sea containers, we have developed a service platform that allows you to exclude the procedure of intermediate weighing in ports. The algorithms use proven RFID radio frequency identification technologies, which makes it easy to integrate the service platform into monitoring, e-navigation and storage schemes in order to optimize the delivery of goods by sea in containers. With the development of technology, the service platform can be used in the Internet of things and blockchain transactions of world trade.

Summary

1. The creation of a service platform for logistics of sea containers weight involves the creation of infrastructure and a single Protocol for information exchange and recording of data on cargo handling in the container.

2. Data processing arrays can be based on the principle of unifying the supply of goods on the Pro-forma of the world trade organization for paperless trade.lt is possible to create market-recognized identifier for SMART contracts and bills of adding.

3. The ID of the shipping containers should be resistant to repeated use, through to disposal of the container. Open standards ISO 8402-87 in the form of barcodes and the global standard 681 can be taken as a basis here.

Keywords
Logistics, weight, shipping container.

T06-5: Marine constructions for oil and gas exploration and technology

A simplified model for umbilical cable by using Carrera unified formulation

Yu Deng, Xu Liang*, Yongdu Ruan, Titao Wang, Yuhong Wang
Ocean College, Zhejiang University, 1, Zheda Str., Zhoushan, Zhejiang, China, 316021
**e-mail: liangxu@zju.edu.cn*

Nowadays, umbilical cables have gained more and more attention in ocean engineering. However, the majority analyses of umbilical cable are using beam model with multilayer for various components, and there are few reports about composite beams as the simplified model. In this paper, the static analysis of fiber-reinforced composite beams is carried out based on the principle of virtual work under simply supported boundary conditions. While applying Carrera unified formulation (CUF) to solve the governing equations, Lagrange-polynomials expansions are chosen to approximate the kinematic field over the cross section. CUF is a unified framework that allows research of composite structure through a single formulation. Therefore, three-dimensional stress and displacement fields can be successfully detected by increasing the order of Lagrange polynomials appropriately. The results give accurate displacement and stress values with lower computational cost in comparison with commercial software. The solution shows practical feasibility to analyze the kinematics of umbilical cables. This study may serve as the foundation for dynamics and fatigue failure of deep-water umbilical cables.

References

1 Carrera E , Petrolo M ., *AIAA Journal*, 2012, **50(1)**, 176-189.
2 Yang Yan, Alfonso Pagani, Erasmo Carrera, D. Li, *Journal of Composite Material*, 2018, **0(0)**, 1-16.
3 A. Pagani, E. Carrera, *Mechanics of Advanced Materials and Structures*, 2018, **25(1)**, 15-31.
4 Yong Bai, Dapeng Zhang, Keqiang Zhu, Tianyu Zhang, *Ships and Offshore Structures*, 2018, **13(8)**, 809-821.
5 Yan J , Yang Z X , Zhao P P, *Scientia Sinica*, 2018.
6 Guttner W C , Santos C C P , Pesce C P, *Marine Structures*, 2017, **53**, 52-67.
7 A.B Custódio, Vaz M A, *Applied Ocean Research*, 2002, **24(1)**, 21-29.

Acknowledgements
This work was supported by the National Natural Science Foundation of China (Grant Numbers: 51879231, 51679214), and Zhejiang Provincial Key Research and Development program (Grant Number: 2018C03031)

Key words
Umbilical cables; Carrera Unified Formulation; Lagrange polynomials

An Experimental Study on Motion Behaviours of a Crane Ship and a Suspended Pile in Installing an Offshore Wind Turbine System

Atsuki Sano[1], Mizuki Yamada[2],
Tomoki Ikoma[3*], Kouichi Masuda[3], Yasuhiro Aida[3], Hiroaki Eto[3],
[1] *Nihon University, CST, Department of Oceanic Architecture and Engineering, 7-24-1, Narashinodai, Funabashi, Chiba 274-8501, Japan*
[2] *FUKADA SALVAGE & MARINE WORKS CO.,LTD., Osaka, Japan*
[3] *Nihon University, CST, Department of Oceanic Architecture and Engineering, Chiba, Japan*
**e-mail: ikoma.tomoki@nihon-u.ac.jp*

The work efficiency of installing an offshore wind turbine should be improved with a crane ship as well as a SEP because of cost reduction.

However, prediction of direction of incident waves is difficult and the knowledge of work out of a port and break waters is a little in fact. An accurate prediction of motion behaviours of a crane ship suspending a pile would make the installation works to be efficient.

An Object of this study is to investigate motion characteristics of a crane ship suspending a pile and any problems in ocean waves. Thus the study conducted a model experiment in a wave tank using regular waves. The experiment was carried out in two wave angle conditions in beam seas and oblique waves of 110 degrees. Motion displacement data was extracted from measurement results of a three-dimensional motion capture system.

The experiment results showed that a mono pile's swing changed due to different of yaw motion. The mono pile repeatedly swayed in the same direction when incident waves induced on a crane ship in beam sea conditions, but the sway in a rotating motion in the oblique waves. Besides, it revealed that the upper part of the mono pile moved rather than lower part in longer and longer wave periods.

References

The Equation of Coupling Motion between a Crane Barge and a Submersible Pontoon in Regular Waves: Tomoki Ikoma, Koichi Masuda and Akio Kobayashi, *Summaries of technical papers of annual meeting Architectural Institute of Japan*, 2004, pp.379-380.
Offshore Wind Power: John Twidell and Gaetano Gaudiosi (Ed.), Andrew R. Henderson,2011, page119-page219.

Acknowledgements

The authors are grateful to FUKADA SALVAGE & MARINE WORKS CO.,LTD. for the information and suggestion regarding a crane ship and the experiments .

Key words

Offshore wind turbine system, Motion behaviors, Crane barge

T06-6: Tsunami engineering

A Fundamental Study on Elastic Response Analysis at a Tsunami Drifting Object Collide with a Structure Applying Elastic Model of MPS Method

Yasuhiro Aida[1*], Tomoki Ikoma[1], Daichi Murata[2], Hiroaki. Eto[1]
[1]*Dept. of Oceanic Architecture and Engineering,CST, Nihon University.,7-24-1,Narashinodai, Chiba, Japan*
[2]*Hitachi Zosen Corporation, Infrastructure Business Headquarters.,1-7-89, Minamikouhoku, Suminoe, Osaka, Japan*
**e-mail: aida.yasuhiro@nihon-u.ac.jp*

The impact force of the tsunami drift on the structure needs to take into consideration the influence of the interaction with the ever-changing fluid. Although some evaluation formulas have already been presented regarding the impact force of tsunami drifting objects, there are still many unclear points in the tendency of the time history change of the impact force due to the fluid force change according to the response characteristics of the structure. In order to clarify the impact force characteristics, it is necessary to develop a numerical simulation method that can reasonably evaluate the impact of the tsunami drifting object on the structure. Therefore, in this research, using the thick elastic body model proposed by Koshizuka et al., we developed an analysis method of MPS method that can realize fluid-drift-structure interaction. In addition, the applicability of this analysis method is shown by comparison with the collision experiment results.

In the collision experiment, a solitary wave was generated using a two-dimensional water tank, and a floating model anchored to the quay was drifted to collide with the structure model. Measurement items are impact velocity and displacement of the structure. In addition, round steel was used for a structure model, and it installed as a cantilever which fixed the upper end.
When the experimental results and the simulation results are compared, the collision force of the drifting object, which is calculated back from the displacement of the structure, agrees well including the collision time. However, compared to the experimental results, it was confirmed that the force obtained by pressure integration of the simulation results tends to overestimate the collision force. From the above, this research has developed an analysis method of the MPS method that can realize fluid-drift-structure interaction and show that it can be applied to the analysis of the impact force of tsunami drifts.

References
S.Koshizuka and Y.Oka, Moving-Particle Semi-implicit Method for Fragmentation of Incompressible Fluid. NuclSci.Eng, 123, pp421-434, 1996.

Acknowledgements
This research was conducted with the support of the JSPS Grants-in-Aid for Scientific Research No.16K06588.

Key words
Tsunami drifts, Impact force, MPS method

A Fundamental Study on Development of Port Tsunami Hazard Map for Business Continuity After Tsunami Disaster Occurrence

Y. FUKUNAGA[1*], T. IKOMA [2], K. MASUDA[2], Y. AIDA [2], H. ETO[2], M. TAKADA[3]

[1] *Department of Oceanic Architecture and Engineering, CST, Nihon University, 7-24-1 Narashinodai, Funabashi, Chiba 274-8501, Japan.*
**e-mail: csyu18029@g.nihon-u.ac.jp*
[2] *Department of Oceanic Architecture and Engineering, CST, Nihon University*
[3] *Tohoku Regional Bureau Ministry of Land Infrastructure Transport and Tourism Miyagi Sendai, JAPAN*

Following the Great East Japan Earthquake, a hazard map that can contribute to making the business continuity plan of harbor functions including coastal cities after a tsunami disaster has been developed. Thus, in this study, we assumed a tsunami caused by the Nankai Trough huge earthquake, and aimed at the development of a port tsunami hazard map for Shimizu Port in Shizuoka Prefecture. This study conducted it with an objective of making proposal of the first version hazard map and the way of the map to be developed. Then, numerical simulations of tsunami propagations applying the nonlinear long wave theory was carried out and the corresponding sea area was from the Pacific Ocean to a port targeted. Besides, the movement of drifting objects due to the tsunami was reproduced with the distinct element method using results of flow velocity fields. We also examined the conditions under which vessels and containers started to drift. In the case of breakage of tethers mooring a vessel was introduced as a starting condition for ship drifting, and in the case of containers starting the drift, the collapse of stacked containers was applied the starting condition for drifting we already developed. By using this method, it is possible to analyze a series of processes until a ship or container turns into a drifting thing and drifts at the time of tsunamis arrival. Based on the results obtained from the calculations, we developed and proposed a port tsunami hazard map that could display the trend of drifting behavior of drifting objects and the landing point quantitatively. As a result, the risk of ships colliding with harbor structures in Shimizu Port and the risk of stopping of the port logistics function due to the closure of the channel due to the drifting of the container was shown.

References

The displacement field of inclined faults: Manshinha.L and D.E.Smyle, Bull Seism SocAmer61, 1971, pp.1433-1440

The Study Meeting for Massive Earthquake model of The Nankai Trough : Cabinet of Japan, 2014.11.. See also URL http://www.bousai.go.jp/jishin/nankai/model/.(Access 2018.12.28)

Numerical Evaluation of Tsunami Impact to Moored Ships in the Port of Shimizu: Haruo Yoneyama , Keiichi Ohgaki , TECHNICAL NOTE OF THE PORT AND AIRPORT RESEARCH INSTITUTE , 2009 March , No.1190

The Study on the Simulation of Collapsing and Drifting Group of Containers in Tsunami with Particle Methods: Yasuhiro Aida , Satoshi Hoshino , Koichi Masuda , Tomoki Ikoma , Hiroaki Eto , Proceedings of the Japan Ship Society of Naval Architects and Ocean Engineers lecture meeting (18) , 2014-05 , pp129-132

Acknowledgements

This work was supported by Mr. Subaru Hosoya of Fujita Corporation. I would like to express our gratitude.

Key words

Tsunami, Hazard map, Business Continuty

Study on surge control function of the artificial fishing reef in the irregular waves

Akito NAKAMURA[1*], Takafumi YAMAMOTO[2], Tomoki IKOMA[3], Koichi MASUDA[3], Tsuneo HONJO[4] and Yoshihiro SUENAGA[5]

[1]Graduate School, Faculty of Engineering, Kagawa University
2217-20 Hayashi, Takamatsu, Kagawa, Japan
[*]nakamura@mikuniya.co.jp
[2]Kaizansenri, Co, LTD.
[3]College of Science and Technology, Nihon University
[4]Seouchi-ken Research Center, Kagawa University
[5]Faculty of Engineering and Design, Kagawa University

As one of the Japanese politic measures for fisheries infrastructure development projects, fishing ground creation by the installation of the artificial reefs is carried out for a long time, and appears in some marine areas where resources production capacity shows a sign of the restoration[1)].

However, in the recent fisheries infrastructure development projects, fisheries ground creation, fishing port construction and any kinds of disaster prevention projects in the shore area become large, and the quantitative evaluation is the poor conditions about the disaster prevention function using artificial reef has in particular[2)].

The authors developed new type of artificial reef to perform the biological effect investigation (fish aggregation, adhesion of prey abundances and algae) and paid their attention to the surge control function of the artificial reef into after setting. Although it was grasped partially by the past experiment, the surge control function of the artificial reef is not established to quantitative evaluation and the utilization as a disaster prevention facilities.

In this study, we have inspected wave energy absorbing function of the artificial reef in the irregular waves by the hydraulic water tank experiment and examined to develop a newly disaster prevention technology like a submerged breakwater. As a result, we have confirmed that wave energy absorption efficiency improved by extending an artificial reef by twofold or more. Also, we pointed out it is effective the other artificial reef is arranged in a vortex flow area caused on the downstream side of the artificial reef arranged on the upstream side.

References

[1]Ministry of Agriculture, Forestry and Fisheries. (2016). Grant for support of agricultural mountain fishing village activation project, Retrieved February 21, 2019, from http://www.maff.go.jp/j/kasseika/k_project/

[2]Yoshihiro SUENAGA (2016). Development of Artificial Reef with Current Control Function to Improve Marine Environment, Kyusyu Environmental Evaluation Association, Journal of Environmental Evaluation, vol.45, pp.29-38.

Acknowledgements

We would like to express sincere thanks to Mr. K. Takasago (President of Takasago Fishery Co, LTD.), Mr. K. Sogo, (President of SUNX Co. LTD) and Mr. N. Yamaji, (Nihon Kogyo, Co, LTD.) for their valuable comments and suggestions. A part of this work was supported by Grant in aid of the Kagawa University.

Key words

Artificial reef, Surge Control, Wave Energy Absorbing Function

Development and Verification of the New Higher Performance Anchor Against Tsunami and Storm

Yosuke Oikawa[1*], Mitsuhiro Masuda[1], Kiyokazu Minami[1]
[1]*Tokyo University of Marine Science and Technology, 2-1-6 Etchujima, Koto-ku, Tokyo, Japan 135-8533*
**e-mail: m185002@edu.kaiyodai.ac.jp*

Background

In the long history of ships, the anchor has been used as a tool to anchorage the ship. In the Great East Japan Earthquake of 11th March 2011, the tsunami caused many ships to be landed on a wharf or to flow out to the port. Rikuryu-maru of Pacific Ocean Kisen Co., Ltd., which had been moored at Ofunato Port, immediately left the pier, dropped anchor near the center of the port. And, this vessel continued to stay by using the anchor in combination with the engine and survived the tsunami. [1] Thus, if the tsunami attacks and vessels can't be escape out from the port, it is possible that vessels can withstand to the tsunami by anchoring in the port. However, AC-14 type and JIS type which are typically used have problems with holding performance and stability. And, they can not necessarily be regarded as safe anchors which can withstand tsunamis. On other hand, a marine accident due to the dredging anchor has been occurred by using these anchors in storm. In this research, new type higher performance anchor which is effective to tsunami and storm was developed and verified about the holding performance.

Material and methods

In order to confirm the performance of the anchor, a water tank experiment was conducted using anchor models. For the experiments, JIS type, AC-14 type, DA-1 type, and new type (OM-1) were used. The experiment was conducted by connecting the weir to a load cell for measuring the holding resistance and pulling it with a winch. There are two ways of pulling; 1) the horizontal pulling experiment, and 2) the turn back experiment. From the experiment, the maximum holding resistance, holding resistance reaching distance, and penetration depth measured and evaluated.

Results

When anchors were pulled as usual, OM-1 type were better at holding resistance equal to or better than AC-14 type. In addition, when anchors were pulled in a different direction, JIS and AC-14, DA-1 types obviously lowered their holding resistance. In the case of OM-1 type, holding resistance did not change significantly even if the pulling direction was changed.

Conclusions

It was shown that OM-1 type has higher holding performance compared with AC-14 type and JIS type, DA-1 type anchors. And, it was shown that this new anchor could maintain the performance even if the pulling method was changed. In the future, it is necessary to verify whether OM-1 type is effective anchor to the actual operation and to prove that it is practical.

References

[1] *Sea and Safety No.552*, Information Magazine of The Japan Association of Marine Safety, pp.118-125, 2012-3.

Acknowledgements

I am grateful to I. Otani for assistance with the experiments and the data analyzation. This research was made possible by the Grant in Aid for Scientific Research B of the Ministry of Education, Culture, Sports, Science and Technology.

Key words

Anchor, anchorage, Ship, Mooring, Water Tank Experiment, Tsunami

Verification of the tsunami protection measures for the vessels moored at wharves against the backwash phenomenon

Wataru Takahata[1*], Mitsuhiro Masuda[1], Kiyokazu Minami[1]
[1]*Tokyo University of Marine Science and Technology, 2-1-6 Etchujima, Koto –ku, Tokyo, Japan 135-8533*
m185010@edu.kaiyodai.ac.jp

Background

When a tsunami attacks to coastal area, vessels moored at a wharf suffer serious damage. In fact, more than 20,000 vessels have damaged such as the landed on a wharf, the drifting and the collision due to the tsunami caused by Tohoku earthquake, 2011. There are two kinds of the first form of tsunami. These are the leading wave and the backwash. Thus, when considering the disaster prevention and mitigation of tsunami damage, it is necessary to conduct effective measures for both the leading wave and the backwash. In this study, the damage status at the time of the backwash occurrence of vessels moored at the wharf was investigated. Furthermore, the effectiveness of the proposal tsunami protection measures was investigated against the backwash.

Material and methods

The authors have been studying this problem by using the MPS method (Moving Particle Semi-implicit method) which is a kind of CFD. [1] The MPS method is a particle method for solving incompressible fluid. In this study, the backwash is simulated as the dam break phenomenon. It can reproduce the characteristics of the backwash such as the flow to the offshore and the drop of the water level.

Results

Authors proposed and verified protection measures by the install more mooring lines (IMML) [2] and the floating tsunami protection wharf (FTPW) [3], [4] to the vessel at the wharf. As a result, IMML was shown to be effective against the backwash. However, FTPW did not work enough depending on the outflow angle.

Conclusions

In the case of the vessel moored at the FTPW, it was shown that the flow velocity of the backwash significantly affect to the break of mooring lines. It was shown that a typical mooring method and IMML are effective to the flow angles of 0 degrees of the backwash.

References

[1] Koshizuka, S. and Oka, Y., Moving-Particle Semi-implicit Method for Fragmentation of Incompressible Fluid, Nucl. Sci. Eng., 123, pp. 421-434, 1996.
[2] Masuda, M., Minami, K., Masuda, K. and Ikoma, T., A Fundamental Study on Tsunami Damage Control of Moored Vessels Using the MPS Method, *Proc. of OMAE'13*, ASME, 11085, 2013.
[3] Masuda, K., Masuda, M., Minami, K and Ikoma, T., Masato OHNO and Fuminori NAKAMURA: Study on Development of the Floating Pier for Damage Protection Control of Ship in Tsunami, *Proc. of OMAE'14*, ASME, 24428, 2014.
[4] Masuda K., Masuda M., Minami K. and Ikoma T., On Optimal Method of Mooring Ship in Floating Tsunami Protection Wharf, *Proc. of OMAE'15*, ASME, 42164, 2015.

Acknowledgements

This research was made possible by the Grant in Aid for Scientific Research A of the Ministry of Education, Culture, Sports, Science and Technology.

Key words

Tsunami, Backwash, Vessel, Tsunami protection measures, MPS method

T07: Undersea vehicles, robotics, acoustics

T07-1: Undersea vehicles and robotics

AUV control algorithms for automatic searching for polynyas and surfacing

A. Bagnitckii[1*], K. Laptev[1]
[1] *Institute of Marine Technology Problems FEB RAS, 5a Sukhanova Str., Vladivostok, Russia, 690091*
**e-mail: bagn@marine.febras.ru*

Background

One of the most reliable means of the Arctic exploration is autonomous underwater vehicles (AUV) capable of sailing for a long time and surfacing from under continuous ice cover. Surfacing is mainly necessary to perform observation (using GPS, GLONASS, etc.) and communication sessions between AUV and control center. Common methods for surfacing in the Arctic seas (returning to dead reckoning coordinates, or aiming to an acoustic pinger) do not allow planning long subglacial missions for AUV. The purpose of the proposed control algorithms is to increase the capabilities and safety of the AUV sailing under the ice.

Material and methods

A polynya is an area of open water surrounded by sea ice. To automatically locate polynyas AUV must move at small depth using ice fathometer and assign coordinates obtained from the navigation system (including upward Doppler log) to the polynya coordinates when it is detected. The optimal AUV trajectory that minimizes search time must have form of a diverging spiral. If detected polynya has acceptable sizes, which can be considered safe for surfacing (at least 50-100 m long), then AUV moves to its center (considering an ice drift, sea current) and surfaces. If search time is running out but detected polynyas are still not inspected, AUV switches over to maneuver similar to flower starting from the center of the each polynya. The first tack of a flower is laid parallel to a direction of ice drift, and the second tack — perpendicular, what quickly gives information about length and width of the each polynya.

Results

The main factors are considered that have an effect on the decision-making algorithm for automatic searching for polynyas suitable for surfacing, and their inspection. Critical conditions have been defined, the implementation of which imposes certain requirements on the mission planned by the operator, as well as on the AUV control system. Algorithms for determining the coordinates and sizes of polynyas using the AUV onboard equipment (ice fathometer and Doppler lag) are proposed, and AUV maneuvering schemes (diverging spiral and flower) are shown to meet the set requirements in the absence or presence of complete information about polynyas coordinates.

Conclusions

Currently, the problem of automatic searching for polynyas is being actively solved by modeling software. The next step is the integration of algorithms into the AUV control system and trials.

Acknowledgements
The reported study is performed under support of the Far Eastern Branch of the Russian Academy of Sciences program of basic science research "Far East" (grant No. 18-5-054) and Program No. 29 "Advanced Topics of Robotic Systems" of the Presidium of the Russian Academy of Sciences.

Key words: AUV; polynya; control algorithms

Thermal stability of the cation exchanger KU-2*8

E. Belova[1,*], A. Rodin[2], I. Tananaev[3]
[1] A.N. Frumkin Institute of physical chemistry and electrochemistry of RAS (IPCE RAS), 31/4 Leninsky prospect, Moscow, Russia, 119071
[2] Scientific and engineering centre for nuclear and radiation safety (SEC NRS), 2/8 bld. 5 Malaya Krasnoselskaya str., Moscow, Russia, 107140
[3] Far Eastern Federal University (FEFU), 8 Sukhanova St., Vladivostok, Russia, 690090
*e-mail: skvortsov.ivan.68@gmail.com

The greatest danger of contamination of the World Ocean by radioactive substances is the testing of nuclear weapons. Other major sources of radioactive contamination of the World Ocean are global fallout of the products of atmospheric nuclear tests and technogenic radionuclides, which move through rivers into the sea from radiochemical plants for the reprocessing of spent nuclear fuel (SNF). Scientists of the FEFU and the CI FEB RAS have been tasked with developing modern technologies that ensure the radiation safety of Primorye and Vladivostok: to remove finally the accumulated liquid radioactive waste (LRW), to clean and rehabilitate the contaminated natural objects from radionuclides and toxic elements. An important task was to discover the promising sorption materials for extraction, concentration, separation from LRW on the basis of sea water of the most dangerous radionuclides: ^{137}Cs and ^{90}Sr.

One of the promising classes of ion-exchange materials for the purification of aqueous media from cations of radioactive elements is sulfonic cation exchangers, based on a copolymer of styrene with divinylbenzene – type KU-2*8. In some technological operations, such a cation exchanger may be in contact with nitric acid solutions, which may be accompanied by the evolution of heat and gaseous products of interaction. To exclude the possibility of a thermal explosion with such a contact, it is necessary to establish the limits of safe operation and maintenance, which requires information on the thermal stability of such systems.

In this work, we studied the thermal stability of KU-2*8 cation exchanger mixtures with 4 and 12 $mol \cdot L^{-1}$ nitric acid under isochoric conditions using the DSC method. It was determined, that the heat of interaction of the cation exchanger KU-2*8 with 4 and 12 $mol \cdot L^{-1}$ nitric acid in the temperature range less than 200 °C has a value of 310-320 and 1730-1890 kJ/kg, respectively. A two-stage heat generation process was noted for mixtures of cation exchanger KU-2*8 with nitric acid in the studied temperature range. Irradiation decreases the starting temperatures of exothermic processes, compared to unirradiated samples under similar conditions. For the sample of cation exchanger KU-2*8, irradiated up to the absorbed dose of 2 MGy, which is in contact with 4 $mol \cdot L^{-1}$ nitric acid under isochoric conditions, the temperature range of exothermic processes was 60-180 °C. The value of the thermal effect also increased to 430 kJ/kg.

The results of the study showed, that in order to ensure the safety of sorption processes with sulfonic cation exchangers, it is necessary to limit the process temperature and the concentration of oxidizer, depending on the dose of ionizing radiation absorbed by the sorbent, and to ensure the removal of the resulting oxidation products. The value of safe temperature should be determined from the thermophysical calculation of the sorption equipment, selected for the technological process, considering the kinetics of the proceeding oxidation processes.

Acknowledgements
The study was conducted at the expense of the Program of the RAS Presidium I.34, project 0137-2018-0051.

Key words
Cation exchanger KU-2*8; Differential scanning calorimetry (DSC); Thermal stability; Isochoric conditions

Creation of an underwater remotely operated vehicle for the implementation of laser induced breakdown spectroscopy in underwater measurements of the elemental composition of sea water and bottom sediments in real time conditions

S.S. Golik[1,2*], A.A. Iliyn[1,2], D.Yu. Proschenko[1,2], A.Yu. Mayor[1,2], Yu.S. Tolstonogova[1,2], V. V. Lisitsa[1,2], M.Yu. Babiy[1], N.N. Golik [1], A.V. Borovskiy[1]

[1]*Far Eastern Federal University, 10, Ajax Bay, Russky Island, Vladivostok, Russia, 690950.*

[2]*Institute of Automation and Control Processes, FEB RAS, 5 Radio, Str., Vladivostok, Russia, 690041*

**e-mail: golik.ss@dvfu.ru*

Nowadays the development of the shelf is becoming important, while along with the standard geochemical research methods; rapid research methods are required, including real-time analysis of the elemental composition of seawater and bottom sediments. In addition, the investigation of the biological productivity of marine waters, the carbon exchange cycle, and the environmental monitoring of marine and coastal water pollution is of considerable interest. Also, an important task to determine the trace concentrations of some critical elements and of the dissolved organic matter monitoring in the ocean [1]. In connection with the above, it is designed, developed and tested an underwater robotic system, allows the analysis of the elemental composition of seawater and sediment in real time condition. This robotic system complex consists of two main units: 1 - an underwater remotely operated vehicle (ROV) - carrier of the spectrometer (ROVS) with the following main characteristics: depth of immersion - up to 150 meters, maximum speed of immersion up to 1 m / s, maximum speed - up to 2 m / s and 2 – connected to the ROVS a laser induced breakdown spectrometer, which consists of a laser excitation source (Nd: YAG, diode pumped, double pulse with an energy of 50 mJ for each pulse, a wavelength of 1064 nm, a pulse duration of 12 ns and a pulse repetition rate of 1- 15 Hz, DF251, SOL Instruments), optical system, spectrum recording system (Maya HR4000 or 2000 Pro, Ocean Optics) and a microcomputer. The connection between the two main units and the surface control panel is carried out via Ethernet, the obtained spectral data are processed on the MATLAB platform. The elemental composition was measured using laser induced breakdown spectroscopy, which is a promising method for use as a field sensor for geochemical, ecological, surface and underwater sounding and provides a detection limit of up to 10^{-6} g/kg, depending on the measurement conditions and the chemical element being determined [2]. This underwater complex was successfully tested both in the laboratory and in-situ conditions in the Amurs Bay of Vladivostok.

References

[1] K. H. Coale, K. S. Johnson, S. E. Fitzwater, R. M. Gordon et al. *Nature*, 1996, **383**, pp. 495-501.

[2] D.A. Cremers, L.J. Radziemski “Handbook of Laser-Induced Breakdown Spectroscopy,” Wiley, 2013.

Acknowledgements

This work was supported by the grant of the Russian Science Foundation No. 14-50-00034 (creation of the equipment part), the Russian Foundation for Basic Research 17-02-00802A (spectral data analysis) and the Government Task 3.5415.2017 / VU and 3.5499.2017 / ITR, 3.5479.2017 / ITR, 3.6813.2017 / ITR (improvement of the software).

Key words

Spectrochemical analysis, ROV, LIBS

Application of the cylindrical glass-metal composite shells manufactured by spin casting method for pressure hulls

V. Goncharuk[1], A. Bocharova[2], I. Maslennikova[1], A. Ratnikov[2*], P. Starodubtsev[3], V. Osuhovsky[3]

[1]*Institute of Chemistry of FEB RAS, 159 Stoletia Vladivostoka ave., Vladivostok, Russia, 690022*
[2]*Far-Eastern Federal University, 8 Sukhanova str., Vladivostok, Russia, 690091*
[3]*Pacific Higher Naval School named after S.O. Makarova Vladivostok, 6 Kamsky Lane, 690062*
**e-mail: ratnikov.aa@dvfu.ru*

Improving competitiveness of deep sea underwater vehicles with submergence depth up to 6000 – 6500 m demands application of principally new construction materials with significantly improved operational features. A new composite nano-material on the basis of glass, unparalleled in the world, is invented by V.V. Pikul, glass-metal composite, as a layered material, in the process of manufacturing of which an outer metal shell, glass layer and inner surfacing are formed layer by layer from metal melt and glass by spin casting method. An outer metal shell firmly connected with a glass layer while cooling, due to a higher thermal expansion coefficient, decreases its dimensions more intensively than the glass layer, thus constricting the surface of glass layer, preventing extension strains and excluding surface microcracks. Outer and inner shells exclude immediate contact of the glass layer with external environment, isolating it from moisture and other negative effects. Inner defects are eliminated by forming glass layer under the pressure. As a result, in the glass-metal composite there forms a defect-free glass layer with spatial nanostructure, which results in the fact that the material in general gets a high durability and impact endurance. In order to manufacture layered aluminum-glass-aluminum cylindrical shells by a method of centrifugal molding a laboratory facility was created. The goal of this research is the determination of an optimal technological operations modes of cylindrical shells manufacturing by spin casting method on the laboratory facility, an optimal temperature of glass melts filling, the temperature of metal shells, providing durable connection of glass and metal, the parameters of the intermediate layer, which is originated due to diffusion on the metal-glass borderline. The research of the interlayer conducted by electronic scanning microscopy shows the durability of connection is provided due to forming of diffusion layer on glass-aluminium borderline, having thickness of 2-4 micrometers and eliminating surface micro-defects of the glass. Applicability of the cylindrical glass-metal composite shells manufactured by spin casting method for pressure hulls to withstand without failure the loading with a comprehensive pressure of up to 100 MPa in static and dynamic modes was confirmed by successful hydraulic testing. Density value in relation to outer content for the obtained glass-metal composite shells is 10-20% lower than the corresponding value (826 kg/м^3) for submersibles durable carcasses manufactured from highly durable titanium alloys, which are nowadays the most effective materials for large-sized durable carcasses. This fact confirms applied significance of glass-metal composite application in underwater vessel engineering.

References

1. Pikul V.V. Sheet glass-metal composite manufacturing technique // RF Patent № 2505495. 2014. Bulletin № 11
2. Bocharova A.A., Goncharuk V.K., Ratnikov A.A. Proceedings of the Twenty-sixth (2016) International Ocean and Polar Engineering Conference, Rhodes, Greece, 2016. – P. 237-241.

Key words
Glass-metal composite, cylindrical shells, spin casting method

Application of USV for environmental monitoring of the Sevastopol Bay

A.N.Grekov[1*], I.E. Shishkin[1], V.V. Nikishin[2]
[1]*Institute of Natural and Technical Systems, 28 Lenina str., Sevastopol, Russia, 299011*
[2]*Sevastopol National Technical University, 33Universitetskayastr., Sevastopol, Russia, 99053*
**e-mail: grekov@protonmail.com*

The problem of the marine environment pollution is extremely relevant. In coastal zones, there is a massive discharge of agricultural, industrial and municipal wastewater under conditions of a significant increase in the load on the shelf zone. Identification and determination of the scale and characteristics of pollution, as well as the speed and direction of their transfer in surface and deep waters are important tasks. To solve this problem, we proposed to use unmanned surface vehicles (USV), allowing carrying out long-term, systematic observations of the marine environment, identifying anomalies in these indications and adaptively adjusting the measurement grid step and carrying out an extended series of measurements.
At the first stage of the work, we proposed an intelligent system concept for selecting the optimal grid density of stations when conducting automatic monitoring of the aquatic environment main parameters in order to detect their anomalies and evaluate quantitative and qualitative indicators, including determining the spatial and temporal characteristics of the field under study. Optimal density control map of station locations is generated by simulation. The work of the algorithm for constructing maps of optimal intervals for monitoring the parameters of the aquatic environment is illustrated by the example of constructing a heat map for conducting measurements relevant to the bay of the city of Sevastopol. The constructed maps of optimal measurement intervals are the input material for the development of USV control systems for solving problems of time optimization, energy saving and selection of a sufficient number of monitoring stations.

Computer simulation model USV has been developed for calculating the environmental resistance at various speeds, and work scenarios in order to optimize energy costs during research missions. We proposed a mathematical model of the USV plane motion and solution of the USV trajectory control problem and course stabilization. The algorithm for correcting the data obtained by a magnetometer, used as the main measuring instrument for the USV course orientation, was developed and tested. Algorithm and software for data processing and calculating the course of the USV were developed.

References
Y.E.Shishkin, A.N. Grekov, *Monitoring Systems of Environment*, 2018, **vol. 4**,pp. 63–69. doi:10.33075/2220-5861-2018-4-63-69.

Acknowledgements
The reported study was funded by RFBR and Government of the Sevastopol according to the research project № 18-48-920018 p_a

Key words
Unmanned Surface Vehicles, Environmental monitoring, Path planning

Investigation of underwater pipeline inspection method for AUV based on laser line recognition

A. Inzartsev[1], A. Pavin[1], G. Eliseenko[1], M. Panin[1*], V. Bobkov[2], M. Morozov[2]
[1]*Institute of Marine Technology Problems FEB RAS, 5a Sukhanova Str., Vladivostok, Russia, 690091*
[2]*Institute of Automation and Control Processes FEB RAS, 5 Radio Str., Vladivostok, Russia, 690041*
**e-mail: kars25rus@mail.ru*

Background

Underwater pipelines (UP) is the part of underwater oil/gas production equipment. The pipeline operation implies periodic survey of their state. The application of AUV for this purpose makes it possible to automate and to reduce significantly the survey procedure cost. The model of an AUV behavior during UP survey may consist of two stages: search and general survey with the help of long-rage sonars and subsequent detailed inspection. During detailed inspection the AUV should move at small distance from the pipeline to provide necessary measurements. This report describes the second stage of automated survey.

Material and methods

The work assumes that exact distance to UP is determined by analysis of the visible line shape from a laser emitter installed on board the AUV and illuminating the pipeline. Further, this data is used to organize precise moving of the AUV along the UP.

The algorithms of source data processing and control were debugged by the modeling method. The high-performance modeling complex (MC) had been used for modeling. It was conjugated with navigation and control system (NSC) of real AUV. The tasks of external environment modeling and analyses of laser line shape were performed on MC side. The AUV dynamic model and control agents of tactic level were operated on NSC side. The control agents use the data from recognition system to perform the inspection. This debugging scheme allows execution of modeling without any modification of NSC software.

Results

The model experiments on inspection missions were carried out for many placement options of pipeline on a sea bottom. Processes of inspection of straight pipeline, curved, partially covered by ground, and located at some distance from the bottom were investigated. The laser recognizer was determining of location of highest top point of UP for its visible areas. It allowed successfully stabilizing the AUV motion with respect to the pipeline. The buried UP areas were being inspected by the AUV search movements. This work reviews and analyses obtained material for many cases of UP location on a sea bottom.

Conclusions

The model experiments have shown the practical applicability and effectiveness of the investigated algorithms and methods for the inspection of UPs.

Acknowledgements
The reported study is performed under support of the Far Eastern Branch of the Russian Academy of Sciences program of basic science research “Far East” (grant No. 18-5-014), Program No. 29 "Advanced Topics of Robotic Systems" and Program No. 30 "Theory and Technologies of Multi-level Decentralized Group Control under Confrontation and Cooperation" of the Presidium of the Russian Academy of Sciences.

Key words
AUV, pipeline, tracking

Development of PLM systems for designing marine robotized devices and underwater vehicles

Olga V. Kolesnikova[1], Mikhail V. Omelianenko[1*], Vladimir E. Lelyukhin[1]
[1]*Far Eastern Federal University, 8, Sukhanova Str., Vladivostok, Russia, 690091*
**e-mail: omelianenko.mv@students.dvfu.ru*

An important role for the accumulation of knowledge and the development of marine technologies in the modern world is assigned to various robotized systems and autonomous underwater complexes. Therefore, their creation and effective use is an urgent task. The creation of such systems and complexes is a long multi-stage process, which includes the formation of the concept, design, development of technologies and production. An effective tool for managing design, technological and production information are Product Data Management (PDM) and Product Lifecycle Management (PLM) systems [1, 2]. Next, we use the common combination of PDM/PLM abbreviations.

The PDM system is able to store information about the product only at any particular point in time. If you make any changes, prior information is lost forever. To solve this problem, PLM systems are used to record and store information both before and after the change.

In fact, the PLM system is like a superstructure over the PDM system, which collects and captures the resulting image of the product at the moments of making changes. To transfer information about the product between the PDM and the PLM, there is a set of two types of documents. These are drawings and specifications. If the drawing contains almost all the information in an implicit form, then the specification displays only part of the relationship between parts and assembly units.

The drawings contain almost all the information, some of which are implicitly. Specifications, albeit explicitly, describe only the composition of the parts included in the assembly unit. In this case, implicitly defined in the drawing, the relationship between the parts is lost.

Thus, for a full transfer of information about the composition and structure of the product between the PDM and PLM, a system of clearly defined relationships is required. This system should provide an unambiguous representation of the geometric structure of each part in accordance with the configuration of the assembly unit. In addition, the relationship in the specification describes only one dimension (one degree of freedom), and the real relationship can be described only using six degrees of freedom [2, 3].

The report proposes the use of structural-parametric representation of geometric information about the details in the space of 6 degrees of freedom in PDM/PLM systems [2, 3, 4].

References

1. Stark, John (2016). Product Lifecycle Management: Vol 2. The Devil is in the Details. Springer. ISBN 978-3-319-24434-1.
2. V. E. Lelyukhin, O. V. Kolesnikova, A. M. Shpilev, Yu. A. Davydov. Digital technologies in the management of design and production. «Scholarly Notes of Komsomolsk-na-Amure State Technical University». Issue IV - 1(36) 2018 «Engineering and Natural Sciences», p. 33 – 39) ISSN 2222-5218
3. Lelyukhin V.E., Kolesnikova O.V. Structural and parametric space of ship structures and technologies in PLM systems. date of the application:Far Eastern Federal University 2019. № 1(38). p.99-107. ISSN 2227-6858. DOI.org/10.5281/zenodo.2578700. URL: https://e.mail.ru/attachment/15517383990000000199/0;1
4. Lelyukhin V.E., Ignatiev F.Yu., Drenin A.S., Kolesnikova O.V. Geometry for the description of real machine parts // Modern high technologies. - 2018. - № 8. - p. 95-99; URL: http://top-technologies.ru/ru/article/view?id=37126 (date of the application: 04/21/2019)

Key words: Marine technology, object engineering, Product Lifecycle Management

The Research of Probability of Extended Ground Objects Inspection by the Use of Tethered Underwater Vehicle in the Mode of Movement Conjointly with Delivery Vessel

V.V. Kostenko, I.G. Mokeeva, A.I. Sebto*
The Institute of Problems of Marine Technologies, Far Eastern Branch of Russian Academy of Sciences, Sukhanova st. 5a, Vladivostok, 690091, Russia
** e-mail: SebtoAIU@marine.febras.ru*

The propulsion-steering system (PSS) specifications correspondence with values, required for the compensation of reaction of delivery vehicle coupling cable determines the efficiency of employment of underwater remotely operated vehicles (ROVs). This paper examines the problem of estimation of PSS specifications, ensuring the designated maneuvering zone for unmanned underwater ROV relatively to the delivery vessel or garage in mode of the system's movement along the extended ground object. The estimation is based on the results of computation of coupling cable tension in flow due to stationary stream and joint moving of tethered system "delivery vessel-garage-vehicle". This tension in aggregate with the hydrodynamic resistance of the ROV's hull predetermines the propulsion performance specifications as well as requirements to the power system of vehicle and tethered system in whole. The paper offers the algorithm of computation of coupling cable tension in stationary stream, based on the numerical integration of inextensible flexible fiber equations. The example of the proposed method using for the calculation of the versions of tethered system.

References

1. Merkin, D.R, Introduction to the mechanics of the flexible thread.// Moscow, publ. "Science", 1980.
2. Kostenko, V.V and Mokeeva, I.G, Choise of ROV's thruster set power according to footprint's radius on steady motion // Proceeding "Ocean- 94" , 1994, Conf. – Brest, France, Vol.2 – pp. 34-37.
3. Kostenko, V.V and Mokeeva, I.G, Research of tie cable influence on ROV's maneuverability// Scientific and Technical Journal about exploration ocean problems 2009. №1 (7). pp.22-27
4. Pantov, EN, Mahin, NN and Sheremetov, BB, Fundamentals of the theory of motion of underwater vehicles.– Leningrad, publ. "Shipbuilding", 1973.
5.

Key words
Tethered system; remote operated vehicle; cable tension.

Production management of marine robotic systems and devices

Vladimir E. Lelyukhin[1], Olga V. Kolesnikova[1], Artyom S. Drenin[1]*
[1]Far Eastern Federal University, 8, Sukhanova Str., Vladivostok, Russia, 690091
*e-mail: art-drenin@yandex.ru

The use of robotic devices in the study of the ocean and the processes occurring in it is required when human use is difficult or impossible. The development of the production of these devices is an important task. The complexity of these devices places high demands on the organization of their production and quality of manufacture. Production of undersea vehicles and marine robotic systems by its nature is small-scale and job shop character and is particularly difficult to manage. Therefore, the relevance of the search and practical use of production effective methods of organization is high.

Information systems of the classes ERP, APS, MES are applied to the organization and planning of such production [1]. Usually planning is divided into strategic, tactical and operational. Operational planning is the most important for organization of production. But it is the most difficult and belongs to the class of NP - time complete problem [2]. In addition, the plan may require adjustments due to changes in situation at the enterprise. In the process of management in small-scale and single production in the event of deviations from the plan, a serious problem is the "reorientation" of the complex production structure of the product in the planning space. This requires a fundamental change in the entire structure of the plan, which leads to the restructuring of the schedule for each workplace. The authors developed a model of end-to-end planning of manufactured products with subsequent operational adjustment (regulation) of the plan in the workplace or individual production areas in the event of inconsistencies [3].

In the model, the control device is a set of units, the result of which is a plan for organization of production process. Production is the object of managements; whose task is to implement the developed plan. The formation of the production plan was repeatedly considered by the authors [4].

The operational plan for enterprises with a single nature of production has a low workload loading rate and many intervals of their idle time. The authors propose to use the time of unemployment of jobs for the rapid redistribution of work in case of deviations from the plan. Timely detection of deviations, as well as the presence of unoccupied periods of time in the equipment operation schedule allows you to add unfulfilled operations.

In enterprises with single-shift and half-shift operation, in cases where it is impossible to adjust the plan parameters during a work shift, it is proposed to use the free time between shifts in order to fulfill daily plan tasks.

References

1. G. Halevi, Industrial Management—Control and Profit, Lecture Notes in Management and Industrial Engineering 1, DOI 10.1007/978-3-319-03470-6_1, Springer International Publishing Switzerland 2014
2. Wang L. Machine availability monitoring and machining process planning towards Cloud manufacturing. CIRP Journal of Manufacturing Science and Technology 6(4) 2013. pp.263–273. ISSN: 1755-5817
3. Lelyukhin V.E., Kolesnikova O.V., Kuzminova T.A. Operational adjustment of plans for small-scale and single production using the dispatch mechanism. //Automation in industry. M.: Publishing house "InfoAutomotive», № 12, 2016. c. 32-35.
4. Lelyukhin V.E., Kolesnikova O.V. Integrated system of design and technological preparation and production management on 1C:SCP platform. //Automation in industry. M.: OOO Publishing house "Infoautomotive»– 2015. – №9 – c. 34-38

Key words: Marine technology, object engineering, production management

Tansuo-100: Portable Autonomous Underwater Vehicle

Shuo Li[1*], Junbao Zeng[1], Yiqun Wang[1]
[1]*State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China,110016*
**e-mail: shuoli@sia.cn, zengjb@sia.cn, wangyiqun@sia.cn*

The emergence of Autonomous Underwater Vehicle (AUV) provides a stable, long-ranged and highly effective platform for continuous observing and spatial sampling in the marine environment. Portable Autonomous Underwater Vehicle is one type of AUV, which is small-sized, modular, and low-cost for the application of simultaneous observation of hydrological, topographic and related chemical elements in the shallow water. Because it is light-weighted and easy to handle, Shenyang Institute of automation, Chinese Academy of Sciences (SIA) has developed the Tansuo-100 (Explore) AUV, which can keep a stable attitude, provides fast response to changes of targets and carries a variety of sensors for scientific investigations. Tansuo-100 is 100 m depth rated with 0.2 m in diameter, and a length of 1.7 meter. The weight is approximately 50 kilograms. The normal operational speed is 3 knots and maximum speed is 5 knots. The maximum range of its movement is 70 kilometers at the speed of 3 knots. The primary observation sensors are Conductivity, Temperature, Depth (CTD) and Bathymetry/Side Scan Sonar (BSSS), the optional sonars include Acoustic Doppler Current Profiler (ADCP), video cameras, turbidity sensors and other modular payloads.

Tansuo-100 adopts a distributed structure, which can be mainly divided into two parts, one part is the control computer which is responsible for the vehicle's motion control, the other part is the payload computer which is responsible for collecting data. Two parts communicate with each other via network. Tansuo-100 can communicate with mobile control console by Iridium satellite, radio, Wi-Fi and umbilical cable. Iridium satellite communication is only used to transmit navigation data when it ends its task or is in emergency situations. Radio can be used to remote control AUV when it is close to control console. Wi-Fi is used to upload the mission file and download the observe data.

Tansuo-100 has succeeded in many sea trials. Recently we are focused on conducting multi-AUV team for cooperative observation of the marine environment. Tansuo-100 AUVs are used for cooperative observation of Harmful Algal Blooms (HABs) in the lake within the distribution area, which is characterized by an unusually hot zone with chlorophyll concentration. According to the results of simulation and lake trials of multi-AUV sampling and mapping, the tansuo-100 performs high adaptability to synchronization-based survey and environmental distribution.

References

Junbao Zeng, Shuo,Li,Yiping Li,et al. Research on dynamic modeling and predictive control of portable autonomous underwater vehicle[C], Proceedings of the OCEANS 2017MTS/IEEE Conference, September 18-21, 2017, Anchorage, USA.
Junbao Zeng, Shuo Li, Yiping Li, et al. Performance of the Portable Autonomous Observation System[C],Proceedings of the OCEANS 2014 MTS/IEEE Conference, April 7-10, 2014, Taipei.

Acknowledgements

This work was supported by the National 863Program 2011AA09A105.

Key words:
Marine environment, Autonomous Underwater Vehicle, Cooperative observation

Motion models of autonomous underwater robot propulsion systems for trajectory survey near the seabed

A. Medvedev
Institute for Marine Technology Problems FEB RAS,.5a Suhanova Str., Vladivostok, Russia, 690091
e-mail: auv@list.ru

The use of an autonomous underwater vehicle (AUV) for sonar viewing and the seabed photo-topography, bottom hydro-physical surveying is associated with the organization of equidistant motion from the bottom and overcoming vertical obstacles. When moving in a changing terrain with slope angles up to 20-25 degrees and differences of depths of 20-25 meters, it is necessary to provide a target equidistant trajectory by means of an effective propulsive system and a spatial orientation system.

Equidistant motion was modeled for two main modes: motion along a slope with a pitch angle corresponding to a slope angle; with overcoming an obstacle reactively with a constant or variable robot velocity. The mode of motion is selected depending on the size of the slope steepness, which is calculated on the basis of data from the multipath echolocation system model at each point of the trajectory. To compare the efficiency of equidistant motion, two variants of the propulsion system are used: traditional stern propulsion complex that provides control of velocity, depth (distance to the bottom) and heading; propulsion complex providing velocity and heading control, and a pendulum-type device for creating a control moment in a vertical plane (pitch control), equivalent to a controlled moment of stability.

Accepted models and motion control algorithms allow obtaining motion simulation data exactly in the mode of instant response at a safe distance from the obstacles corresponding to reality. Through the traditional control propulsion system when maneuvering in a vertical plane is associated with the appearance of sufficiently large attack angles. This leads to a slight increase in hydrodynamic resistance and to an increase in the energy consumption for motion. The control propulsion system with a pendulum device is devoid of this drawback, since control is exercised by creating a pendulum moment without a vertical control force component. In addition, in this case, the control torque is equivalent to the moment of own robot stability, which ensures a compromise of requirements for stability and accuracy of motion.

The implementation of control through a pendulum device requires additional study, taking into account AUV design features and the possibilities of placing on board the corresponding mechanical drive. The simulation results provide an optimistic estimate for this.

References

L. Kiselev, A. Medvedev, Comparative analysis and optimization of AUV dynamic properties for various projects and configurations, *Underwater studies and robotics*, 2012, №1(13), page 24-35.
L. Kiselev, A. Medvedev, On the parametric relations of hydrodynamics and motion stability of an autonomous underwater robot, *Underwater studies and robotics*, 2013, №1 (15), page 33-39.
A. Inzartsev, L. Kiselev, V. Kostenko, Underwater robotic systems, *Systems, technology, application. Vladivostok: Dalpress*, 2018, page 367.

Acknowledgements

This work was supported by L. Kiselev

Key words

Underwater robotics, autonomous underwater vehicles (AUV), motion control, dynamic models, bottom relief

Development of methods for underwater units hulls fabrication

M. Mishchenko[2], V. Goncharuk[1], I. A. Ratnikov[2]*, M. Nagaeva[3], P. Starodubtsev[3]
[1]*Institute of Chemistry FEBRAS, 159, Pr. 100-letiya Vladivostoka, Vladivostok 690022, Russia*
[2]*Far Eastern Federal University, 8, Sukhanova str., Vladivostok 690091, Russia*
[3]*Pacific Higher Naval School named after S.O. Makarova Vladivostok, 6 Kamsky Lane, 690062*
**e-mail: ratnikov.aa@dvfu.ru*

The technology for fabrication of hulls of underwater units used at different ocean depths has been developed. Such a technology consists of three main stages [1, 2]. The first stage includes preliminary selection of glass compositions, development of methods of glass production, and studies of mechanical and physical–chemical properties of the produced glasses used in fabrication of underwater unit hulls. At the second stage, the methods of fabrication of underwater unit hulls by means of metal–glass welding using a centrifuge were examined. At the third (final) stage, the parameters of glass composite annealing and cooling were determined.

In view of production of the glass layer in composite materials of the metal–glass–metal type, the possibilities of synthesis of silicate glasses, whose strength would allow fabrication of hulls of underwater units capable to be operated in the deepest areas of the World Ocean, were investigated. However, such a composite is characterized with low viscosity only at temperatures from 1450 to 1550 °C, which makes expensive the production of composite materials of the metal–glass–metal type by means of centrifugal casting. That is why, in fabrication of hulls of underwater units to be operated at intermediate (down to 7000 m) and smaller (down to 3000 – 5000 m) depths, when requirements to strength parameters are not so strict, the fabrication cost is of primary importance. The present studies resulted in production of feasible glasses with casting temperatures from 1300 to 900 °C, whose synthesis cost was substantially lower than that of glasses used at maximal depths.

As was shown at studies of formation of the glass–metal composite by the rotation method at the second stage of glass production, over the whole process duration, metal surface wetting by the melt and melt spreading over the surface, chemical interaction of the melt components with the metal surface, and diffusion, diffusion–chemical, and other interactions proceeded much more easily and at a substantially lower cost.

In the process of further cooling (in the course of the melt transition to the solid glasslike state), the internal stresses caused by differences in dilatometry and mechanical properties of the metal, intermediate layer, and glass (technological stresses) that remain even upon attainment of room temperature (residual stresses) are significantly lower in the composite material using fusible glasses than in those applied at maximal depths.

References

1. Pikul V.V., Naumov L.A., Goncharuk V.K. Method of fabrication of the shell of a strong hull of the deep-water device // Russian Patent No. 2337036, 27.10.2008. Bull. No. 30.
2. Pikul V.V., Goncharuk V.K. and Maslennikova I.G. A Cylindrical Shell Made of Glass-Metal Composite // Applied Mechanics and Materials. 2015. V. 756 P. 230-235. doi:10.4028/

Key words
Glass-metal composite, cylindrical shell, spin casting method

Mechanical and physical–chemical properties of the composite glass layer

M. Mishchenko[1], V. Goncharuk[2], I. A. Ratnikov[3]*, M. Diagilev[1], V. Buravlev[1]
[1]*Pacific Higher Naval School named after S.O. Makarova Vladivostok, 6 Kamsky Lane, 690062*
[2]*Institute of Chemistry FEBRAS, 159, Pr. 100-letiya Vladivostoka, Vladivostok 690022, Russia*
[3]*Far Eastern Federal University, 8, Sukhanova str., Vladivostok 690091, Russia*
**e-mail: ratnikov.aa@dvfu.ru*

The expansion of research in the World Ocean, there appears a task to create deep sea underwater vehicles for working at the depths more than 6500 m, which demands significant increasing of vessel materials strength. The glass composite developed by Prof. Pikul during the late 20th century comprises a high-strength construction material consisting of glass layers located between metal layers whose surfaces are strongly affixed to each other. High strength of glass–metal composite in combination with its relatively low weight enables one to create unique constructions of deep–water, overground, underground, and outer space engineering facilities. Engineering units operated in deep water become capable to function without using extra volumes providing the buoyancy. The glass composite strength is determined by that of the glass present in its composition. The possibility of imparting the inorganic glass with an extremely high strength attaining 10.4 GPa was corroborated by the results of basic studies performed at the Ioffe Physical–Technical Institute RAS [1]. The glass mechanical properties (Young modulus and density) determining the hull strength and the possibility of its application in deep ocean have been investigated. The mechanical and contact–ultrasound methods were used to determine the Young modulus. The averaged values of many measurements of the density, Young modulus, and other strength characteristics of the glasses that were used in fabrication of multilayer hulls of underwater devices are presented. Aside from strength, glass must be characterized with thermal–physical (viscosity, thermal expansion coefficient – TEC) and physical–chemical properties associated with the process of glass–metal composite fabrication.

The present report describes the results of studies of viscosity and thermal expansion coefficients for the selected glass compositions. Viscosity appears to be the most important physical–chemical property of the glass determining the whole process of the glass composite formation. It is related to such technological properties as solidification rate and fluidity. Since its measurement over the whole temperature range 900 – 1550 °C is rather labor-consuming, the temperature intervals of viscosity reference changes rather than the viscosity itself were measured. Studies of the thermal–physical properties of the glasses resulted in establishment of important technological parameters for fabrication of hull shells made of glass–metal composite – the minimal temperature of glass molding (1450°C), the temperature range of glass composite annealing (560–630°C), and the value of thermal expansion coefficient. The strength characteristics and the density of the selected composition of the silicate glass and other promising glasses have been determined.

References

1. Pukh V.P., Baikova L.G., Kirienko M.F. et al. Atomic structure and strength of inorganic glasses // Physics of Solid State. 2005. Vol. 47. No. 5. P. 850–855.

Key words
Glass-metal composite, cylindrical shell, glass

Strain-stress analysis of layers joints glass-metal composite pressure hulls of deep sea underwater vehicles

A. Ratnikov[1]*, A. Bocharova[1], V. Goncharuk[2], A. Karpachev[3]
[1]*Far-Eastern Federal University, 8 Sukhanova str., Vladivostok, Russia, 690091*
[2]*Institute of Chemistry of FEB RAS, 159 Stoletia Vladivostoka ave., Vladivostok, Russia, 690022*
[3]*Pacific Higher Naval School named after S.O. Makarova Vladivostok, 6 Kamsky Lane, 690062*
**e-mail: ratnikov.aa@dvfu.ru*

Glass metal composite is a composition material consisting of a glass layer embosomed between metal shells. In the process of its manufacturing a durable connection of glass layer and shells is provided and necessary conditions for forming glass layer without surface microcracks are created. As a result, glass layer and glass metal composite obtain in general an exceptionally high shock resistance and durability having a relatively low weight.

In the process of forming a cylindrical shell from glass metal composite the glass melts having the temperature of more than 1000 ºC cools down to the normal temperature of 20 ºC. Forming of cylindrical composite shell happens under the influence of axially symmetric field of temperature change in time. Mathematical model of the cylindrical shell deformation includes fundamental equations suitable for every shell layer, equations of condition characterizing individual mechanical and thermophysical properties of layers materials, conditions of layers conjunction and boundary conditions.

The deformation part of the problem of the glass metal composite cylindrical shell formation is solved beginning from the temperature of glass transition to the temperature of complete cooling (20 ºC). The processing method of glass metal composite formation includes the time of full relaxation of disturbances during the temperature of glass transition. As a consequence, the initial conditions of the deformation part of the problem solution are the conditions of the total absence of disturbances in the layers of glass-metal composite shell. Counting of the displacements and deformations also starts from the time of the absolute relaxation of the disturbances. That is why the initial conditions of the deformation part of the shell formation include the conditions of the total absence of displacements, deformations and the speeds of their change.

The essence of this model is that every layer is considered as an independent shell of constant depth, which is influenced by adjoining layers or environment. The obtained system of ordinary differential equations is in full accordance with continuum mechanics fundamental equations, which clearly reflects physical patterns of the shell material deformation. At the same time the accuracy of assignment of boundary conditions is increasing. For this purpose the materials parameters are taken as integrally-averaged for a definite temperature segment. The final solution is found by summing up all the solutions found in each interval. The main result of this work is that it was determined that maximal shear and detachable strains on the layers conjunctions are dramatically lower than a breaking one.

References

1. Bocharova A.A., Ratnikov A.A. Proceeding of the 2nd International Conference of Advanced Materials, Mechanical and Structural Engineering (Je-Ju Island, South Korea), pp. 210-205 (2015).

Key words
Glass-metal composite, cylindrical shell, strains determination

The Future of Robotics in Deep Water Marine Mining

J.C. Wiltshire
University of Hawaii, USA
**e-mail: johnw@soest.hawaii.edu*

Over the past few decades high grade deposits of manganese nodules, poly metallic sulfides and manganese crusts have been located on the seafloor and mineral claims for these resources have been filed by many nations with the International Seabed Authority. Given grades of key metal such as cobalt (key for electric vehicles), nickel, copper, silver and gold, which in some cases are several times higher than what is currently mined on land, it would seem a mining rush would be in order. At the same time, world population is growing, slated to reach 10 billion by 2050. The population is getting on average older and wealthier. It is using more resources at a time when grades of traditional land based mineral deposits are declining. On the face of it, this would seem to make marine mining soon inevitable, yet none of the world's largest 20 mining companies has a major marine mining program. The reason is that when risk is calculated in the way mining companies evaluate new projects, most marine mining projects are marginally economic at best with the exception of diamonds, sand and gravel and shallow water placers. To improve this situation, perceived risk must be reduced by technology. This is largely robotics. It starts with AUV exploration technology, moves to automated robotic mining systems and ships, advanced processing technologies and automated environmental surveys and mitigation. Work is progressing on each of these fronts and will be briefly described. Future marine mining will be dominated by smart, connected, highly adaptable, resilient new deep-sea robotic technology.

Key words
Robotics, deep water, marine mining

Development of algorithm for coordinating of navigation systems of the AUV group during their move in a desired formation

D.Yukhimets[1], E.Mursalimov[2*], B.Shuvalov[2]
[1] *Institute of Automation and Control Processes FEB RAS, 5 Radio Str., Vladivostook, Russia, 690041*
[2] *Institute of Marine Technology Problems FEB RAS, 5a Sukhanov Str., Vladivostook, Russia, 690091*
**e-mail: murs@dvo.ru*

Currently, one of the promising directions of research in the field of underwater robotics is the creation of control systems for groups of autonomous underwater vehicles (AUV), which can significantly increase the performance of various inspection operations [1]. One of the popular strategies of group control of the AUVs is the leader-follower strategy, in which only one of the AUVs, a leader, has information about the mission, and the rest follow the leader, keeping their position in the formation. The advantage of this strategy is a minimization of the transmitted data between the AUVs, that it is extremely important in the case of using acoustic communication channels that have a low data transfer rate. At the same time, the implementation of the motion control systems of each individual AUV is also simplified, since every AUV-follower must just maintain its position relative to the AUV-leader.

However, this strategy has problems that must be solved in the process of synthesis the control system of the AUV group. The first problem is the limited bandwidth of the acoustic communication channels, which makes it impossible to update the position of the leader AUV with a frequency enough for precise control of the follower AUV motion. The second problem is that the navigation systems of each AUV of the group must be synchronized with each other in order to ensure a correct calculation of the position of each AUV-follower. This is relatively easy to do if each AUV-follower has a high-precision hydroacoustic navigation system. However, the use of such systems on each AUV of the group significantly increases their cost. Therefore, it is advisable to use the specified high-precision navigation system only on the AUV-leader and cheaper inertial navigation systems on the follower AUVs. In this case, the problem arises of correcting of these inertial navigation systems of the follower AUVs in order to eliminate the accumulation of errors in the position and orientation and formation disruption, or even collisions between the AUVs of the group.

Thus, the following problem is solved in the work. Suppose there is a group of AUVs, one of which is the leader and has information about the mission being carried out. The rest of the AUVs should move behind the AUV-leader forming the structure of a given geometry. At the same time, the AUV-leader has a high-precision hydroacoustic navigation system that allows to define the position of the AUV and to transmit this data to the follower AUV with a low frequency. And the follower AUVs have inertial navigation systems that calculate the position of these AUVs based on the measured motion parameters (linear and angular velocities) and the orientation of the AUVs. These navigation systems accumulate the error in determining the coordinates of the AUV, which can lead to errors in maintaining a desired formation. Therefore, it is necessary to develop a method for correction the navigation systems of the follower AUVs, ensuring their continuous coordination with the leader AUV position.

To solve this problem, an algorithm is developed to fuse of data from the inertial navigation systems of the follower AUVs with data from the AUV-leader as well as external measurements obtained from onboard video cameras. These external measurements are necessary in order to associate the coordinates of the AUV-leader with the coordinates generated by the navigation system of AUV-follower. To implement these external measurements, it is assumed that there is a light beacon on the AUV-leader that will be visible from all the follower AUVs. In this case,

the direction from the AUV-follower to the AUV-leader is the data that is used as external measurements. If the data of the position of the AUV-leader is not consistent with the position of the AUV-follower received from its inertial navigation system and the direction to the AUV-leader obtained from the onboard video camera, then the coordinates of the AUV-follower are corrected. The integration algorithm was developed based on an extended Kalman filter [3], which model considers possible delays in the receipt of data from the AUV-leader.

To test the developed algorithm, a simulation of the motion of three AUVs in a desired formation using the V-REP environment was carried out. The simulation results showed that the algorithm proposed in the work allows to provide the coordination of the navigation systems of the follower AUVs with the navigation system of the AUV-leader, and thus the accurate maintenance of the desired formation of the AUV group is achieved.

References

[1] B. Das, B. Subudhi, B. B. Pati, "Cooperative formation control of autonomous underwater vehicles: An overview," *International Journal of Automation and Computing*, Vol. 13(Iss. 3), 2016, pp. 199-225.
[2] I. Bychkov, A. Davydov, M. Kenzin, N. Maksimkin, N. Nagul, S. Ulyanov, "Intelligent control of autonomous underwater vehicles groups," *Proc. of the 2017 3rd International Conference on Control, Automation and Robotics (ICCAR)*, Nagoya, 2017, pp. 180-183.
[3] M. S. Grewal, A. P. Andrews "Kalman Filtering: Theory and Practice with MATLAB", 4th Edition, 2015, P. 640.

Acknowledgements

This work is supported by Russian Foundation for Basic Research (RFBR) grant No. 16-29-04195.

Key words

Groups of AUVs, limited bandwidth of the acoustic communication channels, coordination of the navigation systems

Development of fault detection and identification system for navigation sensors and thrusters of autonomous underwater vehicles

A. Zuev, V. Filaretov, A. Zhirabok, A. Protcenko

Institute of Marine Technology Problems FEB RAS, Vladivostok, Russia
Institute of Automation and Control Processes FEB RAS, Vladivostok, Russia
Far Eastern Federal University, Vladivostok, Russia

The autonomous underwater vehicles (AUVs) are complex technical systems which safety and reliable operation deserves particular attention. Navigation sensors and thrusters are important components of the AUVs which are necessary to control a motion trajectory. The problem of interest to us is to detect and isolate the faulty sensors and thrusters and also is to identify the value of faults. Since malfunctions and faults occurring in these components can lead to erroneous mission fulfillment or loss of the vehicle, it is necessary to detect and isolate a faulty one early and also identify the errors value in order to correct the control program of the vehicle to fulfill pre-assigned task.

There are some different methods of fault diagnosis: signal-based, analytical model-based, knowledge-based. To diagnosis the AUV components, analytical model-based methods are usually used that allows one to use the redundancy of the AUV mathematical model. These diagnostic methods are based on diagnostic observers for checking analytical relationships between input and output signals of the AUV are performed. At this, complex nonlinear equations of dynamics of the AUVs with variable and unknown exactly parameters are used for constructing these diagnostic observers. It leads to forming non-zero residuals by observers even in the absence of faults.

Thus, the problem of the development of effective fault detection and identification systems for the sensors and thrusters AUVs is still topical. For solving this task a new method is proposed. This method includes three main step. On the first step, the bank of diagnostic observers is constructed for fault detection. At this only kinematic model of the AUVs is used for fault detection in navigation sensors and dynamic one - for thrusters. The advantage of proposed bank is simplicity of realization and high precision detection of the revealed faults in the conditions of uncertainty and essential variability of parameters of environment.

On the second step, to isolate the fault in some AUV component it is proposed to designate the relations between faults in the components and residuals generated for bank of observers. These relations can be represented in the form of the faults matrix. The rows of this matrix correspond to the residuals and columns correspond to the faults in the components. The values of the faults matrix are 0 and 1 which reflect a fact of sensitivity of residuals to the fault in some component.

At the third stage, the task of identification of faults value is solved. In this case, the value of some faults can be estimated directly from residual signals obtained from observers. To identify faults in the signals received from other sensors and thrusters it is proposed to introduce new observers containing feedback on the residual signals of a special type.

To investigate the performance and effectiveness of the proposed synthesis method and fault detection and identification system, mathematical simulation was performed. The full verified model of underwater vehicle with the parameters received from the Institute of Marine Technology Problems was used for its simulation. The results of the simulation confirm the high efficiency of functioning of the synthesized system.

T07-2: Underwater acoustics: measurements, simulation, applications

Optimization method in problems of acoustic cloaking of material bodies

G. Alekseev[1,2*], A. Lobanov[1], Yu. Spivak[1,2]
[1]*Institute of Applied Mathematics FEB RAS, 7 Radio Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova Str., Vladivostok, Russia, 690090*
**e-mail: alekseev@iam.dvo.ru*

In recent years, much attention is given to the study of inverse problems for models of acoustic scattering by inhomogeneous inclusions. Starting with the pioneering works [1-3], the development of various cloaking methods has been addressed in numerous publications. Based on the theory [2, 3], it was shown that the effect of perfect cloaking of any object placed inside an ideal cloaking shell can be created if the shell is occupied by an inhomogeneous anisotropic material with some of its parameters taking values from zero to infinity. Obviously, the technical implementation of such solutions is associated with huge difficulties and, in fact, is unfeasible because of the lack of natural materials corresponding to these solutions. A way of overcoming the indicated difficulties is to replace the exact cloaking solutions describing the singular parameters of the anisotropic medium occupying the shell by approximate (nonsingular) parameters and to design cloaking devices based on the mentioned approximations.

An alternative approach is based on the use of an optimization method for solving inverse problems. The problems consist of finding one or two Helmholtz equation coefficients, describing variable medium parameters using specific information about scattered acoustic field. By the optimization method, the original inverse problem is replaced by the minimization of a certain cost functional adequately representing the inverse problem.

The paper consists of two parts. In the first part, cloaking problem is formulated for 3D model of acoustic scattering. The cloaking effect is achieved by choosing suitable functional parameters of the inhomogeneous isotropic fluid medium filling the desired shell. Using the method proposed in [4, 5] the problem under consideration is reduced to minimization of a certain cost functional depending on desired medium parameters. The solvability of direct and control problems for the acoustic scattering model under study is proved. In the second part of the paper, an effective numerical method based on the use of the particle swarm algorithm (see details in [6, 7, 8]) is developed for solving considered cloaking problems for the case of multilayer cylindrical shell. Important properties of optimal solutions are established. Based on these properties simple design rules are formulated allowing to design cloaking and shielding shells, which possess the best cloaking or shielding performance in addition to easy manufacturability.

References

1. L. Dolin, *Izv. Vyssh. Uch. Zaved. Radiofiz*, 1961, **4 (4)**, 964-967.
2. J. Pendry, D. Shurig, D. Smith, *Science*, 2006, **312 (1)**, 1780-1782.
3. U. Leonhardt, *Science*, 2006, **312 (1)**, 1777-1780.
4. G. Alekseev, A. Lobanov, *Journal of Applied and Industrial Mathematics*, 2013, **7 (3)**, 302-312.
5. G. Alekseev, A. Lobanov, Yu. Spivak, *Comp. Math. Math. Phys.*, 2017, **57 (9)**, 1459-1474.
6. G. Alekseev, D. Tereshko, *International Journal of Heat and Mass Transfer*, 2019, **135**, 1269-1277.
7. G. Alekseev, V. Levin, D. Tereshko, *Journal of Applied Mechanics and Technical Physics*, 2019, **60 (2),** 158-168.
8. G. Alekseev, D. Tereshko, *Comp. Math. Math. Phys.*, 2019, **59 (2)**, 207-223.

Acknowledgements
This work was supported by the Program for Fundamental Research investigations of the Far East Branch of the Russian Academy of Sciences “Far East” (project 18-5-064).
Key words: Acoustic scattering; optimization problem; uniqueness, stability

On the sound attenuation in the sea with strong near-surface bubble layer

V.A. Bulanov, V.A. Akulichev V. A., L. K.Bugaeva V.A. Bulanov* V.A. Bulanov
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail: bulanov@poi.dvo.ru

Background: The involvement of bubbles in the sea water column by the dynamics of movements in the surface waves leads to the appearance of bubble clouds[1], which can reach significant depths of tens of meters with a strong wind. There are contradictory views on the contribution of the near-surface layer of bubbles to the attenuation of low-frequency sound in the ocean[2-4]. In the works of Novarini et al.[2] it was concluded that the layer of bubbles has little effect on the attenuation of sound in the sea up to very high wind speeds. In experimental works devoted to the study of sound attenuation at frequencies from 1 to 8 kHz[3], it is shown that the contribution of bubbles to sound attenuation even at low frequencies is predominant. On the other hand, the article[4] states that the influence of bubbles on the sound attenuation is less than the influence of surface waves at the same wind speeds.'

Material and methods: In the conditions of the surface underwater sound channel was carried out the analytical evaluation of the attenuation length of the coherent field. A model of a linear underwater sound channel with a near-surface layer of bubbles is considered. For a more detailed study, numerical simulations were carried out using the approximation of normal modes. The model of the simplest horizontally and vertically homogeneous underwater sound channel with absolutely reflective boundaries (upper border – soft, lower – hard) was chosen. The additional attenuation caused by the bubble layer is described by the imaginary part of the eigenvalues of the modes. Calculations of the sound field was performed according to the KRAKENC (http://oalib.hlsresearch.com/Modes/index.html) program for the interacting modes. The thickness of the layer of bubbles was chosen equal to 7 meters. The tone source with frequency 1 kHz was located at a depth of 10 meters.

Results: The rays coming out of the source at different angles approach the surface, where they fall into the area of strong attenuation associated with the presence of bubbles. The attenuation of the sound decreases with increasing grazing angle and at a certain limit value, which depends on the frequency of the sound, becomes equal to the attenuation in pure liquid. The value of the specified maximum grazing angle in a number of cases can reach or even exceed the typical values of the capture angle for the oceanic underwater sound channel, which is about 20^0. Therefore, even a relatively small surface layer of bubbles significantly affects the nature of the spatial decay of the acoustic field. Under the influence of the near-surface layer of bubbles, an additional field decay at moderate distances is observed, caused by the attenuation of part of the sound energy propagating in the bubble layer. Further, this energy is attenuated, which eventually leads to the absence of the contribution of the bubble layer in the exponential law. The presence of bubbles with an increase in the concentration of $x>10^{-6}$ can lead to a significant restructuring of the acoustic field structure.

Conclusions: It is shown that the influence of the near-surface layer of bubbles on the character of the spatial decline in the propagation of sound can be significant at fairly typical concentrations of bubbles in the near-surface layers of the sea.

References

1. V.A. Akulichev, V.A. Bulanov, J. Acoust. Soc. Am. 2011. **V.130**, P. 3438-3449
2. M.A. Ainslie J. Acoust. Soc. Am., 2005. **V.118**, P. 3513-3523; J.C. Novarini, D.R. Bruno, ibid., 1982. **V. 72**. P. 510-514; G. V. Norton, J. C. Novarini, ibid. 2001, **V. 110**, P. 2946–2955
3. P. Wille et al. Progress in underwater acoustics / ed. H. Merklinger. N.-Y.: Plenum Press. 1987. P. 501-508.
4. D. J. Weston. Acoust. Soc. Am. 1989. V. 86. P. 1546-1553

Acknowledgements

Work performed under state assignment No. 0271-2019-0009 and partially supported by RFBR grants №17-02-00561a and the "Far East" No. 18-I-004

On the sound scattering by bubble clouds and plankton communities in the upper layer of the sea

V.A. Bulanov, A.V. Storozhenko
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail: bulanov@poi.dvo.ru; storozhenko_and@mail.ru

Background: Studies of sound scattering make it possible to study the small-scale structure of the marine environment and its variability associated with the presence of bubbles, plankton and other biological objects[1,2].

Material and methods: A method is based on non-stationary broadband scattering of highly directional beams of ultrasound. The sound scattering coefficient m_V is determined by an expression that takes into account the function of the distribution of inclusions by size $g(R)$[1-4]. The general expression allowing to obtain data on biomass distribution has a complex form and is analyzed in detail in[4]. The bubble size distribution function $g(R)$ can be found from the frequency dependence of the sound scattering coefficient under the assumption that the main contribution to the sound scattering is made by resonant bubbles[2,3]. Detailed experimental studies have been carried out on the shelf of the sea of Japan along various routes up to 100 km long, as well as using bottom inverted emitters, collecting information about the scattering of sound in different seasons in the Bay of Vityaz of the Sea of Japan.

Results: It is shown that with increasing wind there is a significant involvement of bubbles in the thickness of the sea. The obtained experimental results allowed us to approximate the distribution of bubbles by the function $g(R)$ of the form[3] $g(R)=A_g R^{-n}\exp[-n(R_p/R-1)-(R/R_m)]$, where the exponent n and the critical dimensions R_p, R_m are natural parameters that follow from the Garrett- Farmer theory in the inertial interval between the sizes R_p, R_m[2,3], when measuring $g(R)$ in moderate states of the sea turns out to be n~3.5-3.8. It is shown that in the conditions of wind waves accompanied by the formation of bubble clouds, there is excessive sound absorption in the bubble layer, exceeding 100 times the sound absorption in pure water. At great depths, sound absorption tends to the value of sound absorption in pure water. Numerous data on the scattering of sound in the waters of the Gulf of Peter the Great, received in 2008 -2018 years, allowed to reveal the seasonal dynamics of zooplankton and its distribution in the Bay, and to compare the obtained biomass concentration with the results of the harvest in situ, which show good correspondence between the acoustic data and the data of harvest. The results of the study of sound scattering in the Sea of Japan and the Eastern Arctic (Chukchi sea) are presented. Studies have revealed a significantly larger scattering of sound in the Eastern Arctic, due to the higher concentration of plankton.

Conclusions: It is shown, that the application of wideband scattering of narrow-beam ultrasound makes it possible to obtain new experimental data on the structure of bubble clouds and plankton communities in the thickness of the sea. It is shown that the acoustic characteristics of upper layers change significantly with depth and the observed absorption anomalies are caused by the presence of bubbles and other heterogeneous inclusions in sea water.

References

5. J.M. Jech, J.K. Horne, D. Chu, et al, *J. Acoust. Soc. Am*., 2015, **V.138**, P. 3742-3764
6. S. Vagle, C. McNeil, and N. Steiner, *J. Geophys. Res.*, 2010, **Vol.115**, C12054, 16 p.
7. V.A. Akulichev, V.A. Bulanov, J. Acoust. Soc. Am. 2011. **V.130**, P. 3438-3449
8. V.A. Akulichev, V.A. Bulanov, A.V. Storozhenko, *Doklady Earth Sciences*, 2016, **Vol. 470**, P. 972–975.

Acknowledgements

Work performed under state assignment No. 0271-2019-0009 and partially supported by RFBR grants №17-02-00561a and the "Far East" No. 18-I-004

Acoustic sounding of large-scale ocean heterogeneities by a moving source

N. Diuldina
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail: duldina32@mail.ru

Most of the experiments to study the effect of large-scale ocean heterogeneities (frontal zones, synoptic eddies, currents) on the formation of a sound field along signal propagation paths were carried out according to a fixed receiver pattern - a source moving along a path. In numerical sound field calculations, the source is located at the beginning of the path, at a fixed point, regardless of how the experiment was conducted in reality, referring to the principle of reciprocity. To substantiate the results of experiments with similar calculations is absolutely incorrect. When the sound source intersects the ocean heterogeneities, the propagation medium is nonstationary. The change in the initial conditions of radiation leads to variations in the magnitude of sound energy propagating in the water column and redistributing it vertically due to vertical refraction. In this case, the temporal average intensity variability of the signals received at a fixed point can be calculated, introducing the time dependence as a parameter. For convenience of perception, the time coordinate is replaced with the distance of the source from the receiver coordinate.

The results of a numerical experiment on the propagation of low-frequency tonal sound as the source moves along a path crossing the frontal zone are considered. The calculations were performed by the RAM program, which implements the solution of a wide-angle parabolic equation by the "split – step Pade" method [1]. The model parameters are identical to the characteristics in a real experiment, performed under the guidance of V.A. Akulichev at the north western Pacific. Description of conditions and methodology of V.A. Akulichev field studies given, for example, in [2]. The length of the acoustic trace was 1200 km, the trace crossed the subarctic frontal zone. The source at a depth of 100 m was towed from the southernmost point to the northeast, continuously emitting a tonal sound signal with a frequency of 232 Hz. The receiving system was located at the beginning of the trace. The hydrophones of the system were located at depths of 100, 650 and 1000 m. The bottom depth along the trace changed little and in the calculations assumed to be equal to 5500m. Calculations were made for 10 different source positions along the trace. The obtained results are in good agreement with the field data.

Thus, the main causes of variations in the average level of signals received at fixed points:
1. A change in the source position relative to frontal zone leads to a decrease in the sound speed value at the receiver depth and, consequently, to an increase in the amount of acoustic energy propagating in the water column.
2.Vertical redistribution of acoustic energy occur resulting from explicit changes in sound channel structure and from implicit effect of horizontal sound-speed gradients.
Maximum variations in the average level of received signals are observed at horizons close to the depth of the sound channel axis at the receiving system location.

References

1. Collins M.D. A split-step Pade solution for the parabolic equation method, *J. Acoust. Soc. Am*. 1993. **V. 93**. P. 1736-1742
2. V.Akulichev, N.Diuldina, Yu. Morgunov, A. Soloviev, D.Shekhovtsov. Experimental studies of the variability of the sound field in the region of the subarctic front in the northwestern part of the Pacific Ocean, *Marine technologies IMTP FEB RAS, Vladivostok: Dalnauka*, 1996. P. 102-110.
3. *Wapenaar C.P.A.* Reciprocity theorems for two-way and one-way vectors: A comparison. J. *Acoust. Soc. Am*. 1996. **V.100**. № 6. P.3508-3518.

Key words: Large-scale ocean heterogeneities; moving source; numerical experiments.

An attempt of hydroacoustic localization of open-circuit scuba diver using low-frequency respiratory associated noises emitted into water

Sergey Gorovoy[1,2], Vladimir Korenbaum[1*], Anatoly Kostiv[1], Anton Shiryaev[1], Aleksey Borodin[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43, Baltiyskaya Str., Vladivostook, 690041, Russia*
[2]*Engineering School, Far Eastern Federal University, 8, Sukhanova St., Vladivostok, 690090, Russia*
**e-mail: v-kor@poi.dvo.ru*

Respiratory associated noises, emitted by the scuba divers into water, may be pertinent for their passive acoustic monitoring. Sutin et al. (2010) reported on development of the SPADES system capable to detect submerged divers by using a high-frequency band up to 100 kHz.

Objectives of the work were a study of low-frequency noises of open-circuit scuba divers, registered in water, and estimation of possibilities of these noises application to monitor and to localize a submerged diver in shallow-water.

The experiment was conducted in shallow-water area of 8–10 m depth, sand-stone bottom, sea state 2, windless sunny day. Underwater noise level corresponded to heavy shipping traffic Wenz (1962) curves. The open-circuit scuba diver, moving with fins at 1–2 m above the bottom, having approximate velocity of 0.4-0.5 m/s, approached to the bottom mounted 12–hydrophones line antenna array (4 m distanced undirectional hydrophones) near the first hydrophone, passed along the line of hydrophones to the middle of array. Then he turned to the right and began to go away from the hydrophones at the angle of ~45º to the line of array, using a compass. After passing a distance of 320 m (according to GPS data), the diver come up to the water surface, oriented, dived ones more and moved in the opposite direction. To localize moving submerged diver we estimated the delays between maxima of the cross-correlation functions (accumulation time 1 s) of respiratory noises at two pairs of hydrophones (distanced at 20 m), laying in the beginning and in the end of the array. We calculated bearings for these pairs and area of their crossing.

It was experimentally shown that low-frequency (below 1000 Hz) underwater respiratory associated noises of open-circuit scuba diver may be successfully used for passive detection and monitoring his respiration at distances up to 100–150 m. Respiratory noises in the frequency band of 30–1200 Hz provided a possibility to localize open-circuit scuba diver in shallow-water area by two pairs of hydrophones at a distance up to 220 m with dominant discrepancy of no more 10 m in relation to GPS data. To raise the precision of localization it would be necessary to improve an accuracy of hydrophones positioning.

References

A. Sutin, B. Bunin, A. Sedunov, et al. *International Waterside Security Conference,* 2010, art. no. 5730286.
G. Wenz *J Acoust Soc Am,* 1962, **34**, 1936-1956.

Acknowledgements

The work was supported by the Program of Basic Research of Russian Academy of Sciences (No. 0271-2019-0010) and partially by the Program of Basic Research of Far Eastern Department of Russian Academy of Sciences "Far East" (No. 18-1-004).

Key words

Scuba diver, respiratory noises, localization

Qualification of the bubbles in the liquid by using the passive acoustic method

Zhen Cai[1*], Huawei Qin[2], Jiwan Han[3]
[1]Ocean college, Zhejiang University,1 Zheda Road, Zhoushan, China, 316021
[2] Institute of Mechanical Engineering, Hangzhou Dianzi University, 1, No.2 Str., Hangzhou, China, 310018
[3] Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Aberystwyth, UK, SY23 3DA,
*e-mail: caizhen@zju.edu.cn

Gas-liquid bubble flows are typical in many practical industrial and man-related activities. Although various technologies have been developed, it is difficult to detect underwater bubbles and qualify the gas flow with limited conditions. One of the technologies is the passive acoustic method, which mainly based on the relationship between the frequency of sound waves produced by bubble generation and the corresponding bubble size. However, this method is only valid for signal bubble column, not for the chaotic bubble clouds which are occurred in practical situations more often. In this paper, we present a qualification approach by using passive acoustics combined with the bubble coalescence model. Two nozzles with different inner sizes were used to generate two different kinds of bubbles at various air flow rates, including signal bubble columns and bubble clouds. The experimental gas flow rates were controlled by a flow meter. A calibrated hydrophone received the sound waves from the bubbles in the free field for reducing the effect of sound reflections. The flow rates were inverted according to the contribution to each frequency field of the sound wave from different sizes bubbles, and the buoyancy-induced collision model and film drainage coalescences model were applied during the inversion. The results show that calculation with the coalescence model improves the accuracy of inversion. The calculated flow rates of the bubble clouds generated at high gas flow rates, in which bubble coalescence occurs frequently, are closer to the experimental flow rates. The accuracy of inversion decreases with the flow rates decreasing, which is mainly caused by the poor SNR (signal to noise rate).

References

[1]Leighton, T. G. & Walton, a J., *European Journal of Physics*, 1986, **8,** 98–104 .
[2]Boyd, J. W. R. & Varley, J., *Chemical Engineering Science*, 2001, **56,** 1749–1767.
[3]Leifer, I. & Tang, D., *The Journal of the Acoustical Society of America*, 2007, **121,** EL35.
[4]Greene, C. a. & Wilson, P. S., *The Journal of the Acoustical Society of America*, 2012, **131,** EL61.
[5]Bergès, B. J. P., Leighton, T. G. & White, P. R. *International Journal of Greenhouse Gas Control*, 2015, **38,** 64–79.
[6]Chen, L., Trinh, V., Yang, W. & Mohanangam, K., *Acoustics Australia*, 2016, **44,** 325–331.
[7]Liao, Y. & Lucas, D., *Chemical Engineering Science*, 2010, **65,** 2851–2864.

Key words
Bubbles, Passive acoustic method, Flow rate qualification

Reconstruction of a diffuse reflecting surface in the fluctuating ocean

V.A. Kan[1,2], I.V. Prokhorov[1,2*]
[1]Institute of Applied Mathematics of FEB RAS,. 7 Radio Str., Vladivostok, Russia, 690041
[2]Far Eastern Federal University, 8, Sukhanova Str., Vladivostok, Russia, 690091
*e-mail: prokhorov@iam.dvo.ru

The inverse problems for a kinetic equation have a lot of applicability (a remote sensing of the Earth's surface, optical and x-ray tomography [1, 2]). An inverse problem for time-dependent radiation transfer equation in domain with indeterminate boundary is described. The boundary exhibits diffuse reflection by Lambert's law. It is required to evaluate the boundary under some overdetermination of the solution of the initial-boundary value problem. A problem of this kind arises when monitoring the surface of the earth and the sea bottom by aircraft radar and side-scan sonars [3-6].

The report considers a simplified two-dimensional model of Lambertian curve location. The applying such a model is justified if a receiving antenna that is narrow in the horizontal plane of the radiation pattern and low speed of movement of the radiation source in comparison with the velocity of signal propagation in the medium [3-5]. In previous works, the main constraint for the surface was the smallness of the deviation of the reflecting surface from a certain average level. In this case, the solution of the inverse problem was obtained in the form of an explicit formula and a numerical analysis was done for the effect of volume scattering and radiation pattern width on the quality of the Lambertian surface reconstruction. In [6], the inverse problem of the time-dependent radiation transfer equation in a non-scattering medium was investigated without limiting the "smallness" of the deviation of the curve and a nonlinear differential equation was obtained. The solution of the equation obtained by quadrature. The report summarizes the results of [6] in the case of a weakly scattering medium and the analysis of the influence of measurement errors on the quality of surface reconstruction.

Acknowledgements
The reported study was funded by RFBR according to the research project № 18-31-00050.

References
[1] D. S. Anikonov, A. E. Kovtanyuk, and I. V. Prokhorov, Transport Equation and Tomography. VSP, Utrecht, Boston, 2002.
[2] V. V. Tuchin, Tissue Optics: Light Scattering Methods and Instruments for Medical Diagnosis. SPIE, Bellingham, Washington, 2007.
[3] I. V. Prokhorov, A. A. Sushchenko, Studying the problem of acoustic sounding of the seabed using methods of radiative transfer theory //Acoustical Physics. 2015. Vol. 61. № 3. P. 368-375.
[4] I. V. Prokhorov, A. A. Sushchenko, V. A. Kan, On the problem of reconstructing the floor topography of a fluctuating ocean //Journal of Applied and Industrial Mathematics. 2015. V. 9. № 3. P. 412-422.
[5] V. A. Kan, I. V. Prokhorov, A. A. Sushchenko, Determining the bottom surface according to data of side-scan sonars //Proceedings of SPIE. 2016. Vol. 10035.
[6] V A. Kan, I.V. Prokhorov, Determination of a diffuse reflecting surface under pulsed irradiation //Far Eastern Mathematical Journal. 2018. V. 18. № 2. P. 206–215.

Key words
Radiative transfer equation, inverse problems. sea bottom topography,

About the method of calculating acoustic anisotropy in minerals with a crystal structure

V.S. Kim
Far Eastern Federal University, 35 Nekrasova Str, Ussuriisk, Russia, 692500
**e-mail: kim.vs@dvfu.ru*

Counteracting fouling of the underwater hull of ships and structures by the method of coloring with special compositions has its own environmental limitations. The ultrasonic method in this case is more preferable. Efficient generation of ultrasonic vibrations using, for example, the piezoelectric effect, requires knowledge of the acoustic anisotropy of the crystal. The purpose of this work is to describe the "geometric" method of calculating the effective modulus of elasticity C_{eff} for different orientations of the wave vector q of the elastic wave.

METHOD

The equation of motion for the displacement of particles during the propagation of elastic oscillations is derived on the basis of the generalized Hooke law [1], where the relationship between stress and strain is given by the tensor of elastic stiffness C_{iklm}. From the equation of motion, you can get the so-called Christoffel equation [2] $(\Gamma_{ik} - C_{eff}\,\delta_{ik})p_k=0$, where Γ_{ik} is the first Christoffel tensor (FCT), δ_{ik} is the unit tensor, p_k are the direction cosines of the particle displacement vector in the elastic wave, C_{eff} - here is an eigenvalue of the Γ_{ik} and determines the phase velocity of the elastic wave. FTC is given by the expression $\Gamma_{ik} = C_{ijkl}n_jn_l$, where n_j are the direction cosines of q.

MOHR CIRCLE

To determine the FTC eigenvalues, we propose a method based on the search for the principal axes of a second-rank tensor. In the principal axes system, the second-rank tensor has only diagonal components that are equal to the eigenvalues of the second-rank tensor [2].

Suppose that, since Γ_{ik} is a second rank tensor, then the Mohr circle, which was originally used for the strain tensor, is applicable to it. We will rotate q in the XOY plane, which will lead to a change in C_{eff}. Changing the direction of q can be interpreted differently - assume that it is not q that rotates, but the coordinate system in which it is described. Rotation of the coordinate system leads to a change in the component Γ_{ik}. As a result, Ceff for the three acoustic modes become unknown and must be determined by solving the Christoffel equations. Instead, we will make the transition to the main coordinate system Γ_{ik}, in which the eigenvalues Γ_{ik} are easily determined. To go to the principal axes system, we will use the construction of the Mohr circle [2]. To go to the principal axes system FTC, you must rotate the coordinate system around the axis OZ by angle α. In this case, depicting the radius of the Mohr circle is rotated by an angle of 2α. Knowing the radius of the Mohr circle $R=(1/4(\Gamma_{22} - \Gamma_{11})^2 + \Gamma_{12}^2)^{1/2}$, one can find the diagonal components of the FTC and, thus, determine C_{eff} for a given direction q.

RESULTS

We apply the described method to the calculation of the phase velocity of elastic waves to well-studied Ge crystals. The results of calculations are given in the table, where C_{mn} is at 10^{10} N/m^2. V_{QL} and V_{QS} are the velocities of quasi-longitudinal and quasi-transverse elastic waves, respectively, in km/s.

The table shows that the calculations by the proposed method show a good agreement of the calculated values of V_{QL} and V_{QS} with known data from [3]. Thus, to study the acoustic

anisotropy, you can use the construction of the Mohr circle to go to the principal axes system FTC.

Table

Source	C_{11}	C_{44}	C_{12}	V_{QL} [100],	V_{QS} [100]	V_{QL} [110]	V_{QS} [110]
Data from [3]	13,0	6,70	4,90	4.92	3.55	5.41	2.75
Our results	[3]	[3]	[3]	4,94	3,55	5,42	2,76

References
1. Fedorov F.I. Theory of elastic waves in crystals. –M .: Science, 1965. - 387 p.
2. Nye J.F. Physical Properties of Crystals. –Oxford: Clarendon Press, 1957. –386 p.
3. Truell R., Elbaum C., Chick B. Ultrasonic Methods in Solid State Physics. - N-Y: Academic Press, 1969. –308 p.

Key words
Acoustic anisotropy, Christoffel tensor, Mohr circle.

Applicability of the single-scattering approximation for impulse sounding of the ocean

A. Kim[1,2], I.V. Prokhorov[1,2*]
[1]*Institute of Applied Mathematics of FEB RAS,. 7 Radio Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova Str., Vladivostok, Russia, 690091*
**e-mail: prokhorov@iam.dvo.ru*

In this paper, we consider problems of acoustic sounding of a fluctuating ocean. We use kinetic model based on non-stationary integration-differential radiative transfer equation to describe the propagation of acoustic high-frequency radiation in a scattering medium. To solve the transfer equation we express it as Neumann series by multiplicity of scattering. Zero and first member of Neumann series correspond to the non-scattered and single-scattered radiation.

There are many methods for solving inverse problems based on single-scattering approximation [1-4]. In some cases single-scattering approximation significantly simplify the solution of the problem. For example, there is the explicit formula to determine volume scattering coefficients for pulsed sounding with a singular radiation source [5]. We construct weighted Monte Carlo method for numerical analysis of applicability the single-scattered approximation. This numerical method allows one to calculate the intensity of multiple scattered fields spawned by a singular radiation source. We studied the inverse problem for non-stationary equations of radiation transfer equation to determine the scattering coefficients by the angular distribution of the radiation flux density in a certain point.

In the report, we provide results of numerical analysis for multiple scattered radiation influence to accuracy of an analytical formula, based on single-scattered approximation. Numerical tests showing negative impact multiple scattered radiation while reconstruct unknown media are considered.

Acknowledgements
This work was supported by Russian Foundation for Basic Research (project № 18-31-00050).

References

[1] A. Ishimaru, Wave Propagation and Scattering in Random Media. New York: Academic Press, 1978.
[2] I. V. Prokhorov, A. A. Sushchenko, Studying the problem of acoustic sounding of the seabed using methods of radiative transfer theory //Acoustical Physics. 2015. Vol. 61. № 3. P. 368-375.
[3] I. V. Prokhorov, A. A. Sushchenko, V. A. Kan, On the problem of reconstructing the floor topography of a fluctuating ocean //Journal of Applied and Industrial Mathematics. 2015. V. 9. № 3. P. 412-422.
[4] V. A. Kan, I. V. Prokhorov, A. A. Sushchenko, Determining the bottom surface according to data of side-scan sonars //Proceedings of SPIE. 2016. Vol. 10035.
[5] P.A. Vornovskikh, A.A. Sushchenko, Remote sensing problem with multiple scattering effect //Proceedings of SPIE - The International Society for Optical Engineering. 2017. Vol. 10466. art. Number 104661Y.
[6] A. Kim, I.V. Prokhorov, Theoretical and Numerical Analysis of an Initial-Boundary Value Problem for the Radiative Transfer Equation with Fresnel Matching Conditions //Computational Mathematics and Mathematical Physics. 2018. V.58. № 5. P. 735-749.

Key words
Radiative transfer equation, inverse problems. single-scattering approximation

Selected research results of the ship noise studies in Peter the Great Bay, Sea of Japan

Alexei Kiryanov, Sergey Gorovoy*, Eugenyi Zheldak, Igor Dmitriev
Engineering School, Far Eastern Federal University,
8 Sukhanova st., Vladivostok 690090 Russia
**e-mail: GorovoySV@mail.ru*

Monitoring the ship noise, especially in the seaport and fishing areas, is of great importance for ecology [1]. The World Community developed a number of standards and recommendations on measurement uniformity for the shipping noise characteristics [2, 3].

This work reports the research findings about seasoning of ship noise characteristics in conditions of commercial traffic in the shipping passage area nearby the port of Vladivostok, Russia, Peter the Great Bay, Sea of Japan. This work is the continuation of the previous ones [4, 5].

The experimental research was conducted in summertime, in the smooth sea conditions, WMO State Code 2, when the wind speed does not exceed 0.5 m/s, the mean wave height was 0.5 m. The depth of the research area was 20 m, sandy and rocky bottom. Not far from the research area there is an anchorage and water border of the outer aquatic area of the port of Vladivostok; additionally, there is a route that is used for the entrance and exit of oceanic vessels in and out of the port. The acoustic signals were received via four non-directional hydrophones that were placed along the water column. The hydrophones were attached to the floating buoy. Springy shock absorbers were used in order to minimize the influence of surface waves. The signals received with hydrophones were transmitted on board through the cable; the boat was drifting along the buoy; computer recorded the signals. The16-bit ADC was used to digitize the signals. A radar locator was used for controlling the location of passing vessels.

Oscillograms and spectrographs of the recorded signals are presented in this work, as well as variability of shipping noise levels of passing vessels in several frequency bands. The results of computing the correlations of signal levels and time are presented; Pekeris waveguide model [6] was used for acoustic field computations.

References

1. R. K. Andrew, B.M. Howe, J.A. Mercer, *Acoustics Research Letters Online*, 2002, **3**, 65-70.
2. ANSI/ASA S12.64-2009 Part1.
3. ISO 17208-1:2016: Part 1.
4. S. Gorovoy, A. Kiryanov, E. Zheldac, *Proc. Meet. Acoust.* 2016, **24, 070016**.
5. S. Gorovoy, A. Kiryanov, E. Zheldak, *Applied Sciences*, 2018, **8, 142**.
6. C.L. Pekeris, *Geological Society of America Memoirs* 1948, **27**, 1-116.

Key words
Sea noise, shipping noise, C.L. Pekeris waveguide model

Methods for Improved Sea Bottom Image Quality

E.O. Kovalenko[1,2,*], I.V. Prokhorov[1,2], A.A. Sushchenko[1,2]
[1]*Institute of Applied Mathematics of FEB RAS, 7 Radio Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova Str., Vladivostok, Russia, 690091*
**e-mail: kovalenko.eo@dvfu.ru*

We study the problems of construction and improvement quality sonar images of sea bottom by measurement data received from side scan sonar (SSS) installed on autonomous uninhabited underwater vehicles (AUV) [1,2]. We use the radiative transfer equation with boundary condition describes diffuse reflection on the bottom surface. Mathematical formulation of the problem is to find a bottom scattering coefficient if an additional conditions for the solution of the transfer equation are given. We suppose that AUV emits a pulse signal and moves with constant speed in a straight line.

In the single-scattering approximation, an integral equation of the first kind is obtained to find the bottom scattering coefficient. The solution of the integral equation has an explicit solution in the case of a narrow receiving antenna pattern. When we increase the width of the radiation pattern in explicit formula, we have defocusing objects on the sonar images. To solve this problem we used several approaches. The first one is a numerical solution of integral equation by data received from two antennas located on portside and starboard [3]. At discretization, the problem is reduced to solving a system of linear algebraic equations. The report discusses a number of shortcomings of this approach associated with the poor conditionality of the system of linear algebraic equations, and presents the results of numerical calculations. The second way base on multipath echo sounder data and have a series of a priori assumptions about the bottom scattering coefficient. Numerical analysis of the problem for different number of angles of sensing and with different widths of receiving antennas is given. The effect of volume scattering on the quality of the seabed reconstruction is demonstrated.

Acknowledgements
This work was supported by Russian Foundation for Basic Research (project № 18-31-00050).

References
[1] I. V. Prokhorov, A. A. Sushchenko, Studying the problem of acoustic sounding of the seabed using methods of radiative transfer theory //Acoustical Physics. 2015. Vol. 61. № 3. P. 368-375.
[2] E.O. Kovalenko, A.A. Sushchenko, I.V. Prokhorov, Processing of the information from side-scan sonar //Proceedings of SPIE, 2016. V. 10035. 100352C.
[3] E.O. Kovalenko, A.A. Sushchenko, V.A. Kan, Focusing of sonar images as an inverse problem for radiative transfer equation //Proceedings of SPIE, 2018. V. 10833. 108336D.

Key words
Radiative transfer equation, inverse problems, side scan sonar

The software package for modeling of the acoustic pulses propagation in 3D geo-acoustic waveguides by the mode parabolic equation method

S.B. Kozitckiy[1*], M.Yu. Trofimov[1], A.D. Zakharenko[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: skozi@poi.dvo.ru*

Modeling of the propagation of acoustic waves in 3D inhomogeneous media in the last two decades is the subject of numerous studies. The software based on such studies is extremely in demand for various practical purposes. In our work [1] the parabolic equations (MPE) with mode interaction have been obtained for the mode coefficients with accounting for the bottom topography and density inhomogeneities. They are derived by using the generalized method of multi-scale expansions applied to the Helmholtz equation. To simulate the propagation of acoustic pulses in 3D waveguides with the use of the obtained equations a technique (4D simulation) based on fast Fourier transform (FFT) has been developed [2].

Calculations of pulse propagation by this method naturally split into four stages. In the 1st stage we represent the initial pulse in the source as a finite sum of time-harmonic components with different frequencies by FFT algorithm. In the 2nd stage we calculate eigenvalues and eigenfunctions for the each component and determine the coefficients of the equations. In the 3rd stage we solve the equations and obtain the amplitudes of the components in the places of the receivers. In the 4th stage we assemble the final pulse from the individual spectral components by the inverse FFT transform.

Within the framework of this approach, a software package (in MATLAB and C++), has been created and successfully tested by comparing the results of calculations with the analytical solution for the penetrable wedge (benchmark ASA) obtained by the source images method. To solve MPE we have developed numerical method based on Crank-Nicloson scheme with iterations and Perfectly Matched Layer boundary conditions. To calculate eigenvalues and eigenfunctions of the modes we use the bisection method and method of the inverse iterations. The software is implemented in the language C++ with the use of OpenMP technology for parallel sections of the code. As output the software creates code in MATLAB language which can be used for post-treatment of the obtained data and for drawing graphs. The developed software package is actively used for the experimental data analysis and the planning of experiments on the propagation of acoustic pulses in the Far Eastern seas of Russia.

References

1. M.Yu. Trofimov, S.B. Kozitckiy, A.D. Zakharenko, *Wave Motion*, 2015, **48**, 42–52.
2. M.Yu. Trofimov, S.B. Kozitckiy, A.D. Zakharenko, *Computer Physics Communications*, 2018, **228**, 1-7.

Acknowledgements

This work was supported by the POI FEBRAS Program 'Mathematical simulation and analysis of dynamical processes in the ocean' (No. AAAA-A17-117030110034-7) and by the Russian Foundation for Basic Research (No. 18-05-00057 A)

Key words

Parabolic equation method, pulse propagation, acoustic simulation software.

Time reversal signal processing for diagnostics of intense underwater gas leaks

A. Maksimov[1*], Yu. Polovinka[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: maksimov@poi.dvo.ru*

The aim of the study is to develop new methods for detecting underwater gas leaks based on the use of the focusing properties of the time reversal acoustic antennas. Experimental application of an acoustic time-reversal mirror (TRM) is currently a fairly widespread technique in underwater acoustics. In a typical TRM experiment, the source emits a pulse, which is received by the antenna array, reversed in time and reemitted. After this, the reversed signal is focused at the location of the source. Two factors: the local nature of the acoustic radiation due to leakage, and the resonant nature of the radiation of a bubble at its birth lead to an extremely effective scattering of the reversed wave [1]. For intense leaks, accompanied by the emergence of a two-phase flow with a high density of inclusions, it is necessary to take into account the interaction between individual bubbles. In order to consistently describe the work of TRM for diagnosing such an environment, one should take into account the interaction between the individual inclusions, which are dominated by pairwise interactions [2].

The development of previously obtained results [1] that are valid for the registration of individual inclusions consists in taking into account the correlation properties of the bubbles. A description of the inverted signal and the scattered field for two closely spaced inclusions is given. The difference from the problem of a single bubble [1] is in the presence of the terms, which now refer not to the emission of individual bubbles, but to individual modes of coupled oscillations. However, the whole method described in [1] is transferred to the considered case with insignificant modifications. Thus, the oscillations of a bubble under the action of a time-reversal field are transformed into excitation of individual modes of coupled oscillations. The presence in the spectrum of the reversal signal of the natural frequencies of individual modes leads to an extremely effective scattering of the reversal signal.

Thus, taking into account the interaction between individual inclusions does not impair the efficiency of the proposed technique, but rather significantly modifies the shape of emission signals. resulting in the appearance of beats and an increase in its duration due to a small radiative damping of near anti-phase oscillations.

References

[1] A.O. Maksimov, Y.A. Polovinka, *J. Acoust. Soc. Am.*, 2015, **137** (4), 2168–2179.
[2] A.O. Maksimov, Y.A. Polovinka, *J. Acoust. Soc. Am.*, 2018, **144** (1), 104–114.

Acknowledgements
This study was supported by FEBRAS, project Far East no. 18-5-050.

Keywords
Time-reversal processing, bubble, leaks

Delay Tolerant and Concurrent Transmission MAC Protocol for Underwater Acoustic Sensor Networks

Fengzhong Qu[1*], Xiaoxiao Zhuo[1], Hong Yang[1*], Fengzhong Qu[1]
[1]*Key Laboratory of Ocean Observation-Imaging Testbed of Zhejiang Province, Zhejiang University, Zhoushan ,China, 316021*
**e-mail: jimqufz@zju.edu.cn*

With the increasing demand for marine exploration, underwater acoustic sensor networks (UASNs) have been widely used in oceanographic data collection, tsunami warning, pollution monitoring [1], etc. However, the volatile ocean environment makes it an unprecedented challenge to apply underwater acoustic communications, such as long propagation delays, limited bandwidth, and low data rate [2]. These features make UASNs suffer from low network throughput, long end-to-end delay, and large energy consumption. In addition, it is well-known that medium access control (MAC) protocol is one of the critical factors affecting the performance of UASNs [3]. The MAC protocols are mainly designed to tackle the problem of channel resource allocation when multiple nodes share the common channel link. Therefore, it is important to design an appropriate MAC protocol to support UASNs.

Thus, we propose a delay tolerant and concurrent transmission (DTCT) MAC protocol for underwater acoustic sensor networks. It combines reduction of handshaking packets, adaptive collision-avoidance, and concurrent transmission aiming at improving the network throughput, shortening end-to-end delay, reducing average energy consumption, and enhancing the fairness of transmission. First, the handshaking packets, which are low efficient in a way, are reduced with the approach of exchanging information by specially designed packet frames. Second, the packets collisions can be avoided by scheduling the transmission time based on the information of propagation delays between nodes. At last, concurrent transmission can be implemented by leveraging the long propagation delays.

To demonstrate the performance of the proposed DTCT protocol, this paper conducts simulations based on Network Simulator 2 [4] and compares the DTCT protocol with the representative MAC protocols, i.e. UWALOHA [5], HOSM [6], and Slotted-FAMA [7]. Simulation results verify that the DTCT protocol provides better performances in terms of the network throughput, energy consumption, average end-to-end delay, and fairness of the UASNs.

References

[1] D. Pompili and I. F. Akyildiz, "Overview of networking protocols for underwater wireless communications," *IEEE Communications Magazine*, 2009, vol. 47(1), pp. 97-102.
[2] E. M. Sozer, M. Stojanovic, and J. G. Proakis, "Underwater acoustic networks," *IEEE Journal of Oceanic Engineering*, 2000, vol. 25(1), pp. 72-83.
[3] S. Jiang, "State-of-The-Art Medium Access Control (MAC) Protocols for Underwater Acoustic Networks: A Survey Based on A MAC Reference Model," *IEEE Communications Surveys & Tutorials*, 2017, vol. 20(1), pp.1-1.
[4] P. Xie, Z. Zhou, Z. Peng, H. Yan, T. Hu, J. Cui, Z. Shi, Y. Fei and S. Zhou,"Aqua-Sim: An NS-2 based simulator for underwater sensor networks," *In Processing of MTS/IEEE OCEANS 2009*, Biloxi, MS, USA, 2009, pp. 1-7.
[5] H. Yu, N. Yao, S. Cai and Q. Han, "Analyzing the performance of Aloha in string multi-hop underwater acoustic sensor networks," *Eurasip Journal on Wireless Communication and Networking*, 2013, vol. 1(3), pp. 1-10.
[6] Z. Liao, D. Li and J. Chen, "A handshake based ordered scheduling MAC protocol for underwater local area networks," *International Journal of Distributed Sensor Networks*, 2015, vol. 11(1), pp. 2-15.
[7] M. Molins and M. Stojanovic, "Slotted FAMA: a MAC protocol for underwater acoustic networks," *In Processing of IEEE OCEANS 2006*, Singapore, Singapore, 2007, pp. 1–7.

Acknowledgements
This work was supported in part by the National Natural Science Foundation of China for Excellent Young Scholars under Grant 61722113.

Key words Underwater acoustic sensor networks, MAC protocols, data concurrent transmission

Approach for designing an underwater acoustic networks for Arctic and North-Western Pacific regional seas

Rodionov A.Yu.[1*], Unru P.P.[1], Golov A.A.[2], Statsenko L.G.[1], Kiryanov A.V.[3]
[1]*Department of Electronics and Communication, Far Eastern Federal University, Vladivostok, Russia, 690922*
[2]*Laboratory of Acoustical Tomography, V.I.Il`ichev Pacific Oceanological Institute, Vladivostok, Russia, 690041*
[3]*Department of Instrumental Engineering, Far Eastern Federal University, Vladivostok, Russia, 690922*
**e-mail: deodar1618@yandex.ru*

Underwater acoustic network (UAN) is a powerful tool for sea media analyzing, ecological monitoring, sea bottom resource exploration, preventing natural and man-made disasters, providing underwater navigation, etc. Thus, there is an emerging necessity of monitoring of integral characteristics of temperature and stream fields, seismic activities, seawater impurity content and so on. [1, 2] But some of the aquatic areas of the World Ocean impose special requirements to every element of the UAN: signal processing technique, modulation, MAC-protocol, topology, etc. In present work features of UAN designing for the conditions of Arctic and North-Western Pacific regional seas (such as Sea of Japan, Sea of Okhotsk, Bering Sea, etc.) are considered. Hydrological-acoustical, climatic and ice conditions of this region differ from the majority of equatorial, subequatorial and temperate zones seas. That imposes special requirements for the network nodes displacement and leads to the necessity of designing of a trick solutions for establishing a reliable and efficient communication link with navigation functionality for ranging and positioning of AUVs working in UAN covered area.

The analysis of chosen aquatic areas showed that underwater acoustic channel axis depth can vary widely from surface to 300 m during the year. That fact along with the well-known stochastic nature of underwater media and its high noise contamination complicate the process of designing of UAN for long-term (more than 1 year) exploitation [3, 4].

These conditions demand of using algorithms a priori resistant for different types of noise, which do not require regular channel estimation. In addition, underwater communication networks must be capable for integration with moving nodes located on the Autonomous Underwater Vehicles (AUV) and to provide its navigation along with sustainable communication link in highly stochastic UA channel.

First part of the article provides an overview of hydrological conditions of arctic seas and aquatic areas of North-Western part of Pacific Ocean. Second part is dedicated to estimation of data throughput of such a networks and assessment of ranging accuracy of AUVs and other underwater objects using UAN.

References

[1] Akyildiz I. F., Pompili D., Melodia T. Underwater acoustic sensor networks: research challenges //Ad hoc networks. – 2005. – Т. 3. – №. 3. – С. 257-279.
[2] Sozer E. M., Stojanovic M., Proakis J. G. Underwater acoustic networks //IEEE journal of oceanic engineering. – 2000. – Т. 25. – №. 1. – С. 72-83.
[3] Freitag L. et al. Acoustic communications under shallow shore-fast Arctic ice //OCEANS 2017-Anchorage. – IEEE, 2017. – С. 1-5.
[4] Shengyu T. et al. Under-ice underwater acoustic communication based on direct sequence spread spectrum system with parametric emission //2016 IEEE International Conference on Signal Processing, Communications and Computing (ICSPCC). – IEEE, 2016. – С. 1-4.

Acknowledgements
This work was supported by Russian Science Foundation, project no. 16-19-00038.

Key words: Underwater acoustic networks, underwater acoustic communication

The Effective Medium Model of Periodic Structure Manipulating Underwater Acoustic Wave

Y. D. Ruan, X. Liang*, T. T. Wang, Y. Deng, Y. H. Wang
Ocean College, Zhejiang University, 1, Zheda Str., Zhoushan, Zhejiang, China, 316021
**e-mail: liangxu@zju.edu.cn*

The propagation path of acoustic wave can be manipulated by phononic crystals which are artificial periodic structures. This article reports a concept of effective medium model for a periodic structure, which is a flexible approach to explain that the acoustic wave propagates in the periodic structure, and this concept can be used to design the arrangement styles of periodic structure to manipulate acoustic wave as a requested path. In this work, the periodic structure consists of numerous steel rods surrounding water. By gradually calculating the effective density of a unit cell in this periodic structure, both the effective medium model and the complete structure are numerically simulated. Comparing the numerical results of effective medium model with complete structure, it shows that the effective medium model has practical feasibility. Such a periodic structure can be designed and assembled by a simple process, and it is valuable in some useful applications such as underwater wireless communication, nondestructive evaluation, and medical imaging.

References

[8] S. C. S. Lin, B. R. Tittmann, T. J. Huang, *Journal of applied physics*, 2012, **111(12)**, 123510.
[9] M. Chen, H. Jiang, H. Zhang, D. Li, Y. Wang, *Scientific reports*, 2018, **8(1)**, 1861.
[10] S. Tol, F. L. Degertekin, A. Erturk, *Applied Physics Letters*, 2016, **109(6)**, 063902.
[11] X. N. Liu, G. K. Hu, G. L. Huang, C. T. Sun, *Applied Physics Letters*, 2011, **98(25)**, 251907.
[12] T. P. Martin, C. J. Naify, E. A. Skerritt, C. N. Layman, M. Nicholas, D. C. Calvo, J. O. Gregory, T. Daniel, J. Sánchez-Dehesa, *Physical Review Applied*, 2015, **4(3)**, 034003.
[13] A. Darabi, M. J. Leamy, *Physical Review Applied*, 2018, **10(2)**, 024045.
[14] S. C. S. Lin, T. J. Huang, J. H. Sun, T. T. Wu, *Physical Review B*, 2009, **79(9)**, 094302.
[15] V. F. G. Tseng, S. S. Bedair, N. Lazarus, *IEEE transactions on ultrasonics, ferroelectrics, and frequency control*, 2018, **65(1)**, 39-49.

Acknowledgements
This work was supported by the National Natural Science Foundation of China (Grant Numbers: 51879231, 51679214), and Zhejiang Provincial Key Research and Development program (Grant Number: 2018C03031)

Key words
Periodic Structure; Effective Medium; Acoustic Wave

Some results of the studies of beluga whales acoustic signals

Olga Son[1], Ekaterina Ten[1], Sergey Gorovoy[1]*, Vladimir Korochentsev[1], Vasily Chernenko[1], Vladimir Sirenko[2], Grigory Sirenko[2]
[1]*Engineering School, Far Eastern Federal University, Vladivostok, Russia, 8 Sukhanova st. Russia, 690090*
[2]*Primorsky Aquarium, Vladivostok, Russia, 25 Akademika Kasyanova st., Russkiy Ostrov, Vladivostok, Russia, 690922*
**e-mail: GorovoySV@mail.ru*

The beluga whale (*Delphinapterus leucas*) is an Arctic and sub-Arctic cetacean. It is also known as the white whale, as it is the only marine mammal of this color. The beluga whales have a well-developed language of communication using acoustic signals. Despite a substantial range of studies, their language was not completely decrypted up to date [1–3]. The researches of studying beluga whale language are carried out in Primorsky oceanarium and Far Eastern Federal University in Vladivostok, Russia. The research results of the variability of acoustic impulses in the time being explored by beluga whales in their "conversation" with each other during daylight and night time are describe in this paper.

Our experiments with the beluga whale were conducted in autumn 2018, when the sea state was 2, the wind speed was below 0.5 m/s, the water temperature was 16 degrees Celsius and the air temperature was also 16 degrees Celsius. Four adult females of beluga whales were situated in a floating cage of Primorsky oceanarium. This cage of sizes 12 meters by 12 meters was located near the piers of Paris Bay on Russky Island, Vladivostok, Russia. Synthetic fiber net, which is attached to the floating cage and lies at the sea bottom, was used to exclude the possibility of the beluga whales leaving the cage. The sea depth of the study area has been 4 meters, the bottom is sand. Acoustic signals were received by using two omnidirectional hydrophones located near the sea bottom at 10 m from the cage. Received by the hydrophones signals were transmitted via cable to shore laboratory where after amplification and limiting the frequency band of 10 Hz—300 kHz were digitized using a 16-bit ADC (National Instruments USB-6361) and recorded in computer memory. The sampling frequency in the experiments was 1 MHz.

The paper presents oscillograms and spectrograms of the recorded acoustic signals, which are assumed to be signals of the beluga whales communication with each other (not food-finding, detection of predators/hazards, and navigation). Also, there are some results of estimating the temporal variability of the signals parameters both during daylight and night time.

References

1. W. W. L. Au The Sonar of Dolphins. 1993, Springer, New York.
2. E.G. Chmelnitskya, S.H. Ferguson, *The Journal of the Acoustical Society of America*. 2012, **131(6)**, pp 4821–4835.
3. P. M. Scheifele, S. Andrew, R. A. Cooper, M. Darre, *The Journal of the Acoustical Society of America*. 2005, **117 (3 Pt 1)**, pp 1486–92.

Key words
Beluga whale, animal vocalizations

Modelling of sound propagation in complicated shallow

M. Sorokin[1], P. Petrov[2]
[1]V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041
[2]V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041
*e-mail: petrov.ps@poi.dvo.ru

Modeling of sound propagation in complicated shallow-to-deep water scenarios is an important problem in many applications of underwater acoustics, including noise monitoring/mitigation, acoustical navigation and ranging, etc. In such problems, the information about the bottom relief and sound speed distribution in the water column along acoustical tracks of hundreds of kilometers is required. In order to take horizontal refraction into account, one also needs the information about the bottom relief in a stripe few tens of kilometers wide aligned along the track. Such information is seldom available from the direct measurements.

In our work a computational tool that combines parabolic equation (PE) model with the code for retrieving the bathymetry and hydrology data from open databases available on the internet is designed. The coordinates of the source and the receiver are used as an input, and the bathymetry along the respective acoustical track is extracted from GEBCO, ETOPO or SRTM data sets. Hydrological data is retrieved either from measurements databased or from various ocean circulation models. After that the computation of acoustical field for given frequency is accomplished by means of RAM/RAMs [1], [2] PE-based propagation model. The resulting sound field (real and imaginary parts of complex acoustic pressure) is written into binary file and can be used for further analysis.

The application of the developed tool in the problems of acoustical navigation is discussed.

References

1. Collins, M.D., 1993, A split-step Pad´e solution for the parabolic equation method, *JASA*, **vol. 93**, p1736–p1742.
2. Jensen, F.B., Porter, M.B., Kuperman, W.A., Schmidt, H., 2011, Computational ocean acoustics, *Springer*, New-York et al.

Acknowledgements

This work was supported by Russian Foundation for Basic Research (RFBR) under the contracts 18-05-00057_a and 18-35-20081 mol_a_ved.

Key words

Ocean acoustics, parabolic equation, sound propagation

Wide-angle mode parabolic equation with transparent boundary conditions and its applications in shallow water acoustics

A. G. Tyshchenko[2,1], P. S. Petrov[1,2], M. Ehrhardt[3*]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova str., Vladivostok, Russia, 690950*
[3]*Bergische Universität Wuppertal, Gaußstrasse 20, D-42119 Wuppertal, Germany*
**e-mail: ehrhardt@uni-wuppertal.de*

Modeling of sound propagation in the shallow-water environments with the three-dimensional inhomogeneous bottom is one of the main research branches of underwater acoustics. Sound field $P(x,y,z)$ produced by a time-harmonic point source in a 3D waveguide is described by the three-dimensional Helmholtz equation. Its solution can be expressed in the form of modal decomposition

$$P(x,y,z) \approx \sum_{\mathrm{j}=1}^{\mathrm{N}} A_j(x,y)\varphi_{\mathrm{j}}(z,x,y)$$

where $\varphi_j(z,x,y)$ are the mode functions and $A_j(x,y)$ are the modal amplitudes (where z is the depth, and x,y are horizontal coordinates). Mode functions $\varphi_{\mathrm{j}}(\mathrm{z},\mathrm{x},\mathrm{y})$ and the respective horizontal wavenumbers k_j can be obtained from acoustical spectral problem [1], and the modal amplitudes $A_j(x,y)$ satisfy the so-called horizontal refraction equation

$$\frac{\partial^2 A_j}{\partial x^2} + \frac{\partial^2 A_j}{\partial y^2} + k_j^2 A_j = -\varphi_j(z_s)\delta(x)\delta(y)\,.$$

One-way solution of the latter equation can be approximated the solution of wide-angle mode parabolic equation [1]

$$\frac{\partial A_j}{\partial x} = ik_{0j}\left(\frac{a+bL}{1+cL} - 1\right)A_j$$

where k_{0j} is the reference wavenumber and $k_{0j}^2 L = \partial_{zz} + k_j^2 - k_0^2$ (a,b,c are certain constants chosen as explained in [1]). Such equation can be solved using the standard Crank–Nicolson method and discrete transparent boundary conditions [2].

In this study we consider various examples of sound propagation problems for shallow-water waveguides with bottom inhomogeneities, including sloping bottom and an underwater canyon. Obtained results are compared with analytical solutions of these problems.

References

[1] F.A. Jensen, W. Kuperman, M. Porter, and H. Schmidt, *Computational Ocean Acoustics*, Springer, New-York, 2011.
[2] A. Arnold, M. Ehrhardt, Discrete transparent boundary conditions for wide angle parabolic equations in underwater acoustics, *J. Comp. Phys*, 1998, **145**, 611-638.

Key words
Parabolic equation, 3D sound propagation, shallow-water acoustic

Shape estimate of a streamer of hydrophones towed by an Unmanned Surface Vessel

Yuquan Wu , Haining Huang *, Chunhua Zhang , Jiyuan Liu , Qihu Li,Chonglei Liu
Institute of acoustic, Chinese academy of science, 21, west of north 4 ring Str., Beijing, China, 100190
**e-mail:hhn@mail.ioa.ac.cn*

The paper deals with the problem of estimating the shape of a streamer of hydrophones for acoustic survey when towed by an Unmanned Surface Vessel(USV). each one towing a streamer of hydrophones, to perform acoustic survey missions that are traditionally performed using streamers towed by a single manned surface vessel. The replacement of the towing system of the vessel with a team of USVs introduces several issues in the localization of the hydrophones, needed to allow the processing of the acoustic data, because the boat's undulation is bigger. In this paper we want to study the solvability of the streamer shape estimation problem depending on the possibly available measurements and information that can be collected via the hydrophones, the USV's on board sensors, and relying on acoustic communication.

References

[1] Chotiros, N.P. and Pallayil, V. (2013). Seabed charac-terization using acoustic communication signals on an autonomous underwater vehicle with a thin-line towedarray. Oceanic Engineering, IEEE Journal of, 38(3),410–418.
[2] Santos, P., Rodriguez, O., Felisberto, P., and Jesus, S.(2010). Geoacoustic inversion with a vector sensor array. J. Acoust. Soc. Am, 5(128), 2652–2663.

Key words:
USV, estimating, streamer of hydrophones

Perturbation of normal modes caused by bottom inhomogenities

A. Zakharenko[1], P. Petrov[1*]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*

The quantitative description of the horizontal refraction effects in shallow water can be given using normal modes theory [1]. In this framework, the horizontal wavenumbers of normal modes play the role of effective refractive index in the horizontal plane. The modal wavenumbers depend on the bottom depth, and the latter in turn depends on the horizonal coordinates. In many cases it is useful to approximate the dependence of the wavenumbers on the depth by a linear or a quadratic function. Such approximation is obtained in our study from first- and second-order mode perturbation theories with bottom depth variation acting as a small parameter. The perturbative formulae for the mode functions are also obtained.

The results of calculation of horizontal wavenumbers and mode functions by the obtained perturbation formulae are compared with the results of the direct numerical computations for the varying bottom depth.

Application of the developed expansions in various sound propagation models is discussed.

References

1. F.B. Jensen, W.A. Kuperman, M.B. Porter, H. Schmidt, *Computational Ocean Acoustics*. New-York: Springer, 2012. 794 p.

Acknowledgements

The study was supported by Russian Foundation for Basic Research (RFBR) under the contracts 18-05-00057_a, 18-35-20081 mol_a_ved, 18-31-00148 mol_a.

Key words

Ocean acoustics, normal modes, perturbation theory

T08: Ocean hazards

Method for increasing probability of tsunami prediction using "gravitational" waves

V. Korochentcev[1], E. Lisunov[1]
[1]*Far Eastern Federal University*

A method is proposed to increase the probability of a correct tsunami prediction using "gravitational" waves. The change in the gravitational field near the earthquake source is accompanied by a change in the "gravitational" wave.

Registration of signals was carried out by the following devices:
1. CG-5 Autograv Gravimeter located at the Vladivostok seismic station of the Federal Research center of the United Geophysical Survey of Russia Academy of Sciences (UGS RAS)
2. gPhone gravimeter (Micro-g LaCoste, Inc., USA) installed at the marine experimental station Monitoring of variations of the earth's gravitational field is carried out by the Pacific Oceanological Institute of Feb RAS (TOI FEB RAS).

A mathematical model describing the wave gravitational processes near the earth's surface and in the thickness of the Globe with accelerated motion of concentrated masses (earthquakes) is proposed. Analytical solutions of the equations are obtained.

Seismic and gravitational measurements are widely used in the study of the physical fields of the Earth. When measuring the elastic characteristics of the geospheres of the Earth, the determination of the layered structure, the study of the Earth's structure, scale and nature of the inclusions of minerals in the earth's crust, the determining factor is knowledge of the quantitative characteristics of phase and group velocities of elastic waves. Mathematical models, in which the structure of geospheres is calculated, necessarily include the phase and group velocities of elastic waves in waveguides and, therefore, allow to determine the quantitative underwater and underground structures.

In the Einstein's General theory of relativity, it is theoretically proved that accelerated moving gravitational masses (UDGM) emit gravitational waves whose speed does not exceed the speed of light in a vacuum. Further theoretical studies of tensor equations have shown that gravitational waves are transverse waves propagating at the speed of light in a vacuum.

In our work it is shown theoretically and experimentally that the accelerated moving masses near the earth's surface emit not only seismic, elastic and electromagnetic waves, but also "gravitational" waves.

Under the "gravitational" waves in quotation marks, we have determined the change in the gravitational field of the Earth, which can be confidently measured by standard gravimeters.

References

1. Korochentsev V. I. Mathematical model of elastic and electromagnetic waves generation by earthquake source. Proceedings of the southern Federal technical University 2009. page 120-130
2. Korochentsev V. I., Lisunov E. V. Study of "gravitational" waves emitted by earthquakes. Fundamental questions of natural science. Vladivostok: far East naval Institute, 2009. P. 75-79
3. V. I. Korochentsev, Phys.m.N., Professor IACP, E. In Lisunov, FESTU, Vladivostok, Russia A. P. Belash, associate Professor, Changtu, Petropavlovsk-Kamchatsky, A. G. Abdrashitov, associate Professor, Changtu,

Petropavlovsk-Kamchatsky // the possibility For gravitational waves emitted by earthquakes, for navigation// Scientific conference "Vologdin readings" FESTU. C. 21-24
4. Proshkina Z. N., Valitov M. G., Kulinich R. G., Kolpashchikova T. N. Study
tidal variations of gravity in the zone of transition from the continent to the sea of Japan. // Bulletin of Kamchatka Regional Association"Educational-Scientific Center". Earth Sciences» 2015. No. 3 Issue. 27. P. 71-79.

Acknowledgements
I express my gratitude to the staff of the far Eastern Federal University for their help in writing the text. I am also grateful to the employees of the Pacific Oceanological Institute for providing the data.

Key words
Tsunami, earthquakes, "gravitational" waves

The comparison of tsunami sedimentation zones with observed run-ups in the eastern and the southern Primorye

I.I. Lebedev
Pacific Geographical Institute FEB RAS, 7 Radio str., Vladivostok, Russia, 690041
**e-mail: ilya.lebedev.1994@bk.ru*

One of problems of a paleotsunami reconstruction is a problem, so far sediment accumulation zones by which waves parameters reconstruct, are correlated to real run-up zone limits. Distinctions between run-ups and inundation zones of the tsunami 1983 and the tsunami 1993 measured immediately after events (Polyakova, 2012; Gorbunova et al., 1997) and sedimentation zones in the southern and the eastern parts of Primorye were considered.

On the Russky Island, zones of a tsunami run-up were measured in 2 bays. Modern tsunami deposits were found only in Spokoynaya bay. Tsunami 1983 was the most intensive. The run-up value in Paris Bay was until 1,5 m, the inundation zone arrived 36 meters (Polyakova, 2012). On Spokoynaya bay coast was founded a light gray fine-grained sand, leaving by the tsunami 1993 that evidenced on distance 18 meters from the coastal line. Lower sand layer apparently, appears trace of the 1983 tsunami. It is traced on distance up to 50 meters inward. From XIV to XIX centuries were being noticed until 14 intense events. Their deposits stretch so far 60 meters inward. Thickness of tsunami deposits reaches 25 cm (Ganzey L.A. et al., 2016).

Tsunami inundation zone investigations on the coast of the eastern Primorye were conducted in 24 bays (Polyakova, 2012). Tsunami deposits investigation were held in 11 bays: Triozerye, Kievka, Sokolovskaya, Proselochnaya, Kit, Valentin, Milogradovka, Moryak-Ribolov, Kitovoye Rebro, 1-e Langou, and Udobnaya. Generally, the tsunami sediment in these bays consists from light gray fine-, medium-grained sands. Most inundation distance, that measured by tsunami sediments, composed 395 meters (Langou-1 bay). The most distance, on which were modern tsunami sediments founded, arranged 500 meters (along Blagodatnoe lake coast (Udobnaya bay)) (Ganzey et al., 2017), although the run-up value was small there (Polyakova, 2012).

Consequently, the correlation between tsunami inundation zone and the sedimentation area in different bays was diverse. So, on Spokoynaya bay coast (Russky Island), the inundation zone of a modern tsunami is 36 meters. Whereas paleotsunami sedimentation zone equal 60 meters. On eastern Primorye coast the most run-up zone is characterized by modern tsunami.

References

Ganzey L.A., Razjigaeva N.G., Nishimura Yu. Deposits of the 1983 and 1993 Tsunamis on the coast of Primorye, *Oceanology*, 2017, **volume 57, issue 4**, page 628-page 640

Ganzey L.A., Razjigaeva N.G., Grebennikova T.A. Manifestation of historical tsunami on Russian island, Sea of Japan // *Advances in current natural sciences*, 2016, **issue 5**, page 116-page 124

Gorbunova G.V., Didenko G.V., D'yachenko V.D. Investigation of tsunami manifestation of 12-13 July, 1993 on the Primorsky Krai coast // Geodynamics of tectonosphere of the Pacific-Eurasia conjunction zone, 1997, **volume 8**, Page 196

Polyakova A.M. Dangerous and especially dangerous hydrometeorological phenomena in the Northern Pacific and tsunami waves near the Primorye coast, Vladivostok, 2012, Page 181

Acknowledgements

This work has been performed with financial support of the Program of Priority Scientific Research in the interests of integrated development, Far Eastern Branch, Russian Academy of Sciences, Project 18-5-003

Key words

Tsunami, paleotsunami, inundation zone, tsunami deposit, sedimentation

Numerical simulation of storm surges in the inland seas under different types of synoptic situations forcing

E. Lemeshko[1]
[1]Marine Hydrophysical Institute of RAS, 2 Kapitanskaya Str., Sevastopol, Russia, 299011
*e-mail: e.lemeshko@mhi-ras.ru

Wind waves and storm surges are the most important characteristics that determine the dynamics of the coastal zones waters for inland seas. The Azov Sea is a shallow inner basin with bays and river deltas and could be used as a “laboratory” basin for testing modern models of wind waves, and for predicting storm surges.

The best option for modeling extreme storm events in the Azov Sea is the use of joint models that take into account the relationship and interaction between currents and waves. To calculate storm surges and wind waves in this work, it was used the joint model ADCIRC + SWAN - a combination of a spectral model of wind waves and a model of water circulation designed to describe currents and sea level.

The simulation was performed on an unstructured computational grid, including the Azov Sea and the Kerch Strait, consisting of 10,835 finite elements and 6,730 nodes, which allow one to achieve 100–200 m high spatial resolution in the surf zone of wave collapse.

The input data were the driving wind and surface pressure fields over the Azov-Black Sea basin. Homogeneous fields of wind of different directions were used as atmospheric forcing; types of wind synoptic situations were selected based on the self-organizing map analysis of long-term meteorological observations [1].

In a series of numerical experiments, the generation of storm surges in the Azov Sea, the Taganrog Bay and the Don River Delta were investigated by a uniformly spaced wind of various directions and the wind speed magnitude. Extreme wind-induced recessions for the Don river delta occur at 15 and 20 m/s wind speeds for NE and E directions, extreme surges at 15 and 20 m/s wind speeds for W and SW directions.

The extreme storm surges and wind-induced recessions hindcasting are compared with tide-gauges observations. As a result, the model adequately describes the measured variations of the sea level. There is a good reproduction of the rise and fall phases of the sea level during storm evolution.

References

1. Lemeshko E. E., Surkova G. V., Lemeshko E. M.. Structure and long-term dynamics of surface atmosphere of Azov-Black Sea region on the base of self-organizing map analysis. Proc. SPIE 10833, 24th International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics, 108337V (13 December 2018); **doi: 10.1117/12.2504291.**

Acknowledgements

This work was supported by the Russian Federation State Tasks № 0827-2019-0004.

Key words

ADCIRC+SWAN, hindcasting, flooding.

The influence of climate change on tsunami-like solitary wave inundation over fringing reefs

W. Liu[1*], Y. Ning[1]
[1] Ocean College, Zhejiang University, Zhoushan, China, 316021
*e-mail: weijieliu@zju.edu.cn

The protective capability of fringing reefs against tsunami hazards has been reported in numerous post-disaster surveys. It is believed that global warming is changing the water level over the reef flat and reef surface roughness by sea level rise and coral bleaching. In order to better understand the influence of climate change on tsunami hazards over fringing reefs. This study utilized a shock-capturing Boussinesq wave model, FUNWAVE-TVD, to simulate the tsunami-like solitary wave propagation and run-up over fringing reefs. Calibrated and validated by the newly performed experimental data, the present model with shock-capturing scheme, in which only the ratio of wave height to water depth to trigger wave breaking, shows reasonable prediction of solitary wave transformation and run-up height over sharply varying reef bathymetry. Numerical experiments were then carried out to investigate the effects of the sea level rise and degrading of the reef surface roughness on the solitary wave inundation distance and fluid force distribution in the inundation zone. The results clearly demonstrate how tsunami hazard change within the inundation zone in response to higher water levels and lower reef roughness and suggest climate change will have a significant negative influence on the protective capability of fringing reefs against tsunami hazard in the future.

References

Shi, F., Kirby, J.T., Harris, J.C., Geiman, J.D. and Grilli, S.T., 2012. A high-order adaptive time-stepping TVD solver for Boussinesq modeling of breaking waves and coastal inundation. Ocean Modelling, 43-44: 36-51.
Yeh, H., 2006. Maximum Fluid Forces in the Tsunami Runup Zone. Journal of Waterway Port Coastal & Ocean Engineering, 132(6): 496-500.
Vermeer, M. and Rahmstorf, S., 2009. Global sea level linked to global temperature, Proceedings of the National Academy of Sciences of the United States of America, 106: 21,527–21,532.
Solomon, S., 2007. IPCC (2007): Climate Change The Physical Science Basis. AGU Fall Meeting.
Yao, Y., He, F., Tang, Z. and Liu, Z., 2018. A study of tsunami-like solitary wave transformation and run-up over fringing reefs. Ocean Engineering, 149: 142-155.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant No. 51809234)

Key words

Fringing reefs, tsunami inundation, fluid forces

Some dynamical Characteristics of Damrey Storm and their Impact on Marine Environment and coral Reefs at the Northern Region of Khanh Hoa Province (Central Vietnam).

Bui Hong Long[1] , Yuri Latypov[2], Phan Minh Thu[1] ,Tran Van Chung[1] , Nikolai Selin[2]

[1]*Department Marine Physics, Institute of Oceanography, Nhatrang, VAST ,Vietnam*
[2]*National Scientific Center of Marine Biology, Vladivostok, FEBRAS, Russia,*
[3]*Department Marine Ecology , Institute of Oceanography, Nhatrang, VAST ,Vietnam .*
Email address : buihonglongion@gmail.com

Damrey Storm (which is the Storm with the number 12 landed in Vietnam in 2017) landed in Coast of South Phu Yen - North Khanh Hoa on the morning of November 4, 2017, causing serious damage to people and materials and very serious consequences. Damrey Storm (Storm No12) has killed 107 people, 16 missing and 342 injured. More than 165,000 houses were affected, of which more than 3,500 houses were completely damaged. According to a published national report on the material damage caused by this storm, nearly 1 billion USD has caused South Central region. The most severely affected locality of this storm is Khanh Hoa province (currently still have to overcome) to the socio-economy. So far, there have been no published works on the results of analyzing monitoring data and calculating research on marine dynamics caused by the this storm . This paper presented some results of analysis of water level monitoring data, calculation of wave field, storm surge of Damrey Storm in Khanh Hoa coastal area. On that basis, there are initial comments on its impact on coral reefs of this region in order to contribute to considering and assessing the impacts of Storms for management and forecast ... mitigation of local damage caused by natural disasters.

The results of storm impacts on coral reefs are part of the research results of the topic VAST.HTQT.NGA.03 / 17-18 (International Cooperation Project between IO and National Scientific Center of Marine Biology, Vladivostok during 2017-2018 years).

Exothermic processes in solutions of monoethanolamine in nitric acid

I. Skvortsov[1,*], E. Belova[1], I. Tananaev[2], A. Emelyanov[3], A. Rodin[3]
[1] *IPCE RAS, 31/4 Leninsky prospect, Moscow, Russia, 119071*
[2] *FEFU, 8 Sukhanova St., Vladivostok, Russia, 690090*
[3] *SEC NRS, 2/8 bld. 5 Malaya Krasnoselskaya str., Moscow, Russia, 107140*
**e-mail: skvortsov.ivan.68@gmail.com*

Objects of the fuel cycle are the sources of radioactive pollution of the World Ocean, representing a serious danger. Direct entry into the World Ocean of technogenic radionuclides, as well as their movement through rivers into the sea from radiochemical plants for the reprocessing of spent nuclear fuel, including the consequences of the accidents, represents a serious potential danger. The causes of such serious accidents can be natural and technogenic factors that were not considered during the design of a hazardous facility. A typical example of a technogenic catastrophe that occurred due to the complex impact of external factors is the accident at the Fukushima nuclear power plant. The external impacts on an object which uses atomic energy, such as loss of energy supply, fire, air shock wave and others, can cause disruptions in the operation and maintenance of the object and lead to the creation of favorable conditions for the occurrence of uncontrolled exothermic processes in nitric acid solutions, containing reducing agents or contacting with reducing agents, representing a potential danger.

Objective of the study: to evaluate the fire and explosion hazard of systems containing nitric acid and water-soluble organic compound (monoethanolamine).

Monoethanolamine (MEA), used in nuclear power industry as a corrective additive to maintain the pH of the secondary coolant in the range that ensures minimal corrosion of equipment in the system, is a reducing agent in the pair "MEA - nitric acid". Studies were conducted by thermal analysis methods using a differential scanning calorimeter DSC-500 and sealed crucibles, as well as a device for assessing thermal stability under high pressure conditions [1].

It is shown, that nitrate solutions with MEA are thermally highly unstable, and at the temperatures close to boiling points of 105-110 °C decompose with gas evolution, the maximum rate of which increases with increasing concentrations of reagents. When the pressure is above atmospheric, the process is accompanied by heat evolution and proceeds in the mode of uncontrolled exothermic reaction - thermal explosion. The intensity of the thermal explosion depends on the concentration of HNO_3, it is quite high at concentrations from 18 to 26.5% of HNO_3. The maximum intensity of thermal explosions is achieved by rapidly heating the solution to the start temperature of exothermic process T_{SE}, in particular, at a thermostat temperature of 150 °C, which is confirmed by the data of experiments in an autoclave.

Thus, in the presence of even small amounts of MEA in the solution, during their exothermic interaction with the oxidizing agent, it is possible to create pressures which are sufficient to cause emergency situations. To ensure safety, we can recommend to exclude the presence of MEA in solutions entering high-temperature operations.

This work was financially supported by Russian Science Foundation (project 16-19-00191).

References

[1]Rodin A.V., Nazin E.R., Zachinyaev G.M., Belova E.V., Tkhorzhnitsky G.P., Danilin D.I., Tananaev I.G. Radiation-thermal interaction of TBP with nitric acid at atmospheric pressure. Voprosy radiatsionnoy bezopasnosti, 2011, **3**, 45-50

Key words: monoethanolamine, explosion safety, exothermic processes

Research of resonant oscillations in marginal sea

S. Smirnov[1*]
[1]*Institute of Automation and Control Processes FEB RAS,.5 Radio Str., Vladivostok, Russia, 690041*
**e-mail: smirnoff@iacp.dvo.ru*

The report discusses various aspects of the application of a shallow water numerical model with difference approximation on an irregular triangular spatial grid for studying spatial and temporal parameters of resonant oscillations in natural water bodies, using as an example some individual water areas of Peter the Great Bay of the Sea of Japan. Spatio-temporal parameters of forced oscillations were obtained using the numerical model, described in [1, 2]. The model is based on the system of differential equations of the theory of tides. The bottom friction is taken into account in the form of the linear dependence on the components of velocity. On the solid lateral boundary "non-flow" conditions are set. On the lateral liquid boundaries, the radiation conditions are set. When constructing the difference analogues of model equations on the irregular triangular grid, a finite volume method is used. The solutions are sought in the form of steady-state oscillations.

The computational area covers the entire Sea of Japan. The calculate grid consists of triangles with lateral dimensions from 30 m nearshore, up to 2 km in the interior of the Sea of Japan. For constructing the digital bottom relief the ETOPO1 data and nautical charts were used. The external forcing was specified within local area of 100 km radius, centered in Nakhodka Gulf. The calculations of the resonance response of the water area were performed for periods from 35 to 90 minites, for the cases of zonal and meridional wind directions. There are several peaks on the model resonance curves with periods about 38, 40 and 70 min. The location of this peaks corresponds to the well-pronounced maxima of the energy spectrum [3] by data, measured on the station Nakhodka (42.8°N, 132.92°E) of Russian tsunami warning service. This shows the possibility of a substantial resonant amplification of the level oscillations by periodic wind forcing. The spatial structures of oscillations, corresponding to resonance curve peaks, are presented. It is shown, for example, that one of the modes of the Sea of Japan is involved in the oscillation with the period about 71 minutes.

References

1. S.V. Smirnov. *Numerical Analysis and Applications*, 2014, **7**, 168-179.
2. S.V. Smirnov, I.O. Yaroshchuk, A.P. Leontyev, A.N. Shvyrev, A.A. Pivovarov, A.N. Samchenko. *Russian Meteorology and Hydrology*, 2018, **43**, 88–94.
3 S.V. Smirnov. *Russian Meteorology and Hydrology*, 2016, **41**, 57–62.

Acknowledgements

This work was supported by Presidium RAS, Program "Fundamental aspects of supercomputing for simulating complex practical problems" (number 27). Numerical results were obtained with use of IACP FEB RAS Shared Resource Center "Far Eastern Computing Resource" equipment.

Key words

Resonant oscillations

Research on Legal Issues of Marine Disaster Emergency Response in China

Xincong Zhang, Pei Zhaobin
Dalian Ocean University No. 52 Heishijiao Street, Shahekou District, Dalian City, Liaoning Province, China,116023
**e-mail: zhangxincong4@live.com*

While bringing huge economic benefits to mankind, oceans are also brewing various kinds of marine disasters, which pose severe challenges to the safety of the public's personal and property. China's marine disaster emergency management started late and lacked experience. As a result, there are still some problems in the marine disaster emergency response system, such as low public participation, lack of standardization of emergency procedures, lack of supervision and accountability of emergency measures. Based on the analysis of the concept and necessity of marine disaster emergency response, under the guidance of the concept of rule of law, and on the basis of the relevant theories of administrative emergency response power, this paper puts forward some countermeasures for different stages of marine disaster emergency response, such as diversification of emergency subjects, improvement of marine disaster emergency response procedures, and strengthening the accountability of marine disaster emergency response. To provide suggestions and references for the development of marine disaster emergency management and control and the improvement of marine disaster emergency legal system.

Acknowledgements
This work was supported by the school, but also inseparable from my tutor's teaching. The China Association for the Protection of Marine Rights and Law Enforcement has provided a lot of advice and guidance for the completion of this project. Thank you to everyone who has worked hard for this purpose.

Key words:
Marine disasters; administrative emergency; emergency management

T09: Fisheries and aquaculture

T09-1: Fisheries Stock Enhancement

Conceptual designs of coastal fishing vessels

A.I.Azovcev[1], I.S.Karpushin[2], E.E.Soloveva[2]
1A.I.Azovcev , Admiral Nevelskoy Maritime State University . 50a, Verkhneportovaya St., Vladivostok, 6900592.
I.S. Karpushin, E.E. Soloveva Far Eastern state technical fisheries University, 52 b Lugovaya Str., Vladivostook, Russia, 690087
**e-mail: pillers@mail.ru*

The development of coastal fisheries and aquaculture in conditions of unequipped coasts requires new technologies to create solutions for fishing vessels.

One solution is to create a new type of fishing vessels. It can be possible to intensify the development of coastal fisheries and mariculture without the construction ofport and berthing facilities.

References
1. Azovcev A.I., Ogai S.A. "Transport ensuring of coastal fishery by seaworthy all-terrain vehicles" , Transport business in Russia2015 г, №6. p.182-183.
2. Karpushin I.S., Azovcev A.I., Gannessen V.V., Maksimov E.A., Soloveva E.E. patent RU 2 4 7 3 2 0 4 C1 " METHOD OF HARVESTING STORM DRAINS ALGAE " Date of publication: 27.01.2013 Bull. 3

Key words
Coastal fisheries, transport ensuring of fishing trade.

Study on Symbiotic System of Sea Urchin (*Strongylocentrotus nudus*) and Kombu (*Saccharina japonica*) in the Great East Japan Earthquake area

Yusuke Bessho[*], Hitomi Nakanishi[2], Satoru Takahashi[3], Tsuneo Honjo[4], Yoshihiro Suenaga[3]
[1]*Graduate School Student, Faculty of Engineering, Kagawa University*
2217-20 Hayashi, Takamatsu, Kagawa, 761-0301, Japan
**e-mail: yusukebes3@gmail.com*
[2]*Faculty of Arts and Design, University of Canberra*
[3]*Faculty of Engineering and Design, Kagawa University*
[4]*Setouchi-ken Research Center, Kagawa University*

The coastal area of the Tohoku region (North East Japan) is a special sea area called 'Shiome' where the Oyashio Current and the Kuroshio Current collide, which provides an abundant fishing ground. Coastal area of Iwate Prefecture, Japan, which is close to the Shiome, is one of the highest fishery catches in Japan, mainly catching Sea Urchin and Kombu. Kombu grows and forms seaweed bed, takes an important role in maintaining biodiversity and preserving the marine environment, supporting the ecosystem of shallow sea areas[1)]. However, due to the damage caused by Sea Urchins and fishery ground subsidence caused by the Great East Japan Earthquake 2011, Isoyake phenomenon (seaweeds withering phenomenon of a rocky shore, this is also called as sea desertification or rocky-shore denudation or urchin barren) continues and the catch amount tends to decline. Also, the aging and reduction of fishery workers triggers the decrease of catches, leading to serious problems in Iwate Prefecture's fisheries industry.
In this study, we develop a technology that enables symbiosis of Sea Urchin and Kombu, and a function to gather Sea Urchin on artificial reef to create seaweed bed in a cost-effective method prescribed by the Ministry of Agriculture, Forestry and Fisheries[2)]. As a result, we gained a foundational knowledge in creating a sea area to construct a symbiotic system of Sea Urchin and Kombu, that is also safe for older fishermen to use.

References

[1]Akio Kuroyanagi and Yoshihiro SUENAGA (2018). A Study on Resident Life of Tsunami Stricken Area at Omoe South Region of Miyako Iwate Sanriku - A Case Study of ANEYOSHI,CJIKEI,ISHIHAMA,KAWASHIRO area -, Journal of Coastal Zone Studies, vol.30, pp.113-123.
[2]Ministry of Agriculture, Forestry and Fisheries. (2016). Grant for support of agricultural mountain fishing village activation project, Retrieved February 21, 2019, from http://www.maff.go.jp/j/kasseika/k_project/

Acknowledgements

We would like to express sincere thanks to Mr. K. Takasago (President of Takasago Fishery Co, LTD.), Mr. K. Sogo, (President of SUNX Co. LTD), Mr. N. Yakaji, (Nihon Kogyo, Co, LTD.) and Mr. T. Shirokoshi, (Nihon Reef, Co., LTD.) for their valuable comments and suggestions. A part of this work was supported by Grant in aid of the Japanese Institute of Fisheries Infrastructures and Communities.

Key words

Great East Japan Earthquake, Isoyake, Symbiosis of Sea Urchin and Kombu

Post-Release Survival of Hatchery-Reared Juvenile *Snook Centropomus* Undecimalis: The Influence of Habitat Quality

K.M. Leber[*1], R.W. Schloesser[1], P. Caldentey[1], N.P. Brennan[1], and C.H. Peterson[2]
[1]*Mote Marine Laboratory, Sarasota, Florida, USA 34236*
[2]*Institute of Marine Sciences, University of North Carolina at Chapel Hill, Morehead City, North Carolina, USA 28557*
**e-mail: kleber@mote.org*

Marine fisheries enhancement programs afford a valuable opportunity to resolve critical uncertainties about ecological requirements of wild and enhanced fisheries stocks. The common snook (*Centropomus undecimalis*) supports a valuable recreational fishery in southwest Florida, and stock enhancement may aid population recovery in the event of mass mortality from cold stun and red tide events. However, the success of snook stocking efforts are dependent on the specific location, habitat suitability and time at which individuals are released. In particular, the availability of appropriate nursery habitat at release sites may be a critical factor influencing post-release survival in southwest Florida because important habitat has been lost to coastal development and shoreline hardening.

To guide effective marine fisheries enhancement with common snook, we examine spatiotemporal variability in post-release survival of hatchery-reared juveniles, focusing on the influence of release-site habitat within and among systems, as well as habitat acclimation strategies. Using a replicate release design, we stocked 5,450 juveniles tagged with passive integrated transponder (PIT) tags over four experimental release efforts between November 2016 and September 2018. These hypothesis-driven release experiments were conducted in two tidal-creek systems that are monitored with marine-adapted PIT tag antenna arrays.

Recapture histories were highly variable among individuals but general patterns were influenced by release season (fall vs spring) and site-specific differences in hardened or natural shoreline habitat. Cormack-Jolly-Seber mark-recapture models suggest that recapture histories were best explained by short-term differences in survival among the habitats at which individuals were released, and long-term patterns in detectability that are associated with water height (i.e., access to the monitored shoreline habitats). Yet, these patterns differed among seasons, particularly for short-term survival, which has been significantly lower for fall releases. The use of variable tag sizes, pre-release acclimation to habitat, and predator-exclusion cages during release also influenced rates of survival and detectability of hatchery-release fish. Throughout the Gulf of Mexico, stock enhancement programs regularly release hatchery-reared sportfish, and the application of adaptive-management release experiments can identify ideal stocking time frames, the influence of available habitat on post-release survival, as well as reduce short-term mortality of stocked fish to improve the effectiveness of sportfish stock enhancement.

Acknowledgements
This work was supported by donor funding to improve snook enhancement technology and a Florida Fish and Wildlife Research Institute grant to Mote Marine Laboratory.

Key words
Marine Fisheries Enhancement, Responsible Approach to Stock Enhancement, Habitat Suitability

Maintaining level of fish packages of Pacific salmon in the Kakhalin – Kuril region

A. Litvinenko*
Sakhalin State University, Yuzhno-Sakhalinsk 693008
**e-mail: vesna271@rambler.ru*

In terms of the number of young Pacific salmon produced, Sakhalin Region is leading in Russia, releasing more than 800 million units annually in the waters of the Pacific Ocean. Due to the design and construction of several dozen fish factories, this number is planned to increase in the near future. A very effective artificial breeding of Pacific salmon in the Sakhalin region is based on competent combination with unique natural reproduction. In 2018, 52 salmon fish farms of various ownership forms functioned in the Sakhalin Region, of which about13 at the Iturup Island.

All plants use traditional, well-proven biotechnology of artificial reproduction, however, there are some differences in the stages of growing and release of young fish, as well as some technological features of equipping and supplying traditional hatchery enterprises and salmon fish farms built in the last decade. Being in optimal environmental conditions and using a single biotechnology, all modern fish farms are notable for high efficiency of their work, expressed in the number of returned producers.

***Key words**:*

Pacific salmon, hatcheries, artificial reproduction, commercial return.

The functional structure of the habitat area of the Greenland halibut

O. Maznikova
Russian Federal Research Institute of Fisheries and Oceanography,17, V. Krasnoselskaya Str., Moscow, Russia, 107140
**e-mail: maznikovao@vniro.ru*

The Greenland halibut (Jordan et Snyder) is the one of the most important objects of fisheries in the North Pacific. The study of the functional structure of the area is necessary for the sustainable and long-term exploitation of the Greenland halibut stocks.

The work is given based on the bottom and pelagic trawl data collected in 2000–2017 by the employees of «TINRO» («TINRO-Center»), «KamchatNIRO» and central office of «VNIRO». In total data for 66 surveys in the western part of the Bering Sea and the Pacific waters of Kamchatka. A total of 12 600 samples were analyzed, the age was determined to be 1300 individuals of the Greenland halibut.

The interpretation of the functional structure of the habitat area consists of information about the distribution of fish at the different ontogenesis stages and the biological characteristics of the studied species. Sometimes the individual functional parts of the area may overlap or coincide. According to the results of studies conducted in the western part of the Bering Sea and the Pacific waters of Kamchatka the following areas of constant presence of different size groups of halibut are distinguished:

1)6-30 cm (young, immature) – Gulf of Anadyr, Navarinsky district, Olyutorsky, Karaginsky and Korfa Bays, waters of the western part of the Aleutian and Commander basins;

2)30-50 cm (immature, maturing) – shelf of Olyutorsko-Navarinsky district and western part of the Aleutian Basin, Olutorsky Bay;

3)FL>50 cm (adult) – continental slope of Olyutorsko-Navarinsky district, Gulf of Anadyr, Navarinsky district, western part of the Aleutian basin, Olutorsky Bay.

Contrary to earlier views on the distinct bathymetric differentiation of various size and age groups of the Greenland halibut it was not identified from the results of complex bottom and pelagic trawl surveys.

Despite this, the following conclusions were drawn about the bathymetric migrations of the Greenland halibut as it grows:

1) juveniles up to a length (*FL*) of 6-7 cm live in the epipelagic zone of the Commander and Aleutian basins and further descend to the bottom as they grow;

2) halibuts with a length of *FL* 30-50 cm are active migrants; the area of distribution covers the entire shelf and continental slope;

3) Migrations from the shelf to the continental slope is completed when halibuts up a length of 50-60 cm. In spite of the occurrence of halibuts in mixed catches on isobaths up to 200 m, in the period of active feeding, fish of this size group are distributed in the lower sections of the shelf and in the downfall of depths;

4) adult halibuts with a length of more than 70 cm is noted mainly at depths above 600 m.

Thus, in the functional structure of the habitat area of the Greenland halibut, there are locations of constant presence of different size classes and areas of cohabitation of juvenile and maturing fish (Gulf of Anadyr, Olyutorsko-Navarinsky and Navarinsky districts, Olyutorsky, Karaginsky and Korfa bays, waters of the western part of the Aleutian and Commander basins).

Key words:
Greenland halibut, habitat area, Bering sea

T09-2: Sustainable aquaculrure production systems and strategies

Nutritional efficiency of juvenile Far Eastern sea cucumbe (*Apostichopus japonicus*) when grown under controlled conditions during the summer maximum temperatures

Berdasova K.S[1]., Pahlevanyan A.A.[1], Gevorgyan T.A.[2], Botsun L.A.[1], Maslennikov S.I.[1,2]
[1]*National Scientific Center of Marine Biology, FEB, RAS, 17, Palchevskogo Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, FEFU Campus, 10, Ajax Bay, Russky Island, Vladivostok, Russia, 690922*
e-mail: armanpahlevanyan@gmail.com, gevorgianta@students.dvfu.ru

Far Eastern sea cucumber - *Apostichopus japonicus*, has long been used as an important fishing resource in the Far East of Russia, the PRC, Japan, the Republic of Korea and the DPRK [1, 2, 3]. One of the main issues - the assimilation of food by young sea cucumber. **The goal** of our experiment was to evaluate the effectiveness of diets of juvenile Far Eastern sea cucumber when grown during the summer maximum temperatures from July 21 to August 24.

Materials and methods: For the experiment were selected 4 groups of individuals with an average weight: 1) year-old 0.049 g, 2) year-old 0.243 g, 3) 2-year-old 0.956 g, 4) 2-year-old 11.424 g. 4 diets were used: 1 - 10% of feed by weight of trepang, ½ - 5%, - 2.5%, respectively, and 0 - did not feed.

Results: For the period of the experiment (34 days), the minimum water temperature was + 17.8 ° C, maximum + 22.1 ° C. The temperature reached a maximum value at week 3 of the experiment, after which the decline began.

In group 1, a positive weight growth was observed only for a 10% diet in the whole range of temperatures. Also, a positive increase was observed for the diet of 2.5% during the period of rising water temperature. In the second group, negative growth was observed for all diets, except for organisms that received 2.5% of feed by weight. With a period of decreasing temperature with an increase in weight, it was observed for rations of 10 and 5% feed. For the 3rd weight group, the most appropriate diet was a 5% feed by weight ratio. Weight gain was observed on a continuation of 4 weeks out of 5, including during the period of maximum temperatures. The second most effective was a 10% diet. Among large two-year-olds, only the ones that did not receive feeding could survive the maximum temperature. The remaining individuals were eliminated.

Conclusions: 1. In the period of high temperatures for all types of feed for all weight groups, the phenomenon of negative growth was observed depending on the diet. 2. A diet of 10% was most effective for individuals with the lowest weight. 3. The most effective diet for most weight groups was 2.5% feed by weight. 4. For small biennial individuals, the best weight gain is noted for a 5% diet. 5. For the large weight fraction of the sea cucumber, the best feeding strategy during the period of maximum temperatures was starvation (hibernation?).

References:

1. Sloan N.A. Echinoderm fisheries of the world: A review. In: Echinodermata (Proceedings of the Fifth International Echinoderm Conference). 1984. 109–124 pp
2. Steven W. Purcell, Yves Samyn, Chantal Conand, Commercially important sea cucumbers of the word, FAO, 2012
3. Yang H., Yuan X., Zhou Y., Mao Y, Zhang T, Liu Y. Effects of body size and water temperature on food consumption and growth in the sea cucumber Apostichopus japonicus (Selenka) with special reference to aestivation // Aquaculture Research. 2005. №36, 1085–1092 pp.

Key words: Apostichopus japonicus, japanese sea cucumber, mariculture.

Advances in Land-Based Marine Integrated Aquaculture Systems

K.L. Main[1*], M.J. Nystrom[1], N.P. Brennan[1], A. Tarnecki[1], and L. Guttman[2]
[1]*Mote Aquaculture Research Park, Marine Laboratory, Sarasota, Florida, USA 34240*
[2]*National Center for Mariculture, Israel Oceanographic and Limnological Research Institute, Eilat, Israel 88112*
**e-mail: kmain@mote.org*

Future expansion of environmentally friendly and sustainable aquaculture is needed to meet the ever-increasing demand for safe and sustainable seafood. Conventional aquaculture is challenged by high water demand, pollutant discharge, and problems related to biosecurity and disease. Some of these barriers can be addressed by land-based recirculating aquaculture systems (RAS). However, marine RAS face obstacles that need to be addressed, such as high energy demands, biosecurity issues, discharges of saline water and organic salty solids, and the lack of a standardized RAS filtration system.

The need to expand marine fish production and improve the economic viability and sustainability of RAS led to the development of a zero-discharge, integrated marine aquaculture (aquaponic) system (IAS). The prototype, commercial-scale system design incorporated solids filtration, a moving bed bioreactor for nitrification, a sand filter for solids removal and denitrification, ultra-violet light sterilization for water quality, and hydroponic plant beds. Water treatment capacity, nutrient cycling, and biomass production were evaluated in the prototype IAS producing red drum (*Sciaenops ocellatus*), edible halophytes (sea purslane, *Sesuvium portulacastrum*, and saltwort, *Batis maritima*), and organic solids for three production cycles.

Extensive analysis of solids, organic matter, and nutrients (nitrogen and phosphorous) in water and plant biomass was used to develop detailed mass balances for the system. Simultaneous operation of the moving bed bioreactor and plant beds resulted in high ammonia removal rates, allowing the system to support a high fish biomass density (38.8 kg/m^3 in year 1, 48.8 kg/m^3 in year 2, 45.2 kg/m^3 in year 3). This study demonstrates that marine IAS is an effective way to sustainably produce marine fish, edible halophytes, and fertilizer. Addition of biological filtration and a denitrifying sand filter was shown to benefit high-density fish production in situations where there are space limitations or niche markets for plants. Recent findings from research trials to evaluate the biofiltration capacity of periphyton biofilters will also be presented.

Acknowledgements
This work was supported by the NOAA Sea Grant College Program and the United States - Israel Binational Agricultural Research and Development (BARD), Grants No. IS 4995 17R and US – 4599-13R.

Key words
Integrated Aquaculture System, Marine Aquaculture, Periphyton Biofiltration

Prospect of using enzyme algae processing in the feed additives technology for mariculture

Rogov A.M.*, Kadnikova I.A.
Pacific Branch Pacific Branch of the Russian Federal Research Institute of Fisheries and Oceanography (TINRO), 4, Shevchenko alley, Vladivostok, Russia, 690950
**e-mail: aleksandr.rogov@tinro-center.ru*

Algae are the main feed component for sea cucumber juveniles in conditions of artificial cultivation. However, the digestive system of the juveniles is not enough developed for the cleavage of algae polysaccharides, which reduces the effectiveness of feed on their basis. To create effective feed additives, use of the enzymatic algae processing by the enzyme complexes from the gastrointestinal tract of echinoderms is promising. Aim of this work is to study the enzymatic alga processing to obtain feed additives.

As a material for research, commercial brown alga - Japanese saccharin (Saccharina japonica), the insides of a gray sea urchin (Strongylocentrotus intermedius) and Japanese cucumaria (Cucumaria japonica) were used.

When performing studies on the alga chemical composition, standard methods were used [1]. The total content of hydrolysable polysaccharides (HP) was determined by the anthrone method [2]. Enzyme complex was obtained from the gastro- intestinal tract (GIT) of the gray sea urchin and cucumaria by the phosphate buffer extraction [3]. Saccharin was treated with the enzyme complexes from the GIT of the echinoderms at pH 5-8, hydronic module 1:10 (using a sea urchin) and 1:15 (cucumaria) and temperatures 30°C and 45°C during 24 hours.

Chemical analysis has showed that after enzymatic processing by the echinoderm viscera complexes main changes occur in the quantitative composition of carbohydrates. At pH 8, the hydrolysis of alginic acid and fiber increases, and their content decreases. The HP amount is increasing and is at the level of 20.1-22.8%. The maximum degree of polysaccharides hydrolysis (sum of the amount of alginic acid and cellulose) (58.6%) is achieved by processing with the enzyme complexes from the cucumaria GIT for 21 hours at 30°C. When processing algae with the complex from the sea urchin viscera the degree of polysaccharides hydrolysis increases to 66.8% at 45°C for 18 h. The data obtained show the prospects of enzymatic processing for the production of feed additives with a reduced content of polysaccharides from algae.

The data obtained show the prospects of enzymatic processing for the production of feed additives with a reduced content of polysaccharides from algae.

References:

1. ГОСТ 26185-84 Водоросли морские, травы морские и продукты их переработки. Методы анализа.- Введ. 01.01.85.– М: Издательство стандартов, 1984. – 53 с.
2. ГОСТ 26176-91 Корма, комбикорма. Методы определения растворимых и легкогидролизуемых углеводов.- Введ. 01.01.93.-М.: Стандартинформ, 2011. – 10 с.
3. Рогов А.М., Кадникова И.А., Аминина Н.М., Исследование влияния ферментативной обработки морских водорослей *Saccharina japonica* на её химический состав// Химия и технология новых веществ и материалов: тезисы докладов Всероссийской молодежной научной конференции, г. Сыктывкар, 26-30 мая 2014.- с.171-173.

Key words:
Algae, enzymes, echinoderms.

Principles and methodology for application of the Ecosystem Approach to Aquaculture in the Russian Far East

A.V. Sereda[1*], S.I. Maslennikov[2], A.N. Kachur[3],
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*A.V. Zhirmunsky Institute of Marine Biology, National Scientific Center of Marine Biology FEB RAS, 17 Palchevskogo str., Vladivostok, Russia, 690041*
[3]*Pacific Geographical Institute FEB RAS, 7 Radio str., Vladivostok, Russia, 690041*
**e-mail: amrtatjuti@poi.dvo.ru*

The global issues of food security and the associated increasing world demand for seafood proposes a significant role for aquaculture in the overall food supply situation in many States. The Russian Far East is promising region for aquaculture development first of all due to significant volume of the marine areas and proximity to the main consumers of aquatic biological resources. This region accounts for 70% of the total wild catch in the country. Currently the share of aquaculture in the total volume of aquatic resources production is 0.3% in the Russian Far East, which is far below possible (FSO, 2017). However, the development of this sector of food industry is dynamically gaining momentum. In this paper, we discuss the methodological scheme to facilitate the responsible aquaculture development embracing conservation and environmental, as well as social and economic, considerations to address the issues regarding this region, in particular, the Primirsky Krai of the Russian Far East (Kachur et al., 2019). This scheme consists of eight fundamental pillars: political platform, integrated multisectoral and spatial planning, administrative and legal framework, coordinated management, scientific research support, environmental impact and economic assessment, market-trade scale, international cooperation. The use of tools of the integrated ecosystem-based marine management is an essential methodological task. Considerable attention is paid to interaction between civil society, business, scientific institutes, several governmental, non-governmental bodies and organizations (local and international) based on the ecosystem approach (FAO, 2010). In addition, actual associated problems and mariculture potential are revealed (Maslennikov, 2008). The present methodological scheme builds on the key principle of the sustainable use of marine areas, which emphasizes a much tighter coupling of policy, science and management.

References

Russian and North-West Region Fishery Sector Overview, *Fishery Sector Overview*, FI & TMS, Saint Petersburg, 2017, 15 p.

A.N. Kachur, Yu.G. Mikhaylichenko, S.I. Maslennikov, A.V. Sereda. Experience and prospects for the Integrated Ecosystem-Based Marine Management for the Russian Far East // *Vestnik FEB RAS*, 2019, vol.1, p. 75-89.

Aquaculture development 4. Ecosystem approach / *FAO technical guidelines for responsible fisheries*, Food and agriculture organization of the United Nations. Rome, 2010, 54 p.

S.I. Maslennikov. Marine Biological Resources in the Far Eastern Coast: Their Rational Use from Ecological and Economic Viewpoints // *Energy and environment in Slavic Eurasia: toward the establishment of the network of environmental studies in the Pan-Okhotsk region*. Sapporo: Slavik Research Center, Hokkaido University, 2008, p. 89–125.

Acknowledgements

We sincerely thank our colleagues from the Far Eastern Union of Mariculture Enterprises for additional information on issues of current mariculture development in Primorsky Krai.

Key words

An ecosystem approach to aquaculture, mariculture development, the Russian Far East

T10: Ocean observations

T10-1: Ocean data management and citizen science

The concept of multi-level monitoring in the Peter the Great Bay

P. Salyuk[1], V, Fishchenko[1], O. Konstantinov[1], A. Pavlov[2], K. Shmirko[2], I. Stepochkin[1], K. Drozdov[3], D. Lyakhov[4], S. Moun[4]

[1]*V.I.Il'ichev Pacific Oceanological Institute FEB RAS,43Baltiyskaya Str., Vladivostok, Russia, 690041*
[2]*Institution of Automation and Control Processes FEB RAS,5Radio Str., Vladivostok, Russia, 690041*
[3]*G.B. ElyakovPacific Institute of Bioorganic Chemistry FEB RAS, 159Prospect 100 let Vladivostoku, Vladivostok, Russia, 690022*
[4]*Center for Robotics Development, 1 Komsomolskaya Str., Vladivostok, Russia, 690002*
**e-mail: psalyuk@poi.dvo.ru*

There is a modern tendency to create multi-level ocean monitoring systems, from approximate "cheap" measurement methods (per one measurement point) operating on mesoscale, synoptic and global scales, to more accurate "expensive" methods used locally or on demand in the cases of situational monitoring and control. The current trend to solve the problems of regular measurements in the ocean is the complex use of remote sensing methods in the optical and radio spectral diapasons, contact measurements on autonomous buoys, drifters, autonomous underwater and surface vehicles with the simultaneous use of methods of physical and mathematical modeling to improve the space-time coverage of the studied processes.

The equipment carriers are satellites, airplanes, ships, unmanned aerial vehicles, underwater and surface vehicles, fixed and drifting buoys, fixed posts located on the coast, coastal infrastructure or oceanographic / oil platforms. The modern development of smartphones and the component base for creating cheap measurement sensors opens up new opportunities for attracting the broad masses of the population as one of the levels of monitoring in integrated systems for collecting environment information. Each of the data collection methods and equipment carriers has its advantages and disadvantages. Their complex use allows us to enhance the effectiveness of each of the monitoring methods used. One of the current trends is to reduce the cost of individual measuring devices and their carriers, the active use of unmanned aerial, underwater and surface devices capable of actively moving in the marine environment, while maintaining autonomy for long-term research, the creation of information networks for information exchange, which allows scaling marine measurements to large areas, evaluate the quantitative and qualitative indicators of the studied characteristics. In the scientific and innovative organizations of the Russian Far East, the significant experience has been accumulated in creating various systems of automated monitoring of the water areas, which can be combined into a single multi-level system [1-4].

References

[1] V.Fishchenko, G.Dolgikh, P. Zimin, A.Subote, 2018, *Doklady Earth Sciences*, **482(3)**, 336-339, doi:10.31857/S086956520003143-0, [in russian].
[2] Y.Kul'chin, O.Bukin, O.Konstantinov, S.Voznesenskii, A.Pavlov, E.Gamayunov, et al., 2012,*Atmospheric and Oceanic Optics*, **25(6)**, 446–450, doi:10.1134/s1024856012060085.
[3] V.Dubina, V.Fischenko, O.Konstantinov,L.Mitnik, 2011, *Current problems in remote sensing of the Earth from space*,**8(3)**, 214-220, [in russian].
[4] I. Stepochkin, K. Shmirko, D. Burov, P. Salyuk, I. Golik, 2014, Proceedings of SPIE, 92631K, doi:10.1117/12.2068522.

Key words
Multi-level monitoring, operational oceanography, distributed sensors network

Federation of “small science” metadata

Igor Shevchenko[1,2]
[1]*The Pacific branch of the Russian Federal Research Institute of Fisheries and Oceanography (TINRO), 4, Shevchenko Alley,Vladivostok, Russia, 690090*
[2]*Far Eastern Federal University, 8 Sukhanova St., Vladivostok, Russia, 690090*
**e-mail: igor.shevchenko@tinro-center.ru*

The North Pacific Marine Science Organization (PICES) is an intergovernmental scientific organization that promotes and coordinates marine research in the northern North Pacific. PICES supports the exchange of data, information, and services related to marine scientific studies. Most of the research done by its members and expert groups may be considered as “small science”. This means that data are collected by small groups or by single investigators, data are not managed by data centers, there are no data standards, open access to data is not provided, etc. The PICES Technical Committee on Data Exchange (TCODE) began the metadata federation project to create a one-stop web utility for submitting and searching metadata on marine ecosystems. The GeoNetwork opensource software was used to create and maintain the PICES TCODE metadata inventory. Metadata are harvested from servers run by National Institute of Fisheries Science (NIFS) (Republic of Korea) and the Pacific branch of the Russian Federal Research Institute of Fisheries and Oceanography (TINRO) (Russian Federation). First, the inventory was populated with metadata records mostly by a paid staff. At present, the inventory contains more than 8500 records. It turned out that nor PICES individual members, neither expert groups showed any interest in using this inventory for sharing geo-referenced data, information, and services. In our talk, we will describe the history and status of the project. Also, we consider some lessons learned and strategies that may change the situation for better. Our talk will address different aspects of sharing data, information, and services on marine ecosystems using the implementation of the PICES metadata federation project as an example.

References

Metadata Federation of PICES Member Countries. PICES Technical Report No. 1, 2007.

The PICES TCODE Metadata federation. URL: https://sites.google.com/site/picestcodegeonetwork/ (visited 21.04.2019)

The PICES TCODE Metadata Inventory. URL: http://82.162.170.226:8080/geonetwork (visited 21.04.2019)

H. Onsrud, J. Campbell, 2007. Big opportunities in access to" Small Science" data. Data Science Journal, 6, pp.OD58-OD66.

C. Franzoni, H. Sauermann, 2014. Crowd science: The organization of scientific research in open collaborative projects. Research policy, 43(1), pp. 1-20.

Acknowledgements
This work was partially supported by The North Pacific Marine Science Organization (PICES) and the Pacific branch of the Russian Federal Research Institute of Fisheries and Oceanography (TINRO)

Key words
Data management, marine sciences, metadata federation

New approach to radioecological monitoring of sea waters using composite materials based on Zn – K ferrocyanide

Tokar E.A.[1.2*], Egorin A.M.[1], Zemskova L.A.[1], Tananaev I.G.[2]
[1]*Institute of Chemistry, Far East Branch, Russian Academy of Sciences, Vladivostok Russia, 690022*
[2] *Far Eastern Federal University, Vladivostok, Russia, 690922*
**e-mail: d.edd@mail.ru*

The marine area of the Far East is a complex object from the point of view of radioecology. This is due to the release of anthropogenic radionuclides into the environment as a result of the accident at Chazhma Bay and at the Fukushima-1 nuclear power plant, the operation and maintenance of ships with nuclear power reactors and the functioning of coastal nuclear power plants in China.

The anthropogenic radionuclide Cs-137 has a high migration ability and is easily incorporated into trophic chains with subsequent ingestion into the human body. In the case of a high content of Cs-137 in seawater, it forms higher dose loads among the population living on the coast. In this regard, an important radioecological task is the possibility of rapid assessment of the content of Cs-137 in seawater in the event of suspected radioactive contamination. For these purposes, the radionuclide is extracted and concentrated from seawater, which allows to reduce the duration of time and improve the accuracy of radiometric determination. We have developed a two-stage concentration scheme for Cs-137 using hybrid, chitosan ferrocyanide sorbents based on mixed Ni-K ferrocyanide, as well as Zn-K ferrocyanide [1].

This scheme and materials were tested during the sea expedition in the waters of the Sea of Japan, the Sea of Okhotsk and the Bering Sea. During the expedition, water was sampled with a volume of 100 liters and then passed through a cartridge packed with a fibrous sorbent packing based on Zn – K ferrocyanide. Then, under laboratory conditions, the second stage of Cs concentration was carried out with preliminary elution of the radionuclide from the cartridge on granular Ni – K ferrocyanide followed by measurement of specific activity on the radiometer. As a result of the work carried out, we have compiled a map of the content of anthropogenic radionuclides Cs-137 at the points of water extraction in the Far Eastern region. In a number of samples, it was found that the specific activity of Cs exceeded the average values (5–20 Bq / m^3) before the accident at the Fukushima-1 NPP. However, when comparing with the data of 2011-2012, it is possible to conclude about a decrease in the content of radiocaesium in the waters of the Pacific Ocean, in particular in the sea waters washing the territory of the Far East in the range of 2000 Bq / m^3 to 30-200 Bq / m^3

References

[1]References text: Egorin, A., Tokar, E., Zemskova, L., Didenko, N., Portnyagin, A., Azarova, Y., Avramenko V., (2017) Separation Science and Technology, 2017, 52(12), 1983–1991.

Acknowledgements

This work was supported by The Ministry of Education and Science of the Russian Federation, State Order № 0265-2019-0002 of the Institute of Chemistry FEBRAS (synthesis of sorption materials, development of methods for concentrating Cs-137 from seawater).

Key words

Radioecological monitoring, Cs-137, ferrocyanides

Study on Ocean Big Data Analysis and Forecasting Technology-Establishment of Ocean Big Data Quality Assessment and Data Resource Pool

Bing Xin

National Marine Data and Information Service, No. 93 Liuwei Road, Tianjin, 300171

The accuracy of ocean dynamic environmental parameters forecasting and typical ocean phenomena prediction highly depends on the discretization algorithm, initial and boundary conditions and driving field, etc. Based on real-time observation, ecological environment monitoring and other marine environmental data, ocean statistical analysis and reanalysis of products, remote sensing basic datasets and potential data from human activities, the present study carries out data cleaning, standard processing, quality assessment, uncertainty analysis, quality fusion, and credibility evaluation, to establish data resource pool for Ocean Big Data analysis and prediction. Based on this resource pool, through intelligent analysis methods such as association mining, pattern recognition and in-depth learning, the association relationship between multi-factors related to analysis and prediction is formulated, and then Big Data prediction model. The in-situ data are brought into the Big Data model to realize the identification, forecasting and prediction of ocean parameters and ocean phenomena. Therefore, the establishment of the resource pool is of great significance to the Ocean Big Data analysis and prediction. It can provide experimental data for key technologies of Big Data, data support for the development and validation of analysis and prediction model, and data source for its model application and demonstration.

Development and testing of technologies for sea wave, currents and sea level fluctuations registration based on surface and underwater remote video surveillance systems

P.S. Zimin*, V.K. Fishchenko, A.V. Zatserkovniy, A.Ye. Subote, A.A.Goncharova, A.V. Golik
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: petr_zimin_poi92@mail.ru*

The Peter the Great Bay scientific monitoring system, deployed by Pacific Oceanological Institute of FEB RAS, include several IP-cameras. Eight cameras are installed on the coast, they observe the sea surface. Three cameras are installed underwater. According to the set schedule, snapshots and short videos are sent to a database in Vladivostok. In addition, privileged users can watch on the Internet broadcast video from all cameras. One of the important tasks is to estimate the parameters of waves, currents, sea level fluctuations. We make these estimations in real time using the QAVIS program developed by us (Quick Analyzer of Video and Images for Scientists, http://oias.poi.dvo.ru/qavis/). The user puts on the screen of a personal computer with video broadcast the necessary tools of this program, which register estimates of sea wave and sea currents signals

We use four techniques for estimating surface wave signals. The first one is based on cross-correlation tracking of anchored marker objects - fishing buoys, signal buoys, sea vessels, etc. The vertical component of these movements can, with some approximation, be interpreted as a wave height. The horizontal component carries information about variations of currents on the sea surface. An average sampling frequency is 5 Hz; duration of continuous recording can be several days. This allows recording a wide range of wave movements on the sea surface: ripples (typical periods 0.5-1 sec), wind waves (1-6 sec), ship waves (2-5 sec), swell (8-14 sec), seiches (from several minutes to several hours), and tidal fluctuations (12 and 24 hours). The accuracy of the wave height measurements depends on the characteristics of the video camera and the distance from the marker object; it can be a fraction of a one centimeter. The second technique is based on the registration of average intensity of the video signal in a user-defined local area of the sea surface image. When waves pass through this area, due to the periodic change in the slope of the sea surface, the intensity (brightness) of the light reflected to the side of the camera changes. It is clear that the luminance signal carries information about the frequency composition of sea waves, but cannot provide reliable information on the height of the waves. The third technique is applicable to the registration of swell waves, when local wind and currents produce ripples uniformly moving on the sea surface. QAVIS registers the process of the apparent modulation of the velocity of ripples by swell waves. The fourth method is based on measuring the brightness in the local area of the video frame at the border of the sea and the coast. When intense waves come ashore, they collapse, accompanied by the formation of bright spots of turbulent water. The periodic process of appearance and disappearance of bright spots recorded by the QAVIS carries information about the frequency properties of the waves. To measure underwater currents variations, QAVIS tracks movement of artificial or natural markers in the water column, such as organic and inorganic suspensions. The objectivity of implemented methods for estimating waves and currents is confirmed by comparison with data from other means of observation.

Key words
Remote video surveillance systems, sea waves and current registration, sea level fluctuations registration

T10-2: Ocean remote sensing

Estimation of wind drift component of sea surface currents velocities retrieved on satellite imagery

M. Aleksanina [1,2] , O. Korostyleva [1,2]
[1]*Institute of Automation and Control Processes FEB RAS, 5 Radio Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8 Sukhanova Str , Vladivostok, Russia, 690090*
**e-mail: margeo@mail.ru*

Experiments for detection of wind (Ekman) drift component in the velocities computed with feature tracking method are presented. In according to Ekman's theory [1] the wind flow direction on the sea surface in the northern hemisphere deviates from the wind direction on 45 ° to the right, and the value of the wind drift velocity is about 2% of the value of the wind velocity. The wind drift component should dominate in the background flow obtained by averaging vectors of the sea surface currents velocities. In our experiment the sea surface currents velocities are calculated automatically [2]. The wind velocities were taken from the NCEI (National Environmental Information Centers) database [3].

The experiments have shown that wind drift component is presented in satellite estimates of sea surface velocities. The direction of the component is deviated to the right from the wind direction on about 90 degree with large scattering. The value of the component is much less than the theoretical one.

It can be explained by the fact that tracking feature movement does not reflect the surface flow, but displacement of a layer that depth is corresponded to the depth of water mixing during the tracking period. To test this hypothesis the measurements of term garlands for August and October 2016 in Peter the Great Bay of the Japan Sea were used. The depth of the mixed layer was determined visually from the normalized daily temperature profile variability. Wind drift velocity for the mixed layer was estimated. The calculated values explain the observed discrepancies in the values of the near-surface wind drift and the corresponding component extracted from satellite data.

The sea surface current velocities, computed with feature tracking method on a sequence of satellite images, correspond to movement of a certain layer of water. The thickness of the layer is determined by the depth of mixing during the observation interval between two images. Therefore, the component of wind drift is significantly less than on the surface, and the angle is larger.

References

1. Atmosphere and ocean: Our fluid environments. By J. G. Harvey. Artemis Press, Sussex, 1976, 143 p.
2. Aleksanin A.I., Aleksanina M.G., Karnatskii A.Yu., Avtomaticheskii raschet skorostei poverkhnostnykh techenii okeana po posledovatel'nosti sputnikovykh izobrazhenii (Automatic computation of sea surface velocities on a sequence of satellite images), Sovremennye problemy distantsionnogo zondirovaniya Zemli iz kosmosa, 2013, Vol. 10, No. 2, pp. 131–142
3. National Centers for Environmental Information–URL: https://www.ncdc.noaa.gov/data-access/marineocean-data/blended-global/blended-sea-winds

Acknowledgements
The work supported by Fundamental Research Program of Presidium of Russian Academy of Sciences «Fundamental basis of breakthrough technologies in the interests of national security».
Key words: nd drift, currents velocities, satellite imagery

Sea water density estimation on surface internal wave footprints

A.I.Aleksanin[1,2,*], V. Kim[1], O.G. Konstantinov[3], R.A. Korotchenko[3], I.O. Yaroshchuk [3]
[1] *Institute of Automation and Control Processes FEB RAS, 690041, 5 Radio St., Vladivostok, Russia*
[2] *Far Eastern Federal University 10 Ajax Bay, Russky Island, Vladivostok, Russia*
[3] *V.I. Il`ichev Pacific Oceanological Institute FEB RAS, 690041, 43 Baltiyskaya, Vladivostok, Russia*
**E-mail: aleks@iacp.dvo.ru*

A problem of shallow water density estimation based on the surface internal gravity wave images is considered. The images are used for calculation of internal gravity wave speed and wavelength. The 17 cases of in-situ wave registration by vertical allocation temperature sensors are analyzed. The standard two-layer model and constant Väisälä-Brunt frequency model are explored. Two kinds of direct task solutions are considered: solution of Sturm-Louville problem and solution of Korteweg-de Vries equation. The wave speed is calculated by direct task solution with using in situ data and by image data separately, the results are compared. There is a good coincidence between measured with images and calculated results for the most cases. The dependence of internal wave speed from the depth can help us to choose the density model. The density parameters were estimated with sea surface measurements. It was good coincidence between computed and measured values. The discrepancies can be explained by accuracy of the approach developed. There were some cases that can't be explained by the theory. It was shown, that both approaches to the direct task solution give significantly lower speed then the speed calculated from the image sequences for two-layer model with upper layer depth much higher than the bottom one.

Acknowledgements
The work supported by Fundamental Research Program of Presidium of Russian Academy of Sciences «Fundamental basis of breakthrough technologies in the interests of national security».

Key words:
Internal waves, surface manifestations, density estimation

Surface currents measured by SUCE drifters in the Daya Bay and along the eastern Guangdong coast, China

Yang Gao, Yongxiang Huang, Hongyang Lin,
Zhenyu Sun, Jia Zhu, Jianyu Hu*

State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China
* Corresponding Author: hujy@xmu.edu.cn; Telephone: +86-592-2186981

Surface Current Experiment (SUCE) drifter is a kind of GPS-based surface drifter, which has been successfully used to investigate the surface currents in the Daya Bay and along the eastern Guangdong coast, China. Surface current vectors were measured based on the GPS location and corresponding time information sent by drifters through the mobile phone network. The analysis of data from 120 drifters, deployed in late spring 2018 in the case-study region, shows that the drifters are generally capable to capture the surface (tidal and residual) currents. The drifter trajectories suggest the existence of an anticlockwise surface current inside the Daya Bay, and of a northeastward current along the eastern Guangdong coast. The coastal current along the eastern Guangdong coast is faster than that inside the Daya Bay. The surface flows in the investigated region follow an irregular semidiurnal cycle due to the influence of the tidal current, while the currents inside the Daya Bay are impacted by the topography. According to the harmonic analysis performed, an irregular semidiurnal type of tidal current is evident, with an Eulerian residual current speed of 0.09 $m \cdot s^{-1}$ and a direction of 276°. The Lagrangian residual current outside the Daya Bay moves northeastward with a mean speed of 0.22 $m \cdot s^{-1}$ along the eastern Guangdong coast, while the one inside the Daya Bay moves northward to the bay head with a mean speed of about 0.08 $m \cdot s^{-1}$.

Acknowledgements This work was supported by the National Natural Science Foundation of China (41776027), the National Basic Research Program of China (2015CB954004), the Xiamen University Principal Foundation (20720180103) and the municipal project of Huizhou City (F2017-01-1).

Keywords
Drifter, surface current, residual current, Daya Bay, eastern Guangdong coast

Microwave sensing of the ocean and atmosphere from Meteor-M No.2 and GCOM-W1 satellites

Leonid Mitnik, Vladimir Kuleshov, Maia Mitnik
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
e-mail:mitnik@poi.dvo.ru

The purpose of the study is the application of the MTVZA-GY and AMSR2 microwave radiometer data for remote sensing of the ocean and land surface, as well as for measuring the total atmospheric water vapor content V, total cloud liquid water content Q, near surface windspeed W, sea iceconcentration and atmospheric temperature and water vapor profiles. The consideration of radiometer calibration and retrieval algorithm developmentis based on the results of microwave radiative transfer modeling. The MTVZA-GY operation stability in flight was estimated by the comparison of the time series of the brightness temperatures TB(f) with vertical and horizontal polarization measured by Meteor-M No. 2 MTVZA-GY and GCOM-W1 AMSR2 at coinciding frequencies f in the range 10-90 GHz. The MTVZA-GY and AMSR2 data, visible and infrared satellite images, scatterometer-derived wind fields were used to study spatial structure and evolution of tropical, extratropical and polar cyclones and cold air outbreaks over the ocean at the Northern andSouthernHemispheres. The main attention is given to the study of extratropical cyclones which were observed over the Northern Pacific Ocean in the period October 2014 - August 2017. The developed algorithms were used to retrieve the V, Q and W values and detect the rain areas from the measured TBs.The experience of the joint analysis of measurements of two radiometers will be applied in data processing obtained by an advanced MTVZA-GY-NP radiometer, which is installed on meteorological satellites of the Meteor-M N2 series. The launch of Meteor-M N 2-2 is scheduled for June 27, 2019.

References

Cherny, I.V., L.M.Mitnik, M.L.Mitnik, A.B.Uspensky, A.M. Streltsov,*Proc. IGARSS 2010*, 2010, 558-561.
Mitnik, L.M., M.L.Mitnik, I.A.Gurvich, A.V. Vykochko,Yu.A.Kuzlyakina, I.V.Cherny, G.M.Chernyavsky, [in Russian] *Current Problems in Remote Sensing of the Earth from Space*, 2012, **9(4)**, 121-128.
Mitnik, L.M., M.L.Mitnik, I.A.Gurvich, A.V.Vykochko, M.K.Pichugin, I.V. Cherny,*Proc. IGARSS 2012*, 2012, 1940-1943.
Mitnik, L.M., M.L. Mitnik, I.A. Gurvich, A.V. Vykochko,Yu.A.Kuzlyakina, I.V. Cherny, G.M.Chernyavsky[in Russian], *Current Problems in Remote Sensing of the Earth from Space*, 2013, **10(4)**, 161-174.
Mitnik, L.M., Mitnik M.L., [in Russian], *Current Problems in Remote Sens. Earth from Space*, 2016, **13(1)**, 95-104.
Barsukov,I.,G.Cherniavsky, I.Cherny, L.Mitnik, V.Kuleshov, M.Mitnik,*Proc. IGARSS 2016*, 2016, 5528-5531.
Mitnik, L.M., M.L. Mitnik, G.M. Chernyavsky, I.V. Cherny, A.V. Vykochko, M.K. Pichugin, E.V. Zabolotskikh,*Izvestiya, Atmospheric and Oceanic Physics*, 2016, **52(9)**, 1041–1050.
Mitnik, L., V.Kuleshov, M.Mitnik, A.Streltsov, G.Cherniavsky, I.Cherny,*IEEE JSTARS*, 2017,**10(7)**, 3036-3045.
Cherny, I.V.,G.M.Chernyavsky, L.M.Mitnik, V.P.Kuleshov, M.L.Mitnik, A.B. Uspensky,*Proc. IGARSS 2017*, 2017, 1220-1223.
Mitnik, L.M., V.P. Kuleshov, M.L. Mitnik, A.V. Baranyuk,*Intern. J. Remote Sensing*, 2018, **39(13)**, 4513-4530.
Cherniavsky, G. M.,L.M.Mitnik, V.P.Kuleshov,M.L. Mitnik,I.V. Cherny,[in Russian], *Current Problems in Remote Sensing of the Earth from Space*, 2018, **15(4)**, 78-100.
Mitnik, L.M., V.P.Kuleshov, M.K.Pichugin, M.L. Mitnik,*Proc. IGARSS2018*, 2018, 5560-5563.

Acknowledgements
This work was partially supported by the grant of the Far East Branch of the Russian Academy of Sciences 18-I-010.

Key words
MTVZA-GY microwave radiometer, geophysical parameter retrieval,

Improved CFOSAT wind vector retrievals with the use of collocated near-nadir and moderate angle measurements.

A.S. Mironov[1,2*], Y. Quilfen[3], B. Chapron[3]

[1]*Satellite Oceanography Laboratory, Russian State Hydrometeorological University, 98 Malookhtinskiy Pr., 195196 St-Petersburg, Russia*

[2]*Ocean Data Lab, 870 route de Déolen, 29280 Locmaria-Plouzané, France*

[3]*Spatial and Physical Oceanography Laboratory, Institut Français de Recherche pour l'Exploitation de la Mer, 29280 Plouzané, France*

**e-mail:amironov@oceandatalab.com*

The Chinese French Ocean Satellite (CFOSAT) is an innovative space mission dedicated to the observation and monitoring of the ocean sea state and the sea surface vector winds. Recently launched on 29 October 2018, CFOSAT operates two Ku-band rotating radars: the near-nadir Ku-band wave scatterometer (SWIM) and the dual-polarization, moderate incidence angle, Ku-band wind scatterometer (SCAT). Such instrumental configuration provides regular measurements of sea state parameters, including directional wave spectrum, together with simultaneous wind speed and direction. This unique configuration of two sensors operating at two different incidence angle ranges also gives the opportunity to improve the quality of the retrieved parameters by combining both data sources. In particular, this approach can be applied for the improvement of SCAT wind vector retrievals using SWIM near-nadir observations.
Similarly to other rotating scatterometers, the SCAT measurements have a poor azimuthal diversity of the backscatter (σ^0) measurements in the central (nadir) part of the swath, leading to larger and systematic wind errors in this swath region. At the same time, the SWIM altimeter provides high-quality near-nadir σ^0 observations (and derived wind speed estimates), which will be used to further constrain the SCAT wind inversion. In the present study, we show the results obtained from an improved wind retrieval algorithm which is based on the inversion of collocated SWIM and SCAT observations.

Since CFOSAT is currently in the commissioning phase, the validation of the inversion algorithm was performed with simulated σ^0. The simulation of SCAT and SWIM backscatter synchronized measurements is performed on the basis of existing not calibrated products. The standard scatterometer wind vector inversion procedure based on the Maximum Likelihood Estimator (MLE) is extended to accommodate the SWIM collocated measurements. The NSCAT-4 Geophysical Model Function (GMF) is used for SCAT, while the wind-speed only GMF for near-nadir angles is used for SWIM. A preliminary comparative analysis between the combined SCAT and SWIM inversion and the SCAT-only inversion shows that the wind vector errors are significantly lower in the former. Additionally, the latest information on the performance of the SWIM and SCAT instruments will be presented at the time of the conference.

Acknowledgements
The present work was co-funded by CNES and IRFEMER in the frame of the development of CFOSAT IFREMER Wind and Wave Operation Center (IWWOC) with the additional support by the Russian Science Foundation through the Project №17-77-30019 in Russian State Hydrometeorological University.

Key words
Wind and sea state monitoring; ocean radar observations; CFOSAT mission

The problem of distinguish phytoplankton and colored dissolved organic matter contribution into sea surface remote sensed reflectance spectra

P. Salyuk[1], I. Stepochkin[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: psalyuk@poi.dvo.ru*

The cases of various statistical relationships between chlorophyll-a and dissolved organic matter (DOM) fluorescence in different regions of the oceans, obtained by the authors during sea expeditions [1-3], were analyzed. The problem of distinguish of the contribution of phytoplankton cells and colored DOM (CDOM) to the spectra of the sea surface remote sensed reflectance (Rrs) was considered [2].

It is shown that the parameters of the linear relationship between the concentration of chlorophyll-a and CDOM are not constant, and depend on various factors: the stage of development of phytoplankton cells, the degree of degradation of CDOM molecules, the presence of non-phytoplankton sources of CDOM in seawater, different stratification of chlorophyll-a and CDOM in sea water [1,3]. The classical division into "I and II optical cases of waters" or "oceanic and coastal waters" is not always sufficient for the classification of the Rrs spectra, because in open oceanic waters sometimes a statistically insignificant linear correlation between chlorophyll-a and CDOM concentrations is observed, and in case I waters the slope of linear regression is not constant and may change under the influence of various factors.

Various cases of variability of remotely measured concentrations of chlorophyll-a and CDOM obtained from the satellite ocean color radiometers are considered. Own and proposed methods for separating the contributions of phytoplankton and CDOM to the Rrs spectra are proposed.

References

[1] O. Bukin, M. Permyakov, P. Saluk, A. Maior, D. Burov, V. Khovanets, S. Golik, E. Podoprigora, *Atmospheric and oceanic optics*, 2004, **17(9)**, 661-667.
[2] P. Salyuk, I. Stepochkin, I. Golik, O. Bukin, A. Pavlov, A. Aleksanin, 2013, *Issledovanie Zemli iz Kosmosa*, **49(3)**, 45–57.
[3] P. Salyuk, I. Stepochkin, O. Bukin, E. Sokolova, A. Mayor, A. Gorbushkin, J. Shambarova, *Izvestiya. Atmospheric and Oceanic Physics*, 2016, **52(9)**, 988-998.

Acknowledgements

The work was supported by the "Far East" program (project No. 18-01-10, data analysis) and the state budget theme (AAAA-A17-117030110037-8, experimental data and methodological support).

Key words

Chlorophyll-a, colored dissolved organic matter, seawater remote sensed reflectance spectrum

Surface Current Retrieval from Sentinel-2 Multispectral Imagery

Maria V. Yurovskaya[1,2*], Vladimir N. Kudryavtsev[1,2], Bertrand Chapron[2,3]
[1]*Marine Hydrophysical Institute RAS, 2, Kapitanskaya Str., Sevastopol, Russia, 299011*
[2]*Satellite Oceanography Laboratory, Russian State Hydrometeorological University, 98, Malookhtinskiy Prospect, Saint Petersburg Russia, 195196*
[3]*Institut Francais de Recherche pour l'Exploitation de la Mer, Plouzane, France*
**e-mail: mvkosnik@gmail.com*

Due to a special sensor arrangement, the Sentinel-2 MultiSpectral Instrument provides very high resolution time-lagged (up to several seconds) acquisitions between different spectral bands. The work presents a review of Sentinel-2 data capabilities to quantitatively derive spatio-temporal characteristics of ocean surface wave properties, surface current velocity and sea depth. A method for surface current vector field reconstruction is based on the analysis of the image fragments from two spectral channels providing near-simultaneous acquisitions with 1 s time lag and 10 m spatial resolution. Phase shift spectrum of image brightness gives the wave dispersion relation and a measured deviation from the expected linear dispersion relationship can be interpreted as Doppler shift, directly related to surface current impacts. In 2D case, the wave field covering a fairly wide range of angles serves for a practical reconstruction of the total current vector.

Current fields retrieved over different ocean regions agree well with model data and altimeter-derived geostrophic current estimates. Method validity at finer scales is proved by satisfying the conservation laws obtained from wave-ray kinematic equations. In the absence of current and shallow water conditions, the form of the dispersion curve is determined by the ocean depth variations. As such, analysis of the dispersion relationship can provide ocean bathymetry information. The reconstructed sea depth field is obtained to be consistent with ETOPO1 data. Inter-channel time delay can also be exploited directly to estimate speed and direction of moving objects on the sea surface, particularly, detected large whitecaps. This is opening for future investigations, as a potential key capability to infer direct measurements of momentum and gas fluxes.

Method applicability, different error sources and their impact to estimated velocities are considered. As shown, for reliable current reconstruction, the images should be co-located with the accuracy better than 0.03 pixel. For Sentinel-2 measurements, this is generally fulfilled.
The results demonstrate a promising possibility of optical imagery to measure surface current velocity from space over large areas with a spatial resolution down to 1 km. Combining different satellite measurements (altimeter, optical, radar) shall greatly improve the determination of ocean currents from space and studying the wave-current interactions.

Acknowledgements
This work was supported by Russian Science Foundation via grant 17-77-30019 and the Ministry of Education and Science of the Russian Federation under the State Assignment No. 0827-2018-0003.

Key words
Ocean currents, sea surface optical imagery, Sentinel-2

Ka-band Sea Surface Backscatter at Gale Force Winds

Yu. Yurovsky[*1,2], V. Kudryavtsev[2,1], S. Grodsky[3], B. Chapron[4,2]
[1]*Marine Hydrophysical Institute RAS, 2, Kapitanskaya Str., Sevastopol, Russia, 299011*
[2]*Russian State Hydrometeorological University, 98, Malookhtinskiy Pr., St-Petersburg, Russia, 195196*
[3]*Department of Atmospheric and Oceanic Science, University of Maryland, College Park, MD, USA, 20740*
[4]*Spatial and Physical Oceanography Laboratory, IFREMER, Plouzané, France, 29280*
**e-mail: yyyurovsky@gmail.com*

Background. Co-polarized sea surface normalized radar cross-section (NRCS) saturates at gale force winds (more than 20 m/s) complicating hurricane wind retrieval in microwave C/X/Ku-bands. Several satellite missions are now planned in the Ka-band [1,2] where the saturation threshold may be different because of contributions of different backscattering mechanisms (e.g. high sensitivity to the spray teared off the surface at high winds). We report results of the dual co-polarized Ka-band field experiment performed from the Black Sea research platform under strong wind conditions.

Materials and Methods. On 24-25 October 2018, a northerly katabatic wind event occured for about 10 hours with wind gusts up to 35 m/s. The off-shore wave fetch at platform location was 1 km with peak wind wave length about 7 m. The radar measurements were done at Ka-band using dual-copolarized Doppler scatterometer at incidence angles of 20 and 45 degrees in the upwind direction.

Results. When the wind reached 20-25 m/s, wave crests started tearing off and forming visible spray clouds that moved over the surface. Radar signatures of these spray clouds are clearly seen in the Doppler spectrum as very wide-band spikes lasting for a few seconds. In the upwind direction, the spray backscattering results in a positive tail of the Doppler spectrum. From these data, the contribution of the spray to the NRCS and Doppler shift is estimated directly.
Conclusion. For the first time, the Ka-band sea surface cross-section measurements are reported at gale force winds. The NRCS saturates at about 18-20 m/s very similarly to the Ku-band geophysical model functions [3,4]. The NRCS at HH polarization demonstrates somewhat stronger wind sensitivity in comparison to VV polarization.

References

[1] F. Ardhuin, Y. Aksenov, A. Benetazzo, L. Bertino, P. Brandt, E. Caubet, B. Chapron, F. Collard et al., *Ocean Science*, 2018, **14**, 337–354.
[2] E. Rodriguez, A. Wineteer, D. Perkovic-Martin, T. Gál, B. Stiles, N. Niamsuwan, R. Rodriguez Monje, *Remote Sensing*, 2018, **10(4)**, 576.
[3] F.J. Wentz, D.K. Smith, *Journal of Geophysical Research (Oceans)*, 1999, **104**, 11499-11514.
[4] X. Li, B. Zhang, A. Mouche,, Y. He, W. Perrie, *Remote Sensing*, 2017, **9(5)**, 474.

Acknowledgements

This work was supported by the Russian Science Foundation under grant No. 17-77-30019.

Key words

Doppler, scatterometer, hurricane

Shoreline evolution in an embayed beach adjacent to tidal inlet: The impact of anthropogenic activities

Rui Zhang [a], Shuaishuai Liu [a], Lianghong Chen[a] , Heng Zhang [a,b] , Wenping Gong [a,b,c*]

[a] *School of Marine Sciences, SunYat-sen University, Guangzhou 510275, China*
[b] *Guangdong Provincial Key Laboratory of Marine Resources and Coastal Engineering, SunYat-sen University, Guangzhou 510275, China*
[c] *Southern Laboratory of Ocean Science and Engineering (Guangdong, Zhuhai)*

Embayed beaches are widely distributed around the world. Their shoreline evolution is controlled primarily by the upstream headland and prevailing wave conditions. Tidal inlets are also ubiquitous in sandy coasts. They are quite dynamic and act as a sediment source or sink, depending on the sediment transport pattern and budget. An embayed beach may develop downstream of a tidal inlet if a protruding headland is formed at the inlet, owing to either natural processes or human construction. In this study, Gaolong Bay, located downstream of a tidal inlet (Qinglan Inlet) in Wenchang City, Hainan Island, China, is used as an example to examine the effects of an upstream tidal inlet on the evolution of an embayed beach. Emphasis is placed on the impact of anthropogenic activities, such as landfilling and jetty construction. Historical remote sensing data were collected, and the evolution of the shoreline during various periods was analyzed. The shoreline change pattern in Gaolong Bay was identified with the empirical orthogonal function method, and the mechanisms behind these changes were explored with a coupled current–wave–sediment transport modeling system. Our results indicate that the construction of an artificial peninsula and a jetty beside the navigation channel of Qinglan Inlet dramatically changed the evolution of the Gaolong Bay shoreline. A clockwise shoreline rotation was prevalent in Gaolong Bay, along with a shoreline propagation (translation). The static equilibrium shoreline planform model (model of equilibrium of bay beaches [MEPBAY]) was further used to predict the future evolution of the shoreline. This study highlights the importance of interaction between a tidal inlet and its adjacent sandy beach and provides a good example for the necessity of integrated coastal zone management.

Key words:

Shoreline evolution; embayed beach; remote sensing; COAWST model.

T10-3: Ocean observations

NEAR-GOOS: Developing sustained ocean observations for enhanced services in the northeastern Asian marginal seas)

N. Baba, M. Higaki, H. Jeong, J. Kim, V. Lobanov, O. Sokolov, T. Yu, Z. Zhang, W.Zhu
IOC/WESTPAC Coordinating Committee for NEAR-GOOS
**e-mail: lobanov@poi.dvo.ru*

The North-East Asian Regional-Global Ocean Observing System (NEAR-GOOS) is the first regional pilot project of GOOS. This presentation describes its success and challenges over the last 20 years. Initiated in 1996, NEAR-GOOS aimed to facilitate the sharing of oceanographic data in the marginal seas bordered by the partner countries: China, Japan, Korea and Russia. Its development has been coordinated by the UNESCO/IOC Sub-Commission for the Western Pacific (IOC/WESTPAC) through its Coordinating Committee for NEAR-GOOS. The major achievement of NEAR-GOOS at its first phase features the establishment of a network of real-time and delayed mode databases accessible online free-of-charge, with these databases being operated by designated national agencies. Despite some restrictions on oceanographic data exchange in some member states, NEAR-GOOS archives now contain 59 types of data with total volume of 211 GB (as of Feb. 2019). A challenge for NEAR-GOOS at its second phase (after 2003) was to advance from data management to jointly developing sustained regional integrated ocean observations and delivering enhanced services, for a wide range of users in the region. This advancement requires not only continued improvements of the existing data and information exchange mechanisms, but also an enhancement in its observations, and delivering more user-friendly services in the region and beyond. Currently, NEAR-GOOS has three working groups on data management, products, and ocean forecasting system (OFS). Recent NEAR-GOOS projects include Cross Basin Climate Monitoring Section implemented by Japan and Russia since 2011, enhancement of OFS since 2016, and ferry box monitoring since 2018.

Ultrasound laser-induced breakdown spectroscopy for the analysis of elements and impurities in liquids

A. V. Bulanov[1*]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: a_bulanov@me.com*

Background: Laser-induced breakdown spectroscopy (LIBS) of solids is widely used in both commercial technologies and scientific investigations. Importance of studying the mechanism of optical breakdown in liquids is related to the development of new opto-acoustic sources of sound and related methods of diagnostics, as well as the application of LIBS both to elemental analysis of liquids and to analysis of impurities in liquids.

The spectroscopic analysis of liquids encounters difficulties related, in particular, to the fact that the laser-induced breakdown usually takes place on the liquid surface, where a significant contribution to the response signal is due to spectral lines of atmospheric gases. This problem can be solved by using breakdown in the volume of liquid, since the side effect of atmospheric gases in this case is excluded[1]. However, this approach encounters another difficulty related to the attenuation of excited weak lines of elements because of absorption in the liquid.

Material and methods: In this context, it was of interest to study the influence of additional acoustic action on the laser- induced breakdown so as to reveal the possibility of increasing the intensity of emission lines excited during this combined breakdown in a liquid [1,2].

We have used a nanosecond pulsed laser in a broad temporal domain to study the dynamics of laser- induced breakdown with traditional optical detection on both nanosecond time scale and at later stages. Experiments on the induction of optical breakdown in the volume of liquid were performed using an Nd:YAG laser[1,2].

Results: It is shown that the optical breakdown in the liquid in the ultrasonic field is accompanied by an increase in the intensity of the spectral lines of potassium and oxygen with an increase in the amplitude and frequency of ultrasound. It was found that the effect of ultrasound on the intensity of the lines varies depending on the time of the breakdown evolution. Studies of transient processes in the dynamics of resonant inclusions under the action of acoustic pulses with different frequencies have been carried out. It is shown that an excited signal at its own switching frequency has a sufficiently high amplitude for its registration under typical experimental conditions.

Conclusions: The obtained results show the possibility of increasing the efficiency of LIBS in ultrasonic field and applying ultrasound in related technologies.

References

1. A.V. Bulanov, I.G. Nagorny, Physics Procedia, 2, 2017, p.141-146
2. Буланов А.В., Нагорный И.Г., Соседко Е.В Письма в ЖТФ. 2017. Т. 43. № 16. С. 55-60

Acknowledgements
Work performed under state assignment No. 0271-2019-0011 and partially supported by the Russian Foundation for Basic Research, projects no. 18-32-20146 mol_a_ved.

Key words
Laser-induced breakdown, ultrasound field, acoustic spectroscopy

Wind wave and swell in the Japan/East Sea during the passage of typhoon Kong-rey

V. Dubina[1*], V. Fischenko[1], A. Vrazhkin[2]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2] *Far Eastern Regional Hydrometeorological Research Institute, 24, Fontannaya St., Vladivostok, Russia, 690600*
**e-mail: dubina@poi.dvo.ru*

Tropical cyclone Kong-rey in the stage of a strong tropical storm went through the Korean Peninsula to the Japan/East Sea on 6 October 2018 at 06 UTC near 37°N and in 18 hours it shifted at a speed of 25-30 knots through the central part of the sea towards the Tsugaru Strait. The maximum wind near the center of the cyclone was 55 knots.
The spatial features of the wave field are analyzed using a radar image from the Sentinel-1B satellite and a visible image from the Sentinel-2B satellite, taken at 21:21 UTC on October 6 and at 02:07 UTC on October 7, respectively. Satellite data are compared with the results of calculations using the WAVEWATCH III version 5.16 model and frequency measurements performed by means of the Peter the Great Bay scientific monitoring system.

Acknowledgements
This work was supported by project 18-1-010 of the Integrated Program for Basic Scientific Research of the Far East Branch of the Russian Academy of Sciences "Far East".

Key words
Japan/East Sea, typhoon, swell

Registration the wave and sea level fluctuations in the World Ocean coastal zones with use the live video in internet

V.K. Fishchenko*, A.A.Goncharova
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: fischenko@poi.dvo.ru*

In the recent years, there are a lot of open access systems that provide uninterrupted high-quality broadcasting of marine video using a webcam installed at different points in the coastal zone of the World Ocean. The main motivation for their installation is the marketing goals of camera manufacturers and travel companies. At the same time, using the technologies developed at the Pacific Oceanological Institute, it is possible to easily register and study wave processes at the installation sites of such chambers. A key element of this technology is QAVIS (Quick Analyzer of Video and Images for Scientists, http://oias.poi.dvo.ru/qavis/). It is designed to work directly with a video stream, allowing continuous long-term measurements of waves and sea level fluctuations.

We performed studies of marine processes in several places around the world (the west coast of the United States, in Brazil, Chile, Turkey, Greece, Italy, and Spain.) using video broadcast services from https://www.skylinewebcams.com/ for the period from summer 2018 to the present. The most effective method is tracking the movements of marker objects (anchored yachts, buoys, buoys, etc.). The vertical component of these movements is actually an estimate of the signal for a change in the level of the water surface - h(t). The analysis of the obtained signals showed a presence in them of the responses of diurnal and semi-diurnal tides, seiche fluctuations with periods from 2-3 hours to tens of seconds, swell, wind and ship waves. When potential marker objects are absent, it is possible to register the brightness change signal in local zones of the sea surface through which the waves pass. Strictly speaking, this signal is not a signal h(t), but it is substantially correlated with it and carries information about its frequency structure. Conducting simultaneous observations of the brightness signal in several zones, it is possible to estimate the wavelength, direction and speed of their propagation. The information on the wave spectrum can also be obtained from a signal of brightness change in the zone of collapsing waves coming ashore.

A note on the quality of measurements. In two cases, stations of the Global Network for Observing Sea Level GLOSS were located near the web-cameras (distance less than 0.5 km). Comparison of our data and GLOSS data showed that the signals of sea level fluctuations are very similar, the correlation coefficient for tidal oscillations is k = 0.99, for seiches k = 0.86–0.95. The quality of sea level measurements is comparable with both methods. At the same time, our method allows registering components of swell, wind and ship waves that are inaccessible by GLOSS. The correctness of the registration of the latter is confirmed by comparing their Fourier spectra with the spectra of marine microseisms at the seismic stations closest to the cameras.

Key words
Sea waves, sea level fluctuations, live video

Detemination of the microalgae species composition with fluorescence temperature curves of chlorohyll-a

E. Gamayunov[1,2], S. Voznesenskiy[1], A. Popik[1]
[1]*Institute of Automation and Control Processes RAS, 5, Radio Str., Vladivostok, Russia, 690041*
[2]*Far Eastern Federal University, 8, Sukhanov Str., Vladivostok, Russia, 690091*
e-mail: gamayunov@iacp.dvo.ru

Control of microalgae species composition in cultivated and natural conditions is an important task of biotechnology and ecology. A method for determining the species composition of microalgae is presented to control their content in cultivated and natural conditions.

The proposed method is based on comparing the fluorescence temperature curve (FTC) of chlorophyll-a the water sample with test FTC measured for individual microalgae cultures. The algorithm for determining the species composition of microalgae is based on the assumption that the fluorescence intensity of the mixture is the sum of the fluorescence intensities of the microalgae of each culture.

The software implementation of the algorithm for determining the species composition of microalgae is based on a mathematical method for minimizing the root-mean-square residual. For each culture in the mixture, such relative concentrations for each exemplary microalgae were determined, at which the minimum value of the sum of squared differences, calculated fluorescence intensity and measured in the temperature range of 20 ° C - 80 ° C with a step of 1°C was achieved.

The paper presents the results of experimental studies of cultivated samples, both with individual cultures and with their mixtures. The studied samples were solutions containing cells of one, two, and three types of microalgae of the same section (green): *Dunaliella salina, Chlorella minutissima, Tetraselmis viridis*. Analysis of the data obtained shows that the presence of each of the three types of microalgae cultures in all samples was determined quite reliably.

As a result of the studies performed, it was shown that it is possible to determine certain types of microalgae present in the water and to evaluate their concentration, both in monosolutions and mixtures consisting of two or more types of microalgae.

The developed technique can be useful for recognizing microalgae species and monitoring their vital activity during cultivation or in the natural environment.

Acknowledgements
This work was supported by grant from the FEB RAS under the Far East program (DV-0262-2018-0052).

Key words:
Phytoplankton, laser-induced fluorescence, fluorescence temperature curves

Application of coastal seismic stations for estimation of sea wave characteristics in adjacent areas

A.A. Goncharova*, V.K. Fishchenko
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
**e-mail: goncharova@poi.dvo.ru*

It is well known that in the signals recorded by seismic stations in addition to the earthquake responses the Earth oscillations with periods from 2 to 25 sec are consistently present. This is the so called marine microseisms. Their main cause is intense wave processes in the oceans. Primary and secondary microseisms can be distinguished. Primary microseisms are directly caused by surface gravity waves in shallow water. The secondary ones are caused by the impact of standing waves that occur due to interaction between surface waves of similar frequencies but opposite directions. Primary microseisms have the same frequency as the waves generating them; the frequency of the secondary ones is 2 times higher. Analysis of the frequency spectrum and power of microseisms can potentially give a lot of useful information about the processes of waves in the ocean. However, this task is complicated by the fact that most seismic stations are located far from the coastline. Hence in microseism band there is a complex superposition of responses from marine processes in different parts of the ocean. It can be expected that seismic stations located directly on the coast should register microseisms primarily generated by marine processes in the area closest to the station.

In our work, we investigate the possibilities of using coastal seismic stations to estimate the swell frequency spectrum and the significant wave height using data from seismic stations located on Cape Schultz (Posiet Bay, Sea of Japan).

In the first study, using the AXIS-214 network camera and the methods developed by us, we registered the sea wave signal in the area facing south towards the Sea of Japan. The distance from the point of measurement in the sea to the seismic station is about 400m (250m by sea, 150m by land). This signal was analyzed together with the signal of the North-South channel of the seismic station. A significant visual similarity of the Fourier wave spectra of the swell and spectra of primary microseisms was found, as well as the similarity of spectrograms describing the temporal dynamics of the spectra. In addition, a significant correlation between the signals of waves and earth crust oscillations in the frequency range of primary microseisms has been quantitatively confirmed.

The second study reproduces, with small changes in relation to Posyet Bay, the method of estimating the significant wave height (SWH) according to coastal seismic stations, proposed and tested for the Ligurian coast of Italy [1]. Based on a comparison of seismic data with oceanographic buoy data installed in Posiet Bay in 2016, a regression equation was compiled between the power of secondary microseisms and SWH, which well approximated observations of the height of significant waves in 2016 and 2018.

References

1. G. Ferretti, A. Zunino, D. Scafidi et all, *Geophysical Journal International*, 2013, 194(1), 524-533.

Key words
Sea waves, marine microseisms, coastal seismic stations

Observations of the Luzon Cold Eddy in the northeastern South China Sea in May 2017

Zhida Huang[1], Wei Zhuang[2], Jianyu Hu[2*], Bangqin Huang[3]

[1]*Z. Huang (zhidahuang@xmu.edu.cn; Telephone: +86-592-2186981); State Key Laboratory of Marine Environmental Science, College of the Environment and Ecology, Xiamen University, Xiamen 361102, China*

[2]*W. Zhuang (wzhuang@xmu.edu.cn); J. Hu (Corresponding Author: hujy@xmu.edu.cn; Telephone: +86-592-2186981); State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China*

[3]*B. Huang (bqhuang@xmu.edu.cn); Fujian Provincial Key Laboratory of Coastal Ecology and Environmental Studies, College of the Environment and Ecology, Xiamen University, Xiamen 361102, China*

Combining cruise observations, satellite altimeter and Argos drifter data in the northeastern South China Sea in the spring of 2017, this paper reports a Luzon Cold Eddy (LCE), which originated near the northwestern coast of Luzon Island. Then it migrated northwestward and was sampled by the cruise transect to the southwest of Taiwan Island. In the core of the LCE, the isotherm, isohaline and isopycnal all uplifted by approximately 100 m within the depth range of 150 to 300 m. The corresponding geostrophic currents were consistent with satellite altimeter results. In addition, a double-index was applied to study the dynamical process for the LCE evolution. The index reflects well the intraseasonal variability of eddies and the Kuroshio pathway in the spring of 2017. During the second half of April, the enhancement of the LCE was regulated by the velocity shear resulting from a large anticyclonic eddy east of the Luzon Strait. Taken together, the results of this study demonstrate a better understanding of the circulation and mesoscale patterns and a potential implication for water mass renewal in the northeastern South China Sea.

Acknowledgements This work was supported by the National Key Research and Development Program of China (No. 2016YFA0601201), the National Basic Research Program of China (No. 2015CB954004), the National Natural Science Foundation of China (Nos. 41776027, 41806011, U1405233), the China Postdoctoral Science Foundation (2018M632577) and the Fundamental Research Funds for the Central Universities (No. 20720160108). The authors would like to thank the CMEMS, GDEM and AOML data centers for their online data, and the NSFC Open Research Cruise (Cruise No. NORC2017-04) for cruise data collection.

Keywords
Luzon Cold Eddy, South China Sea, Kuroshio

Building the observation sub-network for the eco-monitoring purposes within the area of the Peter the Great Bay

D. Kaplunenko[1], A. Subote[1]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*
**e-mail: dimkap@poi.dvo.ru*

Recently due to technical progress and growth of amount of available sensors for purposes of environmental observations it becomes possible to one make a wide spectra of observations on any kind of the human activity. In this matter the V.I. Il'ichev Pacific Oceanological Institute (POI) as an active scientific research center has an own set of the specialized tele-communication systems unified to the institute private network.

This network and the data obtained inside is separated from other sources of data and networks dedicated to the climate and eco-monitoring and usually is the subject of study mainly of POI-scientists. At the same time the networks made by the volunteers for the same studies is actively developing and might be a good opportunity for the mutually profitable collaboration between them and POI. Hence the POI researchers groups are interested to develop approach to merge data from outer observation networks with the own data and systems to obtain more detailed picture of climatic and ecological processes, which take a part on the shelf of the Primorye Region (Peter the Great Bay) and adjacent area.

Here we are considering the current state of POI-observation resources and the ways to collaborate with the networks and the data sources for the study of marine ecology within the area of the Peter the Great Bay. According with this, using the abilities of Internet of Things (IoT) devices POI develops the own devices for observations and make a preparation for obtaining data from other networks, located in the region, study the opportunities to organize volunteer-based joint networks of observations based on software packages developed by the POI or partner's research groups.

Key words
IoT, eco-monitoring, Arduino, Raspberry Pi

Short-term variability of thermohaline characteristics in the northwestern Japan/East Sea from moored buoy data in 2013-2016

D.D. Kaplunenko*[1], V.B. Lobanov[1], A.G. Ostrovsky[2], A.Yu. Lazaryuk[1],T.A Gulenko[1], K.I. Chang[3], S.H. Nam[3], S.T. Yoon[3]

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostok, Russia, 690041*

[2]*P.P.Shirshov Institute of Oceanology Russian Academy of Sciences,. 36 Nahimovskiy pr., Moscow, Russia, 117997*

[3]*Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Republic of Korea*

**e-mail: dimkap@poi.dvo.ru*

The recent activity and collaboration of V.I. Il'ichev Pacific Oceanological Institute (POI), P.Shirshov Institute of Oceanology Russian Academy of Sciences (IO-RAS) and Seoul National University (SNU) during 2013-2016 have allowed to obtain not only the data of vertical distribution of oceanographic parameters (temperature, salinity, oxygen concentration) during the cruises but also a data of moored stations within the area of Yamato-rise (2013-2015) and Primorye-region shelf-off area (2015-2016) which contains time series data about sea-level pressure, temperature, salinity and water masses dynamics during the period of observation.

So here we are discussing the results obtained from the data-loggers recorded temperature, salinity and sea level pressure for the fixed depths simultaneously with the running the Aqualog-system (IO-RAS) which obtained the profiles of mentioned sea water characteristics daily.

The observed anomalies within the time of observation have been analyzed according with the reanalysis data obtained from the modelling output of the HYCOM model of the Japan/East Sea circulation and product of E.U. Copernicus Marine Service Information (CMEMS) ESA reanalysis named as GLORYS12V1 (global ocean eddy-resolving (1/12° horizontal resolution and 50 vertical levels) reanalysis covering the altimetry era 1993-2018).

The obtained results allow to suggest about the matter of anomalies of oceanographic parameters within the period observation on moored buoy stations, located within the areas of the Tsushima warm (Yamato rise) and the Liman cold currents (Preobrazhenie point) within the northwestern part of the Japan/East sea.

Key words
Japan/East Sea, vertical profiles time series, Tsushima current, Liman current, mesoscale eddies

Features of background internal waves and sound field variations on the Sea of Japan shelf

A. Kosheleva*, I. Yaroshchuk, A. Shvyrev, O. Gulin, R. Korotchenko, A. Pivovarov, A. Samchenko

V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostok, Russia, 690041

**e-mail: kosheleva@poi.dvo.ru*

There are always background internal waves (IWs) on the shelf. In contrast to soliton-like non-linear waves, they represent a random field, which in case of a deep ocean can be satisfactorily described by the Garrett-Munk model. For the ocean shelf zones, such a model is unacceptable because of the complex dynamics of the waters.

This paper discusses the results of experimental and theoretical studies of background IWs and corresponding to them random variations of the sound velocity field in the Sea of Japan coastal zone. Phenomenological models of background IWs and sound velocity field are proposed, and they are compared with the Garrett-Munk model.

The authors obtained experimental data on the fields of IWs within the past ten years in Peter the Great Bay of the Sea of Japan on the basis of CTD probing, current meter measurements, and the long-time data from moored vertical thermostrings [1]. The data from thermistors were converted into the water density and the sound velocity with high accuracy [2]. The development of phenomenological models from experimental data was carried out by randomizing the spectral representation of a random field or its correlation functions [3].

Quantitative characteristics of the background internal waves were obtained: their energy spectra, horizontal scales, phase velocities, and the degree of spatial anisotropy. The statistical properties of the sound velocity field (the first statistical moments and spatial correlation functions) were evaluated. A statistical study for consistency with the Gaussian distribution was also carried out.

As a result of the research it was found that fluctuations of the sound velocity can be considered Gaussian with sufficient accuracy. The Garrett-Munk model does not describe the background IWs on the shelf; however, for each specific case, by varying the model parameters, this model can be fitted to the experimental data. Such fit is not universal; it depends on the region of research and the season.

References

1. A. Leontyev, I. Yaroshchuk, S. Smirnov, A. Kosheleva, A. Pivovarov, A. Samchenko, A. Shvyrev, *Instruments and Experimental Techniques*, 2017, **60 (1)**, 130-136.
2. A. Kosheleva, A. Lazaryuk, I. Yaroshchuk, *Proc. of Meetings on Acoustics*, 2015, **24**, 005001.
3. A. Shvyrev, I. Yaroshchuk, *Lecture Notes in Computer Science*, 2010, **6083**, 191-199.

Acknowledgements

This work was supported by AAAA-A17-117030110031-6 Russian government project.

Key words

Internal waves, sound velocity fluctuations, statistical models

Multipurpose autonomous optical module for network underwater measurements of sea water fluorescence

V.A. Krikun [1*], A.A. Korotenko [2]
[1] V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
[2] Institute of Automation and Control Processes FEB RAS, 5 Radio Str., Vladivostok Russia, 690041
*e-mail: kv99@mail.ru

Optical methods for determining the state of natural water areas have been firmly established in the practice of oceanological research. The advantage of such methods is the possibility of making measurements in the automatic mode without preliminary preparation of water, in real time. There are known scientific works[1,2] in which measurements of bio-optical parameters were carried out with the help of automatic stations, which allowed obtaining new data on the dynamics of the processes taking place in the water area. However, until now there has not been created a sufficiently autonomous and low cost device for carrying out research of this kind.

The aim of this investigation was the development of a low cost multipurpose autonomous optical module for network underwater measurements of sea water fluorescence. The autonomous networks modules for the optical parameters of sea water underwater observation could be used as the single device, or could be individually organized into a distributed network of hydro-optical measurements. Universal optical module could be equipped with the one or several (up to 4) sensors for underwater measurements e.g. fluorescence sensor, turbidity sensor, water pressure sensor, absorbtion sensor etc.

The solutions developed in this research will make possible to universalize the development of underwater hydro-optical measurement systems, as well as to modernize existing underwater vehicles and devices.

References

1 Combined processing and mutual interpretation of radiometry and fluorimetry from autonomous profiling Bio Argo floats. Chlorophyll A retrieval. Xing, X., A. Morel, H. Claustre, D. Antoine, F. D'Ortenzio, A. Poteau, A. Mignot, Z. Lee, S. Shang, and C. Hu J. Geophys., 2011, C06020, p.116.
2 Experience of continuous fluorimetric monitoring of phytoplankton at the pump station. I.V. Konyuhov, M.S. Selina, T.V. Morozova, S.I. Pogosyan / OCEANOLOGY, 2012, vol. 52, № 1, p. 139–149.

Acknowledgements
The reported study was funded by RFBR according to the research project № 18-38-00556, mol_a.

Key words
Autonomous optical module, fluorescence, phytoplankton.

Water circulation under the ice cover of the Amurskii Bay

A. Lazaryuk, V. Ponomarev, P. Fayman, E. Marina
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,43 Baltiyskaya Str., Vladivostook, Russia, 690041

CTD observations in the northern part of the Amurskii Bay during cold periods 2011 – 2019 are performed. The observed temperature, salinity and density distributions show that in winter a background cyclonic circulation is formed under the ice cover in the bay area with depth from 30 to 5m. The currents under the ice cover depend on the density gradients, controlled by the process of brine rejection and high-salinity water formation in the northeastern bay shallows, Razdolnaya River run off and water inflow from the southern part of the Amurskii Bay.

The column of cold brine water with temperature up to -1.9°C and salinity up to 35 psu forms in the northeastern bay shallows during a period of the ice thickness increase. At the same time, relatively warm and low salinity water propagates from of the Razdolnaya River estuary along the northwestern shallows. Northeastern high-denser water propagates westward - southwestward along the bottom slope (inclination 3/1000). The waters mix in the frontal zone and the temperature of the dense brine water increases by 1–1.5°C. High inhomogeneity of the thermohaline structures and low ice thickness are observed in the frontal zone. The relatively warm brine water observes in thin near bottom layer (1-1.5m) along the most of sections from the mix zone. The brine bottom water slides along the bottom slope into the deepest area of the bay covered by ice, where thickness of the near bottom layer increases up to 5-6 m. This water drifts to the south, along the eastern coast of the Amurskii Bay. Under favorable conditions, the layer of brine water reaches the East Bosphorus Strait and further penetrates into the deep area of the Ussuriyskii Bay and external shelf of the Peter the Great Bay up to the shelf break. Water of the upper layer, coming from the southern part of the Amur Bay, spreads in the northern part along the eastern coast, as a rule. It is a cold water of less salinity than waters of the northern part due to the later dates of the start of ice formation. This surface water is involved into cyclonic gyre over the Amurskii Bay shallows.

Long-term measurements of the ice thickness show that the growth of ice thickness stops at the end of the first decade of February in the most of the Amurskii Bay shallows, when the brine rejection reduces. During subsequent period, a transformation of both the near bottom brine water and upper water are observed. Nevertheless, the cyclonic circulation is preserved in the studied area until the ice cover destruction.

Wintertime Guangdong coastal currents successfully captured by cheap GPS drifters

Hongyang Lin, Zhenyu Sun, Zhaozhang Chen, Jia Zhu, Jianyu Hu*
State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China
**e-mail: hujy@xmu.edu.cn*

This study introduces a type of self-developed, GPS-based, simple and cheap (about $30 each) Surface Current Experiment (SUCE) drifters designated for observing surface coastal currents. By examining trajectories of six drifters deployed in the Daya Bay and the drifter-derived velocities, the authors conclude that such drifters are generally capable of capturing the characteristics of wintertime surface coastal currents along the Guangdong coast.

References

Austin J, Atkinson S. 2004. The design and testing of small, low-cost GPS-tracked surface drifters. Estuaries, 27, 1026–1029.

Johnson D, Stocker R, Head R, et al. 2003. A compact, low-cost GPS drifter for use in the oceanic nearshore zone, lakes, and estuaries. Journal of Atmospheric and Oceanic Technology, 20, 1880–1884.

Lin H, Hu J, Liu Z, et al. 2017. A peculiar lens-shaped structure observed in the South China Sea. Scientific Reports, 7, 478, doi:10.1038/s41598- 017-00593-y.

Mullarney J C, Henderson S M. 2013. A novel drifter designed for use with a mounted Acoustic Doppler Current Profiler in shallow environments. Limnology and Oceanography: Methods, 11, 438–449.

Nasello C, Armenio V. 2016. A new small drifter for shallow water basins: Application to the study of surface currents in the Muggia Bay (Italy). Journal of Sensors, 1–5, doi:10.1155/2016/6589636.

Perez J C, Bonner J, Kelly F J, et al. 2003. Development of a cheap, GPS-based, radio-tracked, surface drifter for closed shallow-water bays. Proceedings of the IEEE/OES Seventh Working Conference on Current Measurement Technology, 66–69, doi:10.1109/CCM.2003.1194285.

Thompson K R, Sheng J. 1997. Subtidal circulation on the Scotian Shelf: assessing the hindcast skill of a linear, barotropic model. Journal of Geophysical Research, 102, 24987–25003, doi:10.1029/97JC00368.

Acknowledgements

This work was supported by the National Basic Research Program of China (2015CB954004), the National Natural Science Foundation of China (41606009, 41776027, 91858201, 41890801), Xiamen University Fundamental Research Funds for the Central Universities (20720180099), and Laboratory for Regional Oceanography and Numerical Modeling, Pilot National Laboratory for Marine Science and Technology (Qingdao) (No. 2017A02).

Key words

GPS drifters; coastal currents; Daya Bay

Quality assessment of altimetry data product DT18 in the North Atlantic

L. M. Naumov[1,2*], S. M. Gordeeva[1,2,3], T. V. Belonenko[1]
[1] *Saint Petersburg State University, Universitetskaya nab. 7–9, St. Petersburg, Russian Federation*
[2] *Russian State Hydrometeorological University, 79, Voronezhskaya ul., Saint Petersburg, Russia*
[3] *Shirshov Institute of Oceanology of the Russian Academy of Sciences, 36, Nahimovskiy pr., Moscow, Russia*
**e-mail: levnaumov96@gmail.com*

Background: The objective of this paper is to assess the changes and quantify the improvements in the new gridded altimetric sea level product DT18 in the North Atlantic by comparing the data of satellite altimetry with two types of instrumental data. We use tide gauge records to assess the quality in the coastal zone and data from surface drifting buoys to assess the quality in the open ocean. Thus, we aim to complement previous studies by providing the objective assessment of the quality and performance of satellite altimetry in this important region.

Material: The altimetry product DT18 produced by SSALTO/DUACS computed with respect to a twenty-year mean for the Global Ocean - Multimission altimeter satellite gridded sea surface heights and derived variables. Previously distributed by Aviso+, there is no change in the scientific content in E.U. Copernicus Marine Service. We used tide gauge post data distributed by the Permanent Service for Mean Sea Level (PSMSL, www.psmsl.org). We analyzed sea level records from 6 tide gauge stations (Andenes, Bodo, Rorvik, Kabelvag, Hammerfest and Harstad located along the Norway coast). We also used drifter data are provided by the Global Drifter Program Data Assembly Center of the Atlantic Oceanographic and Meteorological Laboratory.
Methods and Results: In the first step, we provide verification and quality assessment of the altimetric product DT18 in the coastal zone, and after that in the open sea. We obtain the assessment of linear trend and its significance of sea level changes at the tide gauge stations and calculate statistical characteristics of the quality in the description of tide gauge stations data by altimetry data. We also analyze results of *F*-test the equality of two variances and independent two-sample Student's t-test for comparison of satellite altimetry data with the data of the tide gauge stations, and results of *F*-test the equality of two variances and independent two-sample Student's t-test for comparison of velocity of drift buoy and altimetry data as well.

Conclusions: We demonstrate that the new product DT18 reproduces the sea level variability in the coastal zone at an acceptable level (an average error is 3-4 cm), and it reproduces the internal structure of the time series quite well (almost with a 100% correlation). We make a conclusion on improving the quality of the DT18 in the coastal zone of the North Atlantic compared to previous altimetric products. However, we found that altimetry substantially smoothes the pattern of the sea level, which is probably due to the interpolation of satellite track data onto a regular grid when a grid product was creating. This pattern also manifests itself in the open sea, in which, in addition, errors in the form of "diamonds" are revealed due to interpolation from satellite tracks. We revealed the influence of ageostrophic factors in altimetry on the quality description of current velocities in the sea, and this is also true for the coastal zone. Statistical tests also showed some inconsistency between altimetry data and field (buoys and drifters) data in the open sea. This is manifested both in the statistical inequality of mean values and variances, and in differences of empirical distribution functions. Summing up, we assert that despite the improvement in the quality of the altimetric product DT18 compared with previous products, some errors are still observed in high latitudes, both in the coastal zone and in the open sea.

Acknowledgements
This research was supported by **Russian Scientific Foundation** (pr. No. **18-17-00027**).

Key words: altimetry, DT18, tide gauge records, drifters

Internal wave-turbulence interactions in the shelf near-bottom layers

Vadim Navrotsky
V.I. Il'ichev Pacific Oceanological Institute FEB RAS,.43 Baltiyskaya Str., Vladivostook, Russia, 690041
vnavr@poi.dvo.ru

Complex experiments in the near-shore region of the Peter the Great Bay included detailed measurements of temperature, velocity, and bottom pressure fluctuations at anchored stations with bottom depths in the range 15-40 m. Long-term measurements of temperature were made with the help of strings of thermistors (30-40 sensors with 0.5m spacing at each string), and velocity measurements with the help of bottom-installed RDCP-600 or Argonaut-XR. It was shown earlier (Navrotsky, 1999; Navrotsky et al., 2004) that propagating to shore internal waves effectively interact with the mean density field and lead to formation of vertical fine structure, thermocline splitting and deepening. At some distance from shores the seasonal thermocline becomes stratified near-bottom layer, and propagating and destroying internal waves define the main properties of near-shore waters. Classic spectral analysis Fourier shoes that temperature and velocity frequency spectra are not monotonous, change with depth and at some levels can have bumps between tidal or inertial peaks and buoyancy frequency. Analysis of dispersion relations for inertia-gravitational internal waves in layers with vertical gradients of current velocity leads to the conclusion that the bumps can be caused by internal waves generated by turbulent eddies in the layers with nonzero second derivative current velocity $U''(z)$. Vertical structure of Hilbert-Huang (time-frequency) spectra shows that process of such IW generation takes place at some limited depth-frequency ranges and is intermittent in time. We can conclude that process of IW breaking in shallow regions is not monotonous, but proceeds through the stage of wave-turbulence-wave interactions.

References

Navrotsky V. V. Mixing caused by internal waves and turbulence: a comparative analysis // *J. Marine Systems*. 1999. **V. 21. No. 1-4**, P. 131-145. doi:10.1016/S0924-7963(99)00010-X

Navrotsky, V. V., Lozovatsky J. D., Pavlova E. P., Fernando H. J. S. Observations of internal waves and termocline splitting near a shelf break of the Sea of Japan (East Sea) // *Continental Shelf Res.*. 2004. **V. 24**. P. 1375-1395. doi:10.1016/j.csr.2004.03.008

Fluorescence temperature curves of marine microalgae chlorophyll-a

A. Popik[1*], E. Gamayunov[1], S. Voznesenskiy[1], Zh. Markina[2]
[1]*Institute of Automation and Control Processes Far Eastern Branch of the Russian Academy of Science, 5, Radio street, Vladivostok, Russia, 690041*
[2]*National Scientific Center of Marine Biology, Far East Branch of the Russian Academy of Sciences, 17, Palchevsky street, Vladivostok, 690041*
**e-mail: popikay@yandex.ru*

Native bioindicators are topically and priority objects of study for the further development of environmental monitoring devices. Microalgae phytoplankton are one of the well-known examples of such objects. They have photosensitive pigments, including those emitting fluorescent light. Many methods and instruments use measuring of phytoplankton fluorescence for appraisal of water body quality. However, if it unknown fluorescence of what algae is measured, it unknown how to interpret the fluorescence data. However, if it is unknown a fluorescence of what algae is measured, how to interpret the fluorescence data is unknown too. Therefore, continuous calibration of fluorescence meters for species composition becomes an extremely important.

Such calibration technic of a fluorescence measuring system primarily requires the identification of phytoplankton species in the studding water body. It is top necessary to find a fluorescent feature of phytoplankton microalgae, which would allow to identify them and to calibrate fluorescent monitoring system accordingly. Fluorescence temperature curve (FTC) is the dependence of the chlorophyll-a fluorescence intensity on temperature, and can be a potential feature for identification of phytoplankton in situ and automated it. Microalgae from the resource collection “Marine Biobank” of the National Scientific Center of Marine, Far East Branch, Russian Academy of Sciences was studied to research the FTC of pure cultures. We take all cultures at the exponential growth stage. FTC measurements were performed in four replications. The temperature range is 20-80 °C; the speed is 1 °C/m. The algae samples fluoresce in a wide range of wavelengths (490-760 nm).

The result is the standard of FTC for each pure microalgae culture. Their distinctive distinctions make it possible to determine microalgae not only from different departments, but also within them. Their “fingerprint” differences make it possible to determine microalgae not only from different phyla, but also within them. The ability to fluorescence remote measuring through an optical fiber and the temperature control usability allows determining microalgae in the water at any depths. Microalgae FTC is best to identify species composition for further calibration of phytoplankton fluorescence measuring systems. Devices with the ability of such calibration will allow in the future building complete automated systems for species composition and conditions of phytoplankton in natural waters.

Acknowledgements
This work was supported by grant from the FEB RAS under the Far East program (DV-0262-2018-0052); and grant 18-3-52 from program "Priority research in the interests of the comprehensive development of the FEB RAS"

Key words
Phytoplankton, spectrometry, fluorescence temperature curves

Observations of the enhanced diurnal tidal currents over the Bering Sea northern shelf and Aleutian Straits

K. Rogachev, N. Shlyk

V.I. Ilichev Pacific Oceanological Institute, Baltiyskaya Street, 43, Vladivostok, 690041, Russia

E-mail: rogachev@poi.dvo.ru

Background. The Kamchatka Current forms in the western Bering Sea near Cape Olutorskiy and flows to the northern Kuril Islands. The deepening of the halocline near the Kamchatka peninsula and western Bering Sea is one cause of this western boundary current. Summer stratification, created by low salinity and high temperature waters reduced in the regions with strong tidal currents, which are particularly strong in the Aleutian straits and over the Bering Sea northern shelf. It is important to know the features of these tidal currents in order to understand the variations of the halocline in connections with the lunar nodal cycle.

Material and methods. Surface drifters observations were used to determine the characteristics of tidal currents and circulation over the northern shelf of the Bering Sea and Sea of Okhotsk. From April 2014 to October 2018 the first measurements of tidal currents were carried out off the northern shelf of the Bering Sea between Cape Navarin and Cape Olutorskiy.

Results. We presented the first observations of tidal currents over the Bering Sea northern shelf. Tidal currents are dominated by the diurnal variability with fortnightly modulation. The K1 and O1 tidal current ellipses are clockwise with their major axes along the isobaths and their signal propagates with the coast on the right with phase speed of about 3.5 m/s for K1 and wavelength of order of 324 km. The long axis was ~0.5 m/s for K1 tidal currents. The diurnal tidal currents over the offshore part of the northern shelf are significantly smaller than those over the coastal part.

Conclusions. The amplified diurnal tidal currents over the shelf can be explained by the resonant diurnal coastal-trapped waves. The Kamchatka Current forms near Cape Olutorsky and has a cold intermediate layer in summer. We found that the 18.6-year lunar nodal cycle is a pronounced characteristic of salinity variation of this cold intermediate layer in the Kamchatka Current eddies and in the eddies eastward of the Boussole Strait over the period 1990-2018.

Keywords:
Tidal currents Argos drifters, lunar nodal cycle

Strong tidal currents over the eastern Sea of Okhotsk shelf and shallow banks in the Western Subarctic Pacific

K. Rogachev, N. Shlyk

Pacific Oceanological Institute, Baltiyskaya Street, Vladivostok, Russia
E-mail: rogachev@poi.dvo.ru

Background. The south-flowing waters of the Kamchatka and Oyashio currents are key components of the western subarctic Pacific gyre. The dissipation of tidal energy in shallow and coastal regions of these currents and the attendant mixing are the important processes that affect the upper layer temperature and salinity. Examples of the impact of tidal currents on water temperature and salinity are the persistent tide-driven mixing around the Kashevarov and Kruzenshtern banks. The Kruzenshtern Bank is a shallow submarine bank stretching along the eastern continental slope of the Kuril Islands. The Oyashio and Sea of Okhotsk oceanographic features are changing as a result of rapid regional warming and freshening. The density difference between low-salinity and salt waters provides a driving force for coastal circulation in the Pacific Ocean. Coastal currents flow along two shallow banks namely Kashevarov in the Sea of Okhotsk and Kruzenshtern in the Oyashio. Large variations in tidal mixing occur in subregions such as these banks that are strongly dominated by the diurnal constituents. Enhanced tidal mixing exists near the Kuril Islands.

Materials and methods. Surface drifters observations are used to determine the characteristics of tidal currents, and the circulation over these banks and other regions of the Sea of Okhotsk. New software that allows more versatility in the harmonic analysis is used for drifter's data.

Results. The two banks have similar features. The variations in current velocities are dominated by the diurnal signals. The K_1 and O_1 tidal ellipses over the banks are the largest and clockwise. The enhanced tidal currents suggest that the formation of cold and saline water in summer is due to mixing of water column over the banks with intermediate waters. Variations of tidal ellipses over the bank may explain the formation of polynya at the western end of the Kashevarov Bank.

Conclusions. The velocities at both banks and over the eastern Kamchatka shelf are dominated by the diurnal tides. Diurnal currents up to 1.8 m s^{-1} were found at the banks. New data obtained confirmed the strengthening of diurnal tidal currents and the anticyclonic circulation around these banks. It is plausible that the spatial variations of the tidal current amplitude may explain the formation of polynya at the western edge of Kashevarov Bank in winter without drawing relatively warm water from middepth.

We found that the 18.6-year lunar nodal cycle is a distinctive characteristic of salinity at temperature minimum in the eddies near the Boussole Strait southward from the Kruzenshtern Bank over the period 1990-2015.

Keywords:
Tidal currents, lunar nodal cycle, Kruzenshtern and Kashevarov Banks

Development of an In-field Nutrient Analysis System and its Application in Coral Communities of Hong Kong

Sitong QIN[1,2], TzuHao CHUNG[1,2], Walter DELLISANTI[1,2], Jiajun WU[1,2], Jian-wen QIU[3], Dongxing YUAN[4*], Leo Lai CHAN[1,2*]

[1]*State Key Laboratory of Marine Pollution, City University of Hong Kong, 83 Tat Chee Avenue, Hong Kong SAR, China, 999077*

[2]*Shenzhen Key Laboratory for the Sustainable Use of Marine Biodiversity, City University of Hong Kong Shenzhen Research Institute, 8 Yuexing 1st Road, Shenzhen, China, 518057*

[3]*Department of Biology, Hong Kong Baptist University, 224 Waterloo Road, Hong Kong SAR, China, 999077*

[4]*State Key Laboratory of Marine Environmental Science, Xiamen University, Xiang'an Campus, Xiamen, China, 361102*

**e-mail: yuandx@xmu.edu.cn; leochan@cityu.edu.hk*

Coral reefs are important in coastal protection and provide numerous ecosystem services. However, coral reefs are threatened by anthropogenic activities and global climate changes, resulting in large-scale bleaching and degradation. Being able to analyze nutrient concentrations *in situ* will provide reliable scientific data for better understanding and management of coral ecosystems under these threats and assess the impacts of eutrophication, hypoxia and harmful algal blooms. The aims of this study are to develop a compact, rapid, automatic in-field nutrient analysis system and monitor the nutrient concentration in the natural coral communities of Hong Kong. This novel analysis system has two channels, featuring orthophosphate determination using a spectrophotometric detection method and ammonium determination using a fluorescence spectrometer. The detection limits are both 50 nmol/L for both these main nutrients. The relative standard deviation is lower than 4% and only 2 mL/sample is consumed for each nutrient. Moreover, the analytical speed for orthophosphate is 30 and for ammonium 24 data/h. The advantages of this analyzer include avoiding introducing contamination during the processes of sample collection and transport, reflecting the real status of target compounds and expanding the quantitative limits of nutrient concentrations to the trace levels compared to conventional detection instruments.

A preliminary test was conducted to determine the concentration ranges of orthophosphate and ammonium of Hong Kong waters and to evaluate the performance of the analysis system with continuous monitoring at 0.5m underwater and analyzing the water samples collected by divers beside coral communities in Sai Kung. The results showed that the average concentrations of ammonium and orthophosphate were about 0.8 and 0.3 μmol/L, respectively. The preliminary study showed that the concentrations of these two main nutrients in the coral areas of Sai Kung were slightly higher owing to frequent human activities, and that the detection limits of the primary analyzer prototype were low enough for trace nutrient monitoring in Hong Kong waters. A further improved and optimized in-field nutrient analysis system will be applied to the coral reserves throughout Hong Kong waters to assist the government in establishing an environmental monitoring database, and providing services for better conservation and management of coral ecosystems.

Acknowledgements

This study was supported by an SKLMP (State Key Laboratory of Marine Pollution) Open Science Research Fund.

Key words

Coral monitoring; nutrients; rapid in-field analysis

Development of technology of monitoring the functional state and health of marine mammals

E.V. Smolenskii [1,2], G. A. Shabanov[1], A. A. Rybchenko[1], V. I. Korochentsev[2].
[1]*Scientific-research center "Arktika" Feb RAS, Russia, Magadan, 685000, arktika@online.magadan.su*
[2]*Far Eastern Federal University, Department of instrument Engineering, Vladivostok, Russia, 690091, korochentsev.vi@dvfu.ru*

The analysis of methods for assessing the functional state of marine mammals was carried out. The aim of this study was to find and test the technology of monitoring the functional state and health of the animal, non-invasive collection of diagnostic information, which could be carried out repeatedly. Was first tested the method of acoustic registration of EEG with brain Beluga whales. The apparatus "acoustic encephalogram spectrum recorder" (PC AEK-01) allowed to register the rhythm spectrum in the range of 0.1-27 Hz with the release of 8400 spectral harmonics and integration time of 160 seconds. The scheme of the study in the position of Beluga "lying on the water", the method and location of the induction sensors of the acoustic signal was worked out.

References

1. Laura A. Thompson, Tracey R. Spoon, Caroline E. C. Goertz, Roderick C. Hobbs, and Tracy A. Romano, PLoS One, 2014, 9-12.
2. Cumeras R, Cheung WH, Gulland F, Goley D, Davis C., Metabolites, 2014, 3-4.
3. Fuyuko Hashio, NEC Medical System, Tokyo, 2010, 60.
4. Shabanov G. A., Maksimov A. L., Rybchenko A. A., Dalnauka, 2011, 206.
5. Shabanov G. A., Lebedev Y. A., Rybchenko A. A., Maksimov A. L., Korochentsev V. I. Vestnik North-Eastern scientific center Feb RAS. 2017, 115-121.
6. Mirgorodsky V. I., Gerasimov V. V., Peshin S. V., Acoustic journal, 2014, 437-442.

Acknowledgements

This work was supported by Far East branch of the Russian Academy of Sciences, Scientific-research center "Arktika" Feb RAS, "Primorsky aquarium" - a branch of the Central scientific library of Feb RAS, OOO "TOGEOS".

Key words

Marine mammals, acoustic field of the head, functional state of the organism

Doped Polyaniline coated Ag/nano-Ag electrodes for rapid in-situ detection of bromide in seawater

Qiujin Wang[1], Yifan Zhou[1], Yuanfeng Huang[2]*
[1] *Ocean College, Zhejiang University, Zhoushan 316000, China*
[2] *Shandong Special Equipment Inspection and Testing Science &Technology Co., Ltd Jinan, 250002, China, *E-mail: huangyf@sdtj.sd.cn*

Background

Bromine, a natural resource, is found mainly in seawater, underground concentrated brines, sedimentary rock deposits of ancient oceans and salt lake waters. Rapid and accurate determination of bromide is urgently needed in some industries. At present, ion selective electrode (ISE) technology can quickly determine the concentration of ionic elements in water. Compared with the traditional liquid junction ISE, all-solid-state ISE has many advantages, such as convenient storage, easy maintenance, not affected by external pressure, low detection limit and so on. Ion doping improves the conductivity, chemical activity and catalytic activity of inorganic membrane materials.

Material and methods

Electrodeposited nano-Ag on silver wire through a function signal generator and a Schottky diode on a silver wire (99.99%, 0.5 mm). Then, the polyaniline film was prepared by cyclic voltammetry in an aqueous solution of HCl and aniline, and was in-situ doped by KBr solution. Electrochemical performance testing by an electrochemical workstation, SEM, EDS, and EIS were used to analyze electrode performance.

Results and Conclusions

The electrode has a wide linear dynamic range between 1.0×10^{-1} M and 1.0×10^{-7} M and a wide pH (2-10) fitting range with a near-Nernst slope of 57.33 mV per decade. At the same time, the electrode performed extremely low response time (<1 s) and small impedance (300 ohms), high sensitivity (drifted within 2 mV in 8 hours) and good selectivity. SEM results show that the plating is dense and uniform, which is the main reason for the low impedance. Elemental analysis shows that the elements include C, N, Ag, Br, Cl, and the bromine content was as high as 12.22%, indicating that the in-situ doping of bromide ions was successful. The bromide ion electrode has been being assembled with other electrodes into a multi-parameter electrochemical sensor to realize real-time monitoring of various parameters in the water body.

References

1 Migdalski, J., Błaż, T., and Lewenstam, A. *Electrochimica Acta,* 2014, ***133*(7)**, 316-324.
3 Shamsipur M, Rouhani S, Mohajeri A, et al. Analytica Chimica Acta, 2000, **418(2)**:197-203.

Acknowledgements

The authors acknowledge financial support by the National Natural Science Foundation of China (NSFC No. U1709201).

Key words

All-solid state electrode, Bromide ion doped polyaniline, In-situ measurement

A Chemical Sensor with Ir/Ir(OH)$_x$ pH Electrode and its Application in Aqueous Environments

Yifan Zhou[1], Xiao Zhang[1], Jianbo Wu[1], Ying Ye[1*]
[1] *Ocean College, Zhejiang University, Zhoushan, Zhejiang, China, 316021*
**e-mail: yeying.zju@qq.com*

pH is one of the most important indicator of hydrochemistry. It is of great significance to realize the accurate and rapid measuring of pH in the field of environmental monitoring. All-solid-state pH microelectrode based on Ir(OH)$_x$ film was manufactured by cyclic voltammetry method. The pH response ranges from 2 to 12, with response slope of -56.61 and lifetime about 5 months. It was mounted in a chemical sensor which can achieve long time in-situ monitoring. The chemical sensor has low power consumption and small storage demand so that it has broad application prospects in the long-term observation and dynamic detection process.

A one-day fixed-point test was conducted in Taihu Lake, a profile monitoring executed every 2 hours. The results indicate that pH in Taihu Lake is high in the daytime and low at night. In profile monitoring, the maximum pH difference between lake surface and bottom appears at noon ($\triangle$pH=4) and there is no obvious difference in the morning and night. This highly agrees with algal daily activity in the lake. Blue-green algae are abundant on the lake surface around noon and sink at other times. The photosynthesis of blue-green algae on the lake surface consumes CO_2, which increases the surface pH. In the morning and night, the main role of blue-green algae is respiration so that $\triangle$pH between lake surface and lake bottom is small.

Above all, the pH electrode and chemical sensor are sensitive and accurate to be applied in different aqueous environments such as ocean, river and lake.

References

[1]Baur, J. E., Spaine, T. W. Journal of Electroanalytical Chemistry, 1998. **443(2)**: 208-216.
[2]Kuo, L. M., Chou, Y. C., Chen, K., Lu, C. C., Chao, S. Sensors and Actuators B-Chemical, 2014, **193**: 687-691.
[3]Huang W. D, Cao H, Deb S, Chiao M, Chiao J. C. Sensors and Actuators A: Physical, 2011, **169(1)**:1-11.
[4]Kim, T. Y., Yang, S. Sensors and Actuators B: Chemical, 2014, **196**: 31-38.
[5]Qin, H. W., Yang, L. K., Zhu, J. R. Journal of Mechanical & Electrical Engineering, 2013, **30(3)**, 318-321
[6]Wu Kai. Research on floating characteristics and mechanism about water-blooms cyanobacteria (Master thesis). Nanjing: Nanjing University.
[7]Zhao, L. L., Zhu, M. Y. Feng, L. Q. Liu, X. H., Zhu, G. W., Chen, Y. F., Qin, B. Q. Journal of Lake Sciences, 2011, 23(**4**): 649-656
[8]Zhao, L. L., Zhu, G. W., Chen, Y. F., Li, W., Zhu, M. Y., Yao, X., Cai, L. L. Advances in Water Science, 2011, **22(6)**: 844-850.

Acknowledgements

This work was supported by the Open Research Fund of Laboratory of Marine Ecosystem and Biochemistry, SOA (LMEB201701).

Key words

pH electrode; chemical sensor; in-situ monitoring

Design and Ocean Implementation of Adaptive Noise Canceler Based on Recursive Least Squares Algorithm

Xiangguang Zhang[1,2,3], Yongsheng Xu[1,2,3*], Le Gao[1,2,3]
[1] *Key Laboratory of Ocean Circulation and Waves, Institute of Oceanology, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao, China, 266071*
[2] *Center for Ocean Mega-Science, Chinese Academy of Sciences, 7 Nanhai Road, Qingdao, China, 266071*
[3] *Laboratory for Ocean and Climate Dynamics, Qingdao National Laboratory for Marine Science and Technology, 1 Wenhai Road, Aoshanwei, Jimo, Qingdao, China, 266237*
**e-mail: zxg@qdio.ac.cn yongsheng.xu@qdio.ac.cn*

The relationship between the internal wave and the ocean just like baby and mother, while measuring cardiac sounds $s(n)$ of fetus, the heart sound of mother and noise from background (all supposed as $v(n)$) should be detracted. Usually heart sound of mother is 2-10 times stronger than that of embryo, noise from muscle movement and fetus action is stronger than $s(n)$, furthermore $s(n)$ may be stochastically changing as fetus emotion changes. How to restore signal $s(n)$ becomes intractable when using Wiener and typical filter in this case, so adaptive noise canceller is the optimum choice. Adaptive noise canceller is an evolution form of adaptive filter, It is based on the cross correlation of auxiliary input (mainly noise, supposed as $v'(n)$) between noise $v(n)$ in primary input signal $s(n)+v(n)$), design an adaptive filter whose ideal output is $v(n)$ while its input is $v'(n)$, then its output $\breve{v}(n)$ will be the most optimum estimate of $v(n)$, therefore output $\hat{s}(n)$ of adaptive noise canceller will be the optimum estimate of signal $s(n)$ while $\breve{v}(n)$ is subtracted from auxiliary input. Recursive Least Square (RLS) algorithm is adopted in the adaptive filter, and intensive data simulations are performed. The canceller is practical in the case of lacking preliminary knowledge for signal $s(n)$. An ocean mooring system is an effective and common platform for obtaining time series observation data at a specific location in the ocean. Long-term temporal and vertical spatial measurements from an ocean mooring system can help us advance our understanding of dynamic oceanic processes (Zhang et al., 2014), air/sea interactions (Guan et al., 2014), internal wave (Huang et al., 2014), and ocean mixing (Tian et al., 2014b). This adaptive noise canceller can help us to get the internal wave spectrum information from the background signal of the ocean.

References

1. Zhang, Y.W., Liu, Z.F., Zhao, Y.L., Wang, W.G., Li, J.R., & Xu, J.P. Mesoscale eddies transport deep-sea sediments. *Sci Rep*. 2014. 4.
2. Guan, S.D., Zhao, W., Huthnance, J., Tian, J.W., & Wang, J.H. Observed upper ocean response to typhoon Megi (2010) in the Northern South China Sea. *J Geophys Res-Oceans*. 2014. 119(5):3134-57.
3. Huang, X.D., Zhao, W., Tian, J.W., & Yang, Q.X. Mooring observations of internal solitary waves in the deep basin west of Luzon Strait. *Acta Oceanol Sin*. 2014.33(3):82-9.
4. Tian, C., Wang, S.X., Guan, S.D., Yang, Q.X., & Xu, X.Y. Test and evaluation of a moored microstructure recorder. *Chin J Oceanol Limnol*. 2014b. 32(1):201-9.

Acknowledgements

This work was supported by Senior User Project of RV KEXUE (KEXUE2018G15), National Key Research and Development Program of China (2016YFC1402602, 2016YFC1401703, 2016YFC1401004, 2016YFC1401008), National Natural Science Foundation for Young Scientists of China (41606200), National Natural Science Foundation of China (4141676168, 41376028), NSFC-Innovation research group of Sciences Fund (41421005)，NSFC-Shandong Joint Fund for Marine Science Research Centers (U1406401), Leadership in Entrepreneurship and Innovation Awarded by Qingdao Municipal Government (13-CX-26).
Key words: Ocean Implementation. Adaptive Noise Canceler, Recursive Least Squares

T11: Sustainable economy, ocean policy making and education

T11-1: Ecotourism, ecoprojects, marine education

Research on marine information product quality certification and safety assessment technical specification

Tong Gao[1*], Zhi-gang Gao[1]
[1]*National Marine Data and Information Service (NMDIS) , No.93 Liuwei Road, Hedong District, Tianjin, P.R. China, 300171*
**e-mail: nmdis@foxmail.com*

We proposed a specification that fully measures the safety of marine information products based on the latest version of Information Security Evaluation Criteria (CC). As carring out quality certification and safety assessment on marine forecasting products, we use the traceability method to test and evaluate the basic data of the marine environment on which the products are produced. From the perspective of safety attributes, we supplement the safety indicators of marine environmental data and its measurement methods. This specification can be used to improve the quality and safety of products, and to better utilize marine information products.

References

[1] [CC-1] Common Criteria for Information Technology Security Evaluation，Version 3.1, revision 5, April 2017. Part l：Introduction and general model.
[2] [CC-2] Common Criteria for Information Technology Security Evaluation，Version 3.1, revision 5， April 2017. Part 2：Functional security components.
[3] [CC-3] Common Criteria for Information Technology Security Evaluation，Version 3.1, revision 3. April 2017. Part 3：Assurance security components.
[4] [CEM]Common Methodology for Information Technology Security Evaluation，Version 3.1，revision 3，July 2009.
[5] Pfleeger C P, Pfleeger S L. Security in Computing. 3rd Editon. NJ: Prentice Hall, 2003

Acknowledgements
During the preparation of this technical specification, we received careful guidance and assistance from experts such as Zhang Jian, Wei Liru, Bu Ning and Shen Yongbo from China Network Security Review Technology and Certification Center.

Key words
CC; marine information products; safety indicators; measurement methods

Education as a basis of national security

T. S. Komashinskaia
FEFU, School of Education, 35, Nekrasova Str., Ussuriysk, Primorsky Krai, Russia,692508
**e-mail:komashinskaia.ts@dvfu.ru*

The modern world is a world of rapidly changing technologies, the world of the Internet and material values. Does the modern world need such concepts as spirituality, morality, mercy, love? The material basis, not supported by spiritual and moral guidelines, leads to sad consequences. The world cannot exist without spirituality, but where it will come from. Formation and strengthening of spiritual values can be obtained only in the process of education [1].

The development of a modern information society in our country relies on spiritual and moral education. The process of education is governed by Decree of the Government of the Russian Federation of May 29, 2015 N 996-p "Strategy for the development of education in the Russian Federation for the period up to 2025" [2]. According to the strategy for the development of education, the priority task of the Russian Federation is the development of a "highly moral person who shares Russian traditional spiritual values". Upbringing is considered as a "strategic national priority", forming "a high level of spiritual and moral development".

Parenting strategy assumes that spiritual and moral development is carried out by: development of moral feelings (that is, honor, duty, justice, etc.); forming a conscious choice of good; development of empathy, positive attitude towards people; expanding cooperation between the state and traditional religious communities; formation of positive life orientations.

As mechanisms for the implementation of the parenting strategy, special attention is paid to the teaching staff. The document notes the need to increase the prestige of professions related to the upbringing of children (ie, teacher, educator and trainer), as well as creating an atmosphere of respect for their work. It is proposed to develop a series of measures for the social support of educators. Another important document reflecting the national priorities of Russia is the Decree of the President of the Russian Federation dated December 31, 2015 No. 683 "On the National Security Strategy of the Russian Federation" [3].

In general, the problem of education is recognized as nationally significant. The state reserves the right to form, direct and control the process of spiritual and moral development of Russian society. The government proposes to unite the efforts of the education system, the cultural sphere, religious organizations, and the public in solving the problem of spiritual and moral education, the formation and strengthening of traditional values as the elimination of threats to national security.

References

1) Komashinskaia T.S. About the Role of Traditional Values in the Formation of the Information Society. *World of Science. Pedagogy and psychology*, 2018, 2(6). [Online] Available at: https://mir-nauki.com/PDF/81PDMN218.pdf
2) Russian newspaper. Order of the Government of the Russian Federation of May 29, 2015 N 996-p. Moscow "Strategy for the development of education in the Russian Federation for the period up to 2025" [Electronic resource]. - Access mode: https://rg.ru/2015/06/08/vospitanie-dok.html (Access date: 20.04.2019).
3) The official Internet representation of the President of Russia on the Internet. Presidential Decree of December 31, 2015 No. 683 "On the National Security Strategy of the Russian Federation" [Electronic resource]. - Access mode: http://kremlin.ru/acts/bank/40391. (Access date: 04/20/2019).

Key words
Education, upbringing, national security

Seabird monitoring in a frame of shelf projects: theory and actuality

Yu. Krasnov*, A. Shavykin
Murmansk Marine Biological Institute KSC RAS, 17, Vladimirskaya St., Murmansk, Russia,
** e-mail: kharlov51@mail.ru*

Historically, for many decades region studies of seabirds in Russia have been carried out exclusively on land in breeding areas. Until the early 1990s researches in the open sea areas were extremely rare, sometimes accompanying the maim study and carried out by enthusiasts. Active ornithological research in the open and coastal waters[1,2] of the Barents, White and Kara Seas in 1990-2000 resulted in a large amount of relevant information was obtained. The most effective censuring methods of common species were developed, species diversity and relative quantitative indicators were determined, abundance calculating methods, based on aerial surveys[2,3] were developed. Nevertheless, when assessing the impact of planning shelf projects on marine avifauna, such information considers to a small extent or ignore at all. In order to reduce financial expenditure of projects ecological support, avifauna studies during environmental engineering survey (EES) are conducted in minimal amounts. Required parameters for collecting ornithological information are not considered when planning the environmental monitoring of the project impact area. At the same time the research efforts of bird surveys during EES and EIA is not defined in normative documents of the Russian Federation legislation.

To estimate the seasonal distribution of seabirds and their migration routes a complex approach is needed. This approach is based on a) regular aerial surveys as the main tool for open sea areas[1,2], b) regular coastal and ship's observations in coastal and offshore areas, complemented by helicopter observations[4,5]. This should be implemented both during state environmental monitoring or EES of marine projects. A careful systematic analysis of information about the avifauna vulnerability to oil and other anthropogenic influences already published in various sources is required[6]. The other urgent task is to create a unified bank of ornithological data for each particular sea. The legislative instruments are necessary to be adopted for the mandatory including of birds oil and other anthropogenic impacts vulnerability maps into the EIA of offshore projects and in plans of the OSR. As a result, actual monitoring of avifauna, control of the state of seabird populations and their relationships with marine ecosystems will be realize.

References

[1]Krasnov Yu.V., Chernook V.I., Gavrilo M.V. et al., *Zool. zh.*, 2004, 83, 330-341. (in Russian)
[2]Krasnov Yu.V., Goryaev Yu.I., Shavykin A.A. et al., *Atlas of the Pechora Sea Birds: Distribution, Abundance, Dynamics, Problems of Protection*, Apatity, 2002, 164 p. (in Russian)
[3]Sahavykin A.A., Krasnov Yu.V., *Birds of Northern and Southern Russian Seas: Fauna, Ecology*, Apatity, 2013, 178-209 (in Russian)
[2]Krasnov Yu.V., Gavrilo M.V., Shavykin A.A., *Zool. zh.*, 2015, 94, 62-67. (in Russian)
[5]Aarvak T., Øien I.J., Krasnov Y.V. et al., *Bird Conservation International*, 2012, 23, 377–343. Doi: http://dx.doi.org/10.1017/S0959270912000251
[6]*Kola Bay and Oil: Biota, Vulnerability Maps, Pollution*, SPb., 2018, 159–184, 292–317. (in Russian) Doi: http://doi.org/10.325590/renomespb.w0pj-zq52

Acknowledgements
This work was supported by the Ministry of Education and Science of the Russian Federation, State Order 0228-2019-0028, 0228-2019-0029

Keywords
Marine birds monitoring, shelf projects, aerial accounting

Featues of the competence approach in the training of seafarers, development of the autonomous navigation

M. Moskaleko*, I. Druz**
*Maritime state university named admiral G. I. Nevelskoy. 50a, Verkhneportovaya Str., Vladivostok, Russia, 690059, *e-mail: asmsh@rambler.ru, ** e-mail: druz_i_b@mail.ru*

The problematic aspects of improving the quality of Maritime education with the development of the market of semi-Autonomous and Autonomous vessels, taking into account the competence approach and the Convention requirements of the Maritime industry.

Material and methods. From 75 % to 95 % of accidents in the Navy occur as a result of human error, fatigue or incompetence. According to forecasts, by 2025 the Maritime industry will face a deficit of 147,000 officers. Therefore, very tempting are the prospects to resolve the impending crisis by reducing the crew by increasing the degree of automation or the creation of Autonomous (semi-Autonomous) vessels. Our statistical research of the shipping market, confirmed by the fact that the Navy required competencies for professionals in the composition of the crews of modern ships, you begin to significantly outpace the classical Convention the standards of training of seafarers. RESULTS: the Topic of the creation of unmanned vessels of the "MASS" type was supported by the Maritime safety Committee of the International Maritime organization IMO, at the 99th session in may 2018. For the introduction of new types of vessels into operation, it was proposed to all interested Maritime Administrations to develop interior guidelines. The main problem for the introduction of this type of vessel in the Maritime market arises in connection with the International Convention On training of seafarers and Watchkeeping STCW78. The text of the Convention does not clearly define the concept of "seafarer". Nevertheless, the Convention defines, from the standpoint of the "Manila amendments", the standards of minimum competence to be enjoyed by members of the crews of ships and which are checked by the Maritime qualification Commission. Since, in preparation for the program of specialization in higher education institutions are given competence "in the future" training command positions in the crew of the ship, we formalized these processes and proposed adequate mathematical models training of seafarers, taking into account the growing needs of the market. The system of competence acquisition is based on the scheme: "student-teacher" in the coordinates of "learned-transferred" competence, identified critical levels of training and formulated requirements for initial training of students in the form of control parameters. It has been found that the remotely operated vessel does not have a crew, as coastal personnel are not subject to the STCW78 Convention.

Summary.

1. The transition of higher education institutions to the competence model of training does not change the goals and objectives in the field of Maritime education and training of seafarers, taking into account the Convention requirements defined in the STCW78. 2. The creative potential of the teacher in the competence approach in Maritime education is severely limited, as the competence involves almost unambiguous conventional interpretation of the minimum necessary knowledge and skills transferred to the student.

3. The introduction of "MASS" type vessels into the market of sea transportation will require the development of new standards of competence for all participants in the logistics processes of cargo delivery by sea, including for specialists in the field of Maritime education, which will certainly require a significant addition and revision of the STCW78 Convention.At the same time, in our opinion, it is necessary to introduce into the Convention the position of "remote access captain" and competence to the minimum required list of positions required as part of the "remote access crew".

Keywords: Competence, maritime education, convention requirements, unmanned vessel.

Study on surge control function of the artificial fishing reef ' in the irregular waves

Akito Nakamura[1*], Takafumi Yamamoto[2], Tomoki Ikoma[3], Koichi Masuda[3], Tsuneo Honjo[4], Yoshihiro Suenaga[5]

[1]*Graduate School, Faculty of Engineering, Kagawa University*
2217-20 Hayashi, Takamatsu, Kagawa, Japan
[*]*nakamura@mikuniya.co.jp*
[2]*Kaizansenri, Co, LTD.*
[3]*College of Science and Technology, Nihon University*
[4]*Seouchi-ken Research Center, Kagawa University*
[5]*Faculty of Engineering and Design, Kagawa University*

As one of the Japanese politic measures for fisheries infrastructure development projects, fishing ground creation by the installation of the artificial reefs is carried out for a long time, and appears in some marine areas where resources production capacity shows a sign of the restoration[1)].

However, in the recent fisheries infrastructure development projects, fisheries ground creation, fishing port construction and any kinds of disaster prevention projects in the shore area become large, and the quantitative evaluation is the poor conditions about the disaster prevention function using artificial reef has in particular[2)].

The authors developed new type of artificial reef to perform the biological effect investigation (fish aggregation, adhesion of prey abundances and algae) and paid their attention to the surge control function of the artificial reef into after setting. Although it was grasped partially by the past experiment, the surge control function of the artificial reef is not established to quantitative evaluation and the utilization as a disaster prevention facilities.

In this study, we have inspected wave energy absorbing function of the artificial reef in the irregular waves by the hydraulic water tank experiment and examined to develop a newly disaster prevention technology like a submerged breakwater. As a result, we have confirmed that wave energy absorption efficiency improved by extending an artificial reef by twofold or more. Also, we pointed out it is effective the other artificial reef is arranged in a vortex flow area caused on the downstream side of the artificial reef arranged on the upstream side.

References

[1]Ministry of Agriculture, Forestry and Fisheries. (2016). Grant for support of agricultural mountain fishing village activation project, Retrieved February 21, 2019, from http://www.maff.go.jp/j/kasseika/k_project/

[2]Yoshihiro SUENAGA (2016). Development of Artificial Reef with Current Control Function to Improve Marine Environment, Kyusyu Environmental Evaluation Association, Journal of Environmental Evaluation, vol.45, pp.29-38.

Acknowledgements

We would like to express sincere thanks to Mr. K. Takasago (President of Takasago Fishery Co, LTD.), Mr. K. Sogo, (President of SUNX Co. LTD) and Mr. N. Yamaji, (Nihon Kogyo, Co, LTD.) for their valuable comments and suggestions. A part of this work was supported by Grant in aid of the Kagawa University.

Key words

Artificial reef, Surge Control, Wave Energy Absorbing Function

Increasing abundance of Jellyfish in the shorelines of Bangladesh: Analyzing the policy framework for facing the challenges

Md. Mizanur Rahman[1]*, M. Aslam Alam[1], Muhammad Abu Yusuf[1]
[1]*Bangladesh Public Administration Training Centre, Savar, Dhaka*
**email: mizan_peroj@yahoo.com*

The abundance of Jellyfish across the coasts of the Bay of Bengal is increasing sharply due to marine pollution, increased sea acidification and climate change. Jellyfish draws our attention to address the local and global stressors. This also indicates that something wrong is happening in this Bay behind the scenes. This study aimed to investigate how the policy framework governing the sea can be reformed. To do so, this study evaluated the existing policy, regulatory and institutional framework. Empirical data was collected from the middle coastal zone of Bangladesh. The secondary literature on policy, legal documents and institutional arrangements were reviewed. The causes of poor coordination among different public sectors and non-compliance of laws were identified. The key findings show that despite the existing of Department of Environment, poor coordination with other departments, and lack of logistics and technical staffs has resulted in severe marine pollution and degradation of coastal and marine living resources. The existing policies had no monitoring and evaluation mechanisms. Non-compliance of the existing laws has been fueling the problems. This study provides an integrated policy and a guideline for updating the legal and institutional mechanism to manage coastal and marine living resources sustainably in Bangladesh to achieve Sustainable Development Goal 14.

Keywords:
Legal, institutional, framework

Method of vulnerability mapping of sea-coastal zones to based on metric values

A. Shavykin*, A. Karnatov*
Murmansk Marine Biological Institute KSC RAS, 17, Vladimirskaya Str., Murmansk, Russia
** e-mail: shavykin@mmbi.info; karnatov@mmbi.info*

For reducing the environmental impact of oil spills the effective actions of OSR are important, which are impossible without vulnerability maps. A method has been developed for constructing such maps, based on the use of metric values[1,2], although in many countries maps are calculated using ranks[3] (ordinal values). The proposed method takes into account important biotic components (ICB), especially significant social-economic objects (ESO), protected areas (PA). Seasonal maps of density (for ICB) and location (for ESO and PA) are constructed. Vulnerability coefficients of biota (V_b^g) are calculated based on its sensitivity (S^g), the potential impact of oil (E^g) on biota and its recoverability after exposure (R^g): $V_b^g = (E^g \times R^g)/S^g$. Sensitivity is estimated differently for biota in the water column (fish, ichthyoplankton, ...) and for biota that is most of the time contacts with water surface (birds, marine mammals). Sensitivity for water column organisms is calculated based on the ratio of LC_{50} (or LL_{50}) to MPC (maximum permissible concentration of oil in water): $S^g = LC_{50}/MPC$; for biota which in contact with water surface, as the ratio of oil film thickness, resulting in a 50 % loss of biota (LT_{50}), to MPT (maximum permissible thickness that does not affect the biota): $S^g = LT_{50}/MPT$. Priority protection coefficients of ESO (V_c^e) and PA (V_d^f) are estimated expertly on a metric scale.

Seasonal biota vulnerability maps are constructed as the "sum" of seasonal ICB distribution maps multiplied by coefficients V_b^g. Similarly, priority protection maps of ESO and PA are calculated. To sum up VCB distribution maps, presented in different units (sp./km^2, kg/m^2, ...), each considered biota component is preliminarily normalized to the average annual abundance (quantity or biomass) of corresponding group in the area[1,2]. Then the normalization of constructed seasonal maps of ICB, ESO and PA is carried out. Maps of integral vulnerability are constructed for each season by "summing up" ICB vulnerability maps and priority protection maps of ESO and PA, taking into account the accepted contribution of each of these 3 components to the overall vulnerability. The interval of integral vulnerability is classified into 3–5 sub-ranges. Depending on the normalization (on the maximum value of vulnerability per season or per year) the seasonal maps of relative (where the min–max range of vulnerability for each season is different) and absolute (where min–max in each season is part of the annual interval) integral vulnerability of the area are obtained. Examples of the maps are presented in the work[2].

References

[1]A. Shavykin, G. Matishov, A. Karnatov, *Dokl. Earth Sc.*, 2017, **475**, 907–910. Doi: http://doi.org/10.1134/S1028334X17080062
[2]*Kola bay and Oil: Biota, Vulnerability Maps, Pollution*. 2018, 520 p. (in Russian). Doi:http://doi.org/10.25990/renomespb.w0pj-zq52
[3]A. Shavykin, A. Karnatov, *J. of Mar. Sci. Eng.*, 2018, **6**, 115. Doi:http://doi.org/10.3390/jmse6040115

Acknowledgements
This work was supported by Ministry of Education and Science RF, State Order № 0228-2019-0029

Key words
Vulnerability maps, oil spill response, ordinal values

Foundation of the Cosmic-Ecosystem Based Management: outlining a direction for the future

A.V. Sereda

[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041*
**e-mail: amrtatjuti@poi.dvo.ru*

Further developing the foundation of new comprehensive scientific and geopolitical approach to the environmental management is presented here. This is a question of becoming of the Cosmic-Ecosystem Based Management as global mechanism of the sustainable development of civilization based on unbiased understanding of the Universe Cosmic – Solar – Planetary machine that defines the framework for the evolution of human existence (Sereda, 2018). The Cosmic-Ecosystem Based Management has significant advantage over its counterpart the Ecosystem Based Management of considering, among other things, the factors originating in Space and Solar System and their impact on the Earth's ecosystems. It is therefore submitted that an appropriate definition for the Cosmic-Ecosystem Based Management is the universal integrated approach to the environmental governance that combines cosmic, geographic, ecological, social, economic and geopolitical perspectives and recognizes the fundamental dependence of the humankind existence on the cosmic-ecosystem sustainability adhering to the basic principle of peacekeeping. The main outputs of this approach result from following statements. First, the understanding of the correlation of the cosmic and Sun-Planet (Earth) connection contains the vital scientific potential for predicting of Earth's environment changing. Initial task is determination of the planet location at a certain point in time within the Universe Cosmic – Solar – Planetary machine that can be presented like perpetual motion geometric construction based on astronomical data (available for many years to come) and scientific knowledge of the World in the field of the cosmology, including the mechanics of Sir. Isaak Newton and the theory of relativity of Sir. Albert Einstein. Second, "mass" and "energy" shifts in this system can lead to perturbations on the Earth (climate change, seismic activity, etc.). In such periods the anthropogenic impact on the ecosystems should be extremely cautious and reasonable, and exclude powerful effects on the lithosphere in order not to interfere the Earth stabilizing processes. Third, this approach is actual philosophic and political paradigm, which duly corresponds to the unity of global biosphere, including its land, atmosphere and ocean for providing the direction to a safer world in the modern changing environmental and geopolitical conditions. The ocean ecosystem contributes the major part to the sustainability of the planet biosphere (at least 21 trillion dollars annually). The application of the Cosmic-Ecosystem Based Management to the ocean governance diplomacy holds great promise for managing marine ecosystems with the tide of the global strategy of the sustainable development according to the UN 2030 Agenda.

References

A. Sereda. Extension of the ecosystem based management scale in the face of climate change: Cosmic perspective and need to respect the basic principle of peacekeeping / *The Effects of Climate Change on the World's Oceans. Book of Abstracts*, 4th International Symposium, June 4-8, 2018, Washington, D.C., USA, p. 176.

Acknowledgements

I sincerely thank my dear teachers from different fields of science who made the development of this multidisciplinary research possible.

Key words

Cosmic-Ecosystem Based Management; sustainable development management; marine ecosystems; the well-being of humankind

Development of marine ecotourism in Chumphon Province, Thailand, for sustainable uses of coral reef and underwater pinnacle ecosystems

M. Sutthacheep*, T. Yeemin, W. Suebpala, L. Jungrak, W. Aunkhongthong, S. Rongprakhon
Marine Biodiversity Research Group, Faculty of Science, Ramkhmahaeng University, Huamark, Bangkok, Thailand
**e-mail: smakamas@hotmail.com*

Diving tourism provides the great benefits to local and national economy as well as supports local employment and livelihoods. The growth of marine and coastal tourism, particularly diving activities is an important aspect for the blue economy of tropical countries worldwide. The degradation of coral reefs has been documented because of natural and human impacts, particularly coral bleaching, coastal development and tourism impacts. The mass tourism caused negative impacts and delayed natural recovery process of degraded coral reefs. In this study, we applied a transdisciplinary approach to develop marine ecotourism in Chumphon Province, located in the Western Gulf of Thailand, to support coral reef conservation. The ecological, socio-economic, and tourism surveys were conducted to gather relevant information i.e. ecological data, socio-economic, and tourism development. The results revealed some possibilities that some coral communities and underwater pinnacles in Chumphon Province can be developed and promoted as alternative ecotourism sites to attract tourists from the main dive sites at Ko Samui, Ko Tao, Ko Phangan, Mu Ko Ang Thong in Surat Thani Province, Pattaya in Chonburi Province and Phuket. Since the popularity of marine tourism in Chumphon Province is relatively low, tourism promotion and marketing as well as tourism infrastructure development should be heavily emphasized. Also, we suggest that ecotourism concept with local participation should be applied to ensure the sustainability of ecological integrity and social-economic viability. This study provides an integrated baseline information to support sustainable ecotourism management along with coral reef conservation in Thailand which can be applied at other reef sites in the Pacific region.

Acknowledgements
We would like to thank staffs of the Department of National Parks, Wildlife and Plant Conservation and Marine Biodiversity Research Group, Faculty of Science, Ramkhamhaeng University for their field work assistance. This study was funded by a budget for research promotion from the Thai Government awarded to Ramkhamhaeng University and a research grant from the Thailand Research Funds (TRF).

Key words
Coral reef, ecotourism, Gulf of Thailand

T11-2: Marine policy and integrated ocean management

Analysis of the cruise traffic determinants in Primorsky Krai

Elena Galenko[1], Natalia Ovcharenko[2], Iuliia Orlovskaia[3]
[1*] E.V. Galenko, [2]N.P. Ovcharenko, [3]Iu.V. Orlovskaia, Far Eastern Federal University, School of Economic and Management, FEFU Campus, 10 Ajax Bay, Russky Island, Vladivostok, Russia 690922
*e-mail: galenko_tgey@mail.ru

Every year the cruise industry accelerates its growth path, gaining the consumers interest and positively affecting the world economy. In 2017, the number of passengers traveling on cruise ships increased by 5% compared to 2016, which amounted to 25.8 million people (Pakbeen H., 2018), in 2018 and 2019, the dynamics of tourist demand on cruise continues to grow. Russia is not a leader in the development of cruise travel, mainly operated ports were in St. Petersburg and Sochi. Presently, the Vladivostok city has become available for tourists, where you can go on board and take a cruise ship trip. The dynamics of the cruise traffic development on the territory of Primorye is reflected in the cruise passenger traffic of 2018, which amounted to 13,487 tourists compared to 12,455 in 2017 due to an increase in the average tonnage and passenger capacity of liners entering to the port Vladivostok. However, the growing of the cruise flow cannot be considered without taking into account the interests of consumers wishing to visit the far Eastern port and the factors that affect cruise development in the region. The research of scientific literature has shown that in order to attract more cruise liners to the region, it is necessary to take into account the determinants that can affect cruise traffic (J. I.,Castillo-Manzano, 2014; C., Weeden, 2011; P., Wild, 2000). On the basis of statistical and analytical methods, questionnaires and interviews, the following determinants were analyzed: the tourist potential of the region, the number of hotel enterprises, traditions and culture of the local population, transport development (airport, railway, ferries, buses), features of the seaport, a portrait of cruise liners guests. As a result, the hypothesis of the tourist attractiveness of the region as a significant factor able to influence cruise traffic was confirmed. The discussion of the obtained indicators allowed to focus on the proposals for the development strategy of cruise tourism.

References

Pakbeen H. Comparative Study of Leading Cruise Lines'Sustainability Practices and Environmental Stewardship in Contribution to SDGs' Sea and Water Conservation Goal, European Journal of Sustainable Development ,.2018, 7(3), pp 507–516

Russian tourists will open the sea route to Asia from Vladivostok. [Electronic resource]: www.tourdom.ru/hotline/marshruty-i-kurorty/rossiyskie-turisty-otkroyut-morskoy-put-vladivostoka/

Report on the implementation of the state program of Primorsky Krai "Development of tourism in the Primorsky Krai" for 2013-2021 "for 2018. [Electronic resource]: https://www.primorsky.ru/

Castillo-Manzano, J. I., Fageda, X., Gonzalez-Laxe, F. An analysis of the determinants of cruise traffic: An empirical application to the Spanish port system. Transportation Research Part E . 2014, 66, pp. 115–125; Weeden, C., Lester, J.A., Thyne, M., Cruise tourism: emerging issues and implications for a maturing industry. J. Hospitality Tourism Manage. 2011. 18, 26–29; Wild, P., Dearing, J., Development of and prospects for cruising in Europe. Marit. Policy Manage. 2000. 27 (4), 315–333.

Acknowledgements We would like to thank the administration of the region for providing data on cruise development and four interviewees for their useful comments.

Key words
Nautical tourism, cruise ship, tourists

Japan's Ocean Policy: New Approach to the Development of Marine Resources

E. A. Goriacheva *
E. A. Goriacheva, Institute of History, Archeology and Ethnography of the Peoples of the Far East FEB RAS, 89 Pushkinskaya Str., Russia 690001
**e-mail: goryacheva@ihaefe.ru*

The latest maritime strategy of Japan – The Basic Plan on Ocean Policy – was third in the row of similar strategies, approved by Cabinet of Ministers of Japan and covering five years' period, since 2018 to 2023. Its analysis shows changing trends in shifting perception of Japan's role in the Asia-Pacific Region and its views on maritime security and development of ocean resources since 2007.

The comparative and content analysis of three Basic Plans on Ocean Policy of Japan showed that similar to its previous strategies, this maritime strategy includes two categories of priorities: national security and economic priorities of Japan. Realization of the goals and objectives, including that of Arctic policy of Japan, especially in the sphere of development of marine resources, is viewed as a means for making Japan more powerful oceanic state.

Compared to the priorities of Japan's first and second maritime strategy, which included mainly the development of natural seabed resources and other economically oriented aspects, the new strategy focuses more on national security issues: ensuring the security of the country's territory and defending remote island territories. Also, the new strategy sees the development of the DPRK's nuclear missile program and China's sea expansion in the APR as external threats. However, plans for the development of the North Pacific region marine resources still occupy a significant place in the latest Basic Plan on Ocean Policy.

Japan has recently been increasingly positioning itself as 'a new maritime nation', trying not only to maintain its leading position in the development of resources in the nearby water area, but also as a state striving to become one of the states involved in the future development of resources in North Pacific region and the Arctic region. The Japanese government recognizes the lag in this area from its strategic competitor - China, and measures are being taken to eliminate this gap. As for forecasts of Japan's future strategy trends, we can assume that along with the increase in allocations for the development of hard-to-recover resources, investments in infrastructure creation aimed at developing the Arctic, bottom mineral deposits in the exclusive economic zone of Japan, as well as the development of science that allows mining, especially rare earth metals, at depths of over 2,000 will be constantly growing. This may result in reducing Japan's resource dependence on the neighboring countries of Northeast Asia, including China and Russia.

References

Ocean policy of Japan. Cabinet Office. URL: https://www8.cao.go.jp/ocean/english/index_e.html

Acknowledgements

This work was supported by grant "Ocean policy and maritime activities in North Pacific Region in the first quarter of XXI century: challenges and opportunities for Russia" (realization of fundamental research program of the Presidium of Russian Academy of Sciences "Analysis and forecast of new global challenges and opportunities for Russia")

Key words:

Japan, ocean policy, ocean resource development strategy

Restoration of the sea area

Pei Zhaobin[1] Cao Jing[1]
[1]Dalian Ocean University, No. 52 Heishijiao Street, Shahekou District, Dalian City, Liaoning Province,116023
*e-mail: pzb@dlou.edu.cn; 279674573@qq.com

With the rapid development of China's economy, people's craving for land is getting higher and higher, and the use of land resources is close to saturation, so people are turning their attention to the ocean, which has led to the intensification of illegal occupation of sea areas. The illegal occupation of sea areas such as reclamation and reclamation has become an important way for many countries to develop marine economy and develop marine resources. The Law of the People's Republic of China on the Use of Sea Areas provides for penalties for illegal occupation of sea areas, and aims to restore the original use of sea areas in order to protect the healthy development of China's sea areas. This paper mainly identifies the administrative status of the restored sea area as an administrative punishment, and analyzes the problems existing in the implementation status of the original use of the sea area in China. Finally, based on such problems, it proposes countermeasures for recovery. The actual use of the original state of the sea area to make a practical contribution to the healthy development of the sea environment in China.

New Requirements for Legal Guarantee of Marine Eco-environment in Liaoning Province

Pei Zhaobin, Lu Zhengfeng, Zhai Shuying, Yang Siting
(Dalian 116023, Dalian Ocean University)

Protecting the marine ecological environment is an important part of Liaoning's economic thinking of “turning to the sea”. The development of Liaoning's economy is inseparable from marine resources, but there are a series of problems in the legal protection of marine ecological environment. Therefore, how to further protect the marine ecological environment and ensure the sustainable development of Liaoning's economy depends on making up for legal vacancies, improving the corresponding implementation rules, forming a unified law enforcement system, intensifying law enforcement, optimizing the supervision mechanism, and raising citizens' awareness of the rule of law in marine environmental protection， in order to promote the rapid development of marine economy in Liaoning Province.

Keywords:
Turning to the sea, marine ecological environment, legal protection

Study on the Construction of Northeast Asia Maritime Silk Road Economic Belt

Peng Xumei
(Dalian 116023, Dalian Ocean University)

Abstract: The Northeast Asia Maritime Silk Road, as an important part of the "21st century maritime silk road", has a long history and good prospects for development. Strengthening the regional economic construction of the Maritime Silk Road in Northeast Asia is of great significance for driving regional economic cooperation, maintaining regional stability and further building an all-around opening pattern. Northeast Asia Maritime Silk Road economic belt construction is a systematic project. On the basis of elaborating the historical background and current situation of the Maritime Silk Road in Northeast Asia, this paper analyzes the existing problems and reason in cooperation of regional economic development and puts forward some countermeasures, such as propelling the policy communication, promoting the construction of energy community, carrying out the economic exchanges, improving the trade structure, strengthening the monetary cooperation, promoting the development of free trade zone, so as to promote economic growth and sustainable development in all countries along the Belt and Road.

Author's contact information:
Peng Xumei (1979-), female, director of Center for Teaching Development and a professor of Law School of Dalian Ocean University, Research direction: economic and management; Contact: 13516053749; Email: pengxumei@dlou.edu.cn

Keywords:
Northeast Asia, Maritime Silk Road, the Belt and Road, economic belt, sustainable economy

Trends of Modern Geostrategic Dynamics: Maritime Regions

Sergei K. Pestsov *

Sergei K. Pestsov, Institute of History, Archeology and Ethnography of the Peoples of the Far East FEB RAS, 89 Pushkinskaya St. 89, Vladivostok, Russia. 69000
** e-mail: skpfox@yandex.ru*

Regionalism, along with globalization, is, in general opinion, one of the two defining trends of the modern world. Regions, not being natural geographic formations or determined solely by a common culture, are social constructs. They are created by states and other actors pursuing specific interests in the process of cooperation interactions and competitive rivalry. The combination of these processes, ultimately, largely determines the content and guidelines of the general geostrategic dynamics of the modern world.

One of the growing trends in this dynamic is manifested in the growing academic and practical interest in the maritime regions, the active efforts of a growing number of states to increase the maritime power and influence within the maritime spaces.

Based on the analysis of academic discussions and practical efforts related to the maritime dimension of the foreign policy strategies of various countries of the modern world - from the USA, EU countries and Australia to Russia, China, India and Brazil - allows us to draw several basic conclusions. Firstly, a number of circumstances underlie the growing attention to maritime regions. These, on the one hand, are climate change, "opening up" new marine spaces for economic activity; growing importance in the context of the internationalization of maritime communications; technological progress that facilitates access to the widespread use of marine wealth, and, at the same time, increases the importance of the seas and oceans in terms of safety. Secondly, all of this in combination suggests that interest and attention to maritime regions are not opportunistic (situational), but reflect a serious shift that has begun to emerge at the turn of the century in global geostrategic dynamics. Thirdly, this shift is caused, among other things, by the changing meaning of the seas and oceans, which are transformed from "empty" spaces or roads connecting societies on their outskirts to zones of closer contacts and collective interactions.

All these and other circumstances actualize not only the need for coordinated competitive strategies for the maritime activities of different countries, both in the already established maritime regional spaces and in the maritime regions that are being born before our eyes or in the projected regions. It should be recognized that for the time being, the current policies of m

Maritime Economy in Russia's Pacific Maritime Policy

A.B. Volynchuk[1*]
A.B. Volynchuk, Institute of History, Archeology and Ethnography of the Peoples of the Far East FEB RAS, 89 Pushkinskaya Str., Russia 690001
**e-mail: i-abv@yandex.ru*

One of the modern world economic trends is increased attention to the development of marine resources. More and more countries see in the «marine economy» new sources of their socio-economic growth. Russia is a continental power. However, according to the results of its historical development, it managed to provide access to the World Ocean, which allows it to form a national policy in the field of maritime activities. For Russia, the basic document that determines the priorities of the national marine policy is the «Maritime Doctrine of the Russian Federation» of 2015. In the ranking of its priorities, the Pacific region occupies the third place, behind the importance of the Atlantic and Arctic directions. At the same time, the value of the Pacific direction for the Russian Federation is gradually increasing. This is due to the intensive development of the states of the Asia-Pacific region.

Types of activity that can be attributed to the «marine economy» in Russia are engaged in various departments. However, this term is not found in any official document of the federal government or branch ministries regulating maritime activities in Russia. Nevertheless, the Russian Maritime Doctrine determines the development priorities of the Russian Far East in the economic sphere: maritime transport and engineering and technical support for shipping; shipbuilding and ship repair; port facilities; exploration and production of energy resources on the shelf; fishing and fish processing; extraction and processing of seafood; marine ecology, biodiversity conservation; marine biopharmaceuticals; recreation and marine and coastal tourism. However, in practice, the focus is on traditional industries: the transport of goods and passengers, the extraction of fish and seafood, shipbuilding and ship repair. These traditional industries have good prospects, but their development has a number of problems: the poor state of the ports and the logistics infrastructure; aging of a significant part of the composition of the courts; The Far East does not have sufficient fish processing capacity. According to statistics, about 80-90% of all fish harvested in the region are exported to Asian countries.

Thus, firstly, in the marine policy of Russia there is no definition of the term «maritime economy», and, accordingly, there is no concept of the formation of the maritime economy among the «maritime» subjects of the Russian Federation. Secondly, the current structure of maritime activities is focused on the development of traditional economic activities - maritime transport, shipbuilding, and fisheries. The share of promising areas - coastal tourism, biopharmaceutics, etc. - in the social product is extremely low. Third, individual branches of the maritime economic activity do not form a single economic complex. Fourthly, the subjects do not keep statistics reflecting the results of marine activities. As a result, it is impossible to determine the interrelation of regional maritime industries and their contribution to the socio-economic development of the territory.

Acknowledgements
This work was supported by grant «Ocean policy and maritime activities in North Pacific Region in the first quarter of XXI: challenges and opportunities for Russia» (realization of fundamental research program of the Presidium of Russian Academy of Sciences «Analysis and forecast of new global challenges and opportunities for Russia»).

Key words:
Pacific Russia, maritime economy, national maritime policy.

The cruise tourists impression: the challenges and opportunities of tourism potential of Vladivostok

Natalia Ovcharenko[1], Elena Galenko [2], Iuliia Orlovskaia[3]
[1] N.P. Ovcharenko, [2]E.V. Galenko, [3]Iu.V. Orlovskaia, Far Eastern Federal University, School of Economic and Management, FEFU Campus, 10 Ajax Bay, Russky Island, Vladivostok, Russia 690922*
**e-mail: ovcharenkon@mail.ru*

In the modern world the cruise trip is gaining the position of a promising and rapidly developing type of tourism. The share of cruise tourism in the total volume of tourist services consumed by Russians was 3% in 2016, in 2017 demand increased by 30-50 % compared to last year. Since 2015, began to work on attracting cruise tourists to Primorsky Krai, which is reflected in the indicators of the annual increase in the incoming flow of the cruise segment. However, today it is important not only to maintain competitive advantages, but also to expand the fixed positions of the Far Eastern region. To solve the problems, the goal is to identify the problems and opportunities of Vladivostok's tourist potential, to form the impression of cruise tourists, and to develop a competitive market for nautical tourism in the region. The research of scientific literature has shown that the development of cruise tourism requires a regional tourist infrastructure that meets the guests needs and the integration of service and tourism enterprises aimed at a high level of service for cruise tourists (H. Caric,2014; P. Jones, 2016; T. Basyukov, 2018; S. G. Nezdoyminov,2016). Scientists have proved that cruise tourism is effective for the development of the regional economy, and the guests impression is aimed at strengthening the brand of the territory in the international information space of the cruise market. On the basis of statistical and analytical method, conducting a survey and interviews, were identified: the sights of the Vladivostok city, a portrait of the consumer, the problems hindering the promotion of the sea brand of the city. As a result, is formed the scheme of forming the impression of cruise tourists and competitive cruise product. The received materials were discussed, the emphasis was placed on the development of the market potential of sea cruise tourism of Primorsky Krai, proposals to attract investment in port infrastructure and related sectors of the economy of the territories.

References

Report on the implementation of the state program of Primorsky Krai "Development of tourism in the Primorsky Krai" for 2013-2021 "for 2018. [Electronic resource]: https://www.primorsky.ru/

Russian tourists will open the sea route to Asia from Vladivostok. [Electronic resource]: www.tourdom.ru/hotline/marshruty-i-kurorty/rossiyskie-turisty-otkroyut-morskoy-put-vladivostoka/

Caric H., Mackelworth, P. Cruise tourism environmental impacts e The perspective from the Adriatic Sea. Ocean & Coastal Management, 2014, 102, pp350–363; Jones, P., Hillier, D., and Comfort, D. The Environmental, Social and Economic Impacts of Cruising and Corporate Sustainability Strategies. Athens Journal of Tourism. 2016, 3(4), pp 273–285; Basyukov G. T. Cruise tourism: features and trends in 2018. The era of science. 2018, 14 (6), pp 107–112; Nezdoyminov S.G. The modern potential of regional markets for sea cruises. Economy, business and law. 2016. 6 (2), pp 135–146.

Acknowledgements

We would like to thank the administration of the region for providing data on cruise development and four interviewees for their useful comments.

Key words

Nautical tourism, cruise ship, tourists

Conceptual Frameworks for development of the Integrated Ecosystem-Based Marine Management in the Russian Far East

A.V. Sereda[1*], A.N. Kachur [2], S.I. Maslennikov [3]
[1]*V.I. Il'ichev Pacific Oceanological Institute FEB RAS, 43 Baltiyskaya Str., Vladivostook, Russia, 690041*
[2]*Pacific Geographical Institute FEB RAS, 7 Radio str., Vladivostok, Russia, 690041*
[3]*A.V. Zhirmunsky Institute of Marine Biology, National Scientific Center of Marine Biology FEB RAS, 17 Palchevskogo str., Vladivostok, Russia, 690041*
**e-mail: amrtatjuti@poi.dvo.ru*

The environmental harmonization and ecosystem approach are acquired an increasing importance in the efforts of the Russian Federation to evolve the coastal and oceans national policy towards sustainable development. The giant water areas of the country predetermine the need to implement the integrated ecosystem-based marine management as an integral part of the spatial development of Russia in accordance with the Strategy for Developing the Maritime Activities of the Russian Federation to 2030 and the Maritime Doctrine of the Russian Federation.

To improve decision- making, it is necessary to have a harmonized legislative on the different levels of the cooperation and coordination according to common guiding principles. The guidelines and methodologies for the integrated management of coastal zones have been designed and proposals for augmenting Russian legislation have been made (Ministry of Economic Development of the Russian Federation).

In the present paper, we focus on the features of this process and its global meaning for maintenance of environmental integrity and sustainability in the transboundary regions. This is comprehensive overview of the geo-ecological knowledge and modern ecosystem approach policies that reveals national and international requirements, social-ecological key aspects, strategic environmental risk-assessments and possible mechanisms of interaction between the users of marine space. The considerations are concretized for the implementation of the integrated approach to the coastal marine management in the Russian Far East (Kachur et al., 2019) taking into account the modern socio-economic and global environmental processes including current and potential regional anthropogenic and natural threats. The key here is improving the environmental security and promoting the ecological economics due to coherent acting in a setting mutual respect and unite by a common objective to create reliable foundations for sustainable development in the Asia-Pacific region.

Today the assessment of the state and prospects of development of the coastal marine economy of the Russian Far East has been prepared as well as preliminary geographical zoning of coastal areas considering the actual and permissible levels of the impact of human activities on the environment, ecological and geographical nature use restrictions (FEB RAS). An ecosystem-wide assessment methodology is therefore provided. As a consequence, holistic issues of environmental sustainability and geographic potential map the conceptual framework for development of the national integrated ecosystem-based marine management. This also represents a vital step towards building a safer world and better environmental protection.

References
A.N. Kachur, Yu.G. Mikhaylichenko, S.I. Maslennikov, A.V. Sereda. Experience and prospects for the Integrated Ecosystem-Based Marine Management for the Russian Far East // *Vestnik FEB RAS*, 2019, vol.1, page 75-89.

Acknowledgements
We sincerely thank Dr. Mikhaylichenko and our colleagues from the Far Eastern Branch of the Russian Academy of Sciences and Scientific and Research Institute of Maritime Spatial Planning “Ermak NorthWest” for putting together knowledge and strategies for development of the Integrated Ecosystem-Based Marine Management in Russian areas**.**

Key words
Sustainable development; Integrated Ecosystem-Based Marine Management; the Russian Far East

Research on the Marketization Allocation of China's Sea Area Utilization Right and Policy Proposals

Yang Lijing[1, 2,*] Bai Xuhui[1, †] Shi Ping[1,*]

1. South China Sea Institute of Planning and Environmental Research, SOA, Guangzhou 510300,
2. College of Oceanic and Atmospheric Sciences, Ocean University of China, Qingdao 266100
[†]These authors contributed equally to this work.
[*]Authors to whom correspondence should be addressed; E-Mails:yang-lijing1@163.com(L.Y.); 150058619@qq.com(P.S.)

China' economic development has entered a new era. Under this circumstance, the ocean economy development urgently asks for the establishment of a modern market system in China to play the market's decisive role in resource allocation, and combine the market's function with the government's; and the establishment of an ocean property mechanism with clear right & obligation and smooth operation, to promote the free flow of ocean economic factors. In the process of China' sea area utilization right's marketization allocation, the decisive role of the market has been still not fully realized, the evaluation system of sea area utilization right's value not perfected, the levying standard of sea area utilization charges too low, the market development too slow, and the sea area utilization right's exchange platform not set up yet, the effective and unified sea area market supervision and governance still lacked. To comprehensively deepen ocean economic system reform, promote the development of sea area utilization right's marketization allocation, straighten out the relation between market and government, and take advantage of China' socialist market economic system, it should perfect the marketization supply and allocation mechanism, strengthen the evaluation system of sea area utilization right's value, set up sea area utilization charges' dynamic adjustment mechanism, establish sea area utilization right's exchange service platform, and enhance the unified sea area market supervision and governance.

Key word:
Sea Area Utilization Right; Marketization; Resource Allocation; Sea Area Utilization Charges

Legal problems of coastal tourism development

M.G. Zhukovina[1*], P.F. Brovko[1]
[1]*Far Eastern Federal University.8, Sukhanova Str., Vladivostok, Russia, 690091*
**e-mail: zhukovinamasha@bk.ru*

The ongoing development of tourism activities associated with globalization, in which more and more countries are involved, with the active migration of goods, services, jobs, capital, knowledge. It is impossible to disagree with the opinion of A.K. Lukovetskoy that tourism is an effective means of implementing sociocultural values in the field of leisure. The coastal tourism in Russia and in the Primorsky territory in particular, its development and its problems is a greatest interest of this article.

The development of coastal tourism has certain risks for places of recreation and is impossible without solving some problems of an economic and legal nature. One of the significant problems in the regulation of tourist activity is the lack of a systemic legislative act in Russian legislation that would comprehensively regulate tourist activities, in particular coastal tourism, and the use of coastal bands in recreational, economic or other activities.
Nowadays the tourist activities are regulated by the norms of the Water, Land, Town Planning Codes, various laws and regulations of federal and regional importance, which objectively hamper their effective and correct application. This question has been repeatedly raised in the scientific literature by various authors, E.P. Afanasieva, P.F. Brovko, V.P. Kirillov, A.K. Lukovitseva and others. In particular, E.P. Afanasyeva points out that in foreign jurisdictions, unlike Russian legislation, there is a comprehensive management of coastal zones, and there is a legal definition of coastal tourism and coastal zones.

So there is no legal definition of the concepts “coastal tourism” and “coastal strip”in the Russian legislation, what complicates the involvement of the coastal strip into economic activities of tourism activities and creates obstacles in the application of this terminology in the legal regulation of domestic coastal tourism and, accordingly, in the development of regulatory legal acts for organization of coastal tourism, as well as integrated development and restoration of the coastal strip.

Actually at present time the coastal tourism is an independent tourism, carried out by tourists independently without the use of ready-made tourism products, and without the involvement of travel agents and tour operators, which of course on the one hand significantly reduces the cost of such tourism, but at the same time leaves the tourist without any protection and guarantee of high-quality recreational leisure.

The load on the beaches in Primorsky Krai during the summer season is approximately 130 to 400 people per kilometer of beach area, while the indicator of the load per kilometer of beach area in unequipped beach areas is not officially calculated and therefore is not used by government bodies in its activities, accordingly, the ability to restore the ecological balance in these territories is under threat.

The concept of the coastal strip is only in Article 65 of the Water Code of the Russian Federation as a protective strip in water protection zones, on the territories of which additional restrictions are imposed on economic and other activities.

Key words
Coast, tourism, legal

Научное издание

МОРСКИЕ НАУКИ И СОВРЕМЕННЫЕ ТЕХНОЛОГИИ ДЛЯ УСТОЙЧИВОГО РАЗВИТИЯ

26-я международная конференция Тихоокеанского конгресса морских наук и технологий (PACON-2019)
16–19 июля 2019 г., Владивосток, Россия

Тезисы докладов

MARINE SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

The 26th International Conference of Pacific Congress on Marine Science and Technology (PACON-2019)
July 16–19, 2019, Vladivostok, Russia

Abstracts

Тезисы докладов печатаются в авторской редакции
Составители оригинал-макета:
О.О. Трусенкова, Н.М. Безответных
Издательское оформление: ИП Миромановой И.В.
ИНН 253603547050

Подписано к печати 10.07.2019 г.

Сетевое (on-line) электронное издание

Тихоокеанский океанологический институт им. В.И. Ильичева
690041, г. Владивосток, ул. Балтийская, 43
Тел.(423)2311-400, факс (423)2312-573, email: pacific@poi.dvo.ru