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ABSTRACTS

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Session 3: COUPLING BETWEEN THE EARTH'S ATMOSPHERE AND SPACE AND ITS RELATION TO QUIET AND ACTIVE SUN

INFLUENCE OF METEOROLOGICAL PROCESSES ON IONOSPHERE IN EASTERN EUROPE

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We present observations of atmospheric and ionospheric parameters during strong meteorological disturbances (storms) in the Eastern Europe. The critical frequency of the F2 layer (f_0F2) and the total electron content (TEC) were observed at the several stations in Eastern Europe. The analysis of ionospheric observations has shown that during meteorological storms the amplitude of diurnal variations in TEC decreases to 50 %; and in f_0F2, to 15 % as compared to quiet days. The revealed changes in ionospheric conditions during meteorological storms are regularly registered and represent a characteristic feature of the meteorological effect on the ionosphere. Numerical experiment was made to test the hypothesis using global self-consistent model of the thermosphere, ionosphere and protonosphere (GSM TIP). As thermospheric source of disturbance was defined spatially localized moving heat source, simulating the effect of AGW dissipation, extending the field of meteorological storm. The calculation results demonstrate the dynamics of perturbations of the upper atmosphere and ionosphere parameters caused by the source model. The physical processes that determine the resulting ionospheric disturbances are discussed. The characteristics of variations of the total electron content (TEC) in the atmosphere are determined from data collected by GPS navigation satellites. An analysis of the observational data showed that the spectrum of variations of the atmospheric and ionospheric parameters is indicative of acoustic-gravity waves (AGW) propagating from the lower atmosphere. The observed manifestations of TEC disturbances caused by AGW propagating from the lower atmosphere can be explained by the diurnal variation of the altitude of the ionosphere and the waveguide propagation of infrasonic waves.

NUMERICAL MODELING OF NONLINEAR ACOUSTIC-GRAVITY WAVE PROPAGATION INTO THE UPPER ATMOSPHERE AT DIFFERENT LEVELS OF SOLAR ACTIVITY

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According to present views, acoustic-gravity waves (AGWs) existing in the upper atmosphere may be generated near the Earth's surface due to different sources and propagate upwards. An algorithm for three-dimensional numerical simulation of vertical propagation of nonlinear AGWs from the Earth's surface to the upper atmosphere was developed recently. The algorithm of the solution of fluid dynamic equations uses finite-difference analogues of basic conservation laws. This approach allows us to select physically correct generalized wave solutions of the nonlinear equations. Horizontally moving horizontal sinusoidal structures of

vertical velocity on the Earth's surface serve as AGW sources in the model. Numerical simulation was made in a region of the Earth atmosphere with dimensions up to several thousand kilometers horizontally and 500 km vertically. Vertical profiles of the mean temperature, density, molecular viscosity and thermal conductivity are specified from standard models of the atmosphere. Simulations are made for different amplitudes, horizontal wavelengths and speeds of wave sources at the lower boundary of the model. It is shown that after "switch on" tropospheric source atmospheric waves very quickly (for several minutes) may propagate to high altitudes (up to 100 km). When AGW amplitudes increase with height, waves may break down in the middle and upper atmosphere. Instability and dissipation of wave energy may lead to formations of wave accelerations of the mean winds and to creations of wave-induced jet flows in the middle and upper atmosphere. Nonlinear interactions may lead to instabilities of the initial wave and to the creation of smaller-scale structures. These smaller inhomogeneities may increase temperature and wind gradients and enhance the wave energy dissipation. Simulations with background wind and temperature profiles corresponding to small and high levels of solar activity show that AGWs characteristics in the middle and upper atmosphere may change with changes in solar activity. This may alter heating and acceleration of the different layers of the atmosphere and change conditions of dynamical coupling between the lower and upper atmosphere.

QUASI-BIENNIAL VARIATIONS IN IONOSPHERIC TIDAL/SPW AMPLITUDES: OBSERVATIONS AND MODELING

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In this study, we examine the coherent spatial and temporal modes dominating the variation of selected ionospheric tidal and stationary planetary wave signatures from 2007–2013 FORMOSAT-3/COSMIC total electron content observations using Multi-dimensional Ensemble Empirical Mode Decomposition (MEEMD) from the Hilbert-Huang Transform. We examine the DW1, SW2, DE3, and SPW4 components, which are driven by a variety of in-situ and vertical coupling sources. The intrinsic mode functions (IMFs) resolved by MEEMD analysis allows for the isolation of the dominant modes of variability for prominent ionospheric tidal / SPW signatures in a manner not previously used, allowing the effects of specific drivers to be examined individually. The time scales of the individual IMFs isolated for all tidal/SPW signatures correspond to a semiannual variation at EIA latitudes maximizing at the equinoxes, as well as annual oscillations at the EIA crests and troughs. All tidal / SPW signatures show one IMF isolating an ionospheric quasi-biennial oscillation (QBO) in the equatorial latitudes maximizing around January of odd numbered years. This TEC QBO variation is in phase with a similar QBO variation isolated in both the GUVI zonal mean column O/N2 density ratio as well as the $F10.7$ solar radio flux index around solar maximum, while showing temporal variation more similar to that of GUVI O/N2 during the time around the 2008/2009 extended solar minimum. These results point to both quasi-biennial variations in solar irradiance as well as thermosphere / ionosphere composition as a generation mechanism for the ionospheric QBO. We also present results from numerical experiments using the Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) to quantify the sensitivity of the thermosphere and ionosphere to quasi-biennial oscillations in modulated atmospheric tides as well as that present in $F10.7$. Our results are some of the first numerical experiments examining the generation mechanisms behind the ionospheric QBO from both above and below.