Tropospheric ozone measurements by the IKFS-2 spectrometer aboard the Meteor-M N2 satellite

Yana Virolainen[1], Alexander Polyakov[1], Georgy Nerobelov[1,2,3], Svetlana Akishina[1], Roeland Van Malderen[4], Corinne Vigouroux[5]

[1]Department of Atmospheric Physics, St. Petersburg State University, St. Petersburg, Russia
[2]Scientific Research Centre for Ecological Safety of the Russian Academy of Sciences, St. Petersburg, Russia
[3]LIMA lab, Russian State Hydrometeorological University, St. Petersburg, Russia
[4]Royal Meteorological Institute, Uccle, Belgium
[5]Royal Belgian Institute for Space Aeronomy (BIRA-IASB), Uccle, Belgium

In this contribution, we present the first data product of continuous tropospheric ozone column (TrOC) measurements using publicly available IKFS-2 level 1b data. The IKFS-2 spectrometer aboard the Meteor-M N2 satellite measured outgoing thermal radiation in 5-15 μm spectral range with an un-apodised spectral resolution of 0.4 cm^{-1} in 2015-2022. Here, we concentrate on TrOCs in two layers, i.e. from the surface up to 400 mbar and 300 mbar pressure levels. The retrieval technique is based on the artificial neural network (ANN) algorithm and the method of principal components. For the ANN training, we used TrOCs derived from ozonesonde measurements at different ground-based sites taken from the archive created by the TOAR-II (Tropospheric Ozone Assessment Report) HEGIFTOM working group (Harmonization and Evaluation of Ground-based Instruments for Free-Tropospheric Ozone Measurements, see https://hegiftom.meteo.be/datasets/ozonesondes), thus solving the problem of calibration of IKFS-2 TrOC data product. The uncertainty estimated for IKFS-2 TrOC measurements is less than 3 DU for surface – 400 mbar layer and equals ~ 3.5 DU for surface – 300 mbar layer (~ 12 % for both layers).

We compared IKFS-2 TrOC data with FTIR ground-based measurements at the NDACC IRWG (Network for the Detection of Atmospheric Composition Change Infrared Working Group) observational sites (https://www-air.larc.nasa.gov/missions/ndacc/data.html) equipped with the Bruker IFS 120/125 HR spectrometers. For daily averaged measurements with a spatial mismatch of 100 and 200 km, the biases between IKFS-2 and ground-based TrOC datasets depend mainly on the altitude of a site; standard deviations of differences vary within 2-4.5 DU. IKFS-2 TrOCs global distribution correlate well with independent IASI measurements – the operational ozone data product (https://iasi.aeris-data.fr/catalog/).

We analyzed the spatial and temporal distribution of TrOCs estimating their anomalies, seasonal variations, and trends in different regions. We also used IKFS-2 TrOC retrievals for validation of the WRF-Chem numerical regional model, particularly in the vicinity of the Gulf of Finland – the easternmost arm of the Baltic Sea.

Acknowledgement
This work was supported by the Russian Science Foundation in the frame of the project No. 23-27-00166, https://rscf.ru/en/project/23-27-00166/ .