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Measurements of the total ozone column by the IKFS-2 instrument for the period of operation from 2015 to 2022 on board the «Meteor-M» №2 satellite

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Ozone is one of the most important gases in the earth's atmosphere. It makes a major contribution to climate formation and protects the biosphere from hard UV radiation, so an important task is monitoring ozone content using various methods and instruments. The global ozone monitoring system includes remote, ground-based and local sensing methods. Satellite monitoring methods provide a wide range of data on global ozone distribution and anomalies. Among the various satellite methods for measuring ozone, only outgoing thermal radiation measurements provide data independent of solar illumination.

The study presents a method for obtaining information on total ozone content (TOC), based on measurements of the spectra of outgoing thermal radiation by the Russian IKFS-2 instrument on board the «Meteor-M» №2 satellite during the period of normal operation in orbit from 2015 to 2022.

In the period from 2015 to November 2020 (6 years), measurements were carried out with a scanning band of 1000 km, but starting from December 2020, the scanning band was increased to 1500 km. St. Petersburg State University has created a method for obtaining TOC from the spectra of outgoing thermal IR radiation measured by IKFS-2, based on the use of artificial neural networks (ANN) [1]. The inverse problem is solved using an ANN trained using TOC data obtained using measurements from the OMI instrument on the «Aura» satellite and the principal component method (PC). Previously, this technique was developed and applied to measurements with a range of 1000 km (a period of 6 years) [2].

This report investigates the application of the same methodology to measurements in 2021-2022, when the satellite swath width has increased to 1500 km. Based on comparisons of the results with independent measurement data, it’s shown that the transition to the period 2021-2022 slightly worsens the agreement of the IKFS-2 data with independent data. This’s caused by an increase in the scanning angle measurement range, and not by an increase in the TOC variability statistics. It is also shown that training an ANN on the entire data set over 8 years of measurements improved the agreement over the last 2 years, while practically not worsening it over the first 6 years of measurements. The mean differences between the data of independent measurements and the TOC data obtained by IKFS-2 are less than 2%, and the standard deviations of the differences are less than 3%. In polar regions, there is an increase in divergence during the winter and spring periods. Analysis of results in the polar regions is carried out using ozonesondes, which take measurements throughout the year, as well as during the polar night.

There is good qualitative agreement between IKFS-2 and ozonesonde data, including extreme drops in total ozone column at high latitudes of both hemispheres in the winter-spring period. The standard deviations of the differences between the IKFS-2 TOC data and the ozonesonde data ranged from 5.3 to 11% (17 – 33 DU), which corresponds to the uncertainty of the integral ozone concentration in the vertical column according to the ozonesonde data.

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Key words: ozone, total ozone column (TOC), Fourier spectrometer IKFS-2, ozone measurements, outgoing thermal radiation, polar night, ozonesondes

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