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The variability of stratospheric gases in the vicinity of St. Petersburg

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Ozone anomalies that occur during winter-spring periods in the Northern Hemisphere have been increasingly observed in recent decades not only in polar, but also in mid-polar regions, including territories of megacities. A decrease in stratospheric ozone content can lead to an enhanced level of UV radiation that is dangerous for humans, therefore, the study of processes associated with the variability of stratospheric ozone is an important task especially for developing the methods for predicting the appearance of ozone mini-holes and the growth of UV surface illumination.

Regular monitoring of stratospheric gases involved in ozone-depleting processes is required for validation of various atmospheric models and understanding the climate changes. Long-term ground-based FTIR (Fourier Transform Infrared) measurements have been performed at the SPbU site in Peterhof since 2009. The observational site is equipped with the Bruker IFS 125HR instrument of high spectral resolution, which is used for measurements of total columns and vertical structure content of many atmospheric gases. The location of Saint Petersburg (60˚N, 30˚E) near the border of mid and high latitudes allows us to observe changes in stratospheric gases content under different atmospheric conditions, including polar vortex intrusion. In this work, we demonstrate the capabilities of ground-based FTIR-method to study and explain the temporal variability of stratospheric trace gases.

We analyzed time series of O_3, HNO_3, $ClONO_2$, HCl, and HF total or stratospheric columns derived by the ground-based FTIR-method in the vicinity of St. Petersburg in 2009-2023; compared them with independent satellite measurements (ACE-FTS) and the results of the SOCOLv3 with meteorological data assimilation. We compared the results of measurements at the Peterhof site with similar FTIR-measurements at the Kiruna site (68˚N, 20˚E) located 1000 km away.

The variability of stratospheric gases is affected by both chemical and dynamical processes in the atmosphere. Calculating the ratio of chemically active stratospheric gases (such as O_3, HCl, $ClONO_2$ and HNO_3) total columns to HF total columns allowed us to remove dynamical variability and separate time periods of their chemical activity only, that affect stratospheric ozone depletions.

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