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Ozone Profile Retrieval TOPAS for satellite based nadir measurements in the UV and IR spectral range from TROPOMI and CrIS

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Abstract

The monitoring of the vertical ozone distribution is an important task for society and science, because ozone in the atmosphere affects dynamics and chemistry and contributes to climate change. Furthermore human and environmental health depends on the ozone content in the stratosphere and troposphere. Vertical ozone profiles from satellite based nadir measurements provide a valuable contribution to the global ozone monitoring system.

The TOPAS (Tikhonov regularized Ozone Profile retrievAl with SCIATRAN) algorithm to retrieve vertical ozone profiles from space-borne nadir UV radiance measurements was developed and applied to TROPOMI L1B version 2 spectral data. Spectral measurements from 270 to 329 nm (band UV1 and UV2) were used after they were spectrally re-calibrated using comparisons to simulated radiances with collocated ozone profiles from MLS/Aura as input.

The TOPAS retrieved ozone profiles from TROPOMI have a vertical resolution varying between 6 and 9 km in the stratosphere (Mettig et al. 2021). Below 18 km the sensitivity is limited and the vertical resolution is reduced. The TOPAS ozone profiles were validated using collocated stratospheric ozone lidar and ozonesonde measurements. The validation with stratospheric ozone profiles shows very good agreement with a mean bias of to within ± 5% in the 18 - 45 km altitude range and a standard deviation of 10%. In the troposphere, the validation with ozonesonde profiles shows a larger bias with up to +40% between 10 and 15 km and a wider spread of results as well.

To increase the information content and the vertical resolution below 30 km, CrIS (on Suomi NPP) measurements in the infrared spectral range between 9.35 and 9.9 µm were included in the TOPAS retrieval. The combination of collocated UV TROPOMI and IR CrIS pixels, which have a time difference of only 3 minutes, improves the vertical resolution in the troposphere (above 3 km) to about 10 km. Validation of the combined ozone profiles with tropospheric lidars and ozonesondes shows improved tropospheric profiles and tropospheric ozone column values.

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