

QOS2016-345-1, 2016

Quadrennial Ozone Symposium of the International Ozone Commission

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Long-term annual variations of the diurnal cycle of stratospheric ozone.

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Considering the diurnal cycle of stratospheric ozone is essential for a correct estimation of the ozone trends. At northern hemispheric mid-latitudes, the diurnal ozone content varies with altitude from +4% at 25 km to -25% at 60 km with respect to midnight values. The diurnal variation is attributed to dynamical or chemical causes depending on the altitude. In the frame of this study, the long-term variations of the ozone diurnal cycle are investigated. The annual and seasonal variations of the diurnal cycle measured by a ground-based microwave radiometer are compared to simulations by the SOCOL v3.0 chemistry-climate model and the Monitoring Atmospheric Composition and Climate project (MACC) reanalysis.

The ozone diurnal cycle is measured by the ground-based microwave radiometer SOMORA, a total power microwave radiometer measuring the thermal emission line of ozone at 142.175 GHz. Operated continuously since 2000 in the framework of the NDACC, SOMORA is measuring ozone profiles from the stratosphere up to the lower mesosphere with a temporal resolution of 1h. This dataset suits the investigation of the annual and seasonal fluctuations as well as of the diurnal variations of stratospheric and mesospheric ozone. Assessing temporal changes of the diurnal cycle requires the measurements to be fully characterized in terms of uncertainties and measurement contribution. A clear sensitivity of the diurnal cycle intensity to the measurement contribution has been put into evidence. The ozone profile dataset used in this study has been harmonized ensuring a constant measurement contribution to the retrieved ozone profiles.

The SOCOL v3.0 chemistry-climate model forced by nudged dynamical fields from ECMWF ERA-Interim and the MACC reanalysis (MOZART CTM, assimilation of satellite data) provide several ozone profiles per day over a time range similar to the SOMORA microwave radiometer measurements, allowing then an investigation of the ozone diurnal cycle time variations.

An investigation of the 2000-2015 annual and seasonal variations of the diurnal cycle has been performed. Trends in day and nighttime ozone levels as well as in the amplitude of the diurnal cycle have been calculated using a multiple linear regression model. Proxies representing processes known to impact ozone and in particular the diurnal cycle have been used (zonal winds at 30 hPa and 10 hPa, solar radio flux at 10.7 cm, ENSO MEI,...).

Trends of the measured stratospheric ozone diurnal cycle will be compared to trends of diurnal cycles derived from ozone profiles simulated by SOCOL v3.0 and from ozone profiles of the MACC reanalysis. Yearly trends of day and nighttime ozone profiles show differences in function of altitude. The seasonal dependence of the trends and the variations in the significance of the proxies will be discussed for both measured and simulated ozone profiles.