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# Characterization of daily to decadal variation cycles in stratospheric and mesospheric ozone as observed over Europe by ground-based NDSC instruments

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Ground-based remote-sensing observations of the lower atmospheric ozone profile are performed at selected European stations of the NDSC network since the early 1980s. Regular lidar observations of the stratospheric ozone profile started at the Observatoire de Haute Provence, France, in 1986, and were soon followed by a new series of observations initiated in 1987 at the Hohenpeissenberg Observatory, Germany. Continuous measurements of the stratospheric and mesospheric ozone profile by ground-based microwave radiometry are performed at the University of Berne since 1994. Since 2000, the latter are complemented by observations with a second independent microwave remote sensing unit operated in Payerne, Switzerland.

Inspection of the achieved continuous or quasi-continuous data sets allows a detailed characterization of the various cycles observed over decadal to daily time scales in stratospheric and mesospheric ozone over Europe. Characterization of these cycles is of relevance to climate studies, in particular for the investigation of the ozone-induced contribution to radiative forcing and of its natural variations. In the present study, a spectral analysis of the above datasets is performed in order to isolate from each of them the signature of cyclic variations of various periods. The considered periods correspond to those of the 11-years solar cycle, the quasi-biennial oscillation, a seasonal and a semi-annual cycle, as well as the diurnal variation of mesospheric ozone. The amplitude and vertical extent of each of these cycles is derived by spectral decomposition of the datasets as a function of altitude.

We present the results of this analysis, and discuss the consistency of the results ob-

tained with the different datasets. We find that in spite of the fact that only one full solar cycle is contained at most in each of the datasets, an apparant positive response of middle stratospheric ozone concentrations to solar irradiance increases is observed in two of them. In these two datasets, a consistent QBO signal is also observed throughout the stratosphere, with a phase shift of several months from the lower to the upper stratosphere. Seasonal variations of opposite phases in the lower and the middle stratosphere are observed in all datasets. In addition, semi-annual variations are observed in three of the four datasets above 38 km. Finally, diurnal decreases of mesospheric ozone are observed in the microwave data above 50 km.