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A Stratospheric Ozone Climatology From Global Ozone Soundings and Trajectory Statistics

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An understanding of the stratospheric ozone distribution is an initial and critical step to assess the impact of its variability on climate change. In earlier studies, stratospheric ozone climatologies have been generated in 3-D (latitude, longitude, and altitude) or 4-D (latitude, longitude, altitude, and time) from either satellite data or photochemical models. In this study, a domain-filling trajectory method is explored to generate a global ozone climatology from ozonesonde data. This kind of trajectory technique provides a powerful tool to integrate sparse ozonesonde station measurements. The specific objective of this study is to create an ozone climatology dataset for model and satellite retrieval a priori, trend analysis, tropospheric-stratospheric exchange research, and ozone-climate interaction studies.

We employ over 45,000 ozone soundings at 116 stations over 44 years (1965-2008) from the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). Forward and back- trajectories are performed for 4 days each from each sounding, driven by NCEP reanalysis data using the HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory Model) from the NOAA Air Resources Laboratory. The ozone mixing ratios along each trajectory path are assumed the same as each sounding profile, given the long ozone lifetime in the lower stratosphere. In this way, large gaps between ozonesonde stations are filled. The remaining gaps (about 15% of the global area) are filled with a variable-length smoothing algorithm. The resulting global ozone climatology is archived for five decades from 1960s to 2000s at monthly intervals with a grid size of 5 by 5 degrees and 1 kilometer vertically.

This method is tested at selected stations by comparing the actual ozone sounding profile with that found through the trajectory technique, using the ozone soundings at all the stations except one being tested. The two sets of profiles are in reasonable agreement with maximum differences about 20% in the stratosphere.

This ozone climatology is independent of any photochemical model. It reveals strong longitudinal variation in ozone and covers higher latitudes than current satellite data. We will show preliminary results using this data set as the a priori in a photochemical model at Environment Canada. Variability in ozone on seasonal and decadal scales will be discussed.