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An Atmospheric Chemist in Search of the Tropopause

Michael Prather
UC Irvine, Earth System Science Dept, Irvine CA, United States (mprather@uci.edu, 1 949 824 3874)

To those interested in atmospheric composition and chemistry, the tropopause is a somewhat ambiguous boundary between two chemically distinct regions, the stratosphere and the troposphere. Rejecting the traditional definitions of the tropopause (lapse rate or PV) as unusable in a 3-D global framework, we experiment with a definition based on the mean age since contact with the surface. Defining a tracer, e90 with a 90-day e-fold, to map out the tropopause, the CTM using ECMWF/U.Oslo met fields accurately reproduces the sonde tropopauses and moreover matches the O3 values. The tracer e90 gives us a very useful diagnostic for distance from the tropopause in terms of transport, which works well around the jet and folds. As a consequence of this simple experimentation with the tropospheric age tracer, we have identified the oldest air in the troposphere and also demonstrated a large, systematic bias in the use of measurements and models to define the stratospheric age-of-air. Analysis of tropopause values of O3, e90, and stratospheric age-of-air demonstrate clearly that the large seasonal cycle of tropopause O3 at northern mid-latitudes, of order 100 ppb, is not due to changes in diffusive mixing or transport, but to photochemistry in the sub-tropical lower stratosphere.