Title: Quantifying Interannual Variability of the UTLS Ozone Using Assimilation of Satellite Data

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Abstract

An accurate representation of spatial and temporal variability of the Upper Troposphere – Lower Stratosphere (UTLS) ozone is essential for understanding both the tropospheric ozone budget and ozone's contribution to radiative forcing. The complex, dynamically driven structure of trace gas fields in the UTLS presents a challenge to data-based and modelling studies. Small features are not fully resolved in data from limb-sounding instruments such as the Microwave Limb Sounder on EOS-Aura (the EOS-MLS), but are captured in assimilation of those data as vertical structure is added from the assimilated meteorology. This will be demonstrated using a multi-year assimilation of EOS-MLS observations in the Goddard Earth Observing System, Version 5 (GEOS-5) data assimilation system. The results demonstrate the realism of the seasonal and year to year variability of laminar structures in the mid-latitudinal ozone field between years 2005 – 2007, for which independent validation data are available from the HIRDLS instrument. The analysis is done in the context of the underlying large scale dynamics.

The lifetimes of most research instruments are too short for them to be used throughout the duration of long-term (at least 3 decades) reanalyses. For example, the EOS-MLS instrument has operated since mid-2004 until present. By contrast, Solar Backscatter Ultra Violet (SBUV) measurements provide continuous data since late 1978, but their vertical resolution is insufficient to represent the profile shape in the UTLS. Assimilation of these SBUV/2 observations in the GEOS-5 data assimilation system has hitherto not captured a realistic ozone structure in the UTLS, even though transport studies using GEOS-5 wind fields do show such structures. We show that careful construction of the background error covariance structure in GEOS-5 can lead to more realistic UTLS ozone fields when assimilating SBUV/2 observations. The reasoning behind this will be discussed, emphasizing the need to retain the sharp gradient of ozone concentrations across the tropopause. We analyze the UTLS ozone distributions in multi-year SBUV/2 assimilation experiments, comparing the results against the independent HIRDLSdataset and, for a longer period, with the MLS assimilation and discuss the consequences for tropospheric ozone and radiative forcing.