From LIMS to OMPS-LP: limb ozone observations for future reanalyses

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Summary of Issues

Ozone poses a unique set of challenges for atmospheric reanalyses.

Chemically: the distribution is controlled by sunlight, stratospheric transport and chemistry including anthropogenic pollutants that rise between 1960 and 1997, then decline after the Montreal Protocol becomes effective.

Radiatively: ozone in the upper troposphere and lower stratosphere is a climate gas; it also impacts the use of infrared radiances to constrain the 3D thermal field.

Observationally: It is the most widely observed trace gas, yet the observations are inhomogeneous in space and time, especially when information about vertical profiles is needed.

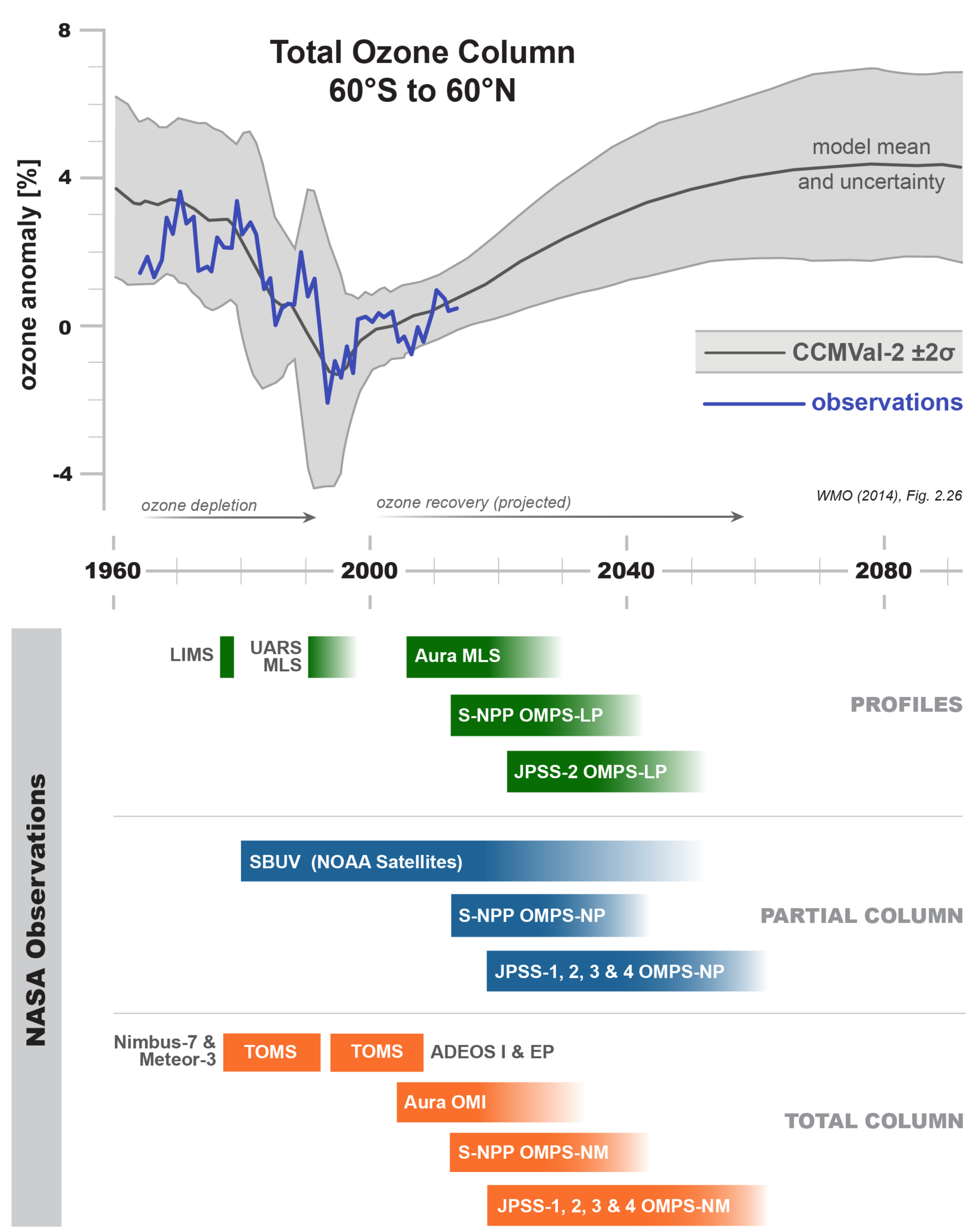
Characterizing the Observations in Periods of Ozone Decline and Expected Recovery

WMO-UNEP documents the global ozone decline between about 1980 and 1997; this is also captured in chemistry-climate models. Early signs of the projected 21st century ozone recovery, as CFCs decline and the stratosphere cools, are evident in satellite observations.

There is a well-documented series of total and partial column ozone data (SBUV, TOMS) for this period of ozone decline. NASA's research observations provide only "snapshots" of the ozone profiles, in 1978-1979 with LIMS and the 1990s with Aura-MLS. Many non-NASA satellite data are also available.

Challenge is to integrate the model, with chemistry, to the observations and to use the assimilation to produce a steady long-term ozone record.

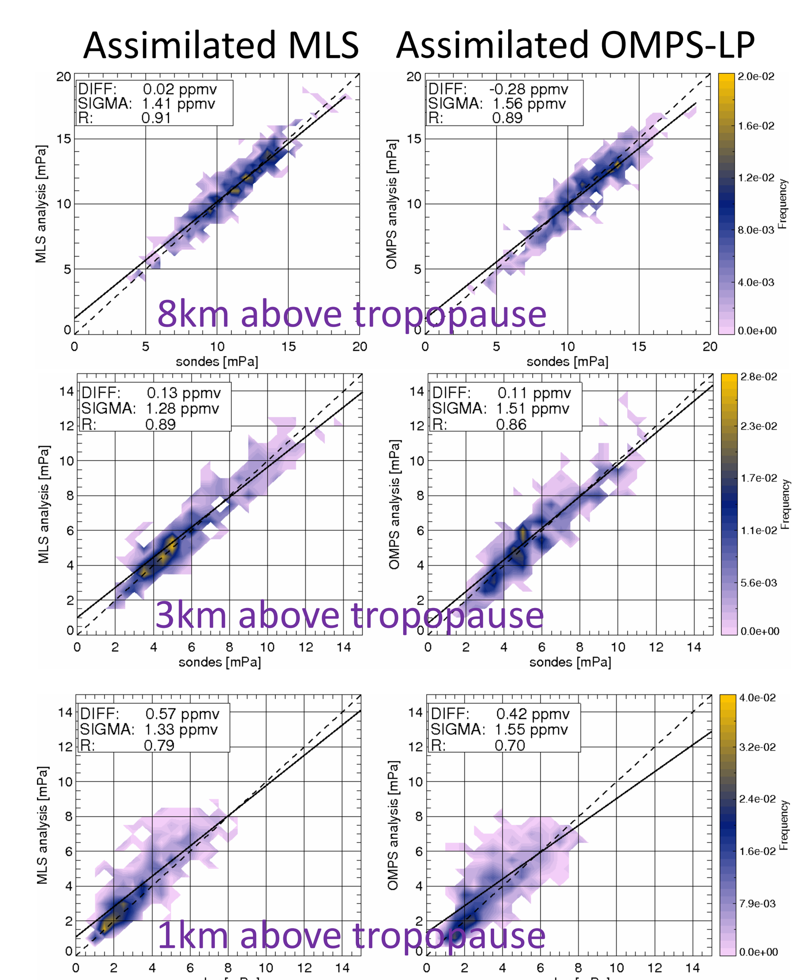
NASA's EOS-Aura MLS so far spans the period 2004-2017. The OMPS-LP (Limb Profiler) observations will continue that record into the late 2020s and beyond.



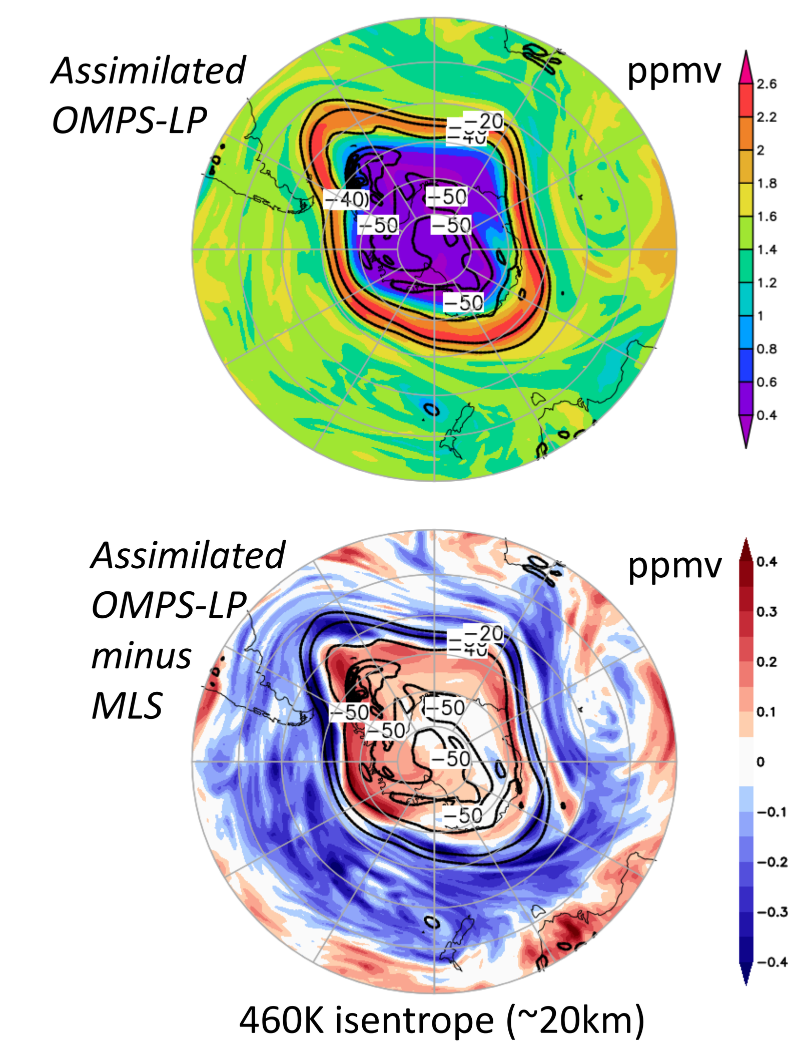
A juxtaposition of past and future ozone change from the WMO-UNEP (2014) assessment and near-global satellite observations of total-column, partial-column, and profile ozone that can be used in reanalyses.

Here we show two examples of initial integration of LIMS (historical) and OMPS-LP (going forward) ozone observations into the GEOS Data Assimilation System, building on the setup used to produce the MERRA-2 reanalysis, which uses SBUV, OMI and MLS ozone data.

Example 1: MLS/OMPS-LP Agreement (2016)



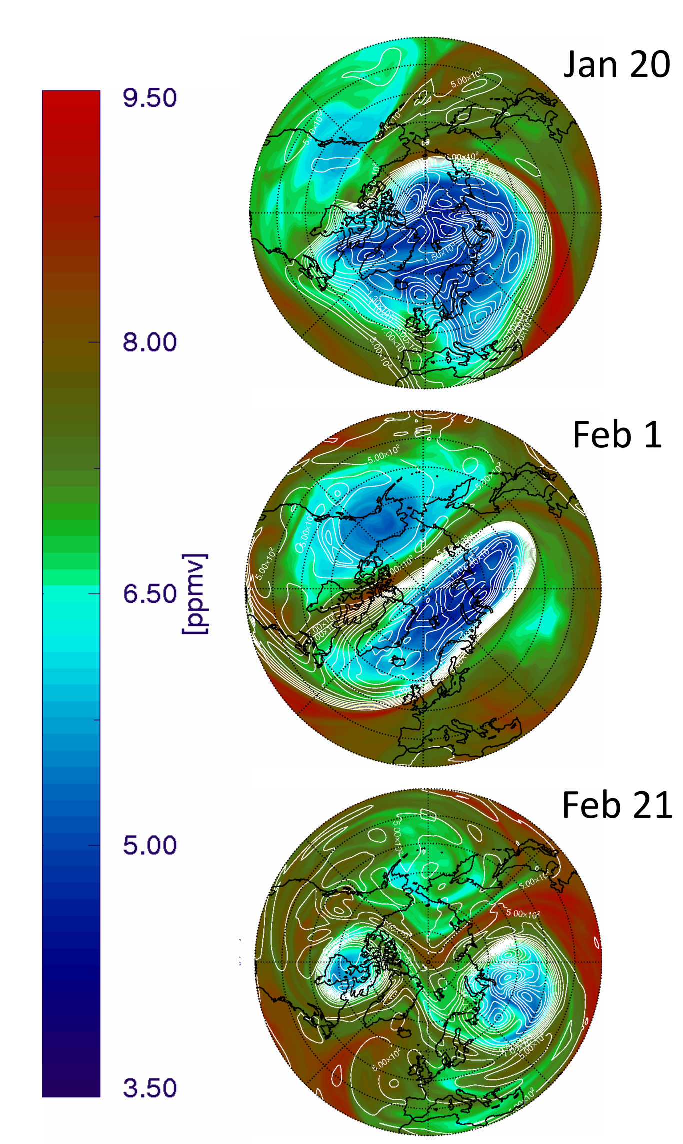
Comparing assimilated data with in-situ ozonesondes shows similar overall agreement for both MLS and OMPS-LP in the period January-October 2016



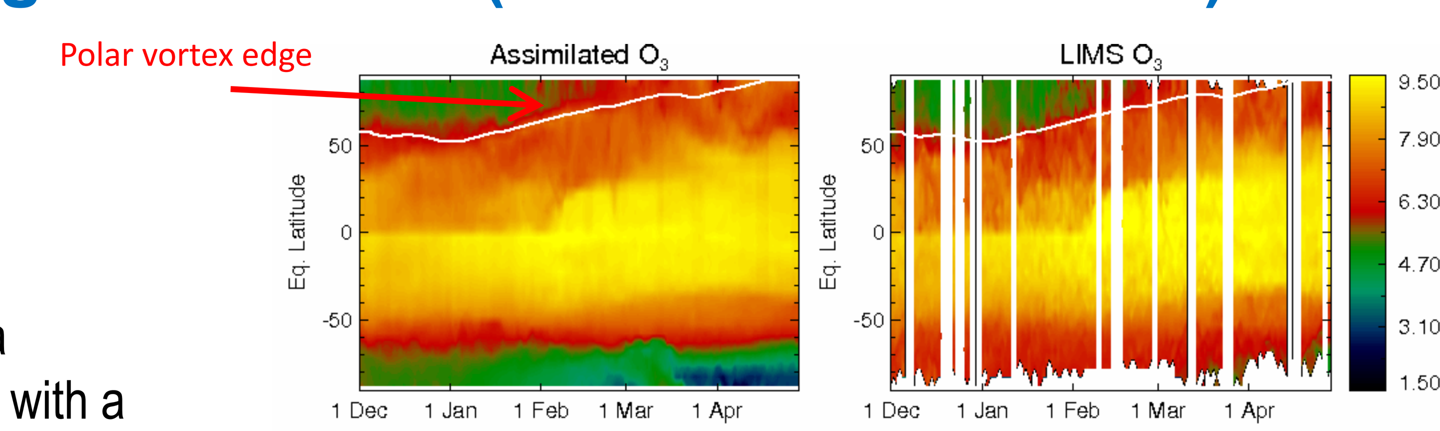
Assimilated lower stratospheric ozone over Antarctica exhibits a realistic distribution but OMPS-LP values are higher inside and lower outside the vortex.

Challenge is to correct inter-instrument biases to produce a continuous multidecadal ozone record useful for trend analyses.

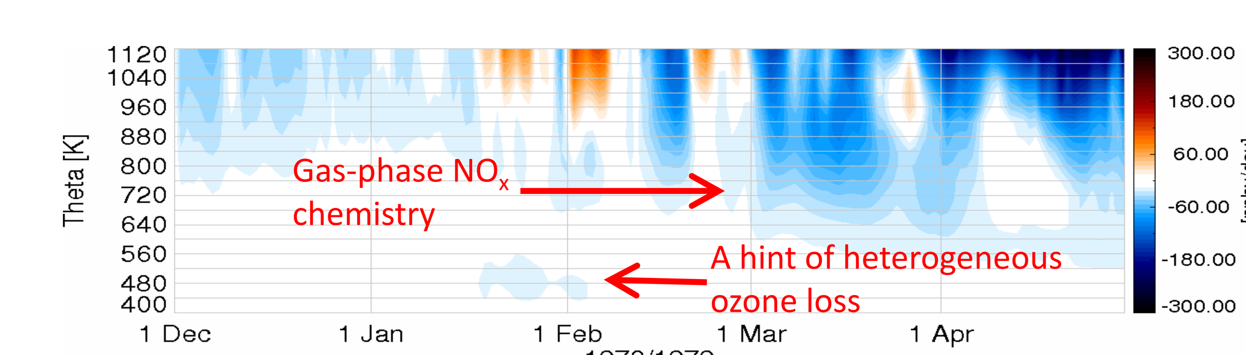
Example 2: Assimilating LIMS ozone (1978-1979 NH winter)



LIMS ozone observations are assimilated into a version of GEOS with a full stratospheric chemistry model. Evolution of the 1000-K ozone shows a series of vortex disturbances and a major stratospheric warming in the second half of February.



Evolution of the 1000-K ozone field and the polar vortex edge as a function of equivalent latitude: evidence of vigorous wave-driven mixing from January onward.



Vortex-averaged ozone change due to chemistry was dominated by NO_x induced loss.

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