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.

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.

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.

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 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 NOx induced loss.