Long-term Ozone Variability and Trends from Reanalyses

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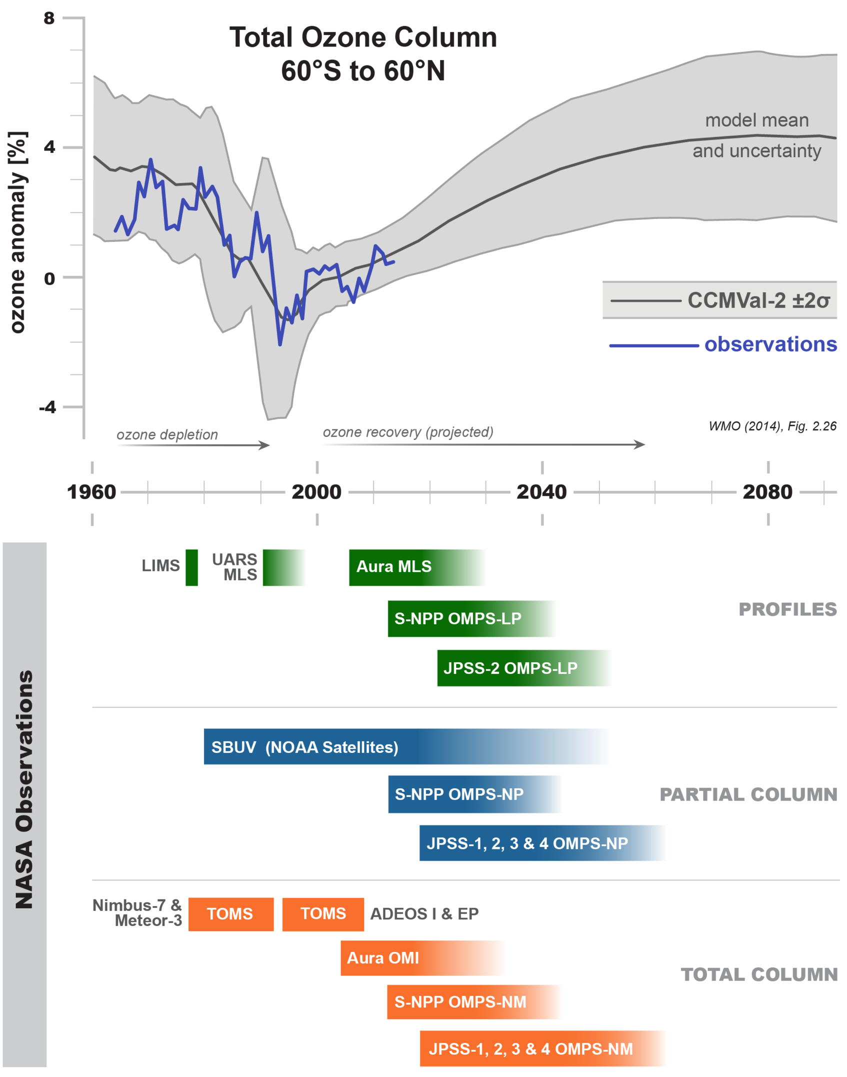
Characterizing the Observations in Periods of Ozone Decline and Expected Recovery



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 series of total and partial column ozone data (SBUV, TOMS) for this period of ozone decline. NASA's EOS-Aura MLS so far spans the period 2004-2018. **The OMPS-LP sensors will continue that record into the late 2020s and beyond.** Non-NASA satellite data are also available.

Summary

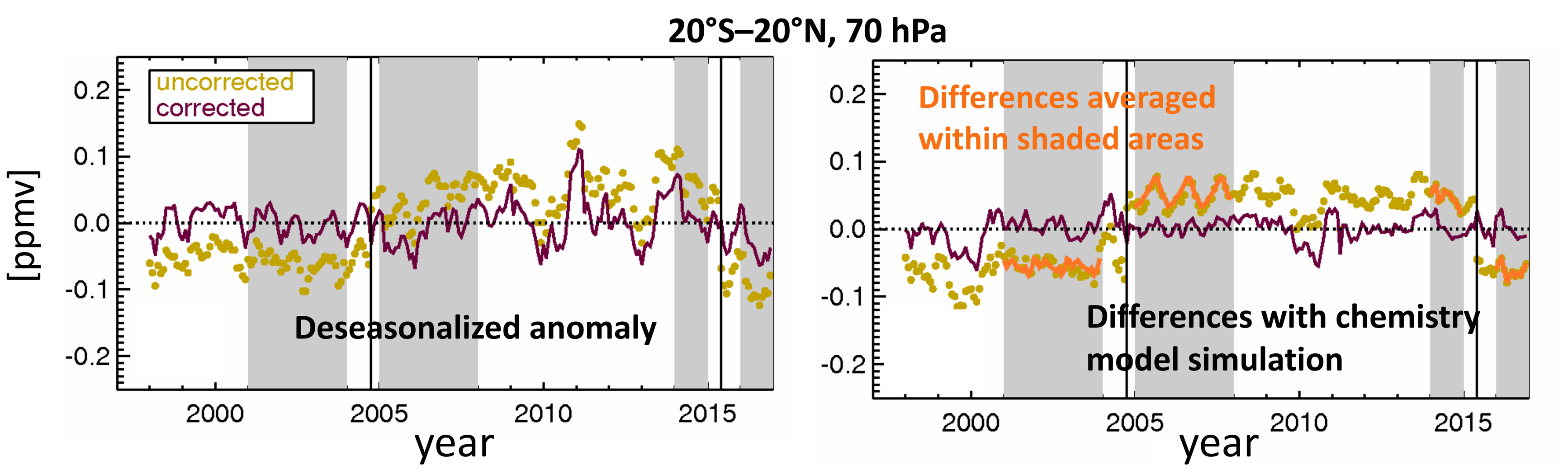
Modern atmospheric reanalyses provide accurate representations of stratospheric ozone from assimilation of long records of satellite data. While invaluable for studies of transport, stratosphere-troposphere exchange and global distributions of stratospheric and tropospheric ozone burden, reanalysis ozone, much like temperature and wind, suffers from temporal discontinuities arising from inevitable changes in the input observations over time. In this presentation we show that it is, nonetheless possible to derive long-term ozone changes from NASA's MERRA-2 reanalysis using a bias correction methodology that employs a chemistry model simulation as a transfer function. Next, we devise a strategy for creating a long-term input ozone data set for a future reanalysis by a simple homogenization of two limb ozone data sets, MLS and OMPS Limb Profiler, projected to span multiple decades during the current period of stratospheric ozone recovery.

Challenge is to effectively use data assimilation to produce a steady long-term ozone record.

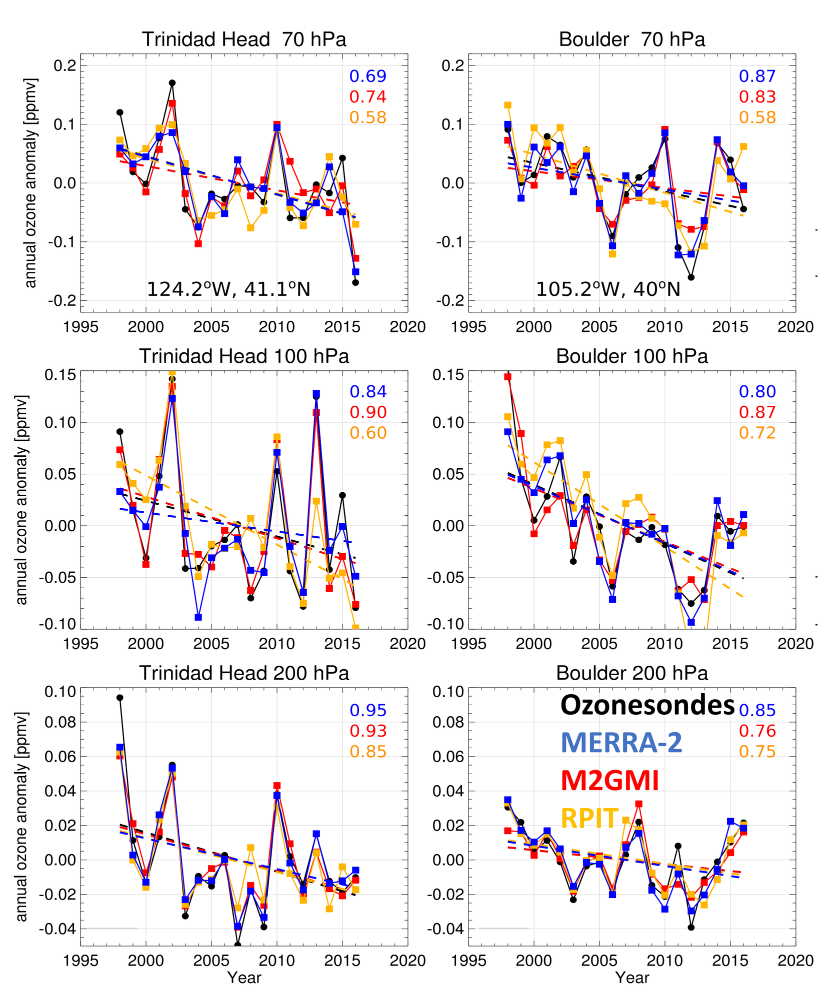
Studying ozone trends and variability using bias corrected MERRA-2

MERRA-2 ozone record has two major discontinuities associated with a switch from SBUV to MLS (profiles) and OMI (total ozone) data in 2004, and a change from version 2.2 to 4.2 of MLS retrievals in 2015.

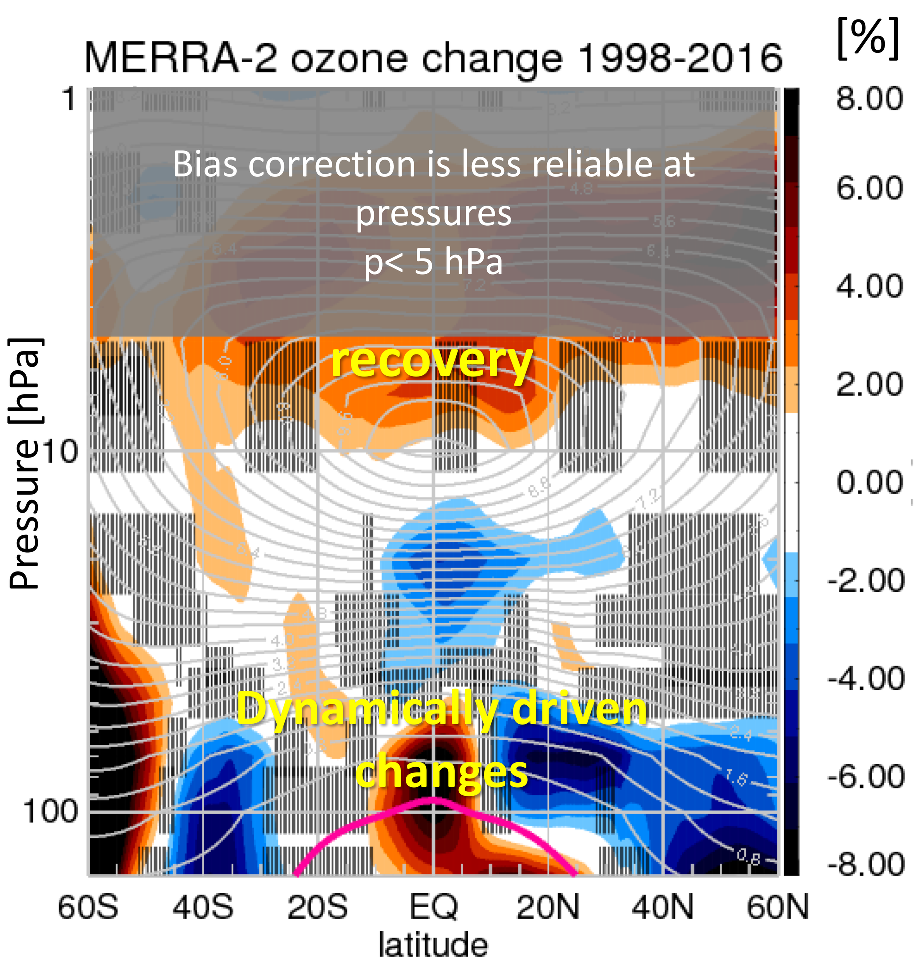
Can these discontinuities be removed to facilitate studies of long-term ozone changes?



The relative bias between two MERRA-2 periods corresponding to a change in the observing system is calculated as a difference from a MERRA-2-driven specified dynamics chemistry model simulation ("M2-GMI"). The bias is then subtracted. This methodology is similar to that used by *Hegglin et al., 2014, doi:10.1038/ngeo2236* for water vapor.



Interannual ozone variability from bias-corrected GMAO analyses, MERRA-2 and RPIT, the M2-GMI simulation and ozonesondes.



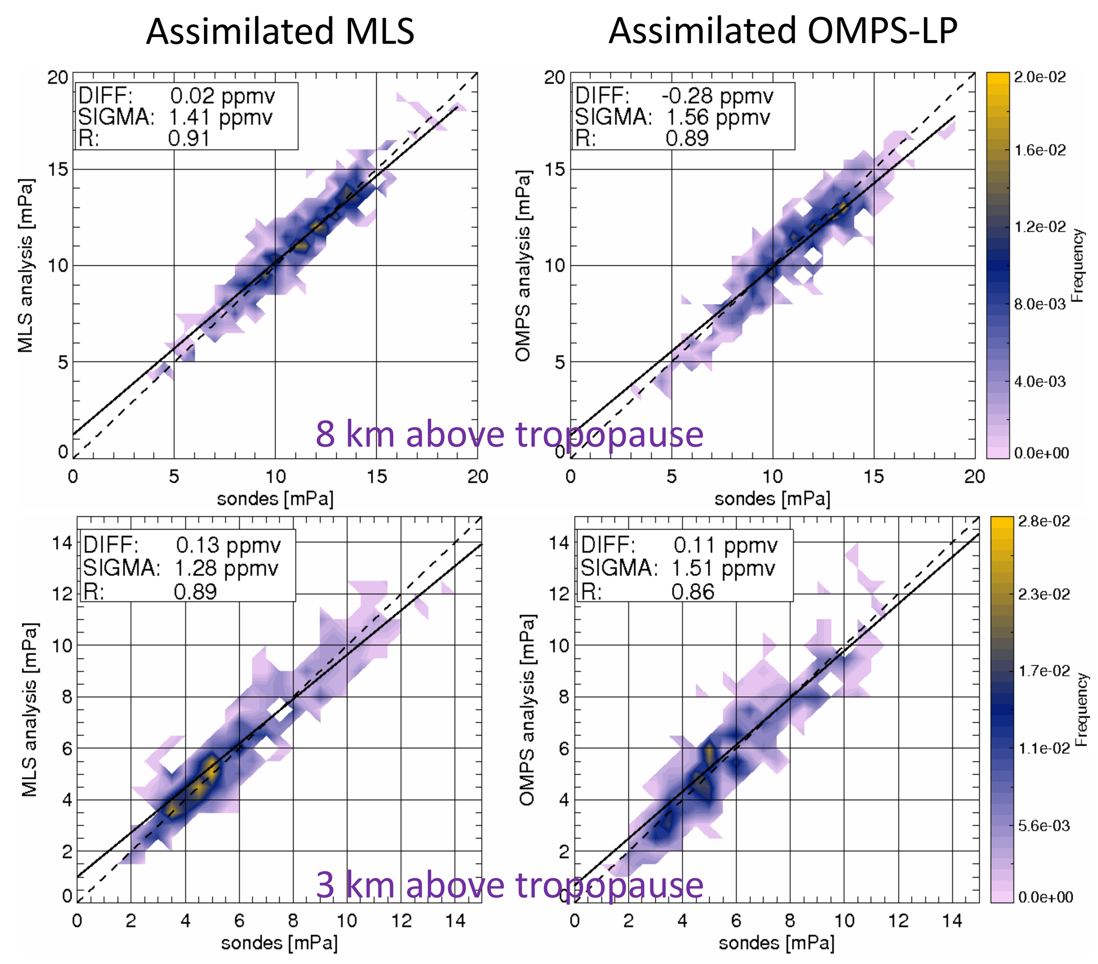
Trends derived from bias-corrected MERRA-2 ozone using multiple linear regression.

Wargan et al., 2018, doi:10.1029/2018GL077406

Future reanalyses: assimilating homogenized ozone data

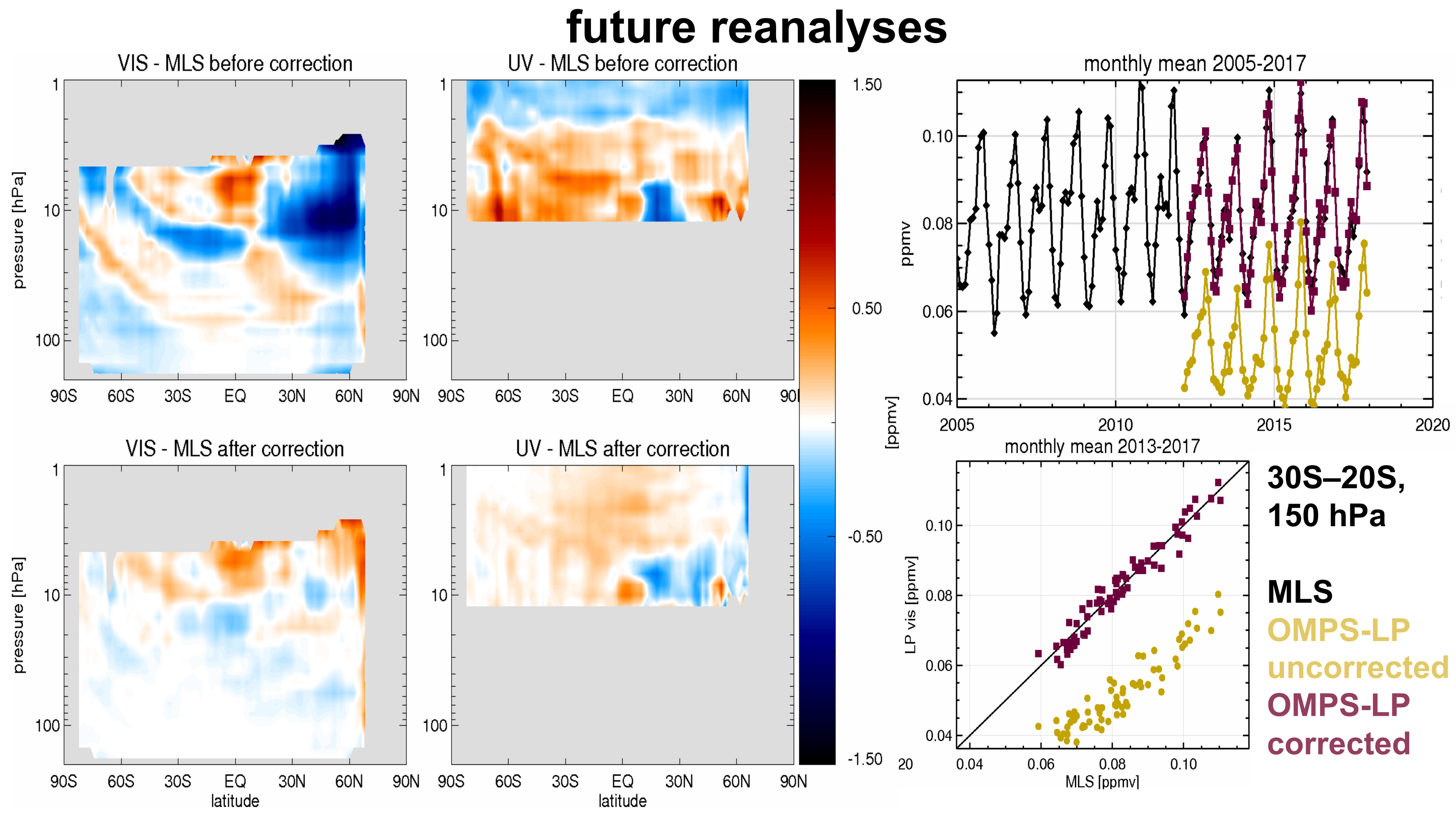
Ozone Mapping Profiler Suite Limb Profiler (OMPS-LP) provides ozone information from scattered visible and ultraviolet radiation.

Can OMPS-LP and MLS observations be combined into a homogenized data set for a future "trends-friendly" reanalysis?



Comparing assimilated data with in-situ sondes: similar overall agreement for both MLS and OMPS-LP.

Construction of a homogenized MLS + OMPS-LP data set for future reanalyses



A simple off-line homogenization scheme: monthly zonal mean differences between OMPS-LP and MLS are averaged over the period between 2013 and 2017 and subtracted from OMPS-LP data. The visible (VIS) and ultraviolet (UV) OMPS-LP channels are treated separately.

The homogenized product exhibits an excellent agreement between MLS and the corrected OMPS-LP data. Drifts require further evaluation!

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