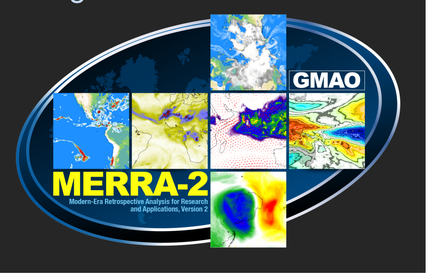
Evaluation of the Ozone Fields in NASA's MERRA-2 Reanalysis

Krzysztof Wargan[1,2], Steven Pawson[1], Gordon Labow[1,2], Stacey Frith[1,2], Nathaniel Livesey[3], and Gary Partyka[1,2]

[1]NASA GSFC, Code 610.1, Greenbelt, MD, USA ; [2]SSAI, Lanham, MD, USA; [3]Jet Propulsion Laboratory, Pasadena, CA, USA

GMAO
Global Modeling & Assimilation Office



Rationale: Assimilating Ozone in MERRA-2

Reanalysis ozone should be recognized as a useful tool for scientific studies

Guiding principles

1. Achieve a faithful representation of ozone fields, particularly in the Upper Troposphere – Lower Stratosphere
2. When possible use the best data available but…
3. Avoid too many temporal discontinuities
4. It is more important to get the variability right than to minimize biases
5. Validate the product: it does not have to be perfect but it will be useful if its uncertainties are quantified

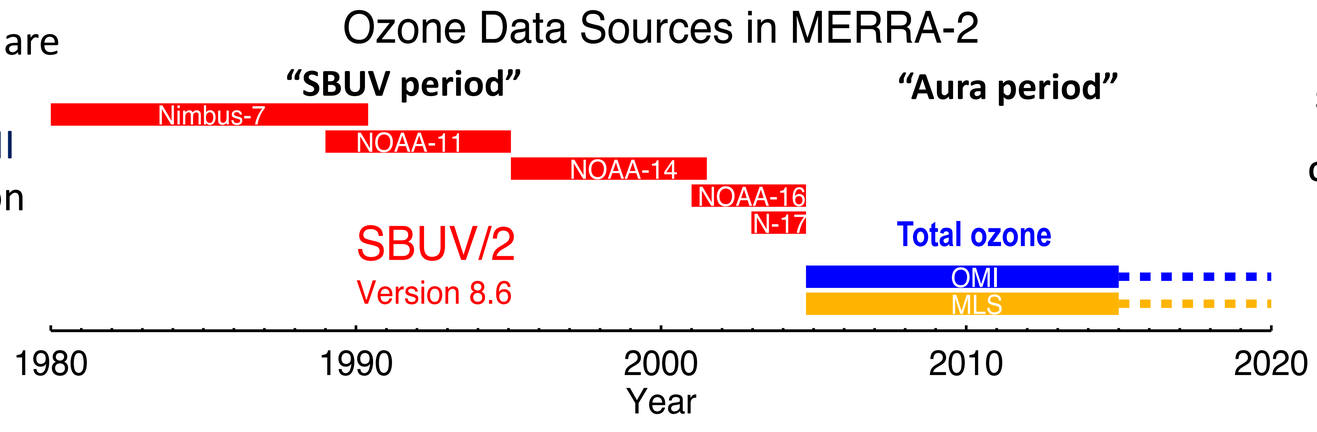
Summary: Usefulness for Science

- Comparisons with satellite data: difference standard deviations within 20% above 100 hPa and within 10% in the middle stratosphere
- Ozonesondes: good representation of variability in the lower stratosphere (LS)
- Representation of LS variability improves in the Aura period
- Upper tropospheric ozone has a low bias in the Aura period but exhibits high correlations with ozonesondes
- MERRA-2 ozone has already been used in several recent scientific studies

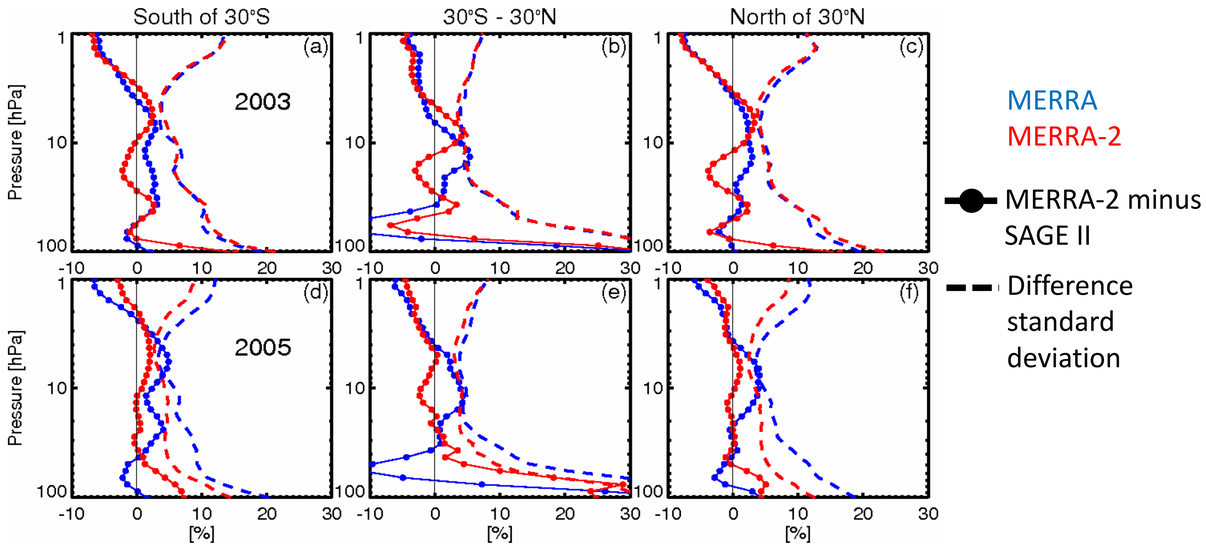
Reference

Wargan K., et al., 2017: Evaluation of the ozone fields in NASA's MERRA-2 Reanalysis, J. Clim. doi:10.1175/JCLI-D-16-0699.1

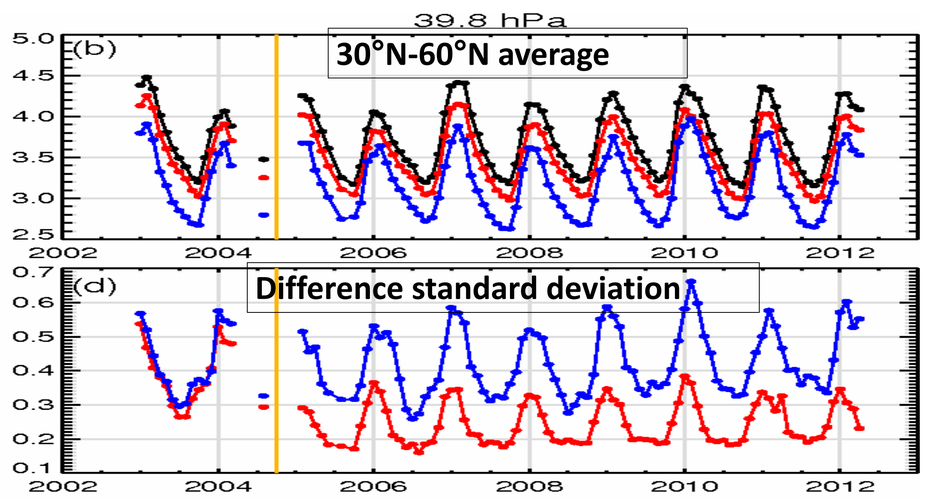
1980-2004: SBUV partial and total columns are assimilated.
2004-present: total column ozone from OMI and stratospheric profiles from MLS, both on the Aura satellite are used instead.
The change from SBUV to Aura results in a discontinuity that should be quantified.
GMAO's MERRA reanalysis used only SBUV



Stratosphere

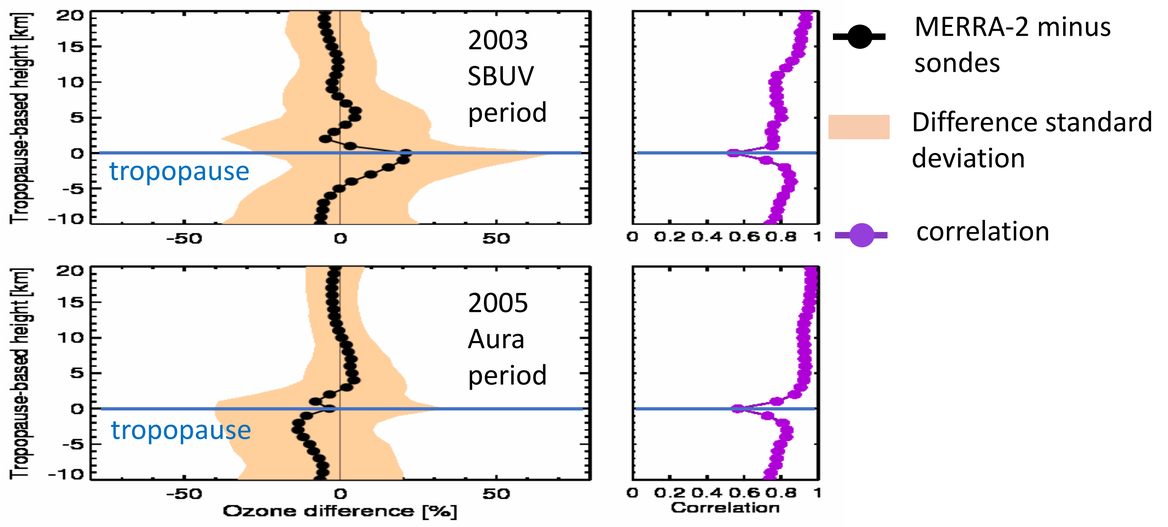


Bias with respect to SAGE II is within ~5% above 50 hPa in both reanalysis in 2003. Difference standard deviation is within ~10% above 50 hPa, up to 20% below.
In 2005 (Aura period) the bias and the difference standard deviation in MERRA-2 are significantly reduced compared to MERRA and to the SBUV period in MERRA-2.

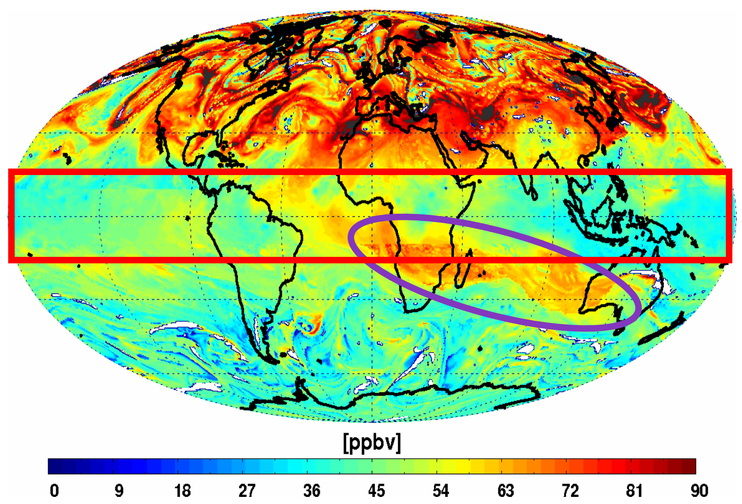


The seasonal cycle is captured by both reanalyses; MERRA-2 has a smaller bias. Difference standard deviations in the SBUV period range from 0.3 to 0.6 ppmv for both reanalyses in the SBUV period and improve by a factor of two in MERRA-2 in the Aura period.

Upper Troposphere – Lower Stratosphere



There is a good agreement between MERRA-2 and ozonesondes in the UTLS overall. The Aura period: Smaller difference standard deviations, sharper cross-tropopause gradients and higher correlations but there is a low bias in the upper troposphere.



Mean ozone mixing ratio between 500 hPa and the tropopause from MERRA-2 on 1 July 2013.

Despite a low bias (as seen above) MERRA-2 produces realistic spatial representation of upper tropospheric ozone. Readily seen are high concentrations in the northern extratropics, the tropical "wave one" and the Southern Hemisphere ozone maximum

E-mail: steven.pawson@nasa.gov | *Web:* gmao.gsfc.nasa.gov

SSAI JPL National Aeronautics and Space Administration NASA