Tropospheric ozone derived from Suomi NPP OMPS satellite measurements

Ziemke[1,2], J. R., N. A. Kramarova[1], P. K. Bhartia[1], R. D. McPeters[1], G. J. Labow[3], L. D. Oman[1]

[1] NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

[2] GESTAR/Morgan State University, Baltimore, Maryland, USA

[3] SSAI, Lanham, Maryland, USA

AMS 2019 Meeting – Phoenix, AZ 6-10 January 2019

Goal

Develop a daily global tropospheric ozone operational data product of high accuracy/precision for March 2012 – present from Suomi NPP OMPS satellite measurements

Why Important?

- Tropospheric ozone is important as a greenhouse gas and radiative forcing of the atmosphere

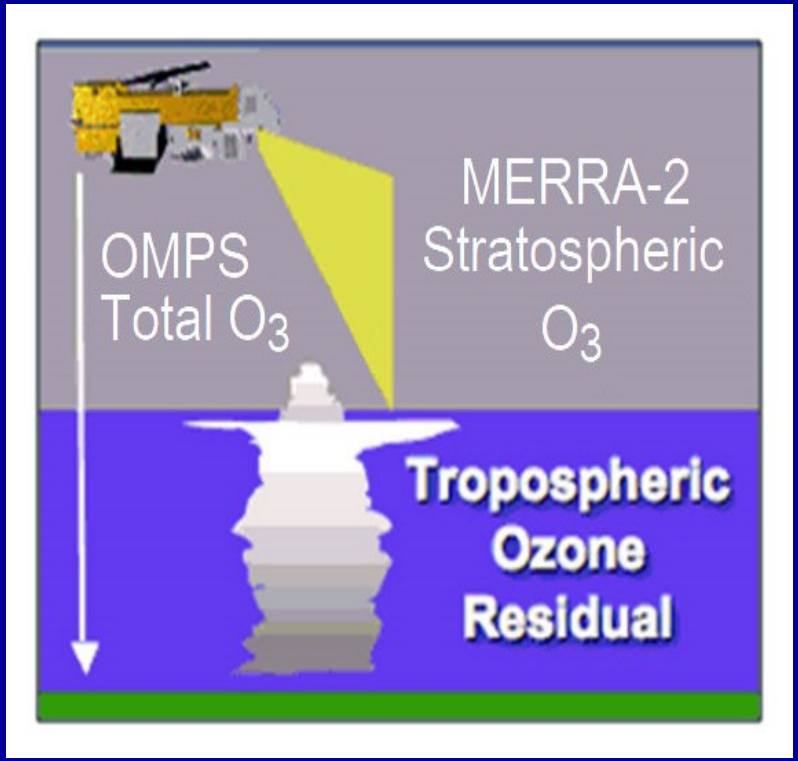
- Tropospheric ozone provides assessment of regional pollution, STE, and changes in global circulation from short to decadal/trend timescales

- Tropospheric ozone can be used to aid in evaluation and development of global chemical transport models

Methodology to Derive Tropospheric Column Ozone

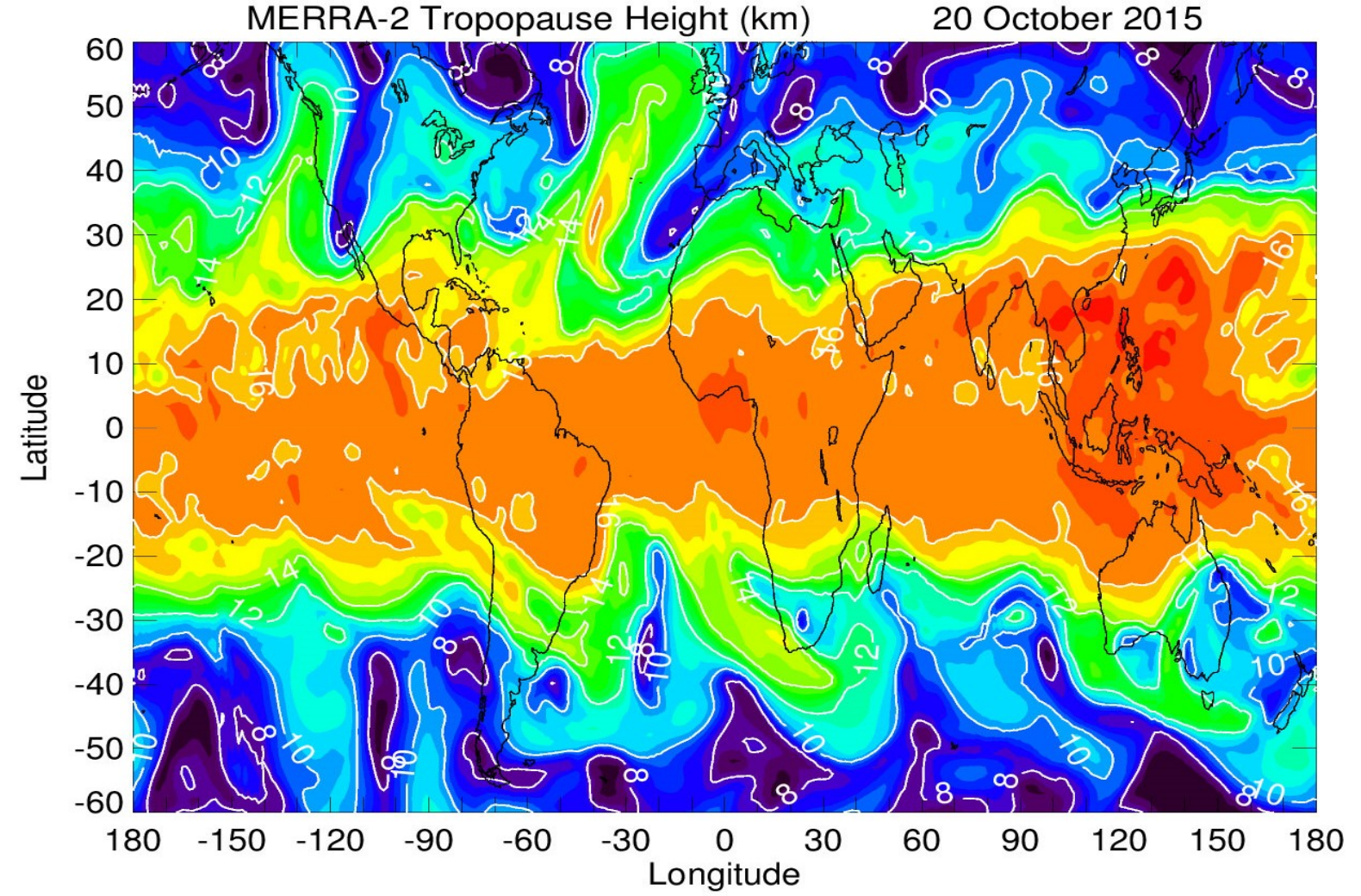
Tropospheric column ozone = OMPS nadir mapper total column ozone minus co-located MERRA-2 stratospheric column ozone

Tropopause pressure is derived from MERRA-2 potential vorticity (2.5 PVU) and potential temperature (380 K)



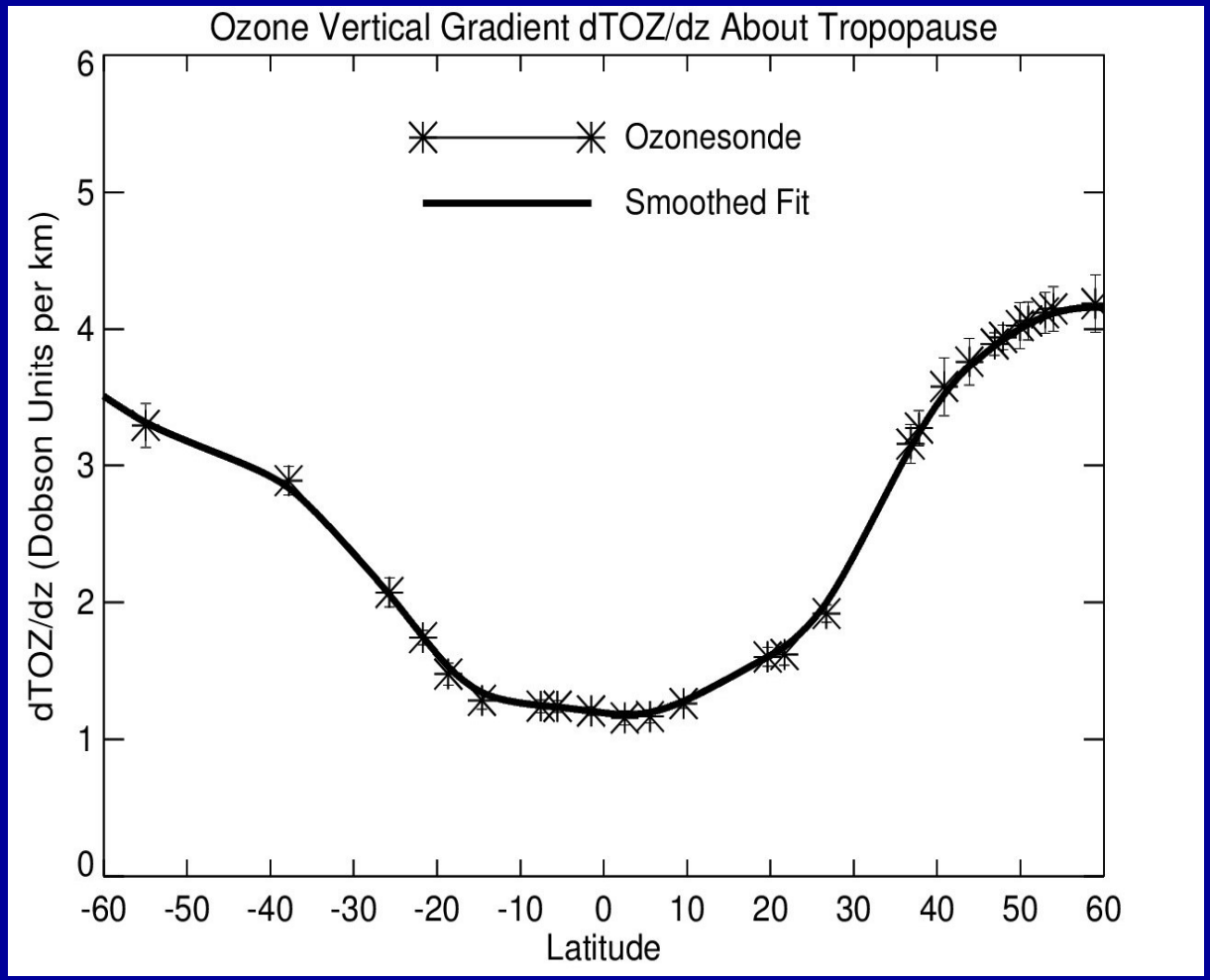
(Note: MERRA-2 is assimilated MLS ozone profiles)

Tropopause Height (km)



MERRA-2: Mapped to OMPS orbital footprint times

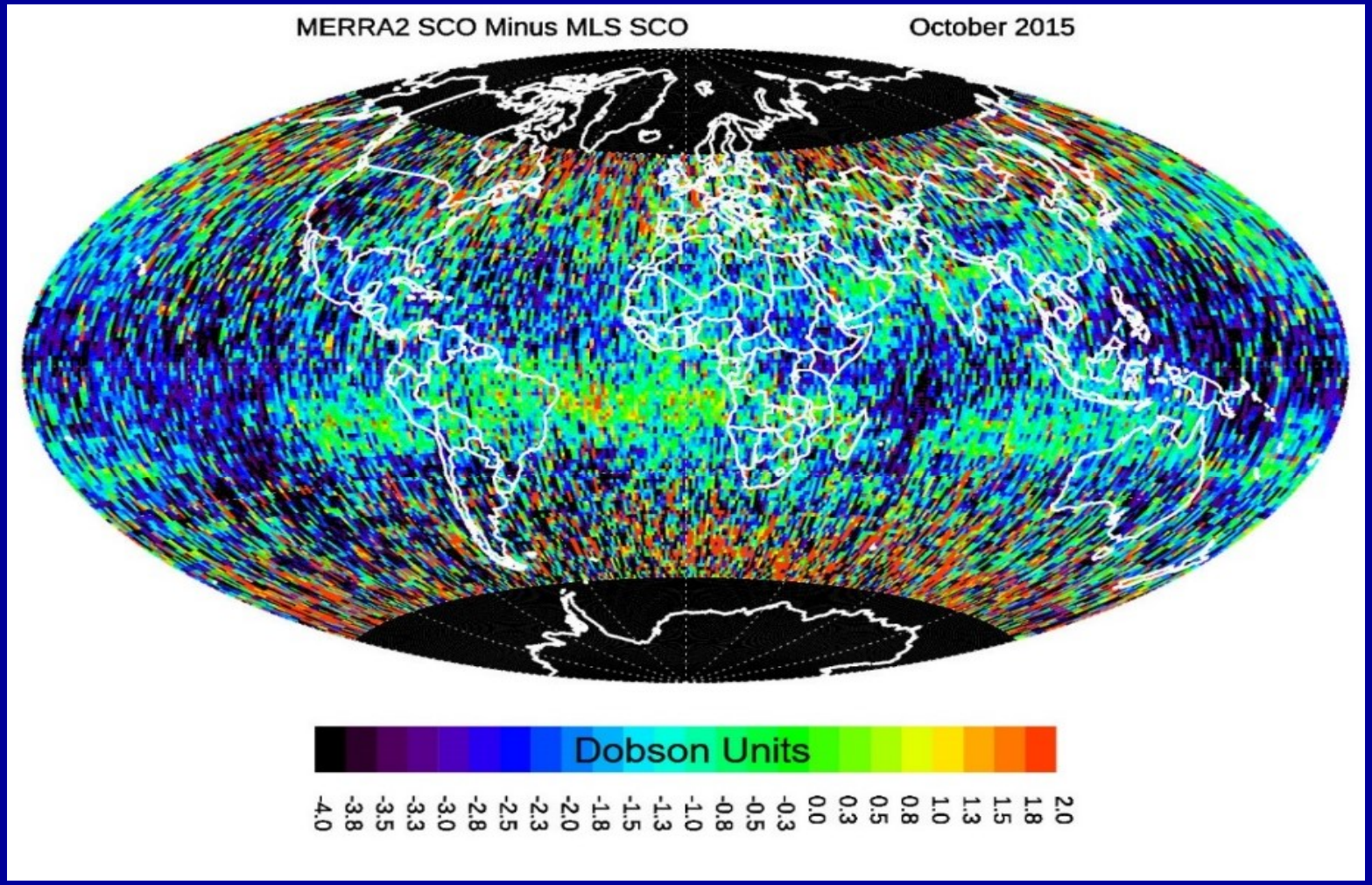
Error in Tropopause Pressure/Height is Not a Major Source of Error in Tropospheric Ozone



Sondes:

Approximate error in tropospheric column ozone due to a ±1 km error in tropopause height

How Good is MERRA-2 Daily SCO?



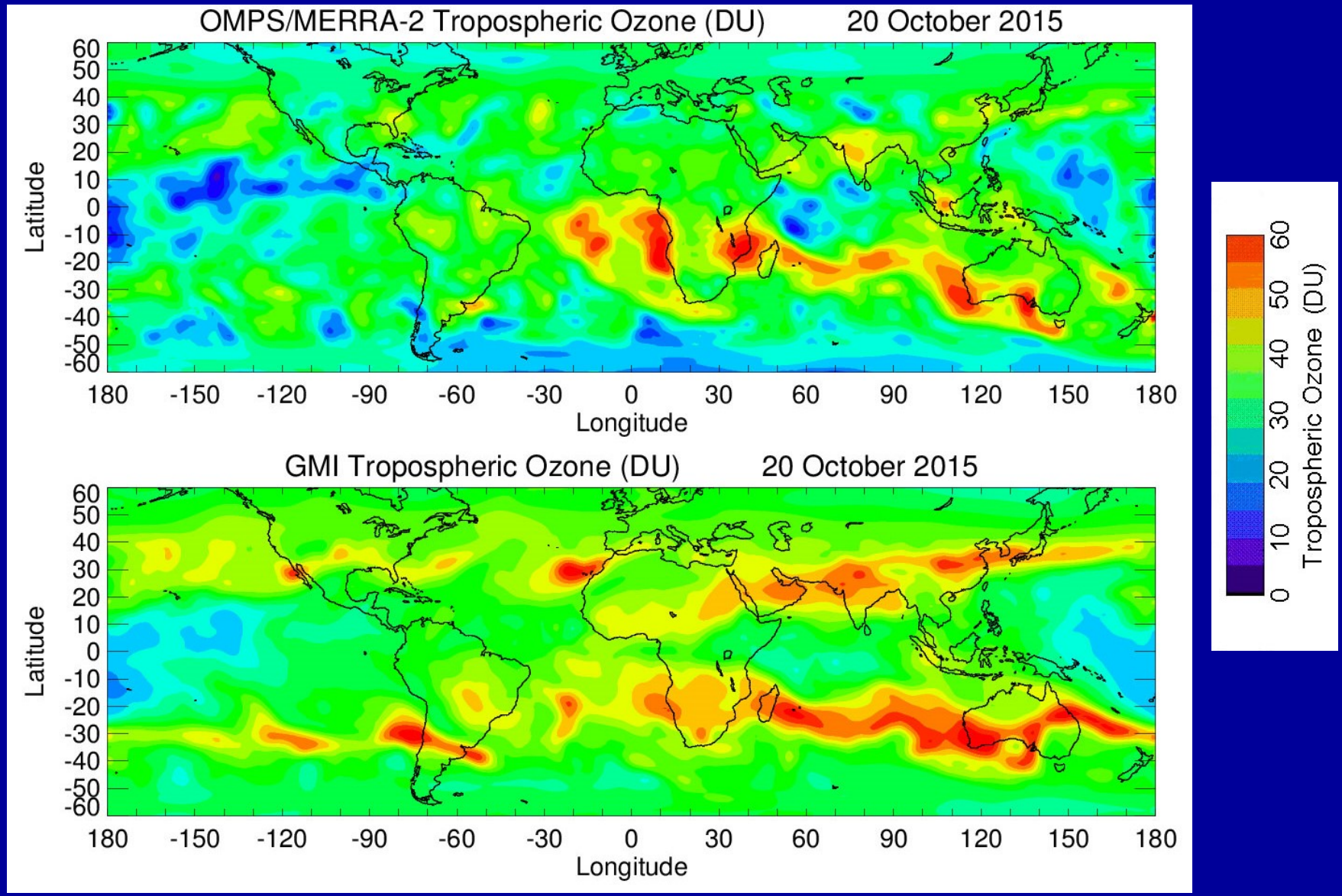
Answer: ~2-3 DU everywhere in replicating and filling in MLS daily SCO between orbits

A Larger Source of Regional Error is OMPS Difficulty in Detecting Boundary Layer Ozone

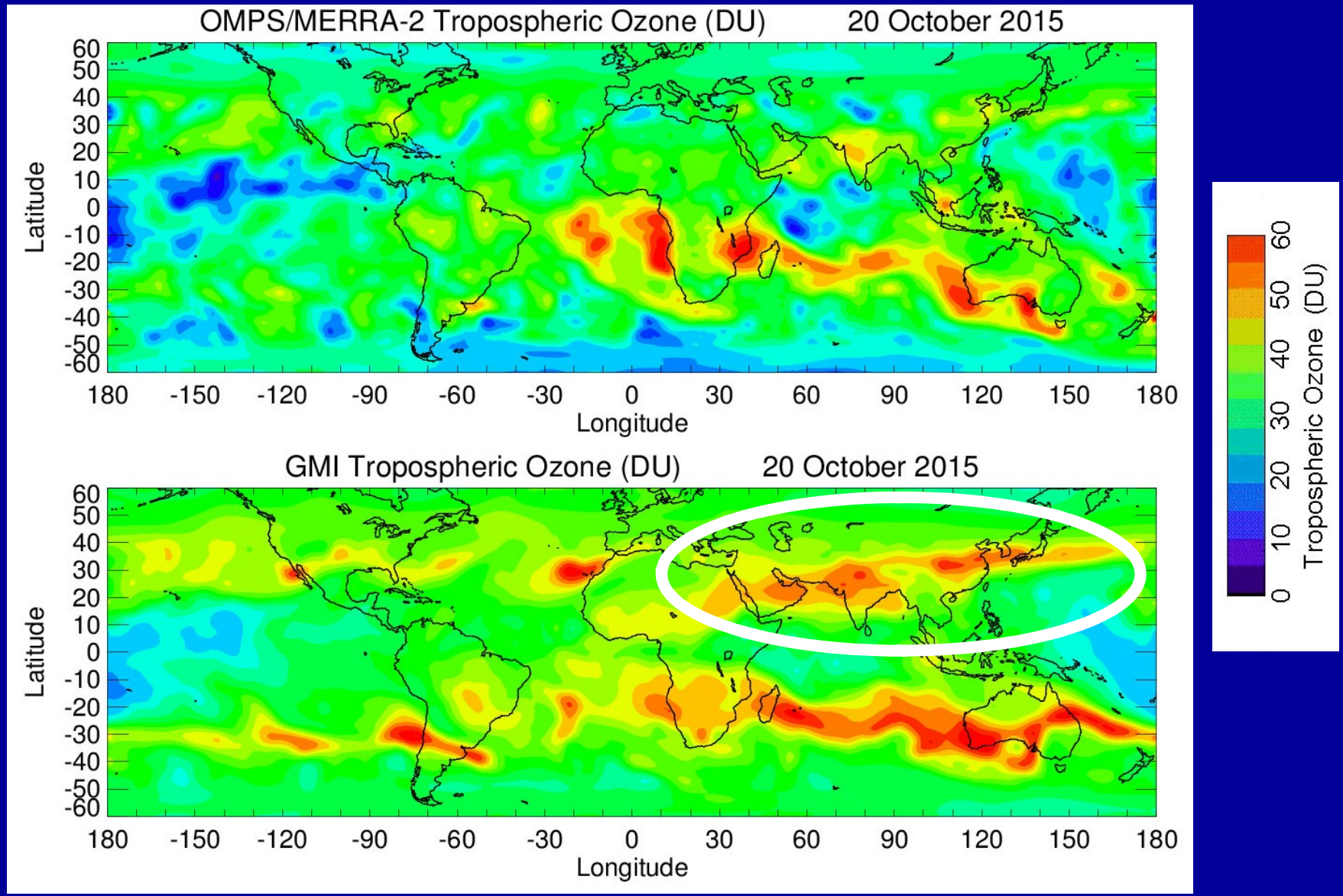
Approach: Use the MERRA-2 Global Modeling Initiative (GMI) simulation of ozone to assess these errors and correct OMPS total ozone using OMPS BL sensitivity (i.e., apply OMPS averaging kernels to GMI)

(MERRA-2 GMI is a global chemistry-transport model from NASA GSFC Code 614 where MERRA-2 assimilated winds from GSFC GMAO are used)

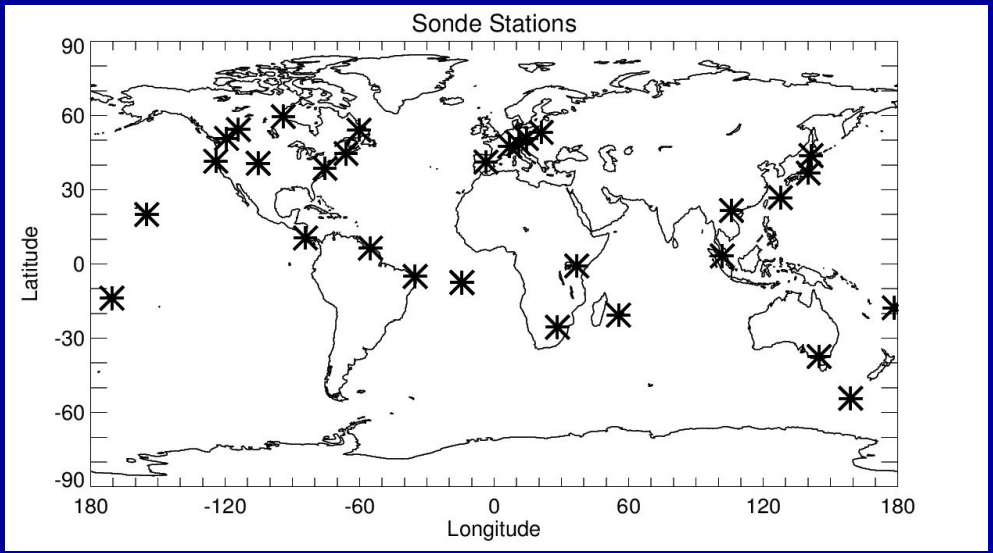
OMPS versus GMI shows discrepancies – partly due to OMPS missing some BL ozone



OMPS versus GMI shows discrepancies – partly due to OMPS missing some BL ozone

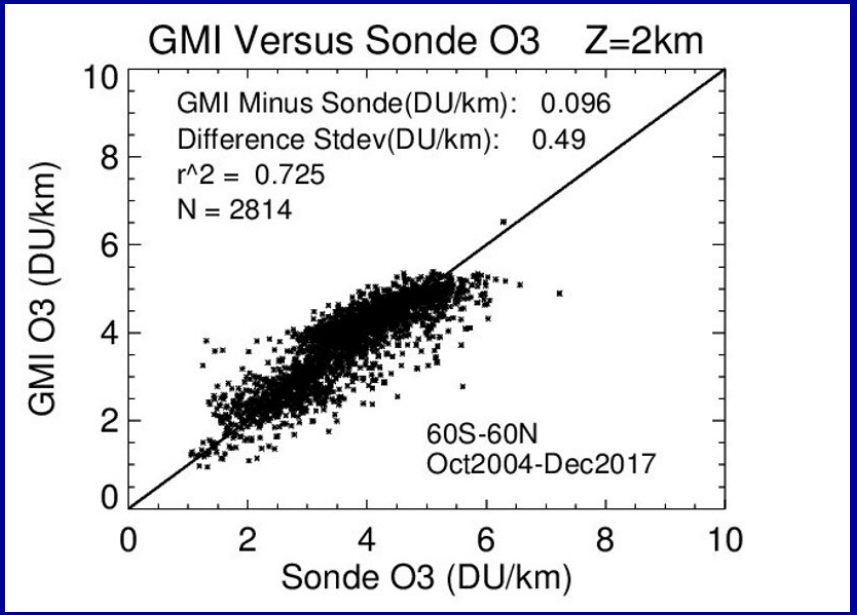


MERRA-2 GMI Boundary-Layer Ozone at 2 km

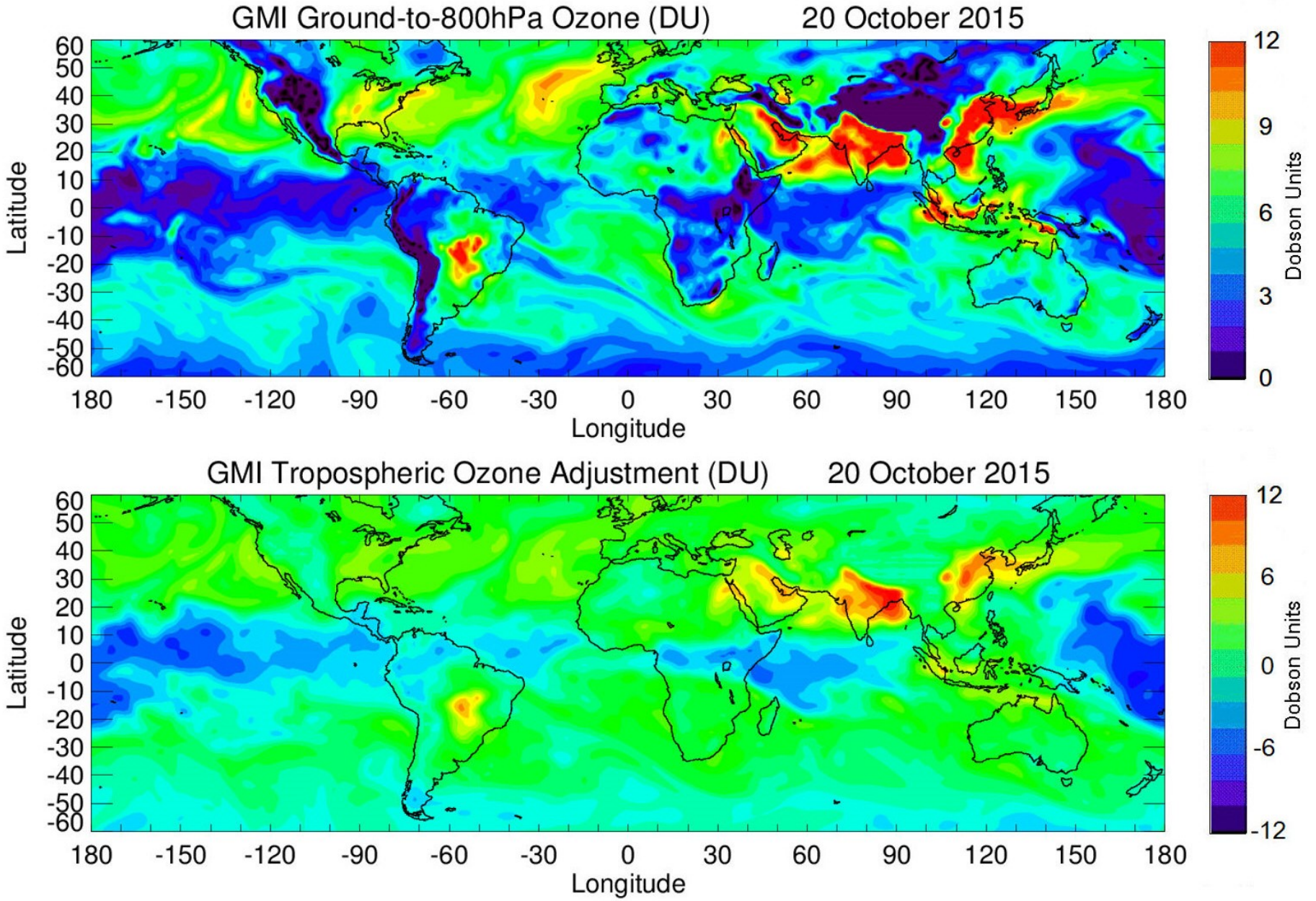


31 stations
60°S-60°N

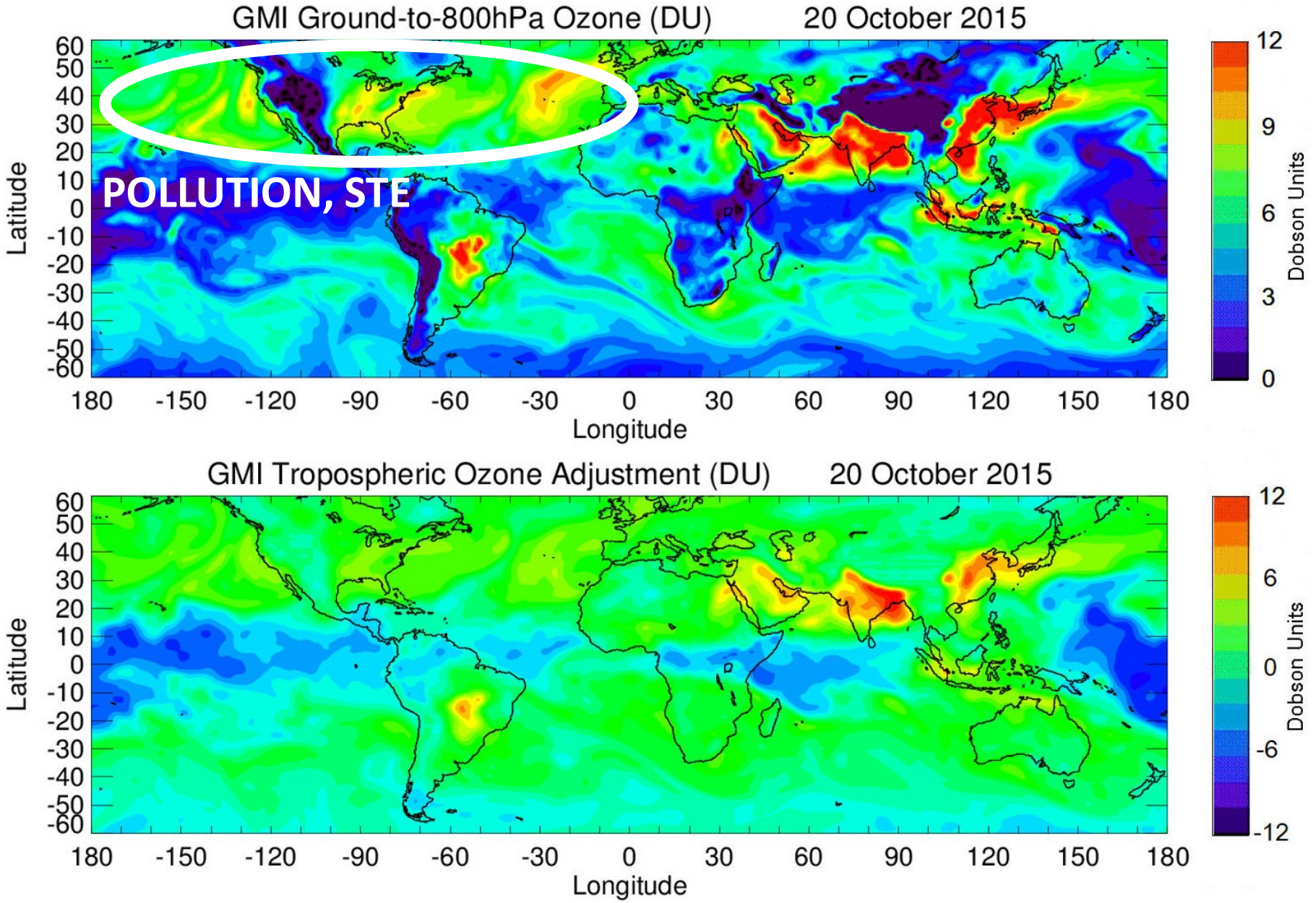
Daily co-located
matchups
for 2004-2017



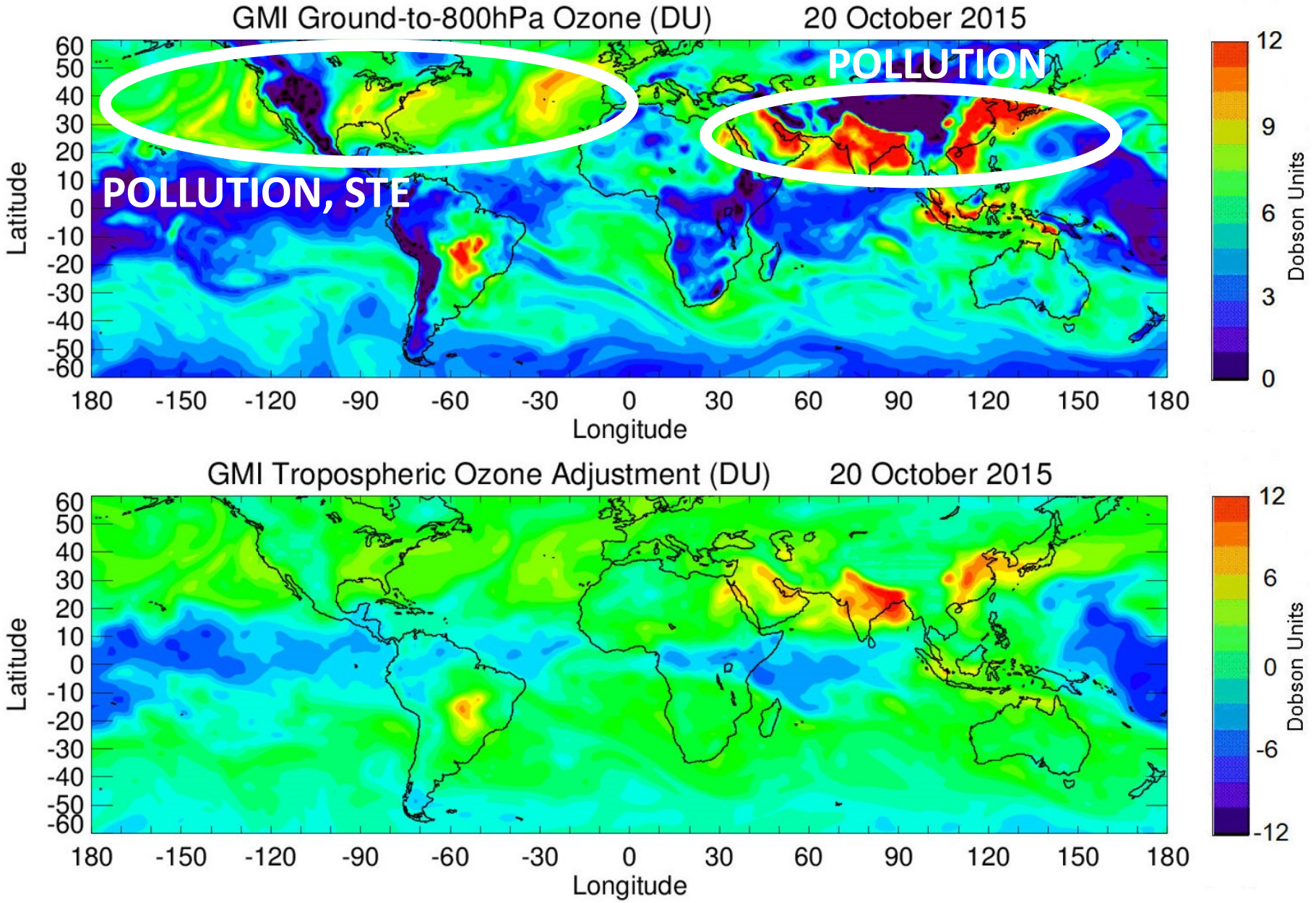
GMI Indicates that OMPS misses some BL ozone



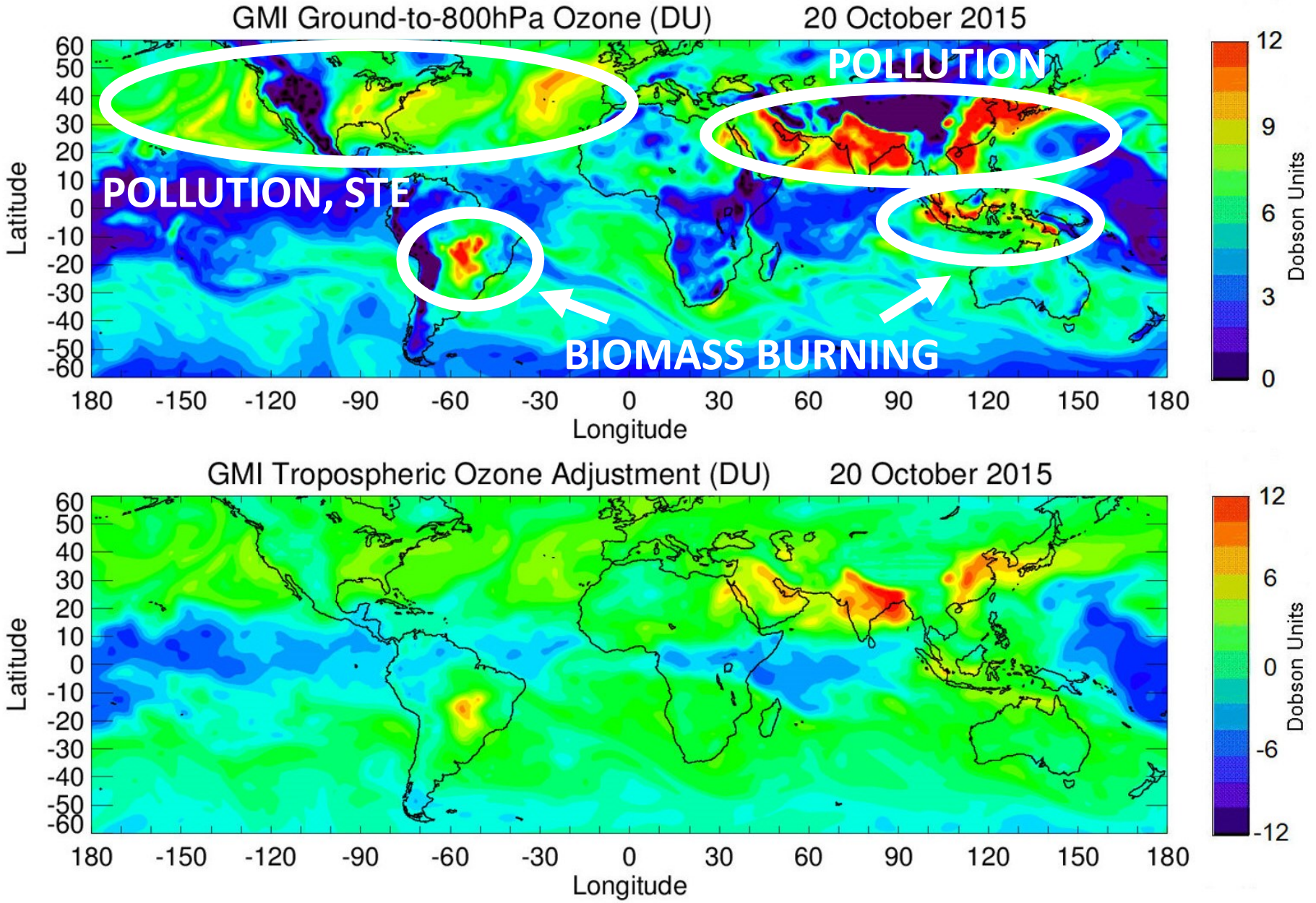
GMI Indicates that OMPS misses some BL ozone



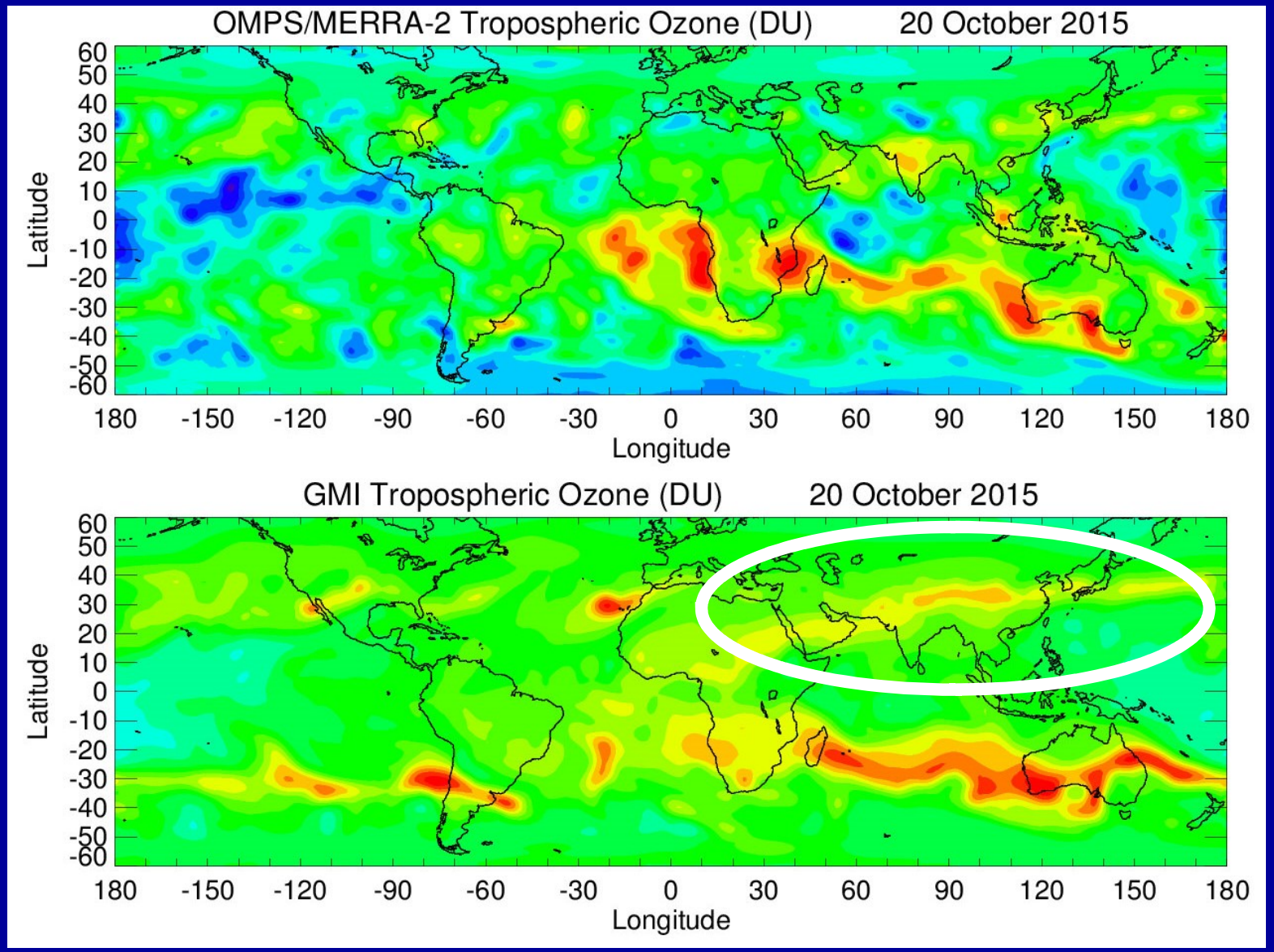
GMI Indicates that OMPS misses some BL ozone



GMI Indicates that OMPS misses some BL ozone



Agreement is better after GMI is adjusted for OMPS averaging kernels

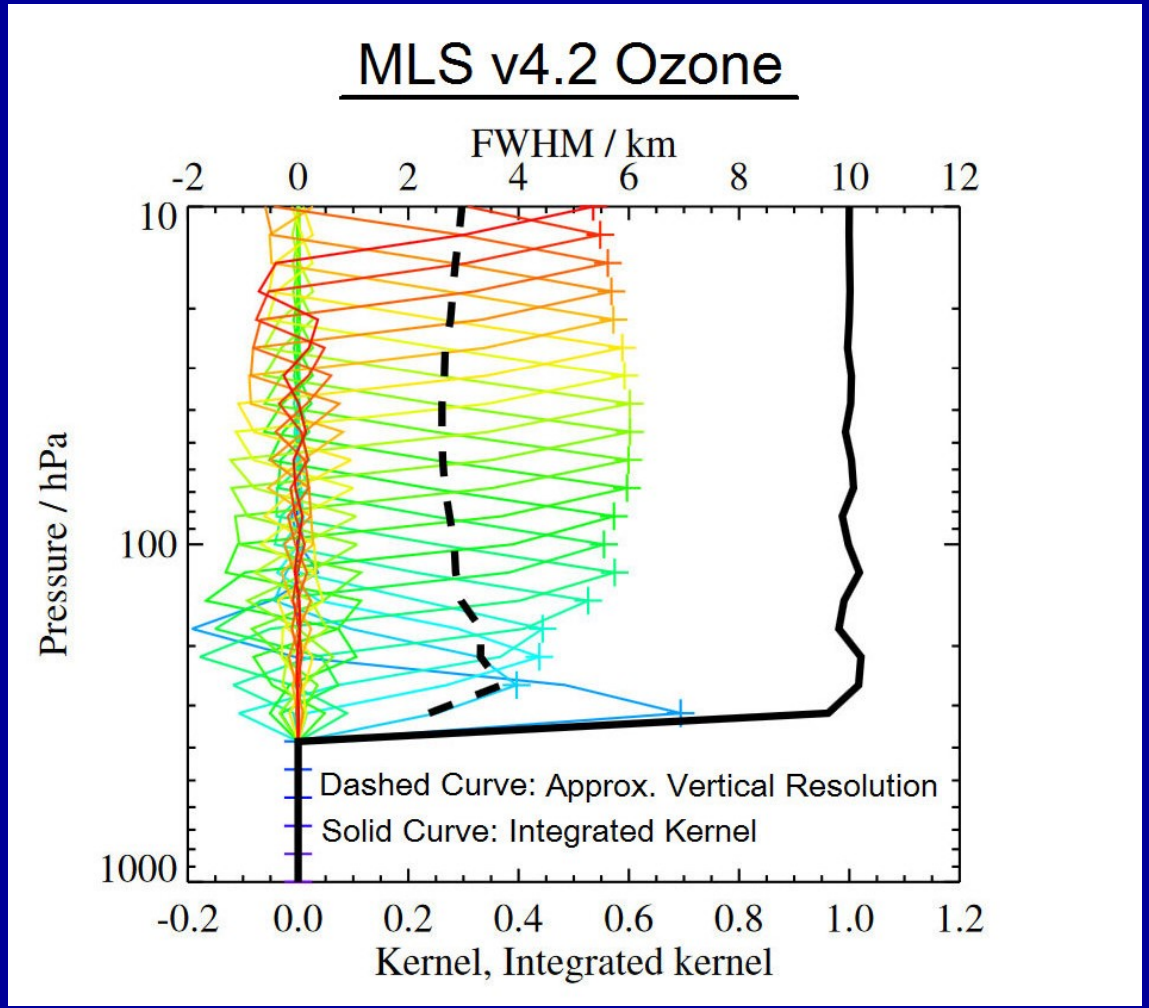


Conclusions

- Analyses shows OMPS/MERRA-2 tropospheric ozone to be a viable daily product with global coverage (outside polar night regions) for March 2012 – present
- Largest regional error in OMPS/MERRA-2 tropospheric ozone appears to be OMPS difficulty in detecting BL ozone (We adjust OMPS total ozone using the GMI model simulation of BL ozone)
- OMPS/MERRA-2 will continue the record of OMI/MLS and TOMS tropospheric ozone for 1979 – present

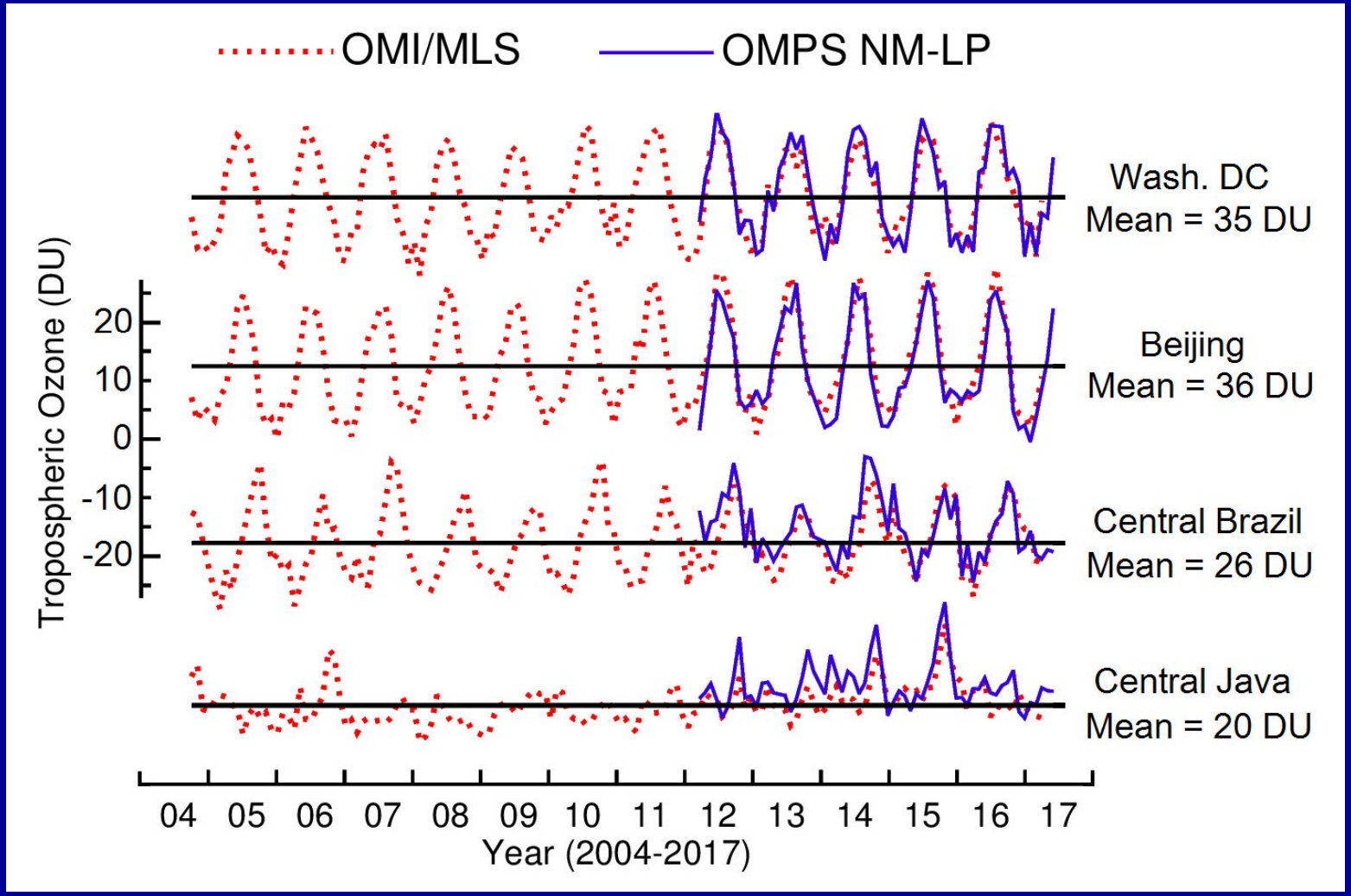
Extra Slides

MLS measures stratospheric column ozone with high precision and accuracy

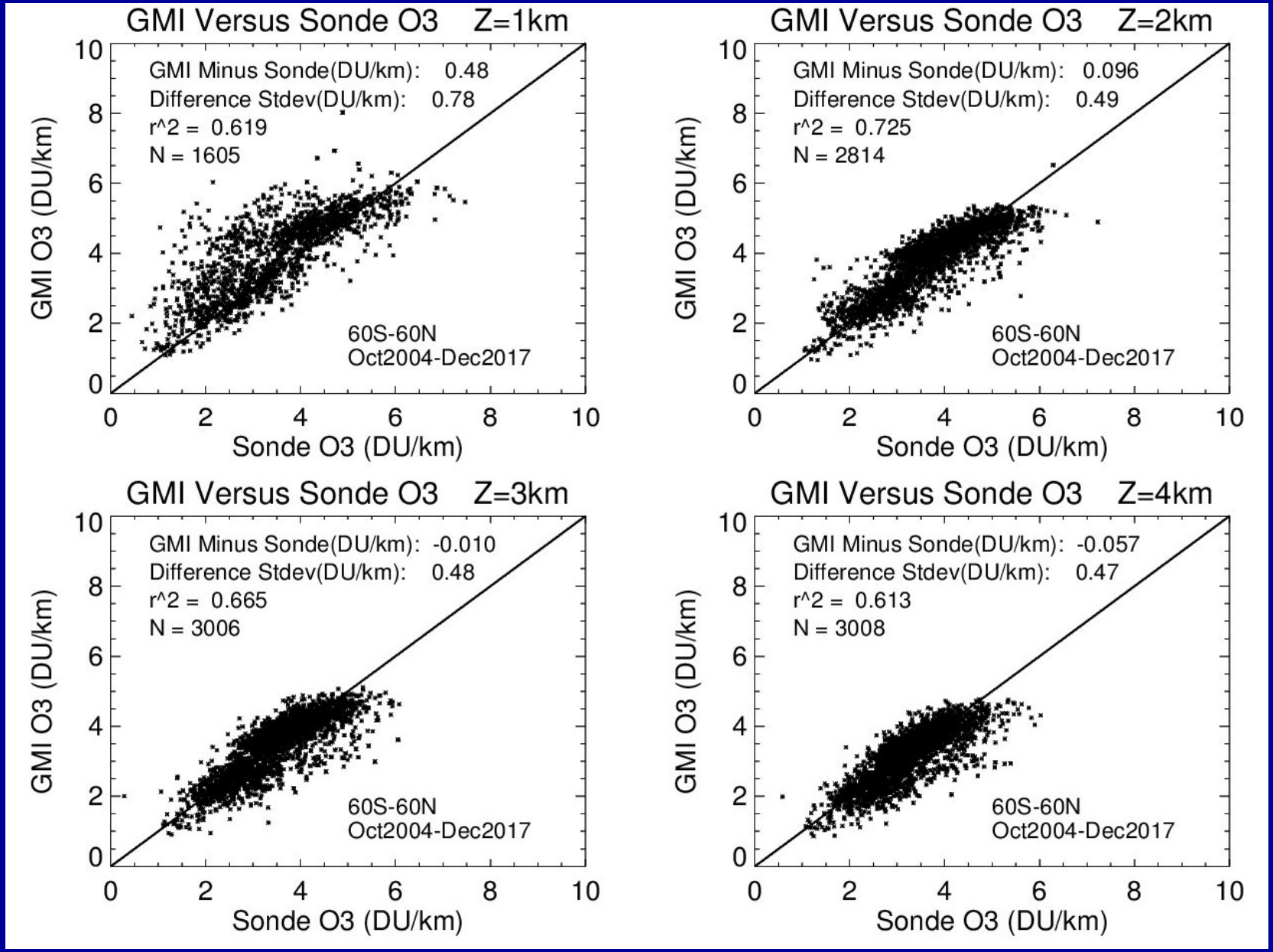


(MLS v4.2 data product user's guide)

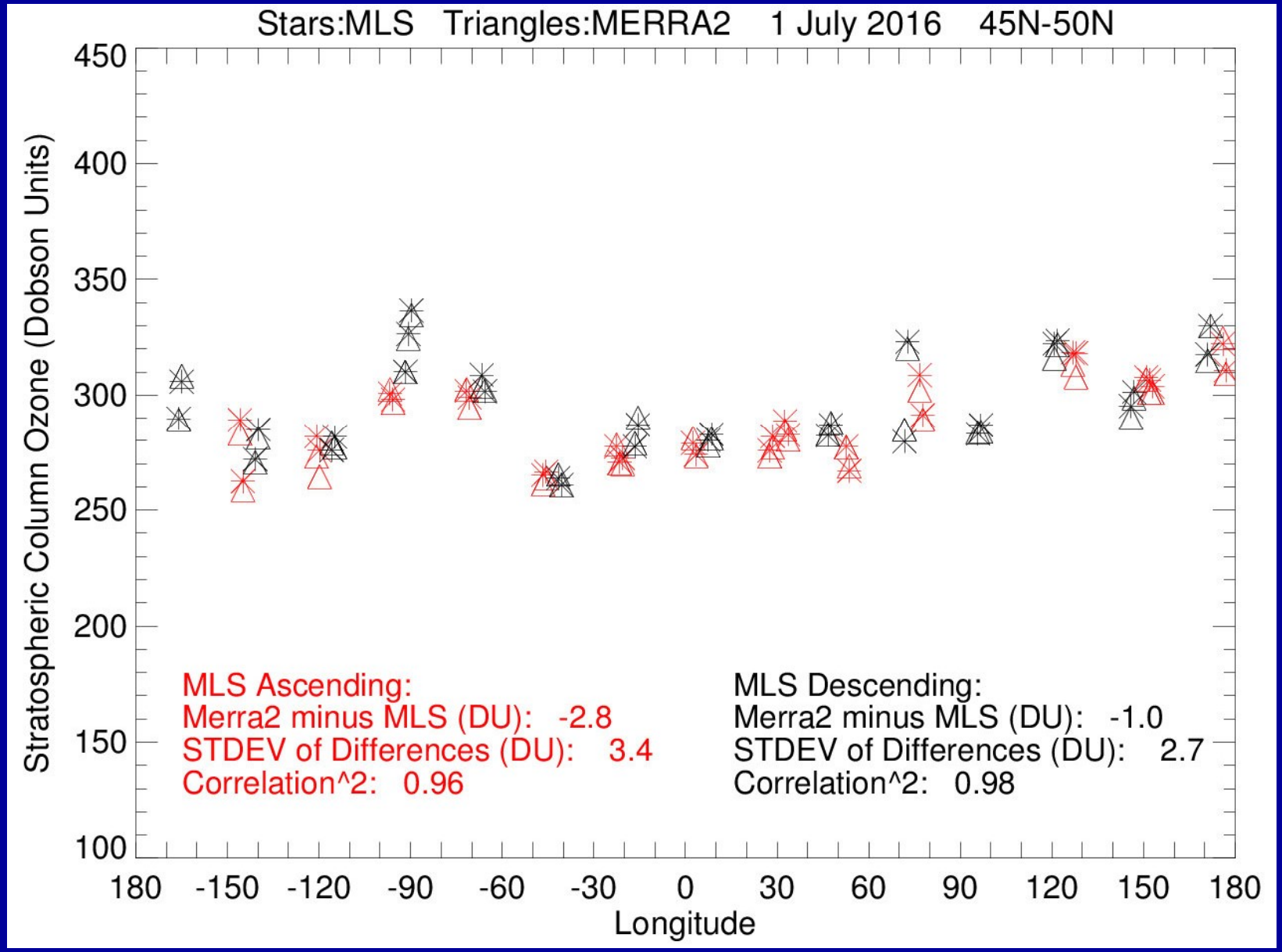
OMPS will continue the OMI/MLS record of tropospheric ozone that starts October 2004



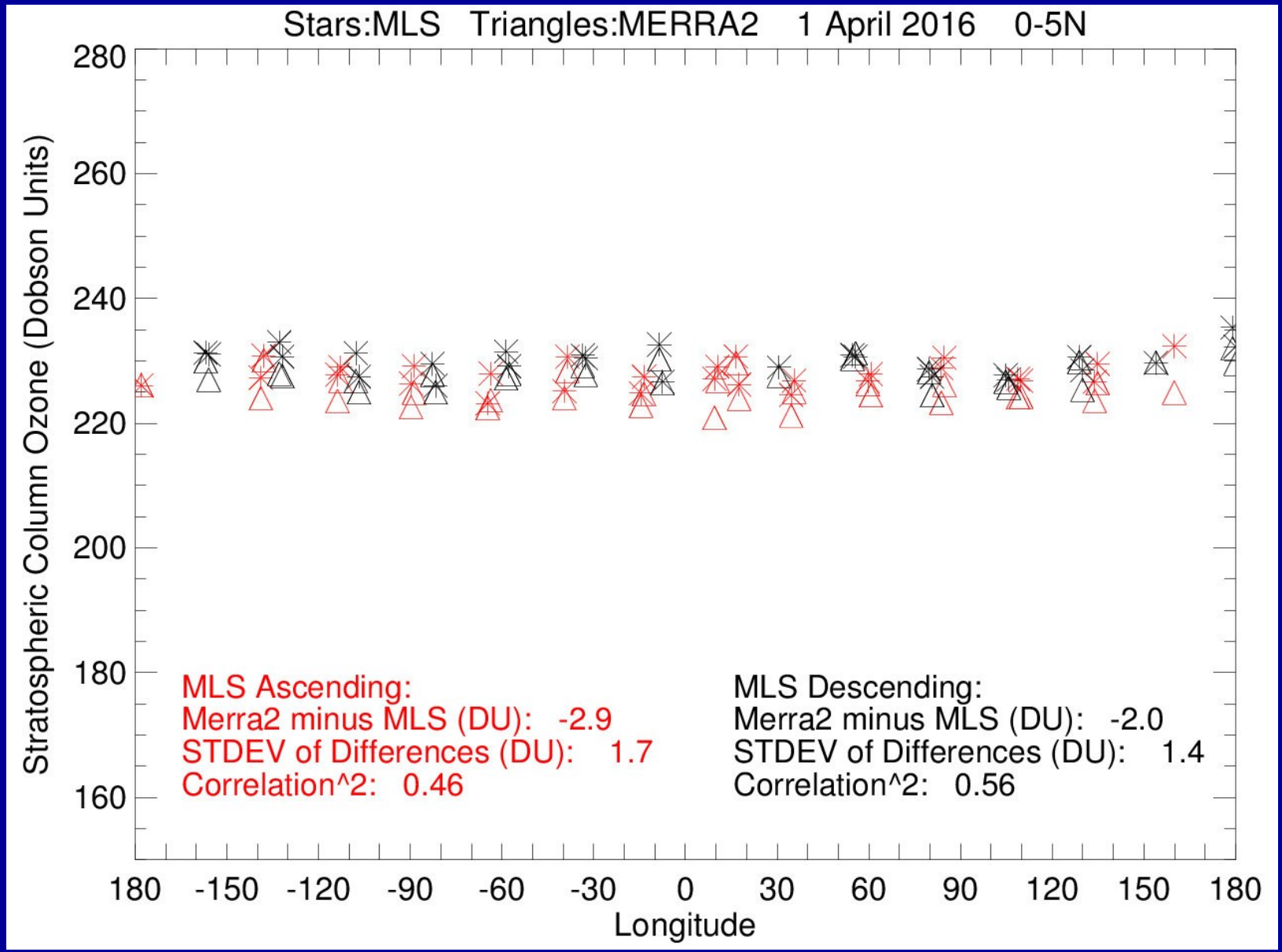
MERRA-2 GMI Boundary-Layer Ozone at 1,2,3,4 km



MLS SCO (stars) versus MERRA-2 SCO (triangles)

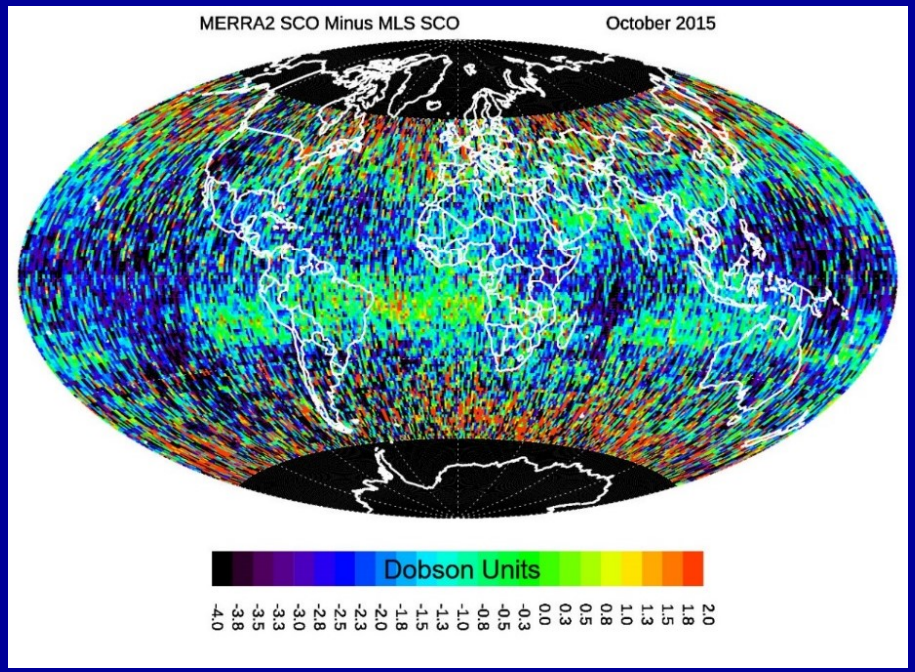


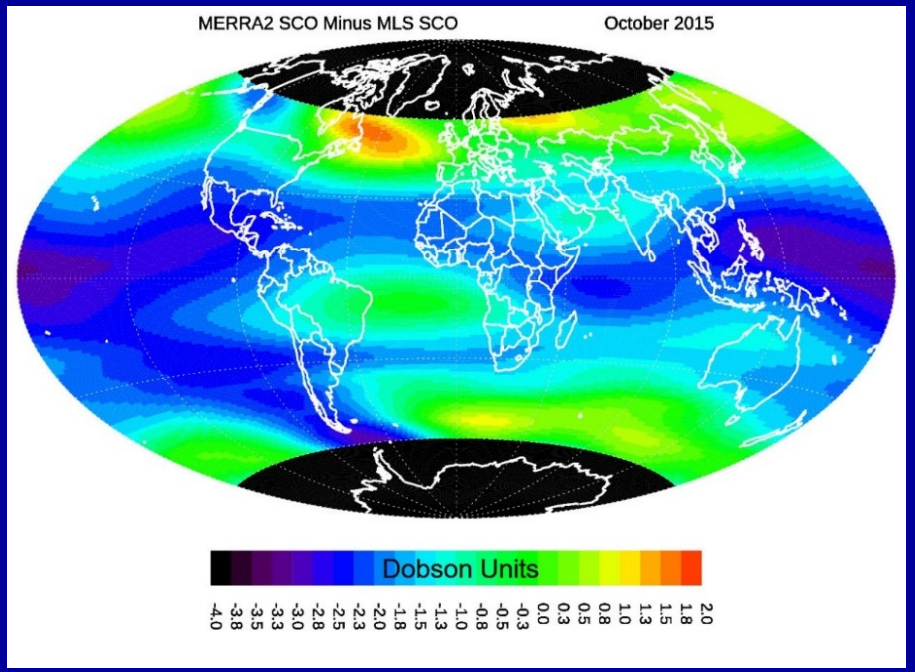
MLS SCO (stars) versus MERRA-2 SCO (triangles)



Validation: Just How Good is MERRA-2 Daily SCO?

(Co-located MERRA-2 SCO minus MLS SCO daily differences accrued over entire month)

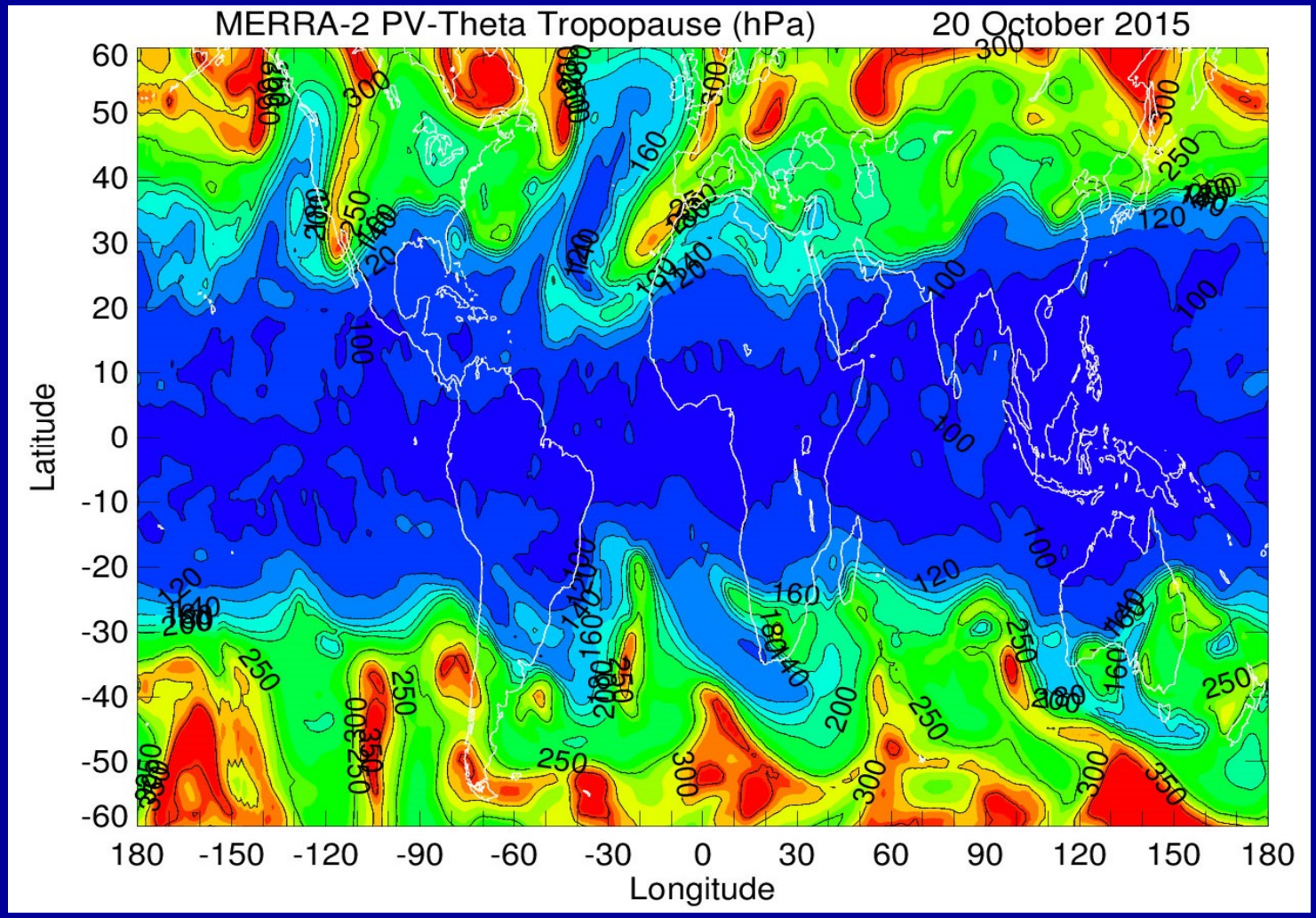




MLS SCO: Both ascending and descending daily measurements

MERRA-2 SCO: Precisely space-time co-located with MLS each day

Tropopause Pressure (hPa)



MERRA-2: Mapped to OMPS orbital footprint times