Tropospheric ozone derived from Suomi NPP OMPS satellite measurements

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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

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
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MERRA-2 GMI Boundary-Layer Ozone at 2 km

Daily co-located matchups for 2004-2017

31 stations 60°S-60°N
GMI Indicates that OMPS misses some BL ozone
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![GMI Ground-to-800hPa Ozone (DU) map for 20 October 2015](image)

- Pollution
- Biomass Burning

![GMI Tropospheric Ozone Adjustment (DU) map for 20 October 2015](image)
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.
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

GMI Versus Sonde O3  Z=1km
- GMI Minus Sonde (DU/km): 0.48
- Difference Stdev (DU/km): 0.78
- $r^2 = 0.619$
- N = 1605

GMI Versus Sonde O3  Z=2km
- GMI Minus Sonde (DU/km): 0.096
- Difference Stdev (DU/km): 0.49
- $r^2 = 0.725$
- N = 2814

GMI Versus Sonde O3  Z=3km
- GMI Minus Sonde (DU/km): -0.010
- Difference Stdev (DU/km): 0.48
- $r^2 = 0.665$
- N = 3006

GMI Versus Sonde O3  Z=4km
- GMI Minus Sonde (DU/km): -0.057
- Difference Stdev (DU/km): 0.47
- $r^2 = 0.613$
- N = 3008

60S-60N  Oct2004-Dec2017
MLS SCO (stars) versus MERRA-2 SCO (triangles)

**Stars:** MLS
**Triangles:** MERRA2
1 July 2016
45N-50N

**MLS Ascending:**
Merra2 minus MLS (DU): -2.8
STDEV of Differences (DU): 3.4
Correlation^2: 0.96

**MLS Descending:**
Merra2 minus MLS (DU): -1.0
STDEV of Differences (DU): 2.7
Correlation^2: 0.98
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