OMPS data validation with NOAA ground-based systems

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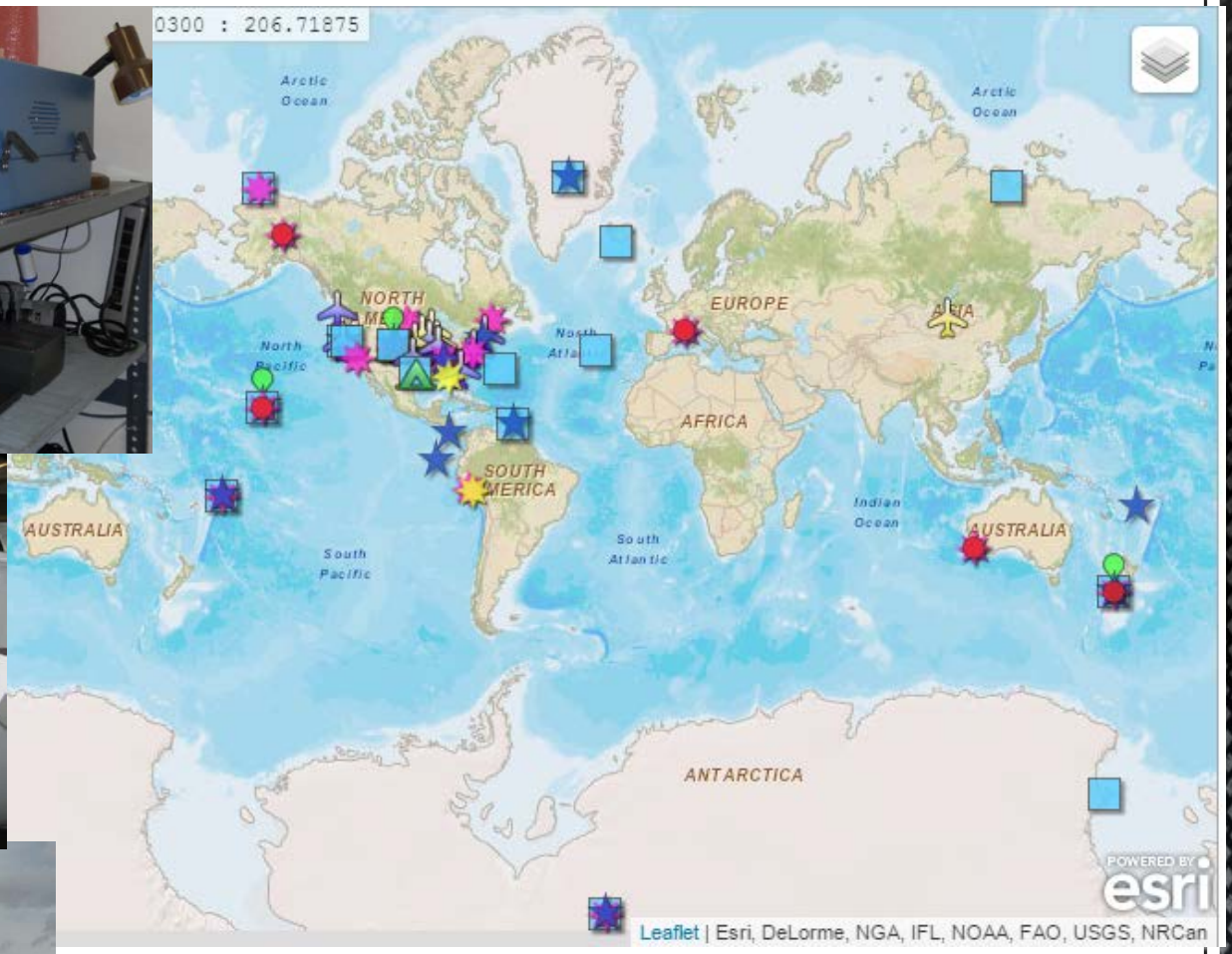
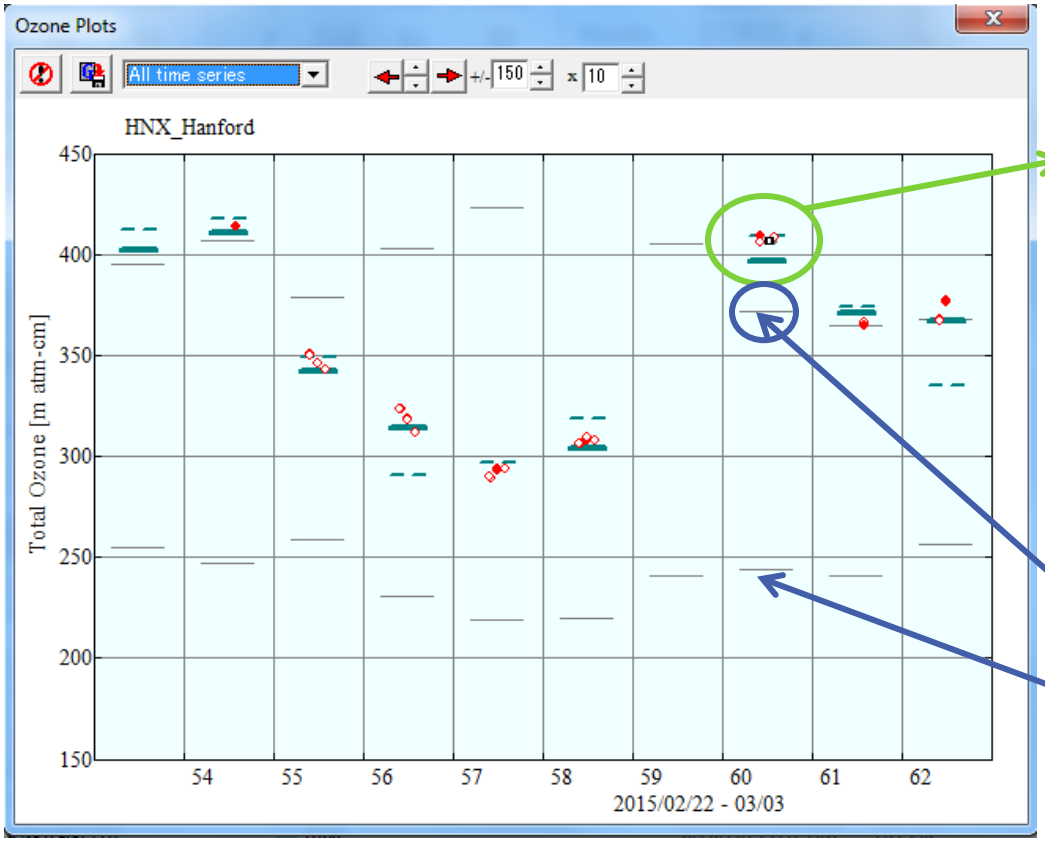
Introduction to NOAA's Ozone Network



NOAA GMD ozone and water vapor group maintains long-term records of total column and ozone profiles at 20+ unique locations around the globe.

Comparison of Daily Total Ozone Variability

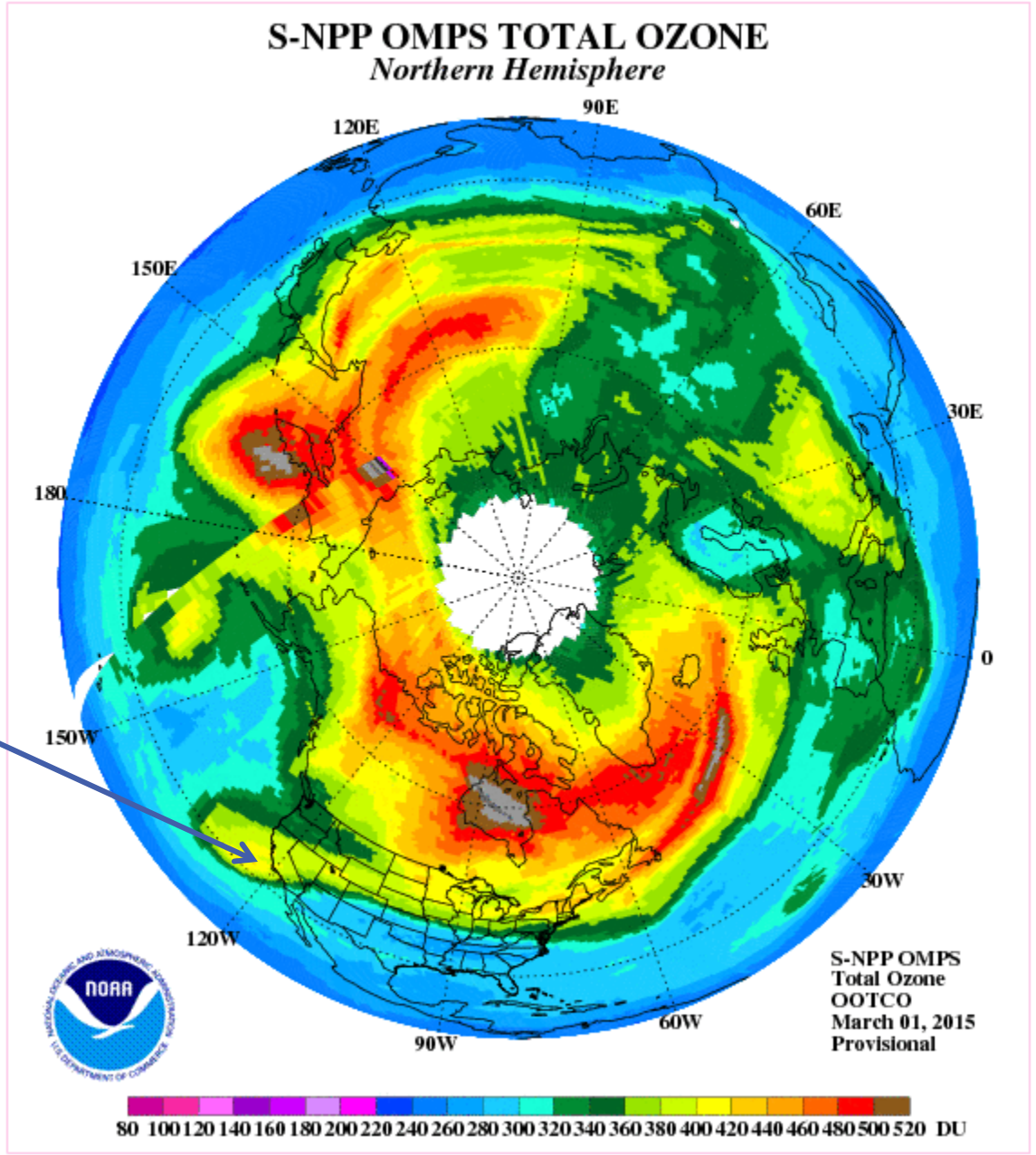


Example for ozone column measurements at NOAA Dobson station Hanford, CA (red circles) and OMPS total column ozone reading over the station (Teal lines).

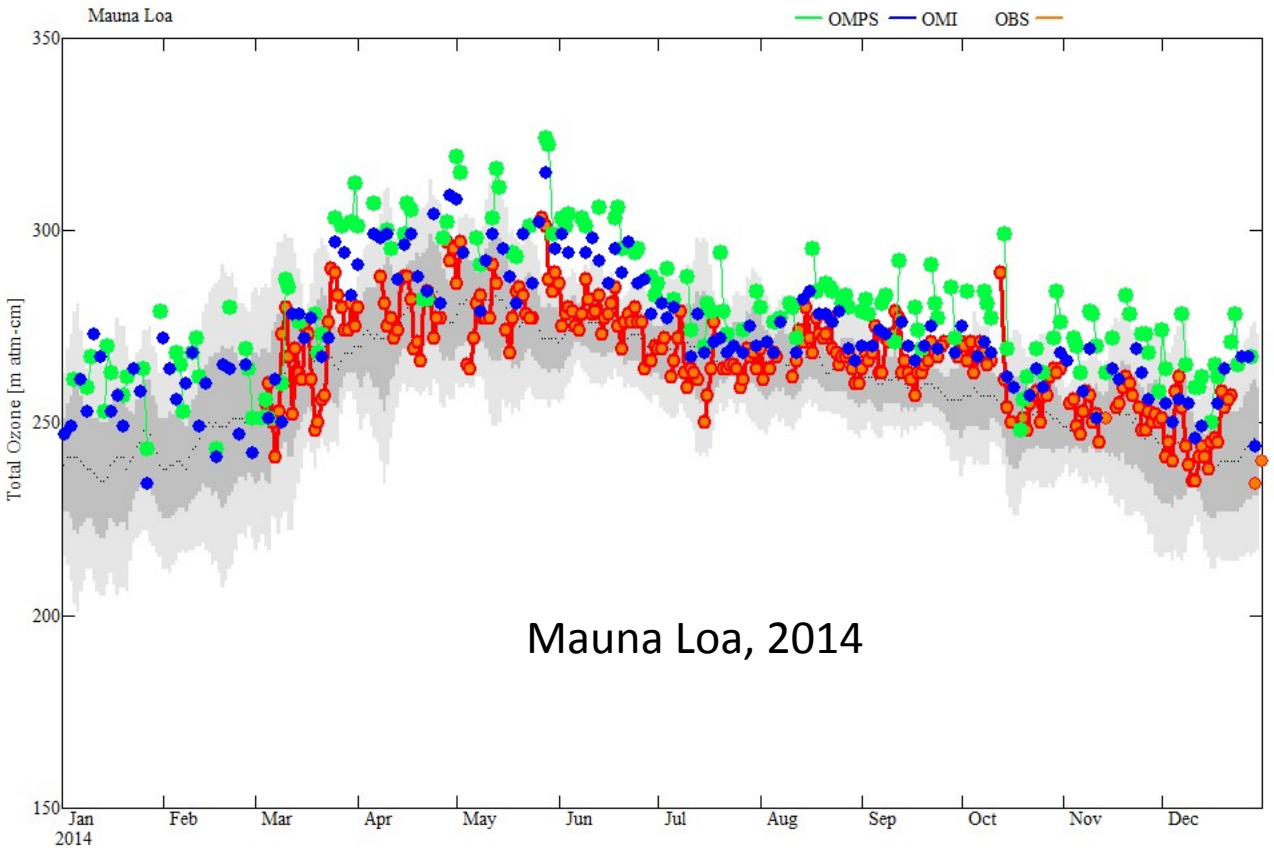
Thin Grey lines represent the climatological two standard deviation limit

- As a part of routine quality checks, Dobson and OMPS daily total ozone measurements are compared to long-term averages and standard deviation for each respective station.
- In the example from Hanford, California, the unusually high total column ozone was observed on March 1, 2015 by both systems.
- If there is unusually large and abrupt change in the Dobson ozone measurements (outside of two standard deviation limits), the OMPS total ozone maps are used to interpret spatial ozone variability.

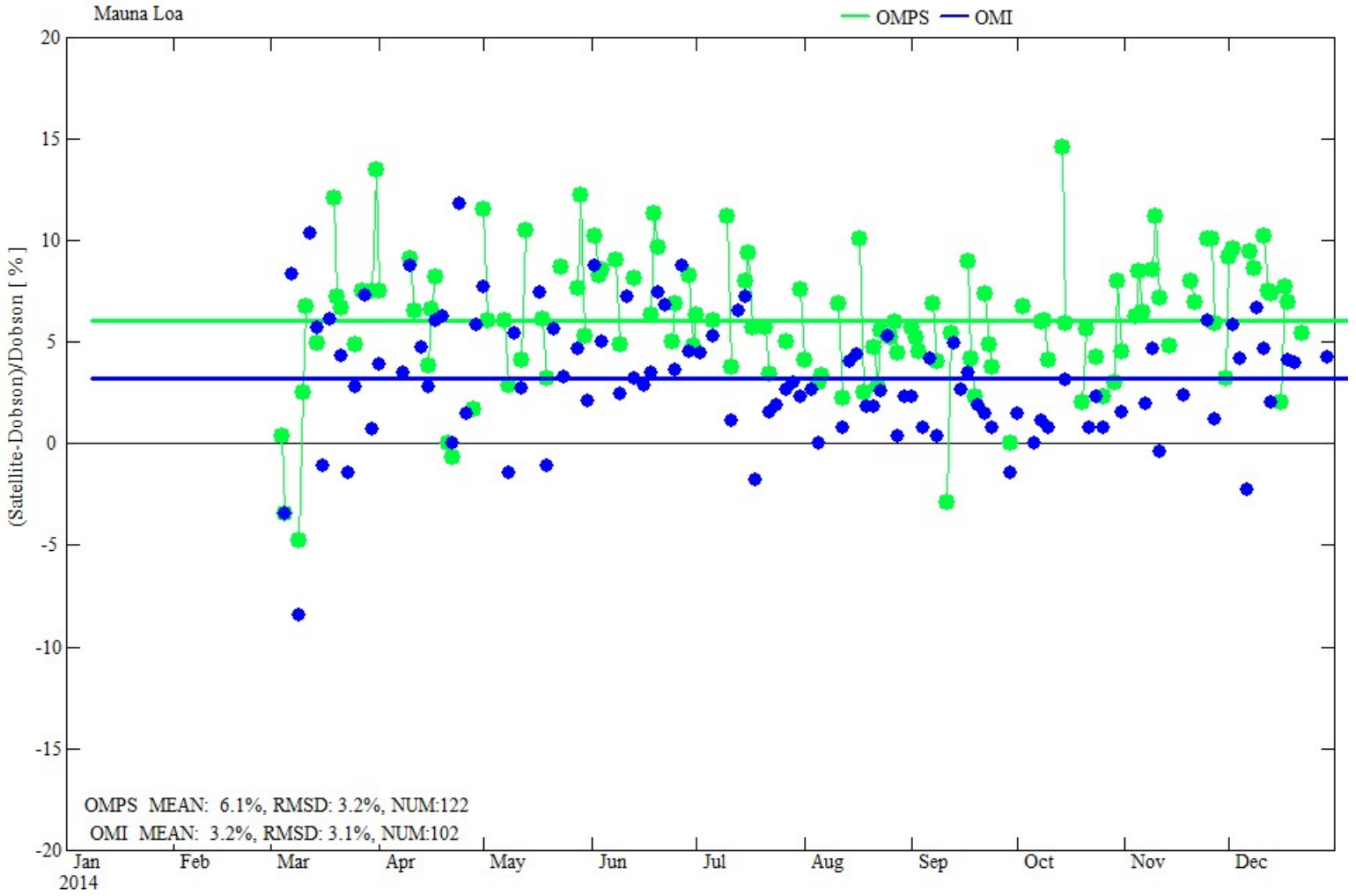
The origin of elevated ozone is also seen from the OMPS daily gridded map for March 1, 2015. The high ozone filament was transported from high latitudes and brought over Hanford CA.



Seasonal Comparison with Dobson Total Ozone

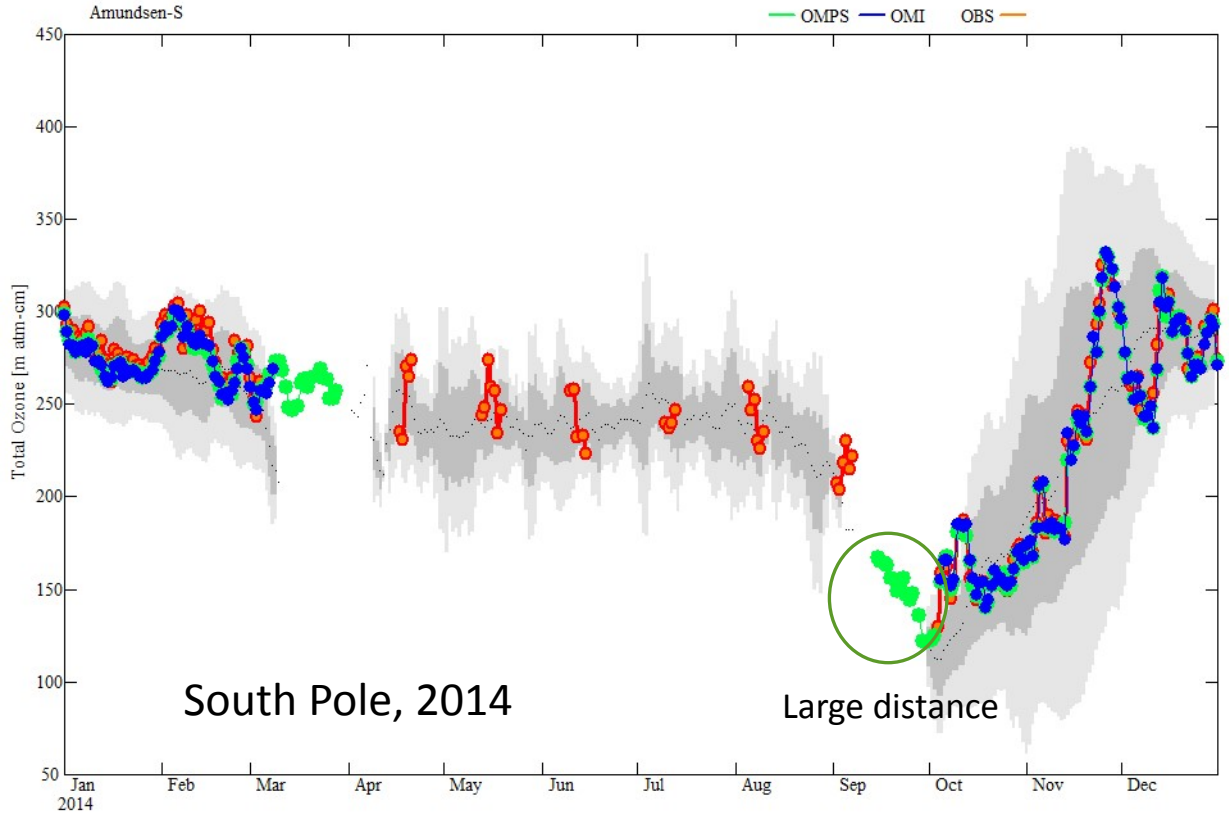


Daily total ozone values (large red dots) from the Dobson Ozone Spectrophotometer (red) at MLO, Hawaii are plotted with co-incident ozone values from Aura/OMI (blue) and JPSS/OMPS satellite data (green). Apparent annual ozone cycle in Dobson measurements is shown with dark line (smoothed). The 1 and 2 STD are shown in grey. This plot is used for assessment of the inter-seasonal ozone variability and identifies measurements that exceed expected variation limits.

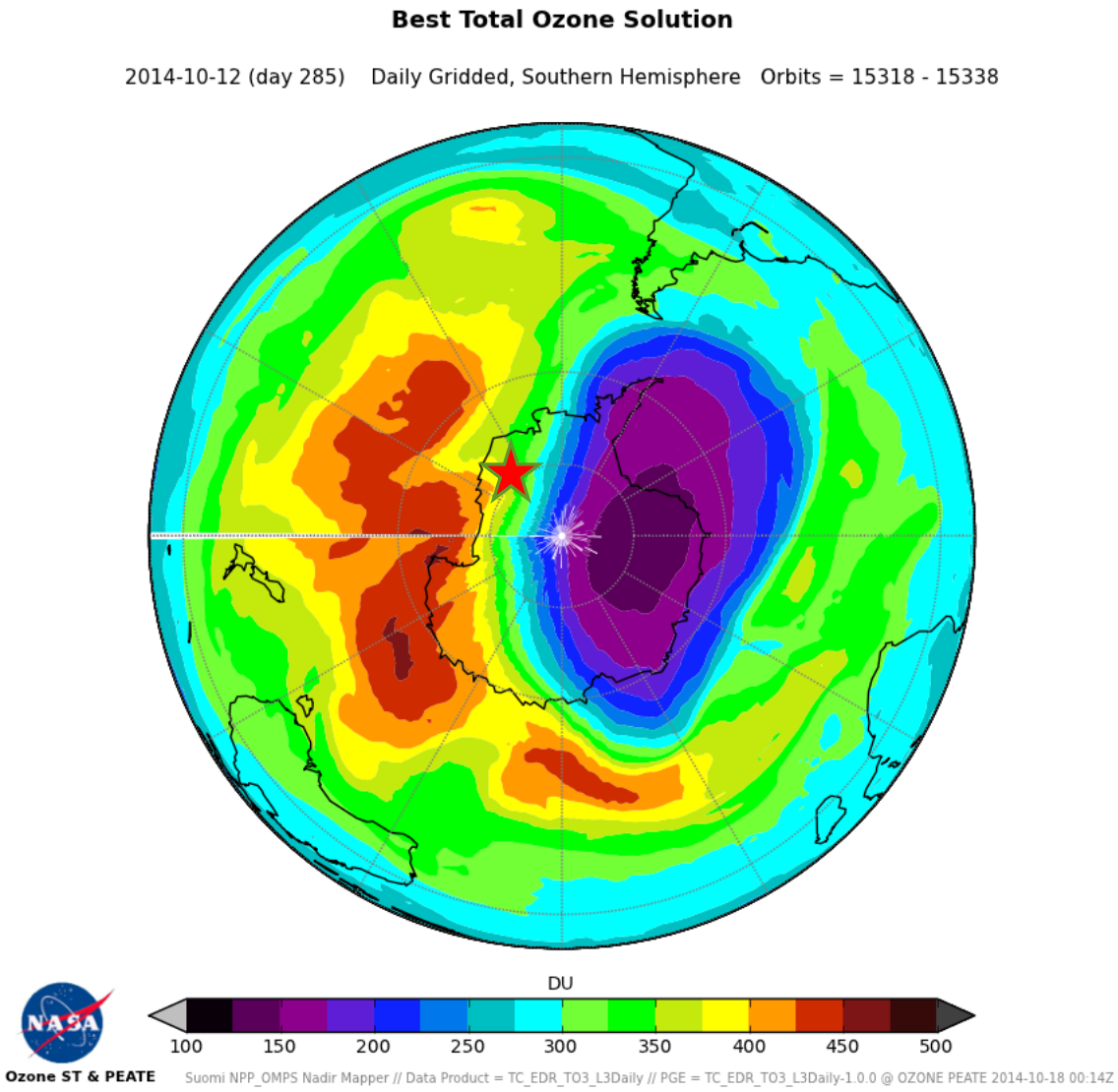


Example of comparisons for MLO. Data are matched by date and location. Looking for offset and apparent seasonal cycle caused by temperature sensitivity of ozone cross sections or stray light.

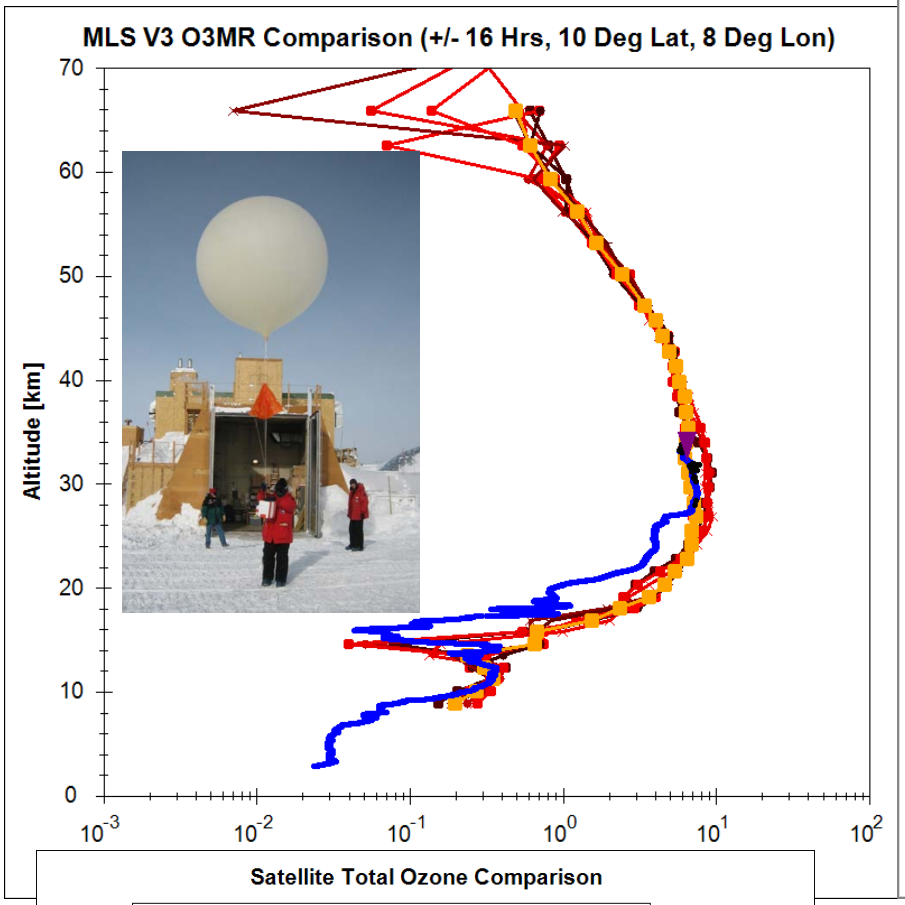
Long-term Stratospheric Ozone Depletion Monitoring

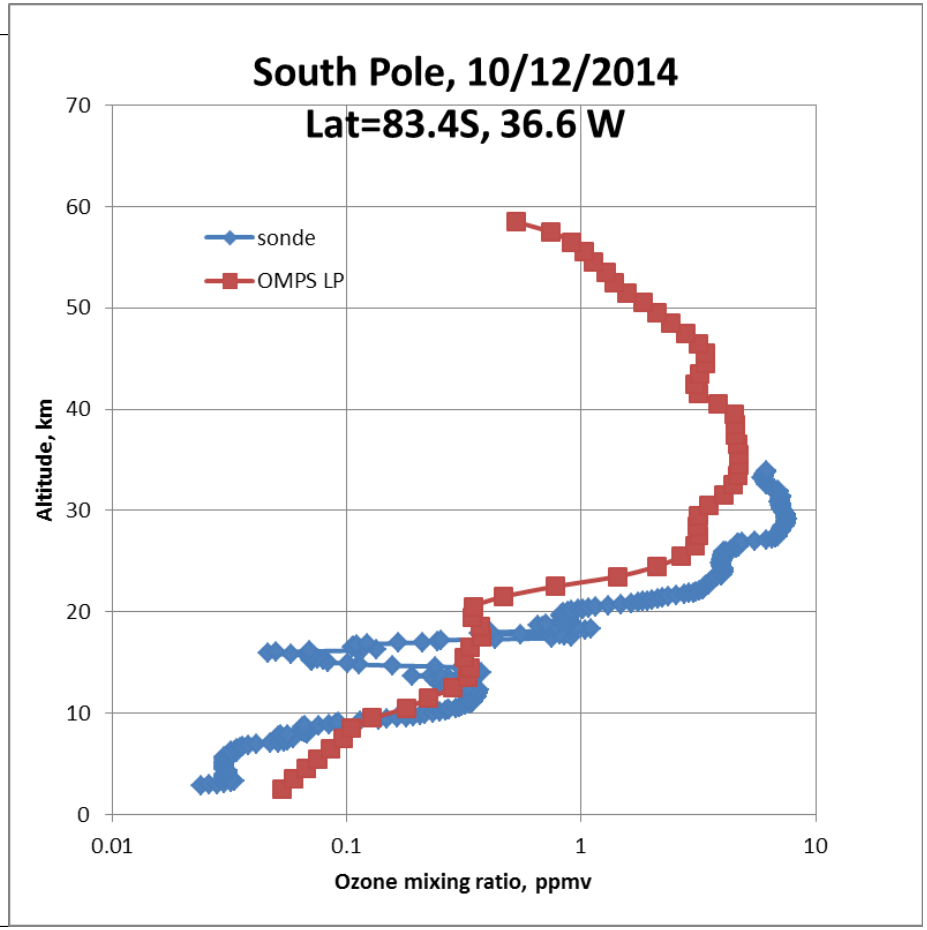


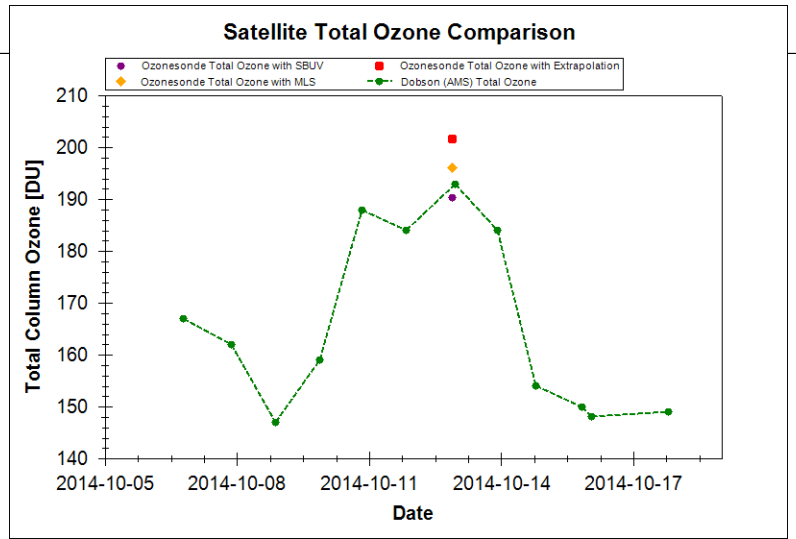
Dobson Total Column ozone measurements have been maintained since 1960 providing a reliable, long-term record of the ozone hole each year. This record is used for understanding of trends and levels of on-going recovery in the ozone layer.



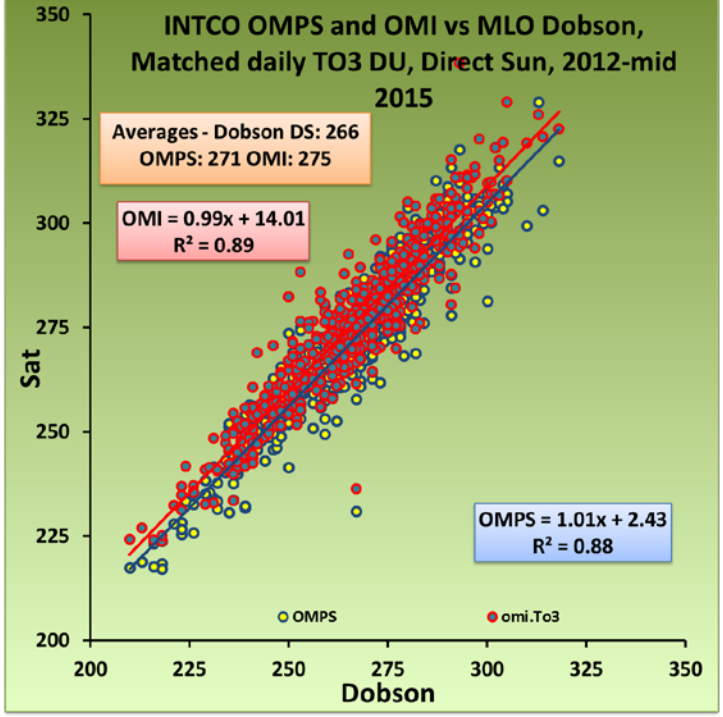
Problem with satellite comparisons in Sept/Oct – difficult to match satellite tracks with SP ozone sonde profiles (matching overpass satellite data are large distance away from SP, or by 8-10 degrees in latitude)

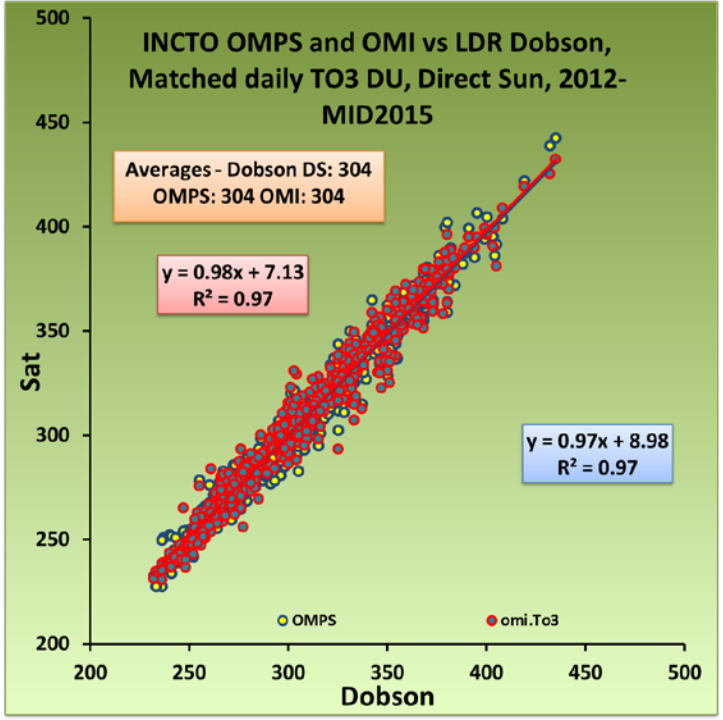


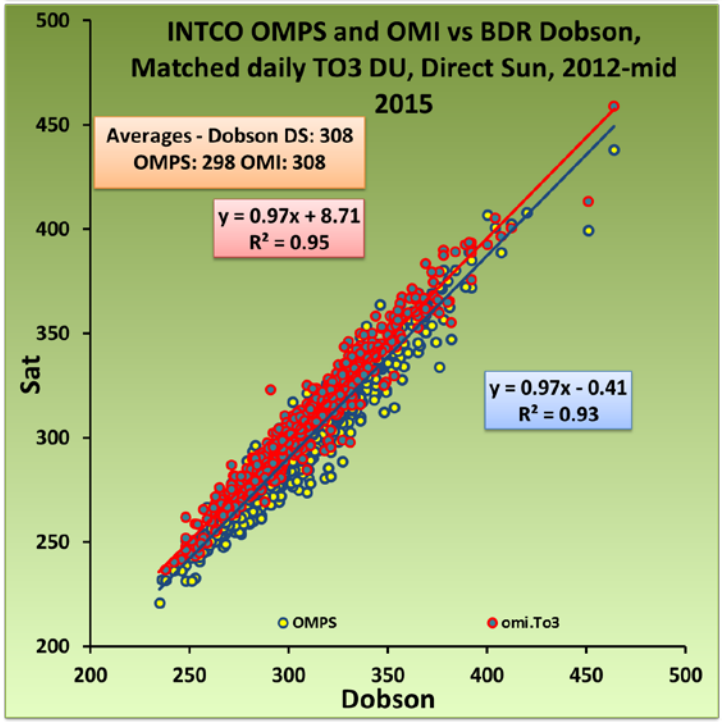


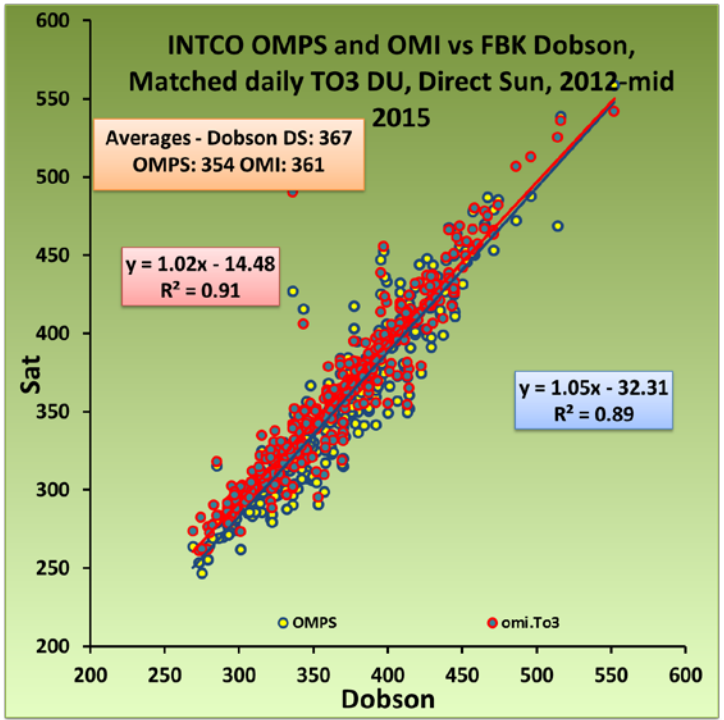


Issues with ground based/satellite comparisons in Sept/Oct –OMPS, OMI, or MLS overpass is lower by 8-10 degrees in latitude from SP location.

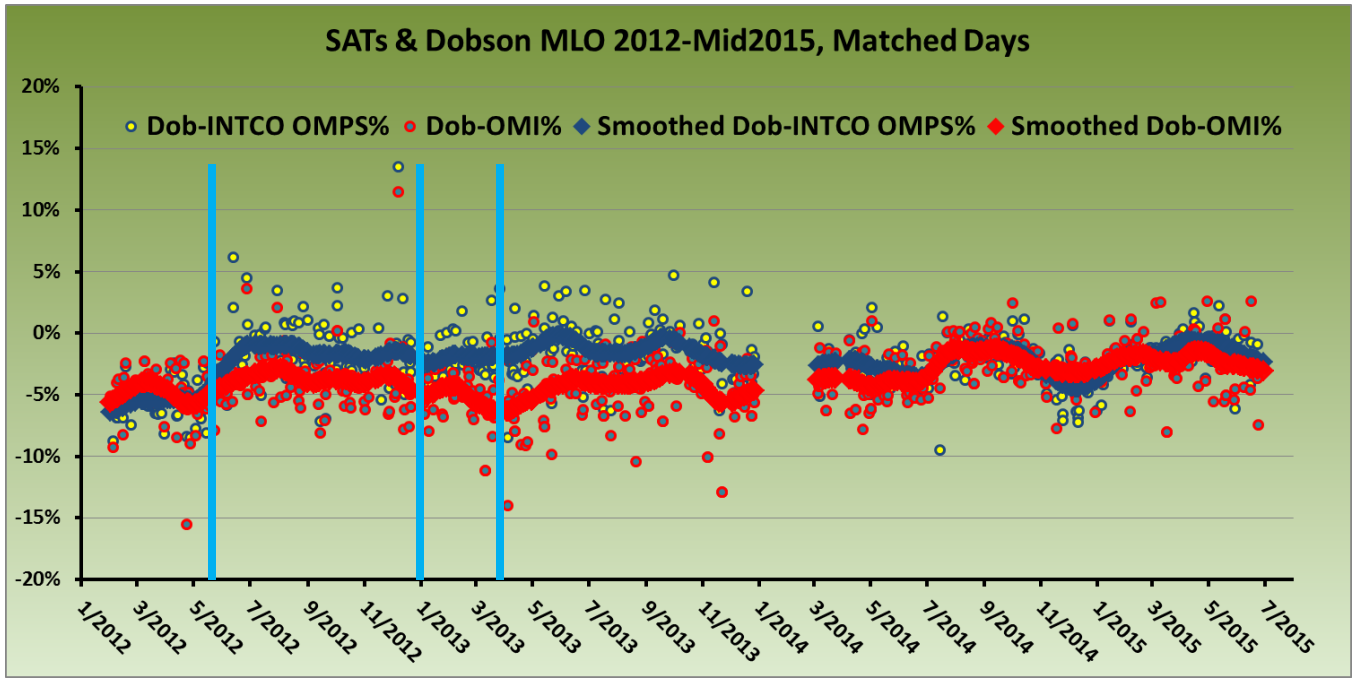

INTCO OMPS and OMI vs MLO Dobson, Matched daily TO3 DU, Direct Sun, 2012-mid 2015
Averages - Dobson DS: 266
OMPS: 271 OMI: 275
OMI = 0.99x + 14.01
R² = 0.89
OMPS = 1.01x + 2.43
R² = 0.88
OMPS
omi.To3
Sat
Dobson
200
225
250
275
300
325
350


INCTO OMPS and OMI vs LDR Dobson, Matched daily TO3 DU, Direct Sun, 2012-MID2015
Averages - Dobson DS: 304
OMPS: 304 OMI: 304
y = 0.98x + 7.13
R² = 0.97
y = 0.97x + 8.98
R² = 0.97
OMPS
omi.To3
Sat
Dobson
200
250
300
350
400
450
500

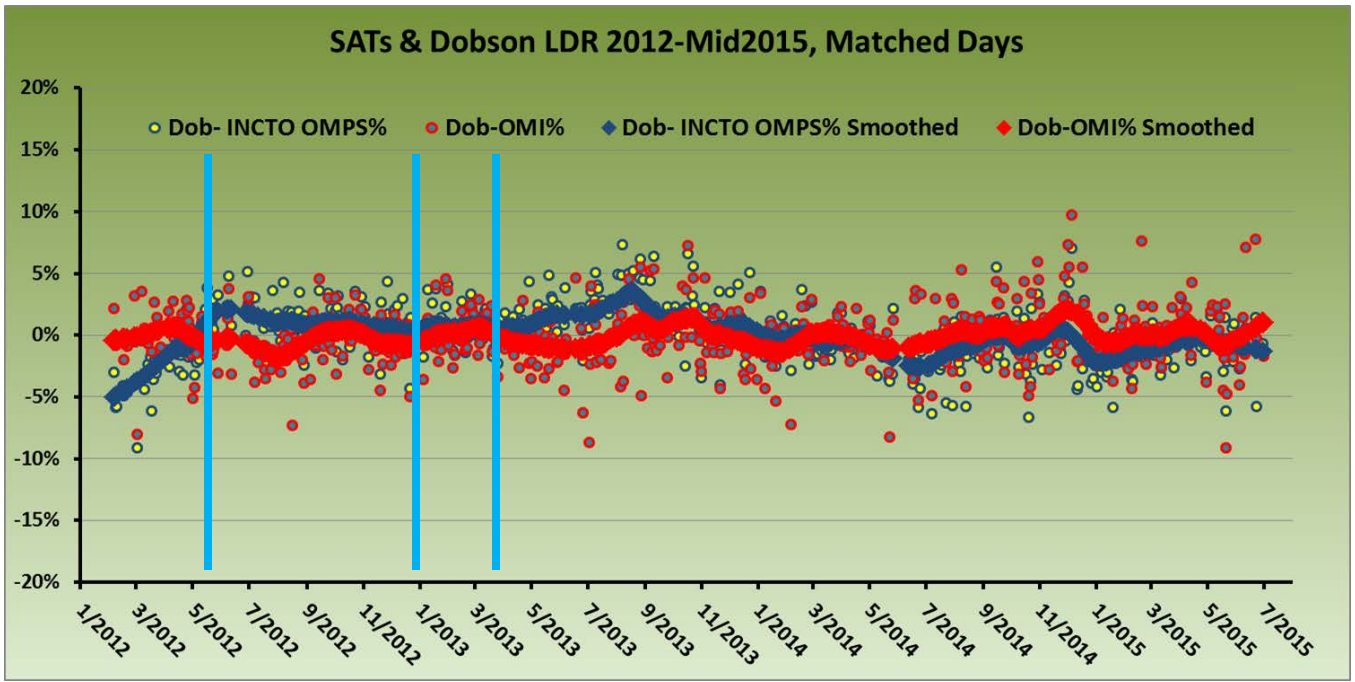

INTCO OMPS and OMI vs BDR Dobson, Matched daily TO3 DU, Direct Sun, 2012-mid 2015
Averages - Dobson DS: 308
OMPS: 298 OMI: 308
y = 0.97x + 8.71
R² = 0.95
y = 0.97x - 0.41
R² = 0.93
OMPS
omi.To3
Sat
Dobson
200
250
300
350
400
450
500


INTCO OMPS and OMI vs FBK Dobson, Matched daily TO3 DU, Direct Sun, 2012-mid 2015
Averages - Dobson DS: 367
OMPS: 354 OMI: 361
y = 1.02x - 14.48
R² = 0.91
y = 1.05x - 32.31
R² = 0.89
OMPS
omi.To3
Sat
Dobson
200
250
300
350
400
450
500
550
600

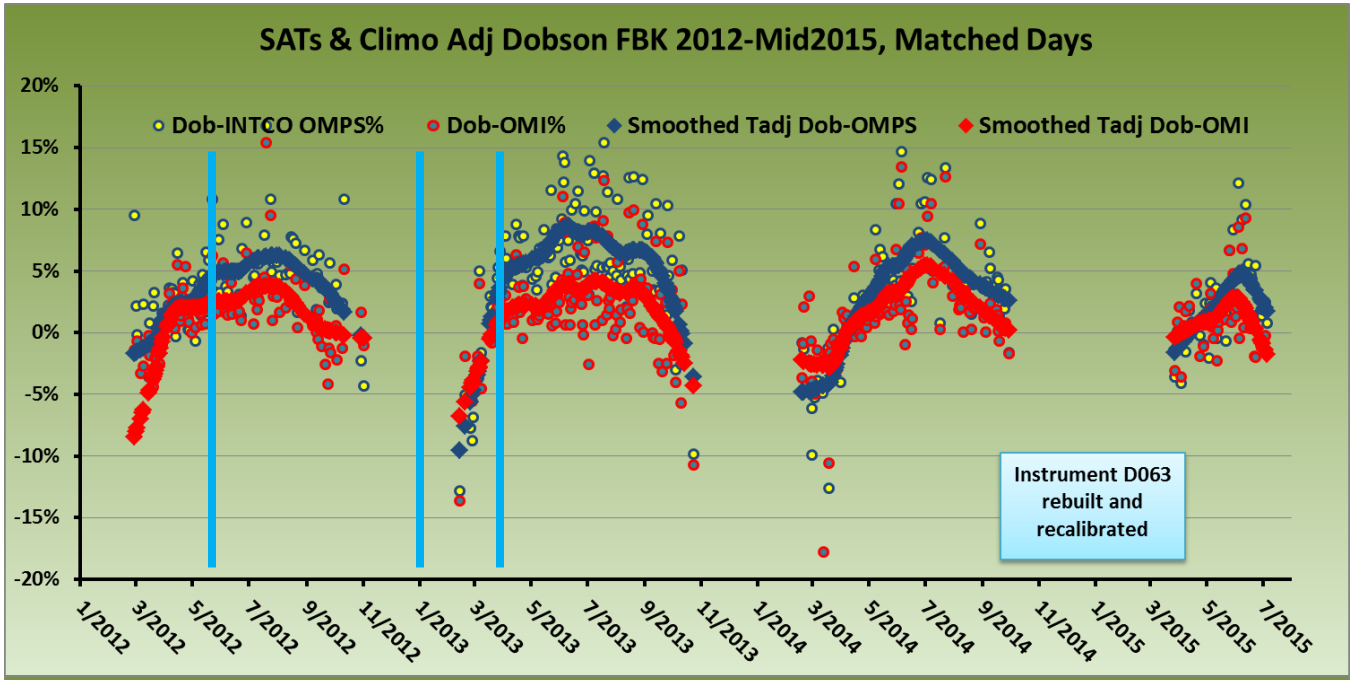
Mauna Loa



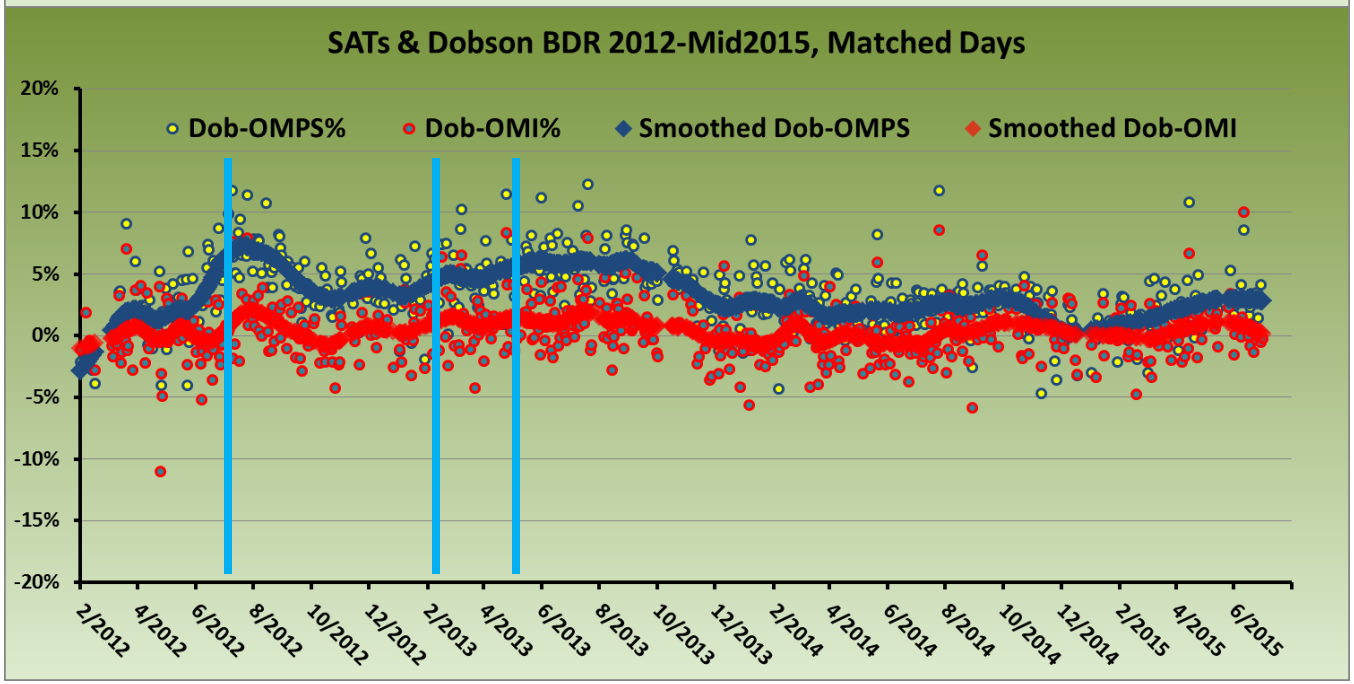
Lauder



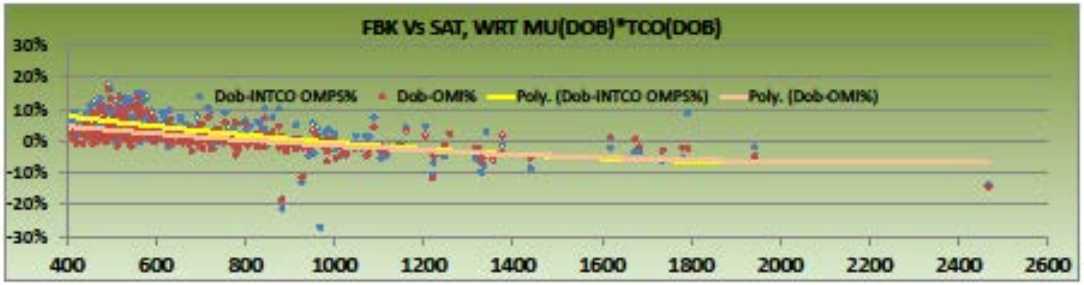
Fairbanks



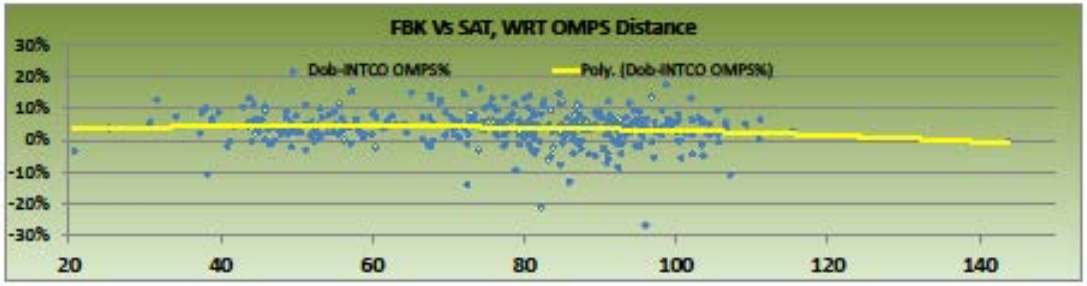
Boulder



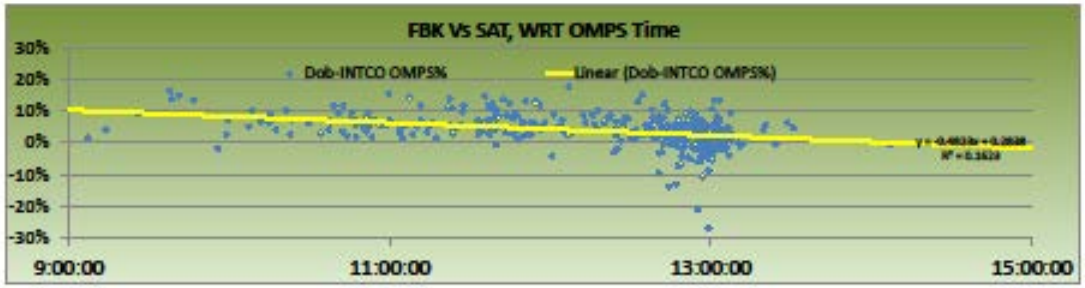
TOC*airmass



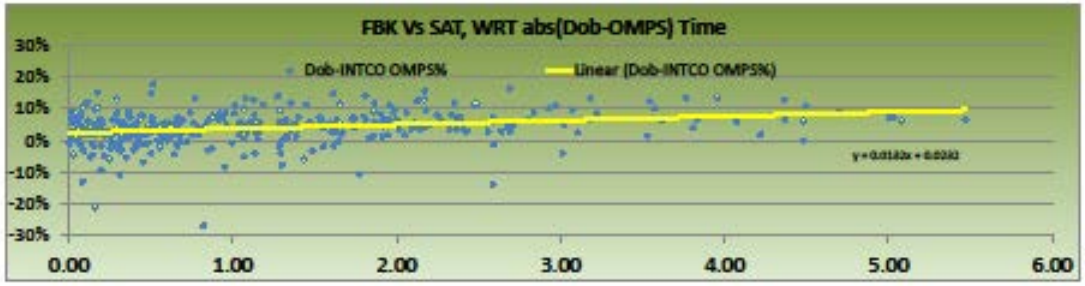
Distance from stations

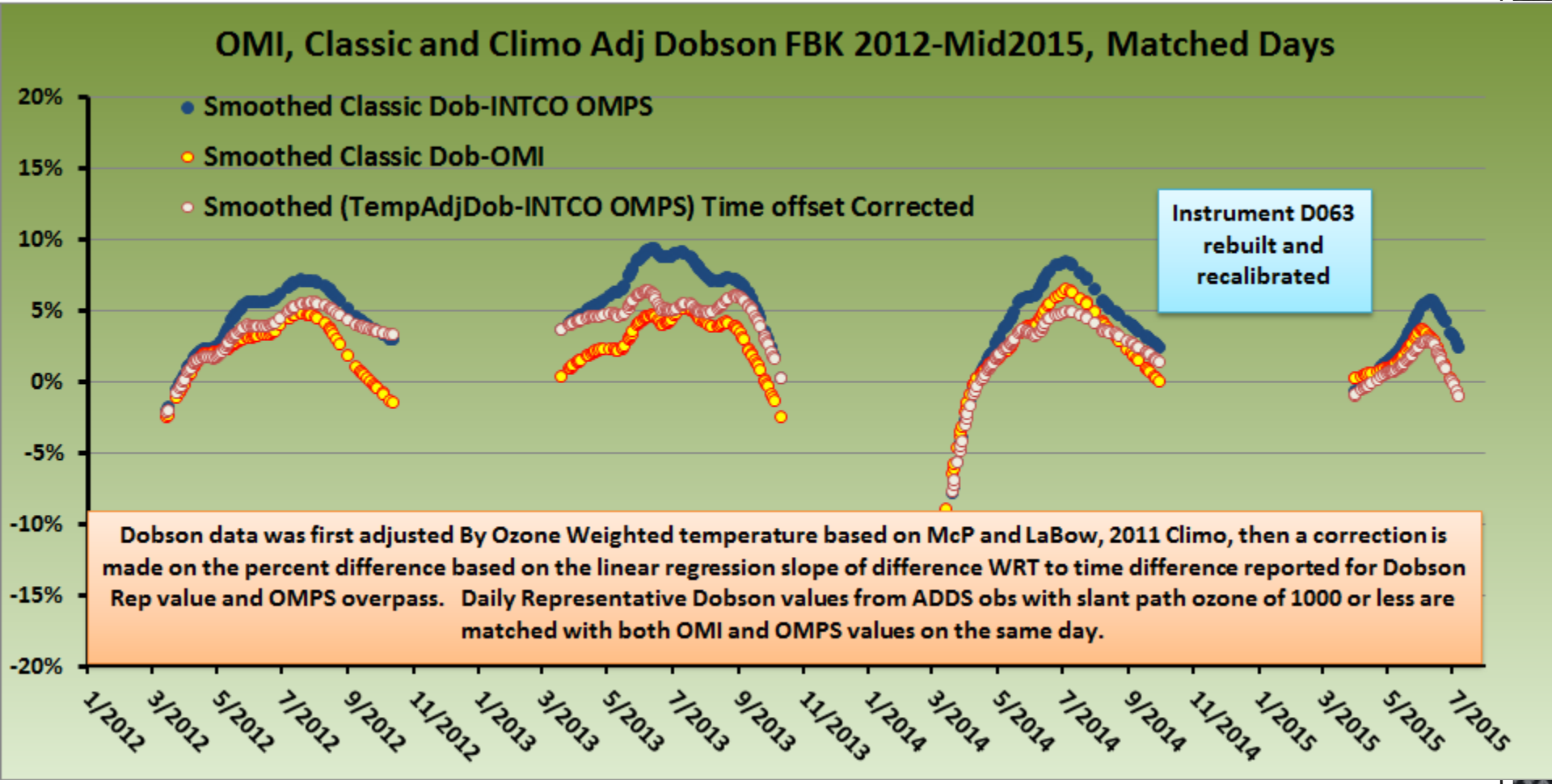


Time of satellite overpass



Time difference between satellite overpass and Dobson measurement

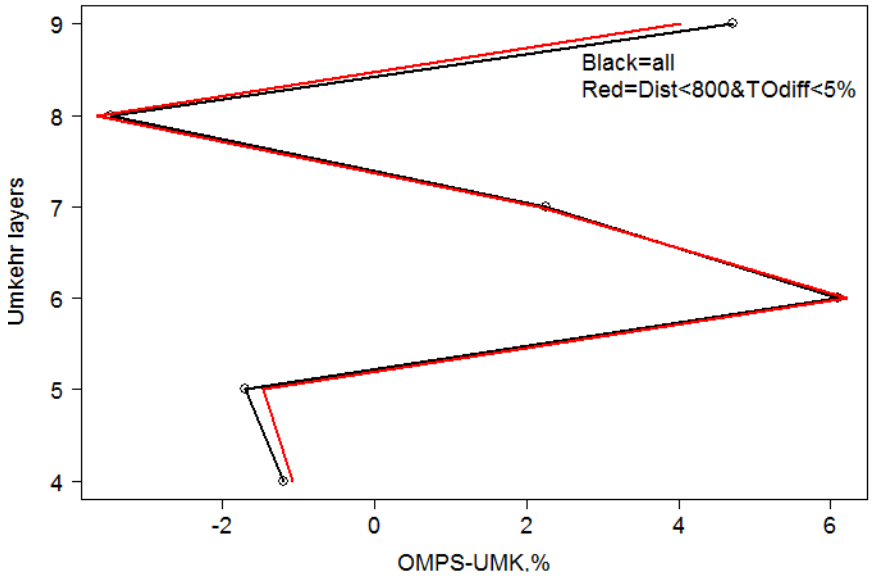



OMI, Classic and Climo Adj Dobson FBK 2012-Mid2015, Matched Days
Smoothed Classic Dob-INTCO OMPS
Smoothed Classic Dob-OMI
Smoothed (TempAdjDob-INTCO OMPS) Time offset Corrected
Instrument D063 rebuilt and recalibrated
20%
15%
10%
5%
0%
-5%
-10%
-15%
-20%
Dobson data was first adjusted By Ozone Weighted temperature based on McP and LaBow, 2011 Climo, then a correction is made on the percent difference based on the linear regression slope of difference WRT to time difference reported for Dobson Rep value and OMPS overpass. Daily Representative Dobson values from ADDS obs with slant path ozone of 1000 or less are matched with both OMI and OMPS values on the same day.
1/2012
3/2012
5/2012
7/2012
9/2012
11/2012
1/2013
3/2013
5/2013
7/2013
9/2013
11/2013
1/2014
3/2014
5/2014
7/2014
9/2014
11/2014
1/2015
3/2015
5/2015
7/2015

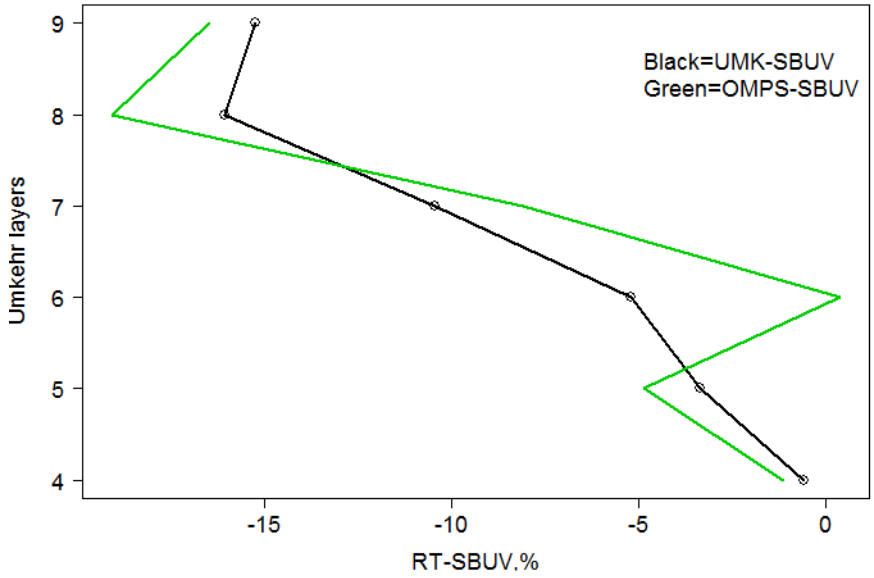
Comparisons of vertical ozone profiles between Umkehr, SBUV (NOAA19) and OMPS (IMOPO, V6).

The overpass satellite data are tested for dependence on distance and TO differences.

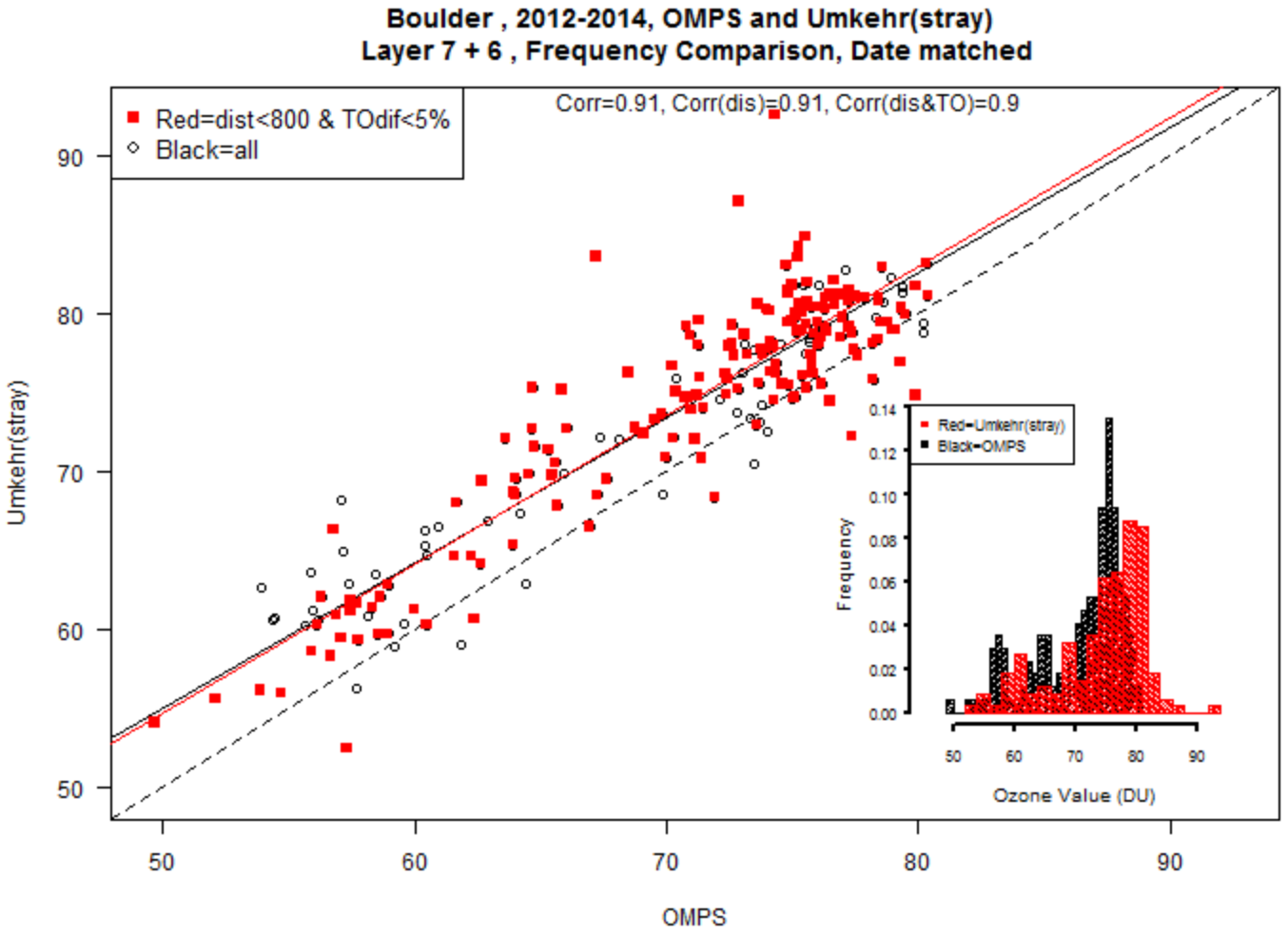
Boulder, 2012-2014

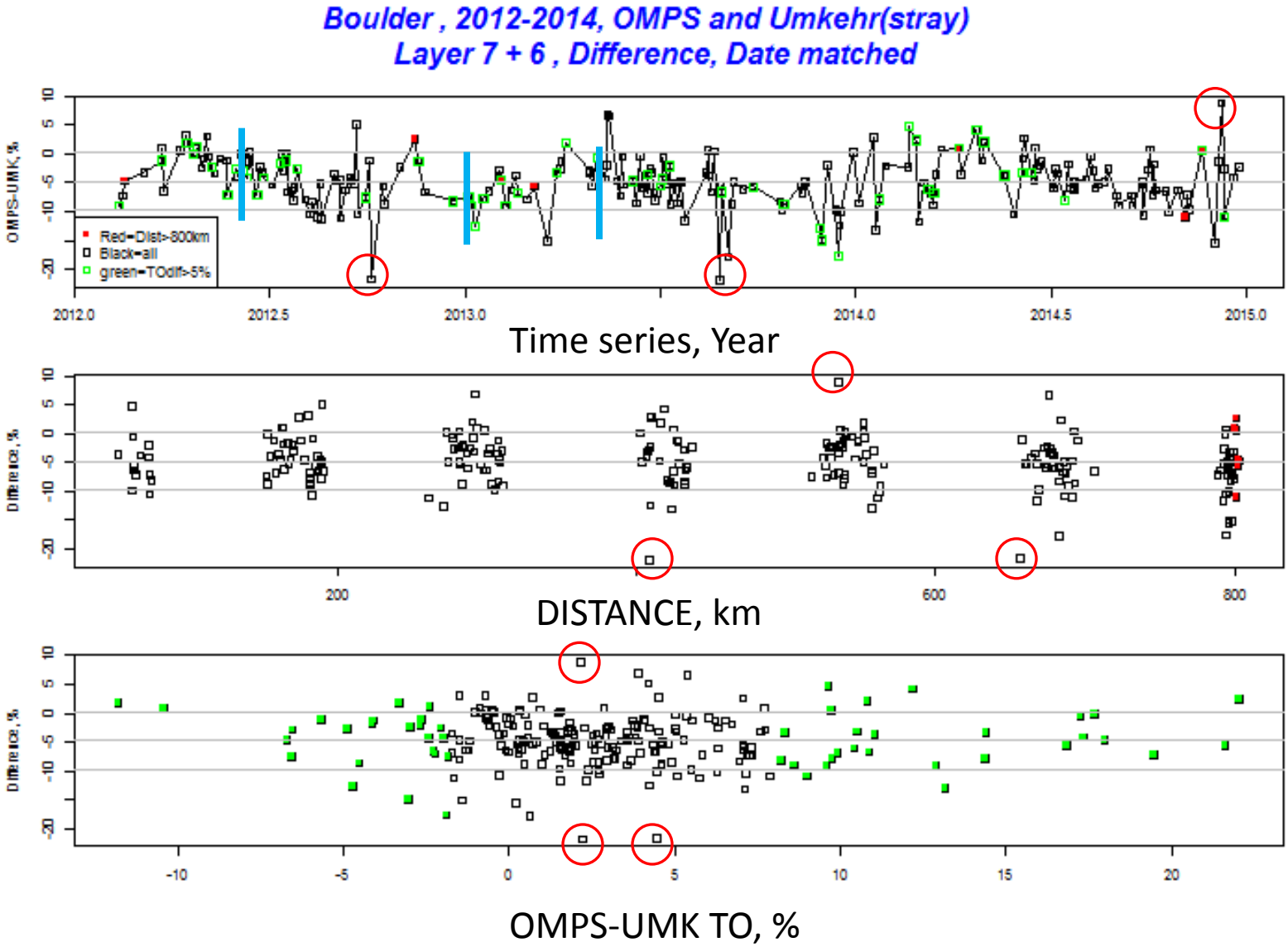


OMPS/Dobson Bias in layers 4-9 is within +/- 5 %

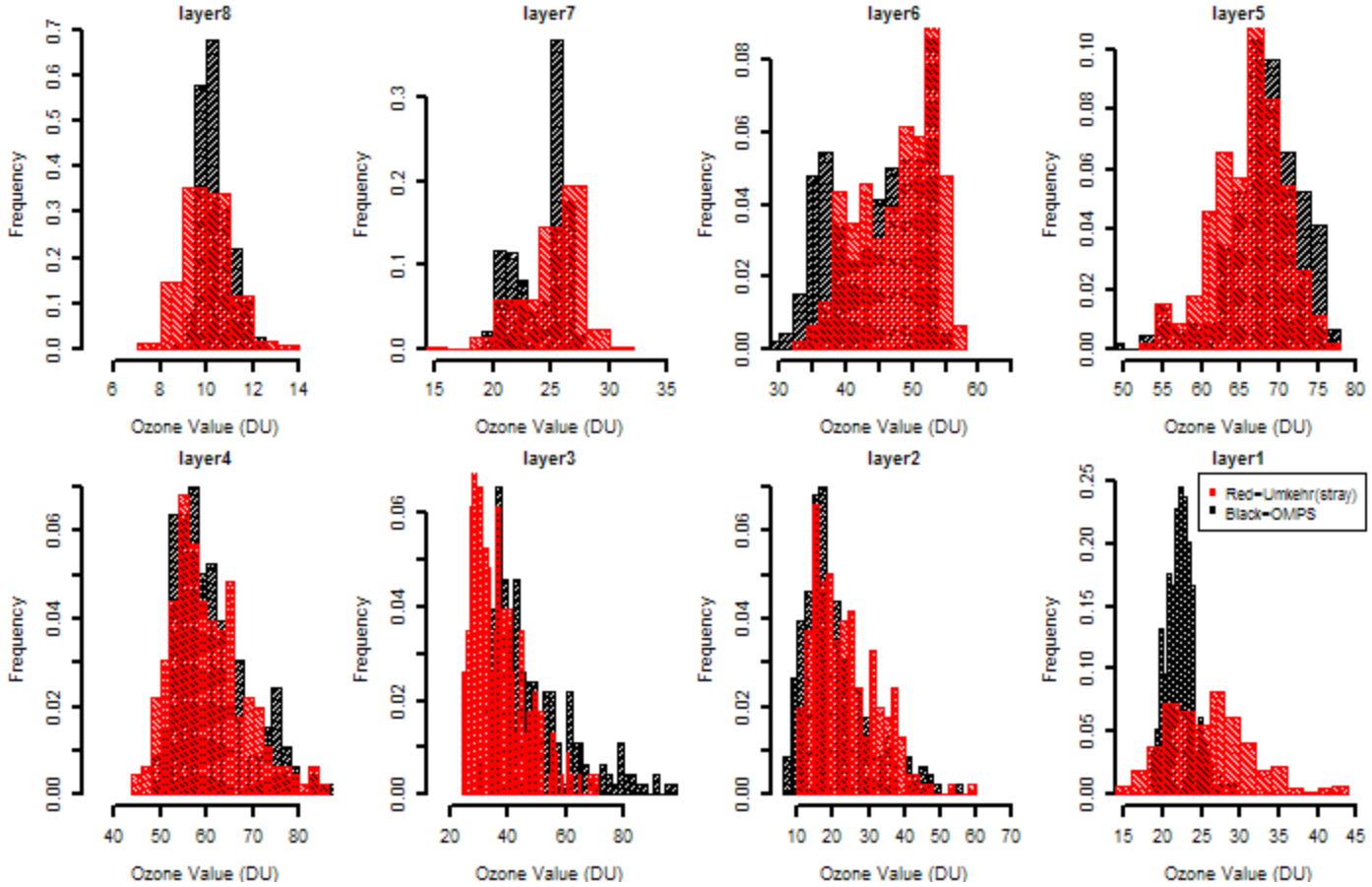


Bias between OMPS or Umkehr relative to SBUV N19 in layers 4-9 increases with altitude, note negative 15-20 % offset in layer 8.

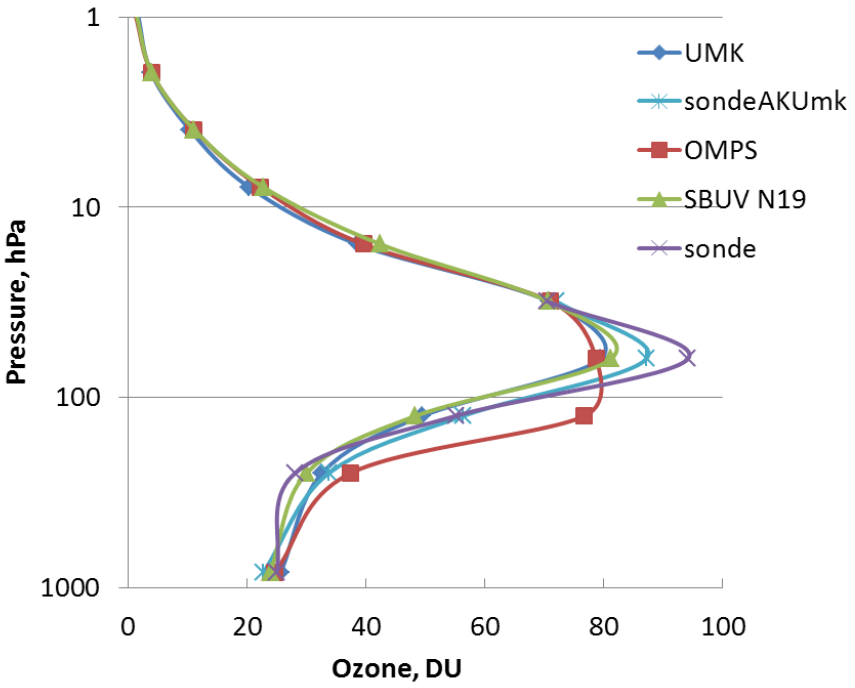

Boulder , 2012-2014, OMPS and Umkehr(stray)
Layer 7 + 6 , Frequency Comparison, Date matched
Red=dist<800 & TOdif<5%
Black=all
Corr=0.91, Corr(dis)=0.91, Corr(dis&TO)=0.9
Umkehr(stray)
OMPS
Red=Umkehr(stray)
Black=OMPS
Frequency
Ozone Value (DU)

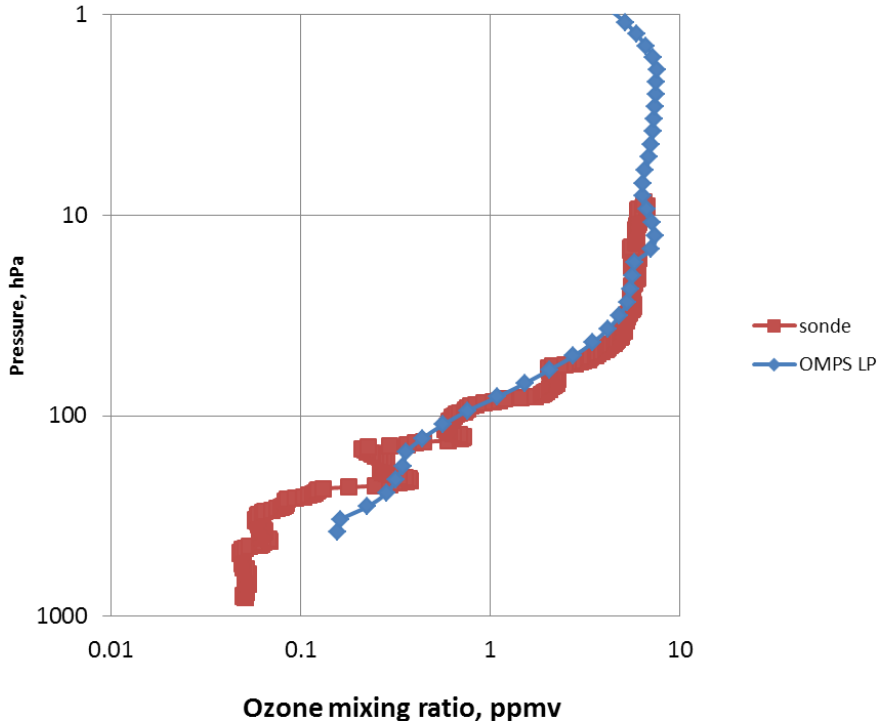

Boulder , 2012-2014, OMPS and Umkehr(stray)
Layer 7 + 6 , Difference, Date matched
OMPS-UMK,%
Red=Dist>800km
Black=all
green=TOdif>5%
2012.0
2012.5
2013.0
2014.0
2014.5
2015.0
Time series, Year
Difference, %
200
600
800
DISTANCE, km
-10
-5
0
5
10
15
20
OMPS-UMK TO, %

Boulder , 2012-2014, OMPS and Umkehr(stray) Frequency Comparison, Matched Date



Boulder 02/19/2014





- Profile comparisons show OMPS has different profile shape as compared to Umkehr and SBUV.
- Ozone sonde integrated in Umkehr layers has more ozone in layer 5 than in satellite or Umkehr retrieval. Note, improved agreement with AK smoothed sonde.
- The plot with high resolution reveals several lamina in the ozone-sonde measured vertical structure. Although OMPS LP does not capture these lamina, it captures profile shape in stratosphere fairly well.

Conclusions

- Ground-based Dobson data have been regularly used to keep track of temporal and spatial variability in overpass OMPS (SDR, level1) ozone column and profile data
- 5 Dobson stations are currently outfitted with the automation system. Real time data comparison capability is available from the associated WinDobson software package.
- Correlations in TOC are between 0.88 and 0.97 (distance/time)
- The mean bias and seasonal cycle offsets are noticed in MLO, Boulder, and Fairbanks stations. Lauder appear to compare very well.
- The overpass NM INCTO data are created within a box that is +/- 0.5 degrees in latitude and +/- (1/cos(lat*pi/180)) in longitude, but it may need to be more restrictive to have adequate comparisons.
- Profile comparisons between NP IMOPO and Umkehr are within +/- 5 % in stratosphere (or above 68 hPa pressure level).
- In troposphere and lower stratosphere agreement depends on a priori and algorithm's difficulty to resolve profile around the tropopause.
- Looking forward to work on validation of the V8 data