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Differences Between the Reprocessed Dobson Total Ozone and Satellite Observation Records

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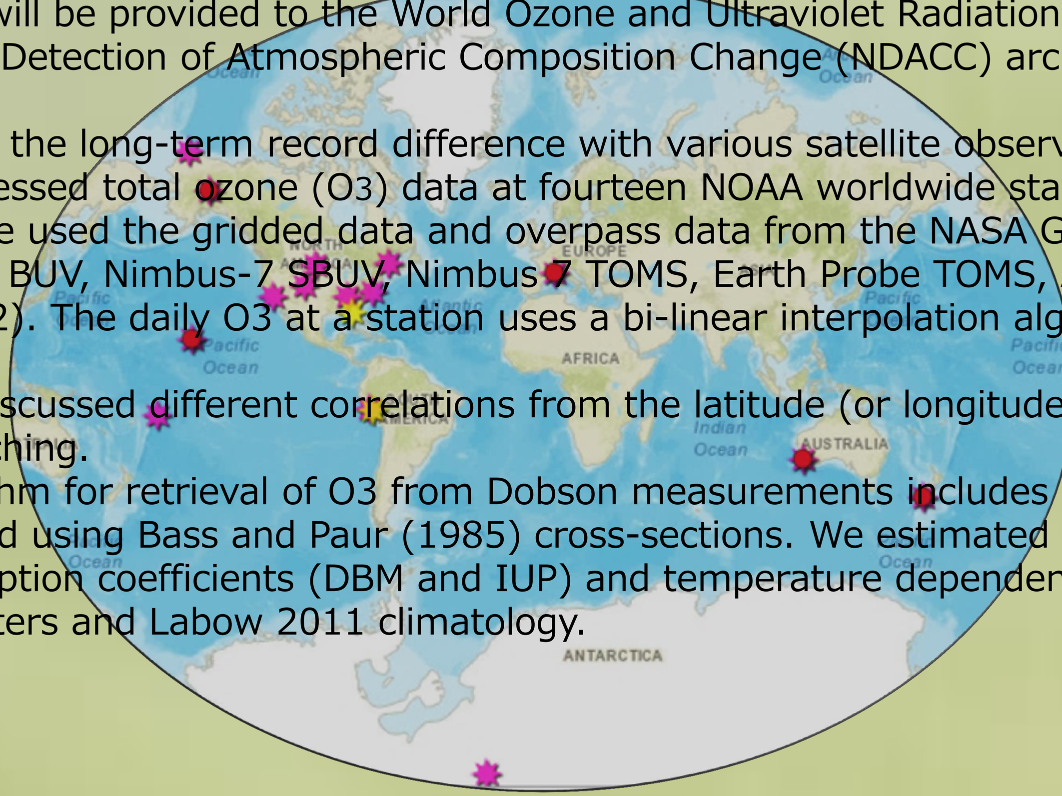
1. Introduction.

The entire Level-Zero data record from the NOAA Dobson Ozone Spectrophotometer network has been reprocessed with a new software system, with updated quality control features. The reprocessed data set from the 1960s will be provided to the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) and Network for the Detection of Atmospheric Composition Change (NDACC) archives.

This study compares the long-term total ozone record difference with various satellite observations to assess the quality of the reprocessed total ozone (O_3) data at fourteen NOAA worldwide stations.

- For comparison we used the gridded data and overpass data from the NASA Goddard Space Flight Center (Nimbus-4 BUV, Nimbus-7 SBUV, Nimbus-7 TOMS, Earth Probe TOMS, Aura OMI, NPP OMPS and NOAA SBUV/2). The daily O_3 at a station uses a bi-linear interpolation algorithm from the gridded data.
- Additionally, we discussed different correlations from the latitude (or longitude) of a station for gridded data matching.
- The official algorithm for retrieval of O_3 from Dobson measurements includes static absorption coefficients derived using Bass and Paur (1985) cross-sections. We estimated the impact of using different O_3 absorption coefficients (DBM and IUP) and temperature dependent coefficients (Redondas et al.) using McPeters and Labow 2011 climatology.



2. Comparison of Dobson and satellites.

Below, the long-term total ozone record from fourteen NOAA stations was compared to various satellites to assess the quality of the reprocessed total ozone record . For this work, we compared Dobson total ozone observations to both gridded and overpass satellite data. The daily O_3 from gridded data used a bi-linear interpolation algorithm. At the South Pole, we applied the bi-linear extrapolation or the closest gridded data. We used ADDS for Dobson so that the difference between a station and a reference instrument might be ~1% when direct sun (ADDS) observation.

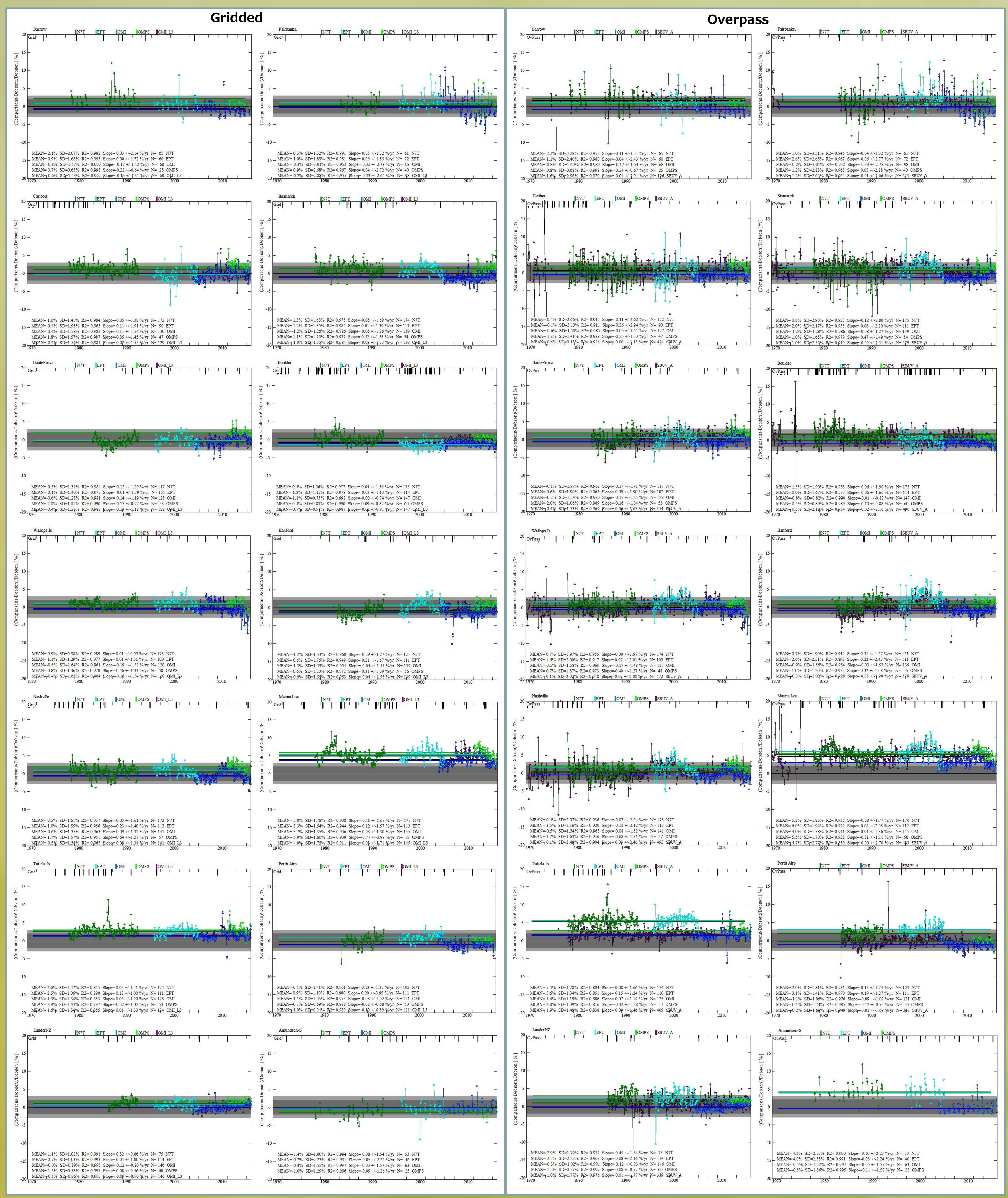


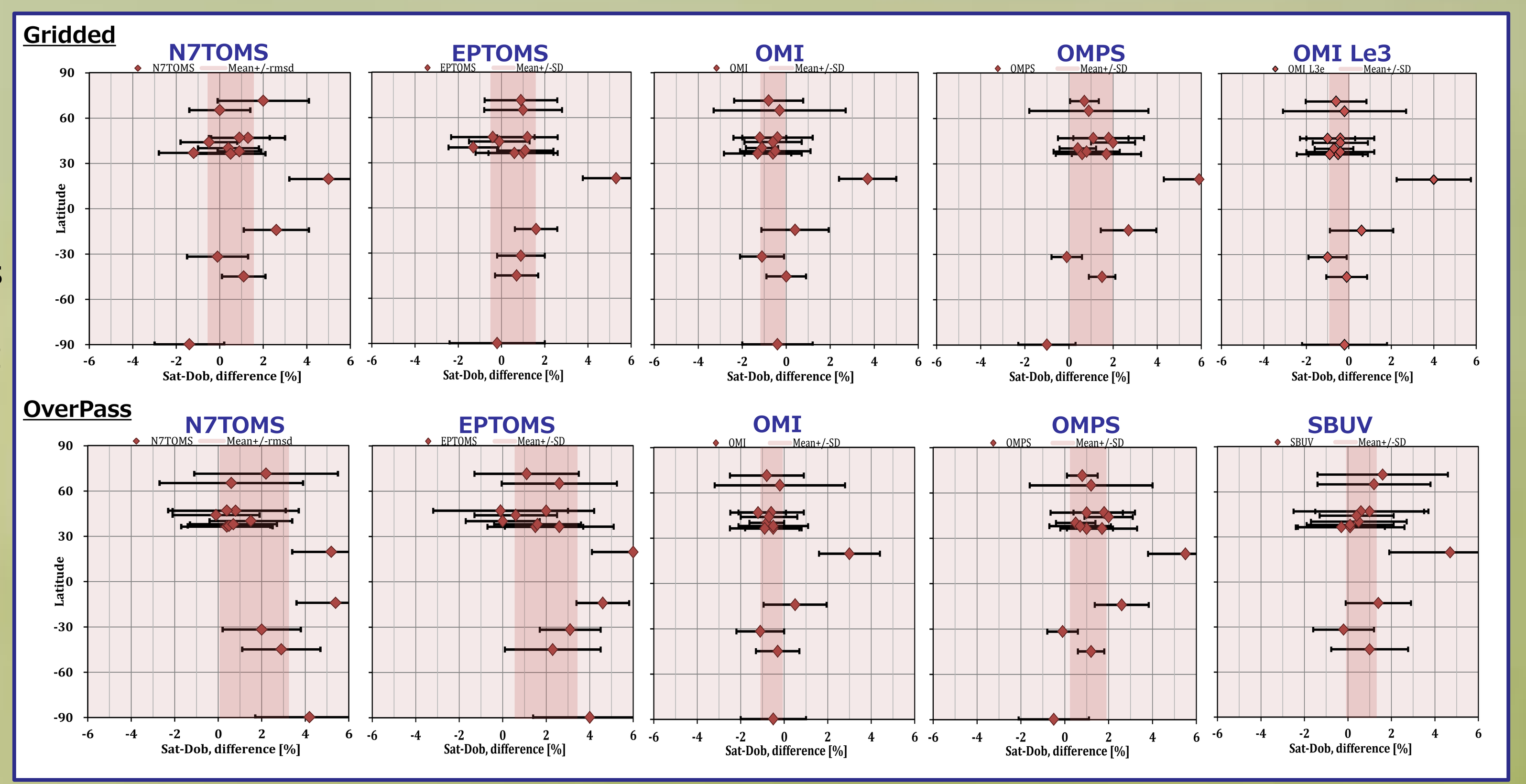
Figure 1. Monthly average difference of the total ozone with Dobson (ADDS matched) and satellites (Nimbus-4 BUV, Nimbus-7 SBUV, Nimbus 7 TOMS, Earth Probe TOMS, Aura OMI, NPP OMPS and NOAA SBUV/2). The left panel shows Gridded data and the right panel is Overpass. Overpass data from NIMBUS-7/TOMS, EP/TOMS, OMI and OMPS used measurements under 50 km average distance (for the South Pole under 100 km), and SBUV used under 300 km distance.

3. Summary.

In this analysis, OMI gridded Level 3e shows the highest overall quality without latitude dependence. The time series comparisons show an agreement within 1% over the past 13 years (2004-2016). Additionally, Mauna Loa, Hawaii has better agreement than indicated due to ozone below the station that is seen by satellites but not by the Dobson (ozonesonde observations indicate about 3.5% difference). The mean difference of N7TOMS (and EPTOMS) shows a large difference between gridded and overpass.

Table 1. Summary of difference of Dobson and satellites from Figure 2. Mean value, and standard deviation of the differences.

Gridded (%)	Mean	S.D.	S.E.	S.D. mean
N7TOMS	0.5	1.2	0.14	1.5
EPTOMS	0.5	0.8	0.16	1.5
OMI	-0.6	0.5	0.16	1.4
OMPS	1.0	1.0	0.19	**1.3**
OMI Le3	**-0.5**	**0.4**	**0.13**	1.5
Over Pass (%)	**Mean**	**S.D.**	**S.E.**	**S.D. mean**
N7TOMS	1.7	1.6	0.22	2.3
EPTOMS	2.0	1.4	0.23	2.1
OMI	**-0.6**	**0.4**	**0.14**	1.5
OMPS	1.1	0.8	0.20	**1.3**
SBUV	0.6	0.6	0.12	2.2



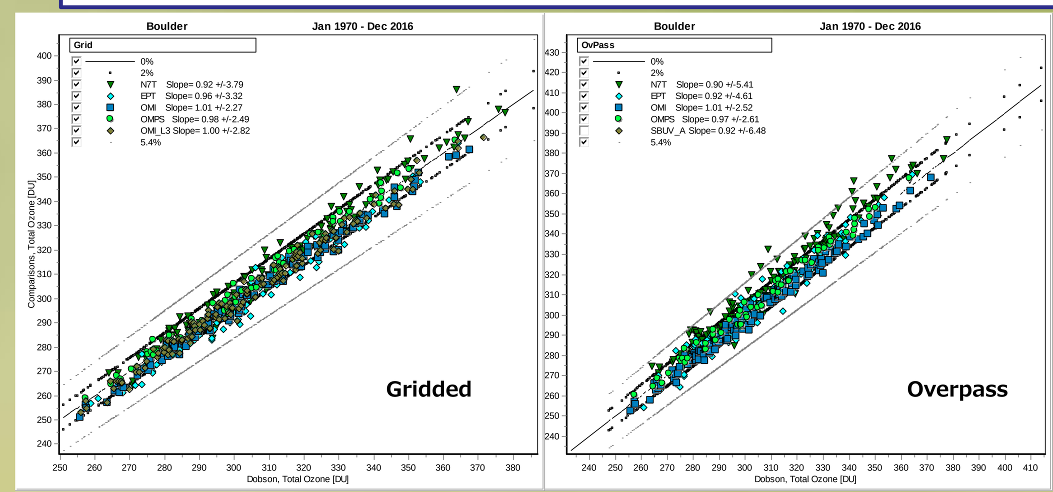


Figure 2. Averaged differences between Dobson and satellite gridded and overpass measurements. The error bar shows ± 1 standard deviation.

Figure 3. Monthly average scattering of the total O_3 of Dobson and gridded satellites at Boulder (Left).

4. Discussion.

Using McPeters and Labow 2011 climatology we estimated the impact on the latitude using three different ozone cross-sections (BP, DBM and IUP) and temperature dependence (Redondas et al.). Furthermore, we calculated the impact of other O_3 cross-section over Boulder as Dobson are using 1992 BP officially (Evans). The difference with a satellite shows reduction for OMI, OMPS and SBUV for the temperature correction using BP.

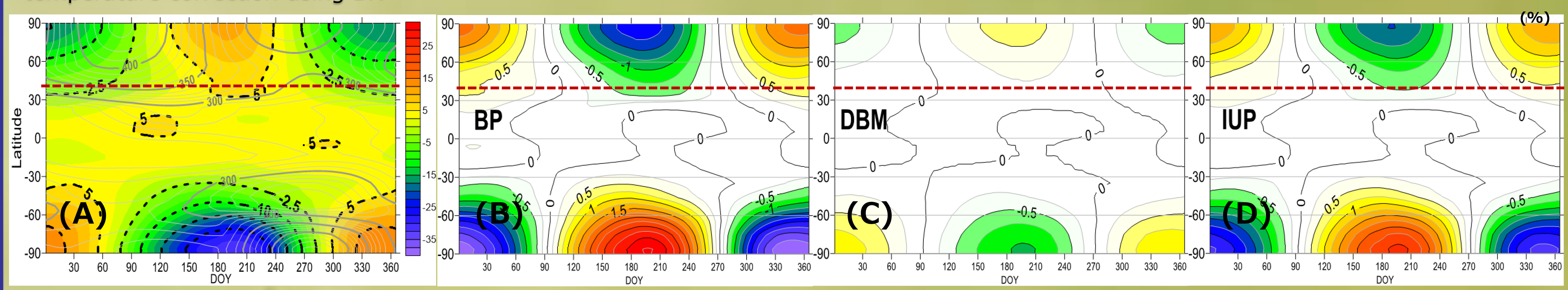


Figure 4. Different O_3 cross-sections and temperature dependence from McPeters and Labow 2011 climatology use. A) Difference of Dobson ozone-weighted temperature (226.7 K) and Total ozone (gray line). B) Temperature correction applied to Dobson official BP, C,D) DBM and IUP applied O_3 cross-sections and temperature correction.

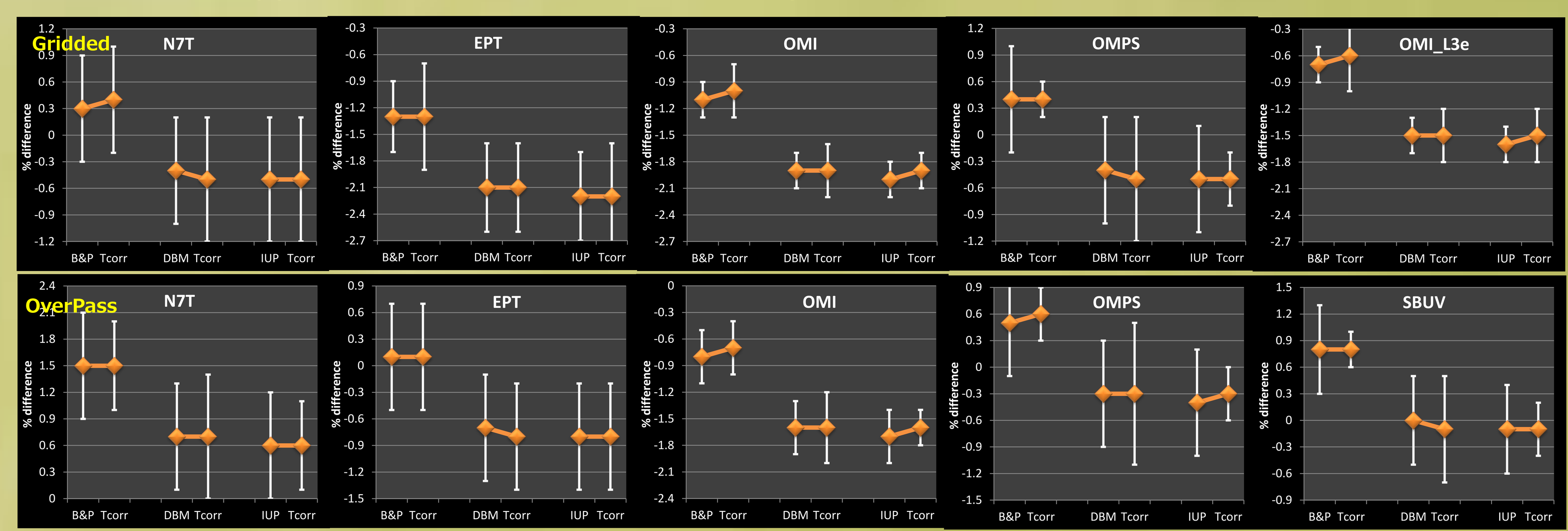


Figure 5. Annual cycle average and ± 1 standard deviation (%) of three different O_3 cross-sections at Boulder (40N), and temperature dependence is applied (Tcorr). Gridded data is thought for OMI (BP), OMPS (BP_Tcorr) and OMI_L3e (BP) to be good agreement.

X sec DBM	X sec IUP	T corr BP	T corr DBM	T corr IUP
1.008	1.009	-0.133 %k-1	+0.042 %k-1	-0.104 %k-1

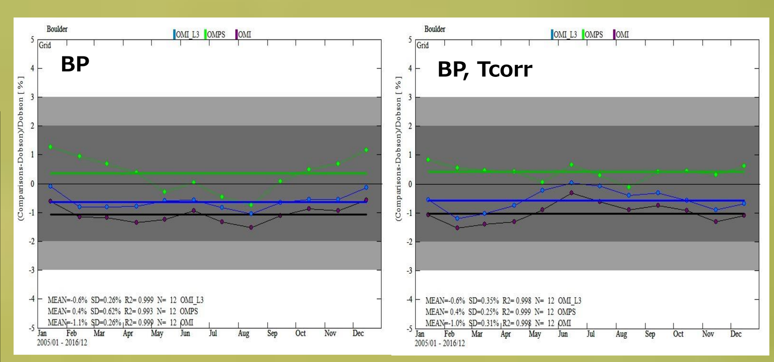


Figure 6. After applying temperature corrections to BP cross sections in Boulder and OMPS the difference further improved.

Gridded data matching;

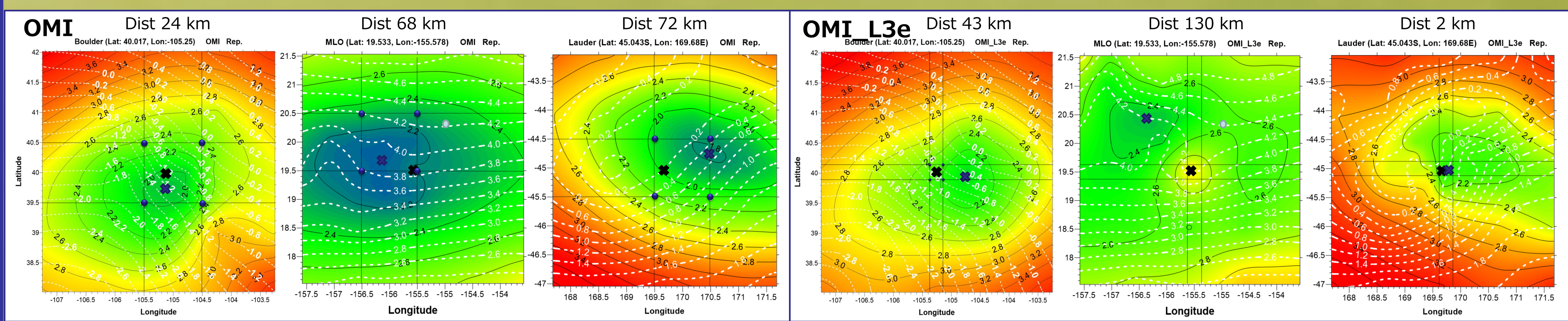


Figure 7. We calculated correlation with different latitude (and longitude) from a station in order to see gridded data matching. Data matching calculated from a station official location (black cross) and moving correlation based on the minimum error (gray cross). OMI data at 1.0 x 1.0 degrees steps, OMI Level 3e data at 0.25 x 0.25 degrees steps. A black solid line shows standard deviation and a white dotted line shows average value.

References.

Evans, R. D.: Operations Handbook - Ozone Observations with a Dobson Spectrophotometer - revised version, WMO/GAW Report No., 183., 2008.

Redondas, A., Evans, R., Stuebi, R., Köhler, U., and Weber, M.: Evaluation of the use of five laboratory-determined ozone absorption cross sections in Brewer and Dobson retrieval algorithms, Atmos. Chem. Phys., 14, 1635-1648, doi:10.5194/acp-14-1635-2014, 2014.