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Estimating Uncertainty in Long Term Total Ozone Records from Multiple Sources
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1. Introduction
Long-term ozone records required for time series analysis must be constructed from multiple instrument records of varying type and quality. Also needed are realistic estimates of the uncertainty of the long-term record, including contributions from the individual instrument uncertainty and from the merging process. In this work we estimate uncertainties in the SBUV V6.8 merged Total Ozone Data Set (updated from Frith et al. [2014] through June 2014). With only a single SBUV instrument still in operation, we investigate extending the record with data from AURA/OMI and S-NPP/OMPS nadir-view instruments, and the ramifications on the error analysis. Updated ozone trend results from SBUV V6.8 MOD are shown.

2. Data intercomparisons demonstrate relative stability of instruments

3. Error estimates not sensitive to additional year of data
Following the procedure outlined in Frith et al. [2014] we update the VI6.6 MOD error estimates using new measurements from N14 and N19 SBUV. We use Monte Carlo simulations to represent uncertainties in the merged record and test the sensitivity of derived trends to these potential variations. SBUV measurements are inter-calibrated at the radiance level. Long overlap of OMI and SBUV will help maintain consistent calibration of merged record into future.

4. Including OMI improves error slightly as SBUV instruments end

Figure 1. Equator crossing time of orbits for SBUV satellite series, AURA/OMI and S-NPP/OMPS.

Figure 2. 60°N-60°S zonal monthly time series differences between OMI-SBUV (left) and OMPS-SBUV (right) indicate the overall stability of all three records with respect to each other. OMI ozone cross-sections used in the retrieval differ from those used by SBUV and OMPS leading to a 1.5% offset (will be rectified in next version release of OMNI).

Figure 3. Distributions of offset and drift derived from comparisons of SBUV data during overlap periods. ‘Tier 1’ and ‘Tier 2’ values computed to reflect differences in data quality: N14 and the morning ECT portions of N13 and N16 are considered Tier 2 instruments. These values are used in a Monte Carlo model to simulate 10000 sets of potential instrument records with random offset/drift.

Figure 4. Step-by-step error estimation procedure. Panels a-c address relative uncertainty between instruments; Panel d includes absolute uncertainty term.

Table 1. The final step is to analyse each potential MOD error term with regression model to establish sensitivity of proxy terms to the uncertainty.

Figure 5. OMI-SBUV offsets and drifts for overlap periods as a function of latitude. OMI shows a small positive offset at most latitudes and remarkably stable drift values. Including these values in the error analysis shows a very small but increasing effect as the number of instruments decreases. The 2-sigma error variability (red curves, Fig. 4 Panel d) were reduced by 0.25 DU at the end of 2013 (not shown).

We do not include OMI or OMPS data in the MOD record at this time as new versions of both are anticipated in the next year.

Figure 6. Ozone Trends as computed in Frith et al. [2004] updated with one year of N16/N19 SBUV data. Results shown for EESC fit over the full time period and a linear trend fit to data from January 2000-June 2014. Standard terms for seasonal, solar cycle, ORO, volcanic and ENSO included; no dynamical terms.

Conclusions

- Aura OMI and S-NPP OMPS NM are quality data sets that can be used to extend the MOD record. New releases of OMI and OMPS are expected in 2015 and will likely be incorporated at that time.
- Including calibration and instrument quality information gives a more realistic model of noise in a merged data set which can then be tested for potential interaction with common regression process.
- Despite a statistically significant fit to EESC, a longer time series is required to detect an ozone increase using a linear trend fit starting in 2000 and thus verify the assumed EESC recovery rate.

References