Comparison of Tropospheric Ozone Columns Calculated from MLS, OMI, and Ozonesonde Data

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Abstract

This poster shows a comparison of four derived tropospheric ozone column products with integrated tropospheric ozone columns from ozonesonde profiles. The three products include the tropospheric ozone residual methods of Ziemke et al. (2006) and a modified version of Fishman et al. (2003), and an approach that uses trajectory mapping. In each case, MLS ozone profiles are integrated to the tropopause and subtracted from OMI (TOMS retrieval) total column ozone. The effectiveness of each of these four techniques is examined as a function of latitude, time, and geographic region. In general, we find good agreement between the derived products and the ozonesondes, with the Fishman et al. Product (labeled "Amy") generally high and the Schoeberl trajectory mapping (labeled "Mark") product generally low as compared to the integrated ozonesonde profiles (labeled "Sonde").

The Competitors

In this poster, we compare three approaches to computing a tropospheric ozone residual product. All three approaches subtract an integrated statospheric ozone profile measured by MLS from a column ozone measurement by OMI. Both MLS and OMI fly on the Aura satellite platform. Each approach uses the WMO definition of the tropopause to define the height to which to integrate the MLS data. The TOMS retrieval is used with the OMI data for total column ozone. We analyze the period August 2004 through July 2006

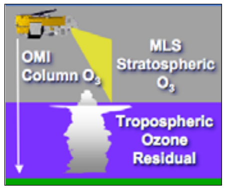


Figure 1. This cartoon illustrates the tropospheric ozone residual calculation made by each of the three competing approaches compared in this poster.

"Amy"

The first approach follows the tropospheric ozone residual (TOR) technique of *Fishman et al.* [1990] and *Fishman et al.* [2003] to produce a daily, 2-D gridded TOR product.

"Jerry"

The second approach follows the methodology of *Ziemke et al.* [2006] to compute a TOR product. Tropospheric column ozone is determined using the residual technique of *Fishman et al.* [1990] by subtracting MLS stratospheric column ozone (SCO) from OMI total column ozone after adjusting for inter-calibration differences of the two instruments using the convective-cloud differential method of *Ziemke et al.* [1998]. Gridded global maps of SCO from MLS at 0.25°× 0.25° and 1°×1.25° resolution are produced in daily measurements using a 2D interpolation scheme. These SCO fields are then subtracted from similarly gridded OMI total column ozone fields. Maximum tropopause pressure was taken as MLS retrieval value of 316 hPa. The derived TOR product is also filtered for cloud errors by rejecting scenes where OMI reflectivity is greater than 0.3.

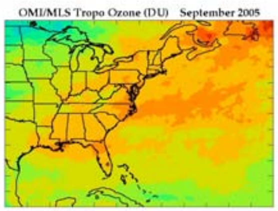


Figure 2. Monthly mean tropospheric ozone residual as computed using the method of *Ziemke et al.* [2006, JGR in press]

"Mark"

The third approach creates a high resolution trajectory maps [*Morris et al.*, 1995] of total ozone residual using forward trajectory projections of the previous six days of MLS ozone data. The integrated, trajectory-mapped MLS ozone data are then subtracted from the level-3 OMI data in the manner of *Morris et al.* [1997]. In addition to the WMO tropopause definition, a 3.5 PVU criteria is applied in the extra tropics, usually resulting in a somewhat lower tropopause height.

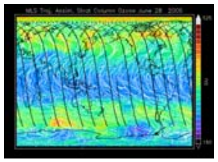


Figure 3. MLS SCO produced with 6-day trajectories. Notice the improved resolution over the one day MLS data (black dots)

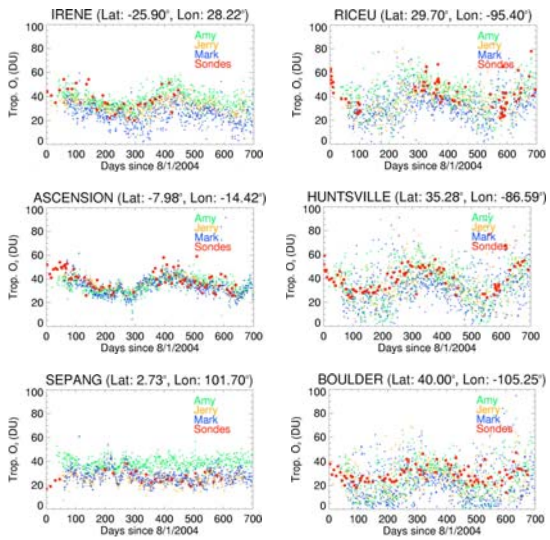
The Ozonesonde Stations

Ozonesonde data from the Aura Validation Data Center (AVDC) include most available soundings. Thirteen stations provided 551 profiles used in the analysis presented. The Table summarizes the stations and indicates the latitude groupings used in this study. We thank all of the teams involved in gathering and processing the ozonesonde data.

Station Name	Principal Investigator	Latitude	Longitude	# Profiles
Alert	D. Tarasick	82.50	-62.33	21
Ascension Island	A. Thompson	7.98	-14.42	69
Boulder	S. Oltmans	40.00	-105.25	91
Cotonou	A. Thompson	6.21	2.23	29
Egbert	D. Tarasick	44.23	-79.78	25
Hilo	S. Oltmans	19.43	-155.04	50
Houston (Rice U)	G. Morris	29.70	-95.40	77
Huntsville	M. Newchurch	35.28	-86.59	85
Irene	A. Thompson	-25.90	28.22	35
LaReunion	A. Thompson	-21.06	55.48	16
Sepang	A. Thompson	2.73	101.70	26
Summit	S. Oltmans	72.60	-38.50	11
Watukosek	A. Thompson	-7.50	112.60	16

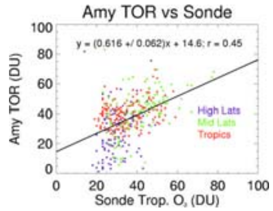
Time Series of TOR Products vs Ozonesondes

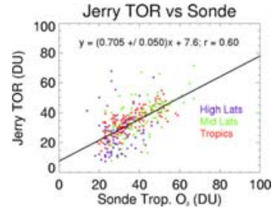
Figure 4. Below time series for 6 of the 13 stations showing the derived TOR products and the integrated ozonesonde profiles. All three TOR products generally follow the seasonal cycles well. Amy tends to be high, while Mark tends to be low. Significantly tighter distributions are found in the tropics as compared to midlatitude sites.



TOR Products vs Integrated Ozonesondes

Figure 5. Scatter plots illustrate the relationships between the TOR products and the integrated ozonesonde profiles as a function of latitude. Dots are colored by the latitude groupings of the sonde stations (see Table at left). A regression fit and correlation coefficient accompany each plot. Jerry's approach produces the highest correlation coefficient and a regression slope nearest to the expected value of 1.0. All three approaches produce lower values than observed by sondes.





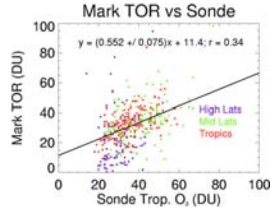
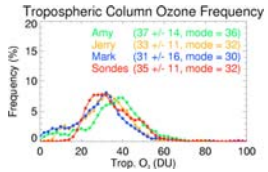


Figure 6. A probability distribution function for the co-located TOR product and ozonesonde data. Mean, standard deviation, and mode statistics are provided with each data set. All TOR products produce far more small values (< 20 DU) than are seen in the sonde data. Jerry and Mark match the mode of the sonde data well, while Amy does a better job on the high side of the distribution.



Conclusions and Future Work

This poster has presented a preliminary evaluation of three TOR products derived from Aura MLS and OMI measurements. In general, all three products reproduce well the tropospheric ozone columns integrated from ozonesonde profiles and the observed seasonal cycles. More variability is seen in the TOR products at midlatitues than in the tropics. If OMI is unable to see to the surface, however, additional ozone from pollution (e.g. Houston & Huntsville) will result in a low bias of the TOR data.

Future work will integrate all MLS profiles to 200 hPa in the tropics and 100 hPa elsewhere so that the problems associated with tropopause definitions will not enter into the evaluation of the three products.

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