9-1-2006

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

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September 11 - 15, 2006
AURA Science Team Meeting
Boulder, Colorado

Abstract

This poster shows a comparison of three derived tropospheric ozone residual (TOR) products with integrated tropospheric ozone columns from ozonesonde profile: (1) the method of *Ziemke et al.* (2006), (2) a modified version of *Fishman et al.* (2003), and (3) a trajectory mapping approach. 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 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. TOR (labeled "Amy") generally high and the Schoeberl trajectory mapping (labeled "Mark") product generally low as compared to the integrated ozonesonde profiles (labeled "Sonde") as computed using the WMO tropopause definition. Differences in TOR results are due, at least in part, to non-uniform tropopause height definitions between the three approaches.

The Three TOR Products

We compare three approaches to computing TOR. All three approaches subtract stratospheric column ozone (SCO), as computed by integrating stratospheric ozone profiles (SOP), from a column ozone measurement by OMI. The TOMS retrieval is used with the OMI data for total column ozone. We analyze the period August 2004 through July 2006

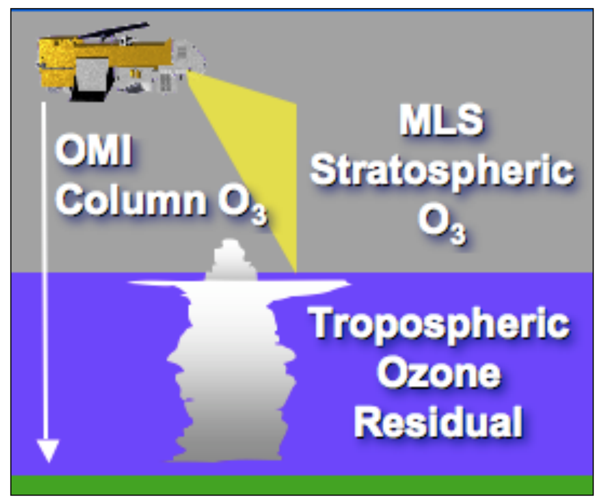


Figure 1. This cartoon illustrates the tropospheric ozone residual calculation made by each of the three approaches presented in this poster. Note that currently, Amy uses an assimilated SBUV product rather than MLS.

"Amy"

The first approach is based on the TOR of *Fishman et al.* [1990] and *Fishman et al.* [2003]. A model that assimilates SBUV SOP provides daily, gridded SCO to be subtracted from the level 3 OMI data. An ozone climatology fills in ozone values between lowest reliable SBUV observation and the tropopause. A standard WMO tropopause definition of 2K/km is used.

"Jerry"

The second approach is described in *Ziemke et al.* [2006]. TOR is determined using the residual technique of *Fishman et al.* [1990] by subtracting MLS stratospheric column ozone (SCO) from OMI total column ozone. An adjustment for inter-calibration differences of the two instruments (~ +3 DU), computed using the convective-cloud differential method of *Ziemke et al.* [1998], is included in the TOR. Gridded global maps of SCO from MLS at 0.25° × 0.25° and 1° × 1.25° resolution are produced daily using a 2D interpolation scheme. These SCO fields are then subtracted from similarly gridded OMI total column ozone fields. The WMO tropopause is used with a maximum pressure of 316 hPa. The derived TOR product is filtered for cloud errors by rejecting scenes where OMI reflectivity is greater than 0.3.

OMI/MLS Tropo Ozone (DU) September 2005

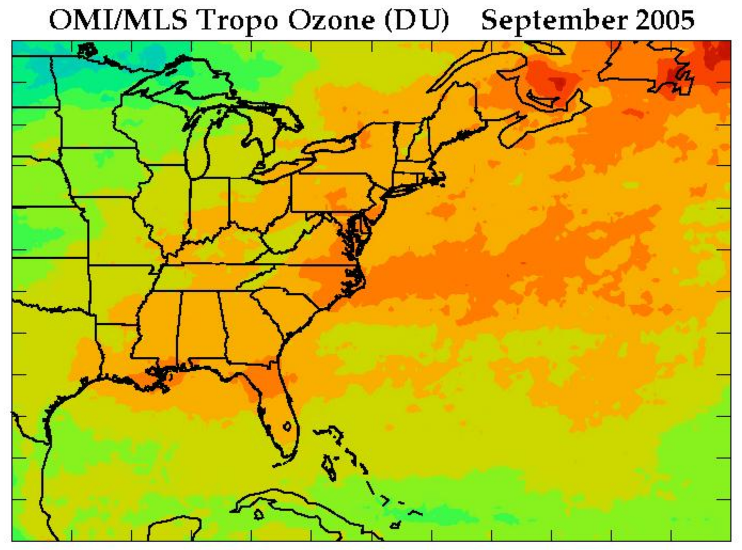


Figure 2. Monthly mean tropospheric ozone residual as computed using the method of *Ziemke et al.* [2006, JGR in press]

"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 lower tropopause height and smaller TOR values.

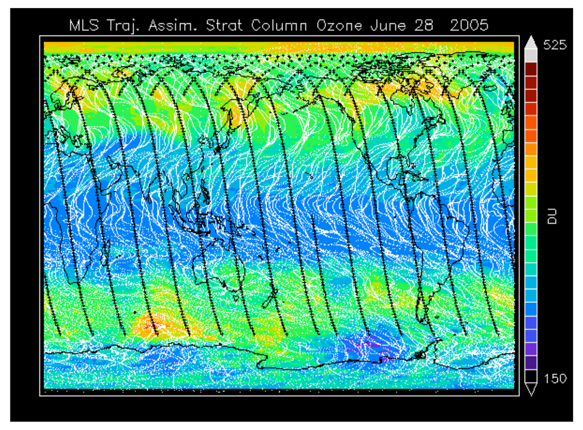


Figure 3. MLS SCO produced with 6-day trajectories. Notice the improved resolution over the one day MLS data (black dots)

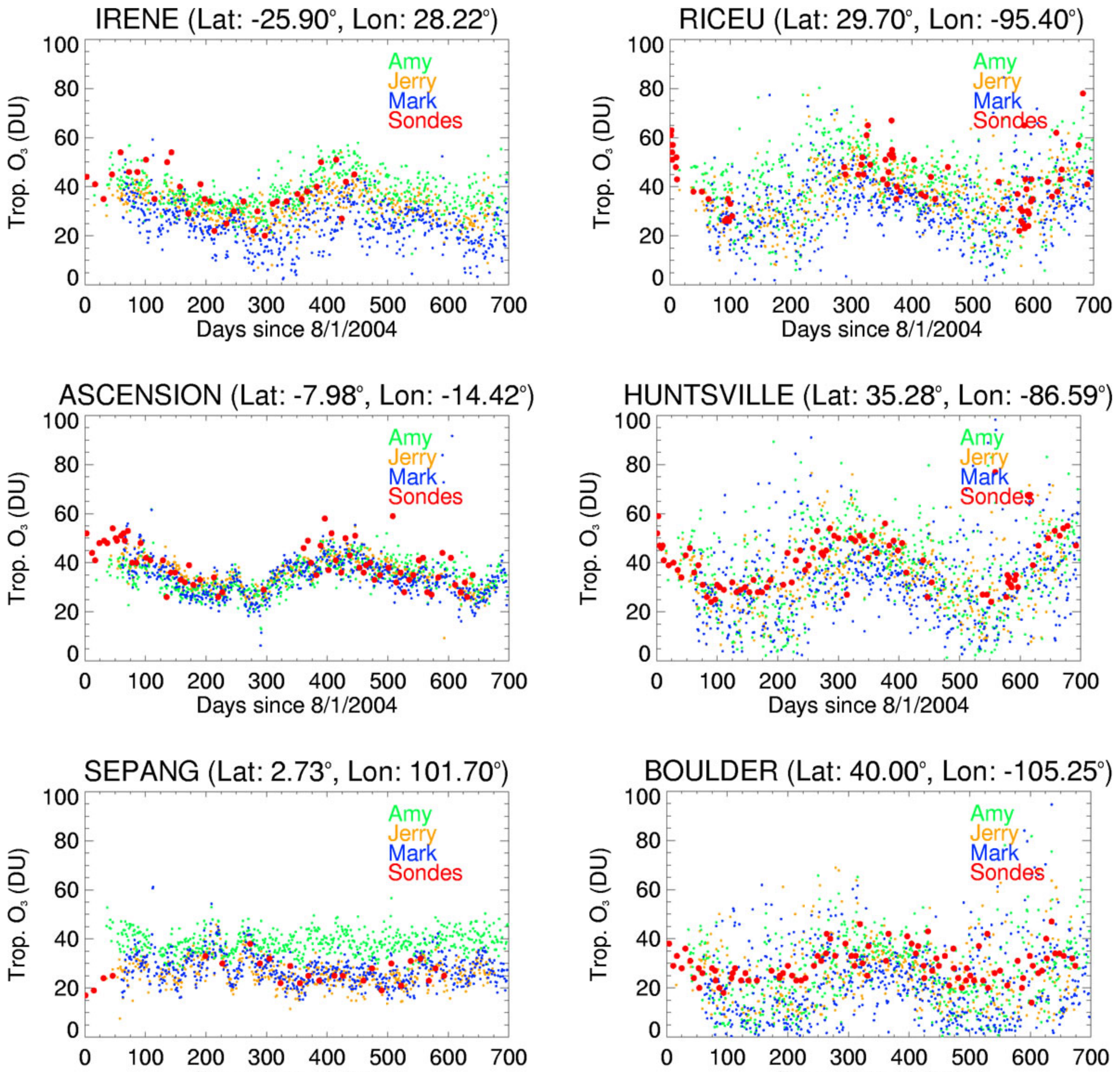
The Ozonesonde Stations

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 where day-to-day variability is smaller and the tropopause definitions used by the three approaches tend to be the same.



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 perform better in the tropics.

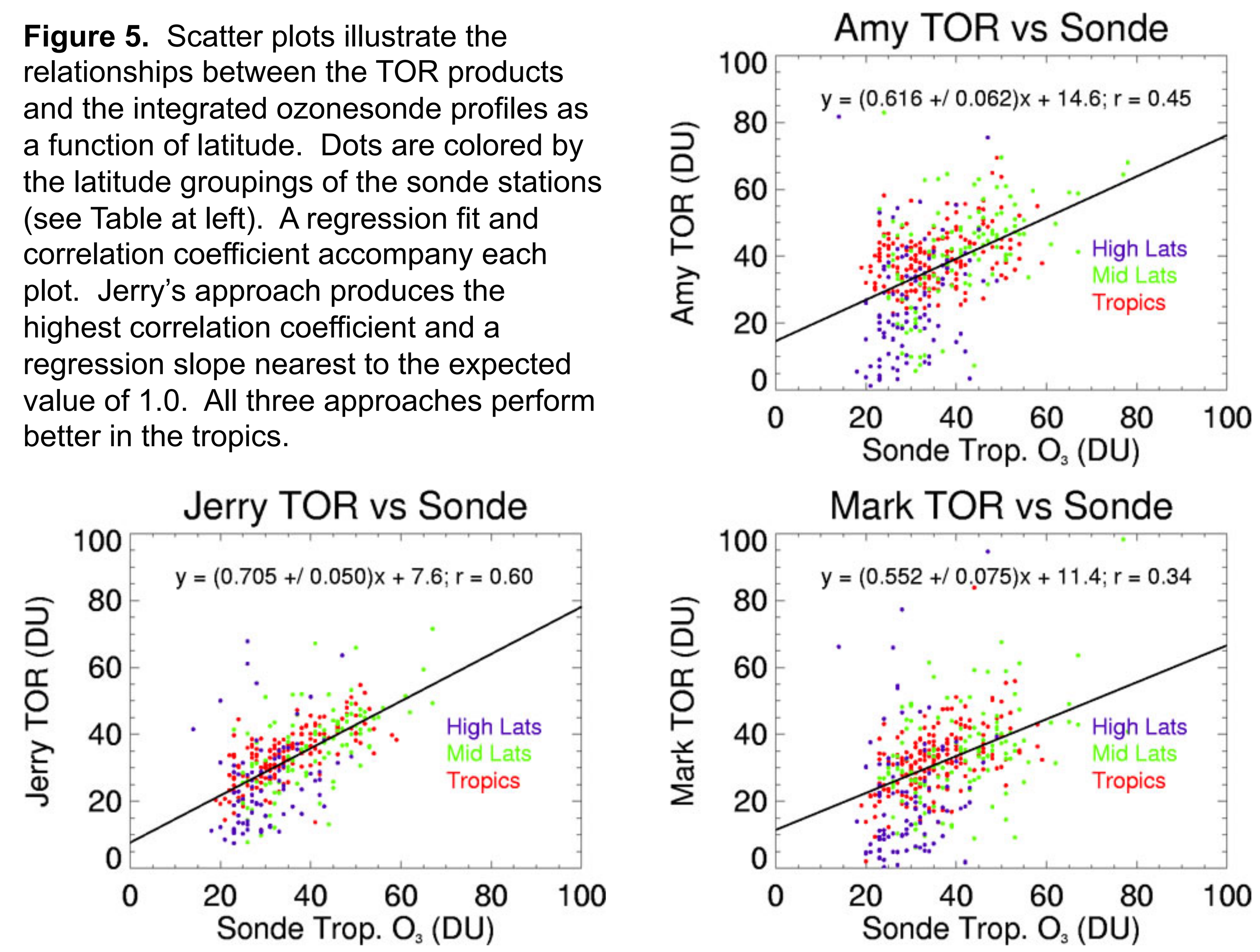
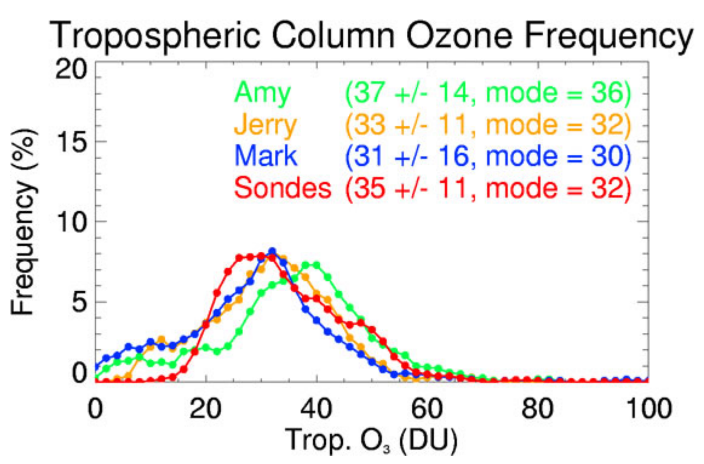


Figure 6. A probability distribution function for co-located TOR and ozonesonde data. Mean, standard deviation, and mode statistics are provided with each data set. All TOR products produce far more small values (< 20 DU) than are seen in the sonde data. Jerry and Mark match the mode of the sonde data 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 SBUV, Aura MLS, and OMI measurements. In general, all three reproduce well the tropospheric columns computed from ozonesonde profiles and the observed seasonal cycles. More variability is seen in the TOR products at midlatitudes than in the tropics and than seen in the ozonesonde data. If OMI cannot see the surface, ozone pollution (e.g. Houston) will result in a low bias of the TOR data as compared to the sondes.

Future work will integrate all MLS profiles to 200 hPa in the tropics and 100 hPa elsewhere to eliminate problems associated with using various tropopause definitions. Amy's TOR will be updated with assimilated MLS replacing SBUV in SCO calculations.

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Funding for this research was provided in part by Goddard Earth Science Technology (GEST) grant NCC5-494 and a separate grant to Valparaiso University, both under the Aura validation and atmospheric composition program of NASA's Earth-Sun System Division. Thanks to the MLS, OMI, SBUV, and ozonesonde teams!