Comparison of Eta/CMAQ and OMI – MLS Tropospheric Ozone

Kenneth E. Pickering[1], Jerry Ziemke[2], Changwoo Ahn[3], P. K. Bhartia[1], Lackson Marufu[4], Russell Dickerson[4], Rohit Mathur[5], Paula Davidson[6]

[1] NASA Goddard Space Flight Center, Greenbelt, MD USA
[2] GEST-UMBC, NASA Goddard, Greenbelt, MD USA
[3] SSAI, NASA Goddard, Greenbelt, MD USA
[4] University of Maryland, College Park, MD USA
[5] NOAA, Research Triangle Park, NC USA
[6] NOAA, Silver Spring, MD USA

Aura OMI-MLS Tropospheric Ozone

- Residual method [Fishman, et al., 1990] used to derive daily gridded tropospheric ozone maps
- MLS stratospheric column ozone (SCO) along orbital track derived by pressure integration of MLS ozone mixing ratio profiles down to NCEP tropopause
- MLS SCO gridded maps generated using 2D interpolation
- Gridded tropospheric column ozone (TCO) = OMI total ozone – MLS SCO
- TCO cloud filtered using OMI gridded reflectivity < 0.3
  TCO filtered for NCEP tropopause < 170 hPa
- Mean volume mixing ratio (**ppbv**) = 1.27×TCO (**DU**) / [$P_{\mathbf{TERRAIN}}$ (**mb**) – $P_{\mathbf{TROPOPAUSE}}$ (**mb**)]

Eta/CMAQ Ozone Forecasting System

- Community Multiscale Air Quality (CMAQ) model developed by US EPA
- Driven by NCEP Eta weather forecast model
- Run at 12- km horizontal resolution with 22 layers in the vertical with model top at 100 hPa.
- Model domain – Eastern United States
- Model initialized at 1200 UT each day for a 48-hour forecast

Comparison of OMI-MLS and Eta/CMAQ Tropospheric Column Ozone

- Use 1900 UT Eta/CMAQ data (7-hour forecast), which is closest to OMI overpass time in Eastern US
- Regrid Eta/CMAQ data to OMI 1 x 1.25 deg. grid and integrate model data from surface to NCEP tropopause.
- Filter OMI-MLS and Eta/CMAQ gridded data to remove regions with NCEP tropopause pressure > 170 hPa, such that strong stratospheric ozone gradients are eliminated.
- Obtain OMI “averaging kernel” (profile of efficiency factors) from Level 2 data.
- Apply “averaging kernel” to Eta/CMAQ tropospheric profile ozone data
- Compute OMI-MLS minus Eta/CMAQ (adjusted) for each grid cell and compute statistics for each day over model domain

Adjust CMAQ tropospheric column O_3 using OMI "averaging kernel"

Tropospheric column O3: CMAQ adjusted for appropriate comparison with (OMI – MLS)

Layer efficiency from OMI L2 data

Tropospheric column O_3 from a priori profile

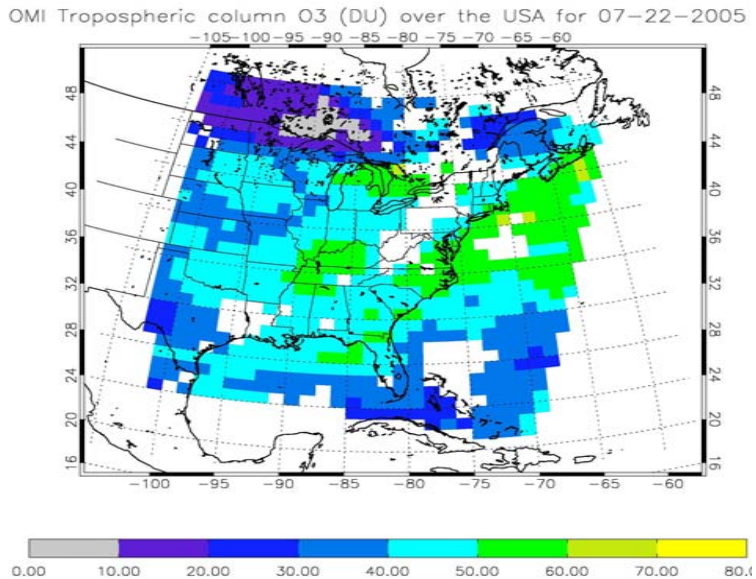
$$X_{CMAQadj} = [\Sigma E (x_{CMAQ} - x^0_{a\ priori})] + X^0_{a\ priori}$$

Layer O_3 from CMAQ profile

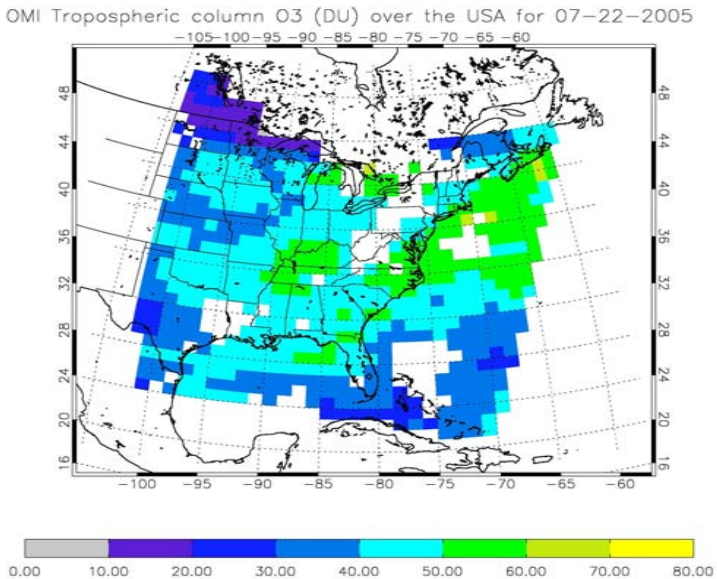
Layer O_3 from a priori profile

July 22, 2005

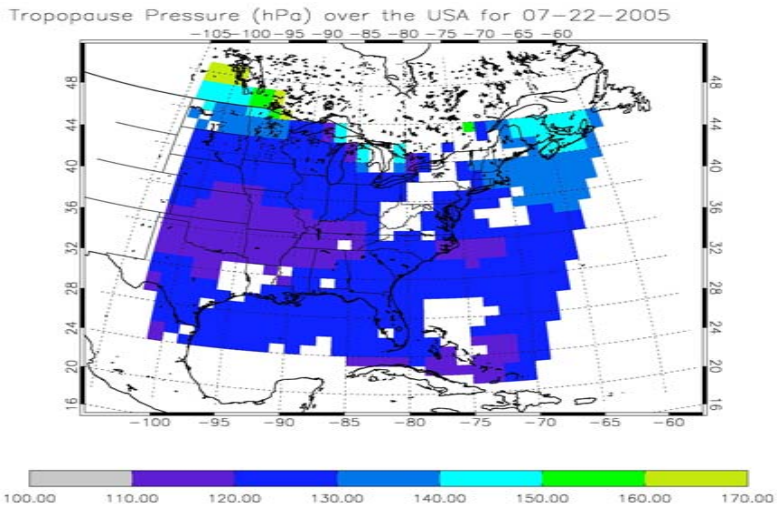
OMI - MLS



Filtered OMI - MLS

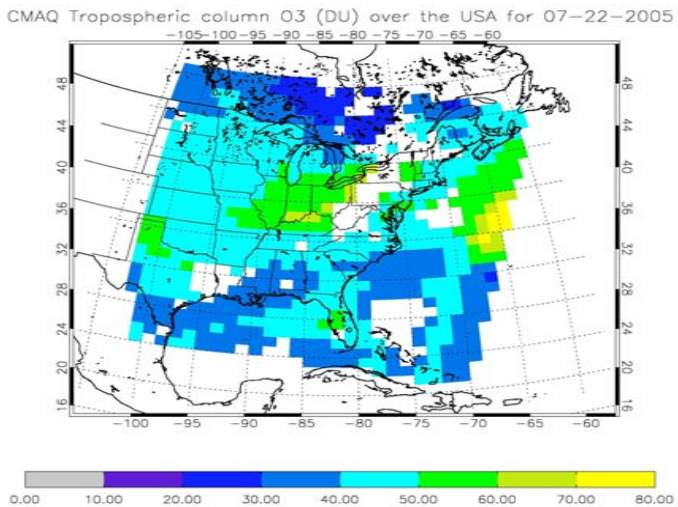


NCEP Tropopause Pressure

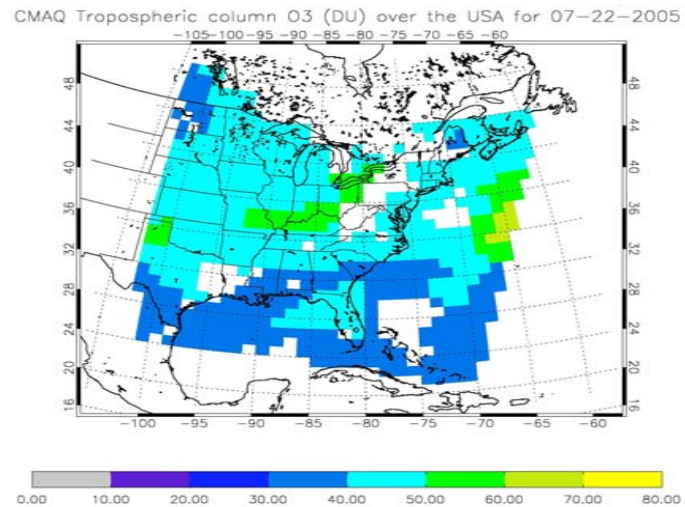


July 22, 2005

CMAQ Model



CMAQ Filtered and Adjusted



Summary Statistics

Ran CMAQ adjustment and comparison with (OMI – MLS) for 19 particularly low and high surface ozone days from 10 July to 15 Aug 2005 period over the Eastern US

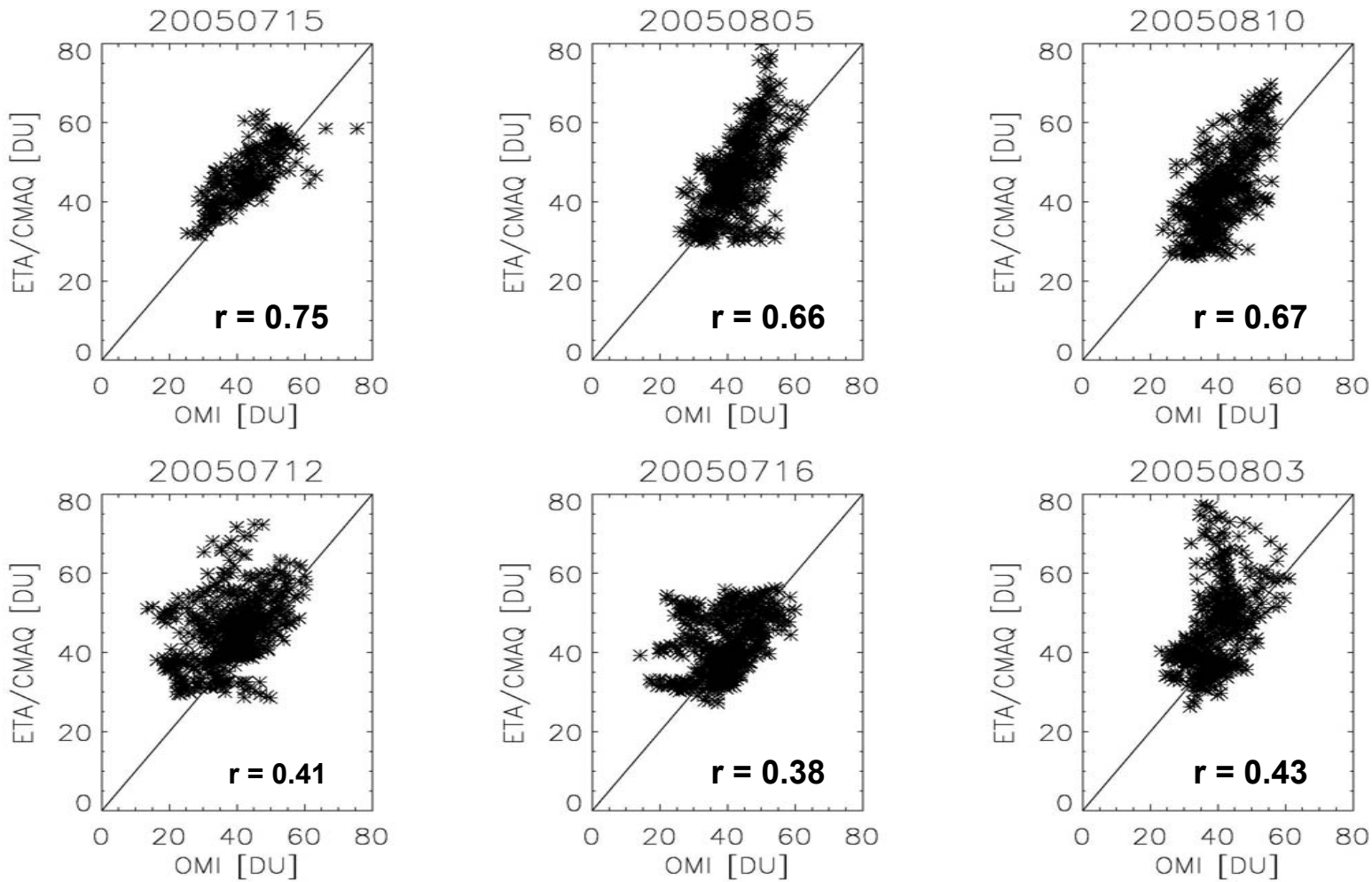
For (OMI – MLS) minus CMAQadj:

Mean spatial correlation = 0.54

Mean bias = -3.8 DU

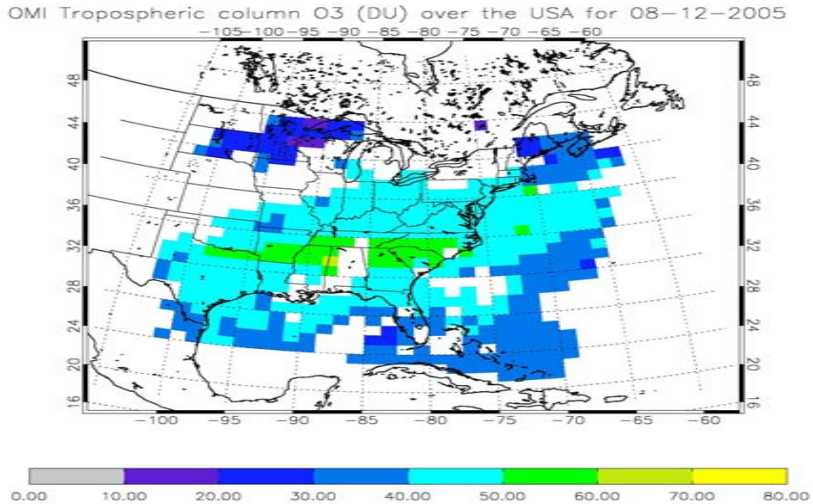
Mean absolute error = 7.1 DU

OMI vs ETA/CMAQ Tropospheric Column O3 Comparisons With Efficiency Corrections & Tropopause Filtering

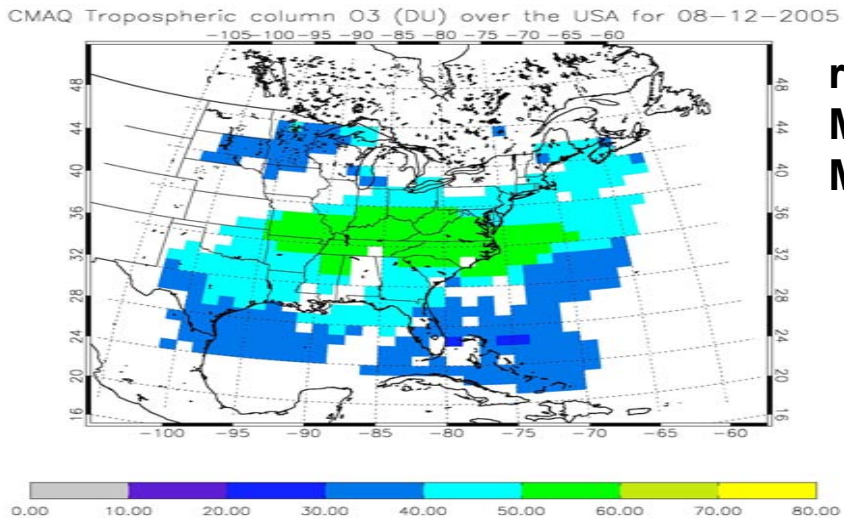


August 12, 2005

OMI - MLS Filtered



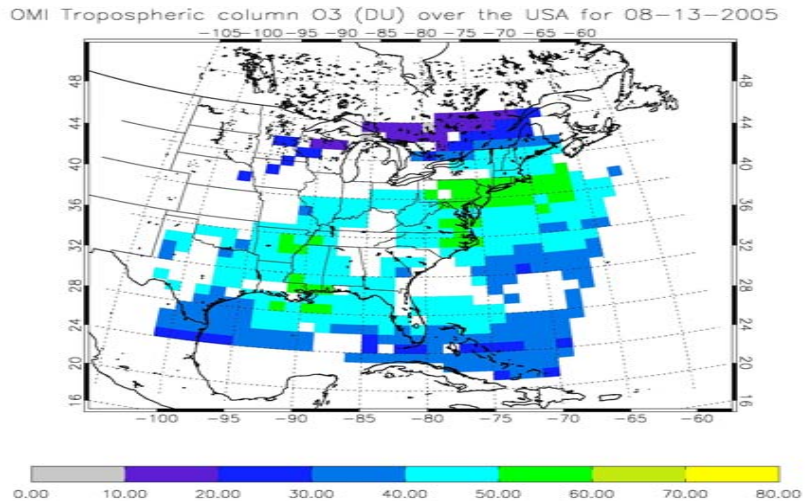
CMAQ Filtered and Adjusted



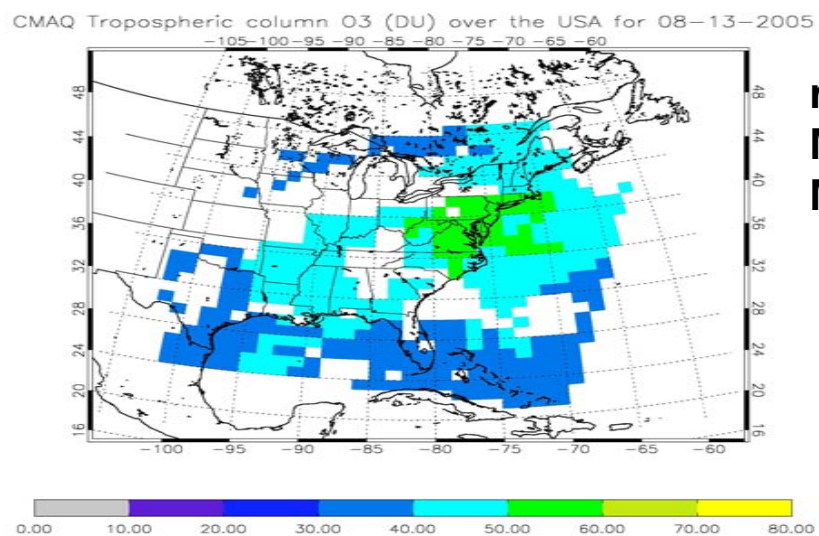
r = 0.56
Mean bias = -1.66 DU
Mean abs. error = 5.58 DU

August 13, 2005

OMI – MLS Filtered



CMAQ filtered and adjusted



r = 0.57
Mean bias = -2.53 DU
Mean absolute error = 5.67 DU

University of Maryland Piper Aztec

Aircraft vs. OMI Summary

Eight early afternoon spirals over Maryland during Summer 2005:

(OMI-MLS) minus A/C:

Mean Absolute Difference:	A/C PBL	15.5 ppbv
	A/C FT	5.9 ppbv

OMI-MLS much more closely related to pollution above boundary layer – indicative of regional transport

Summary

- Preliminary results for comparisons between the OMI-MLS tropospheric ozone product show reasonable agreement on the pattern of this variable over the Eastern United States.
- Spatial correlations exceeded 0.60 on 7 of 19 days studied.
- CMAQ tropospheric column ozone larger than OMI-MLS by 3.8 DU on average. Model may be biased high due to NCEP/GFS boundary condition.
- Both OMI-MLS and CMAQ show movement of high ozone region to East Coast during largest pollution event of Summer 2005. Demonstrates usefulness for forecasting.
- Based on comparison with UMD aircraft, OMI-MLS captures variability in O_3 transport layer above PBL.