Potential Air Quality Applications of Data from OMI

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OUTLINE

- **OMI data applications for tropospheric ozone production and transport**

  OMI Tropospheric O_3, NO_2, HCHO

- **OMI data applications for aerosols**

  OMI Aerosol Index, extinction optical depth, single scattering albedo, absorption optical depth, SO_2

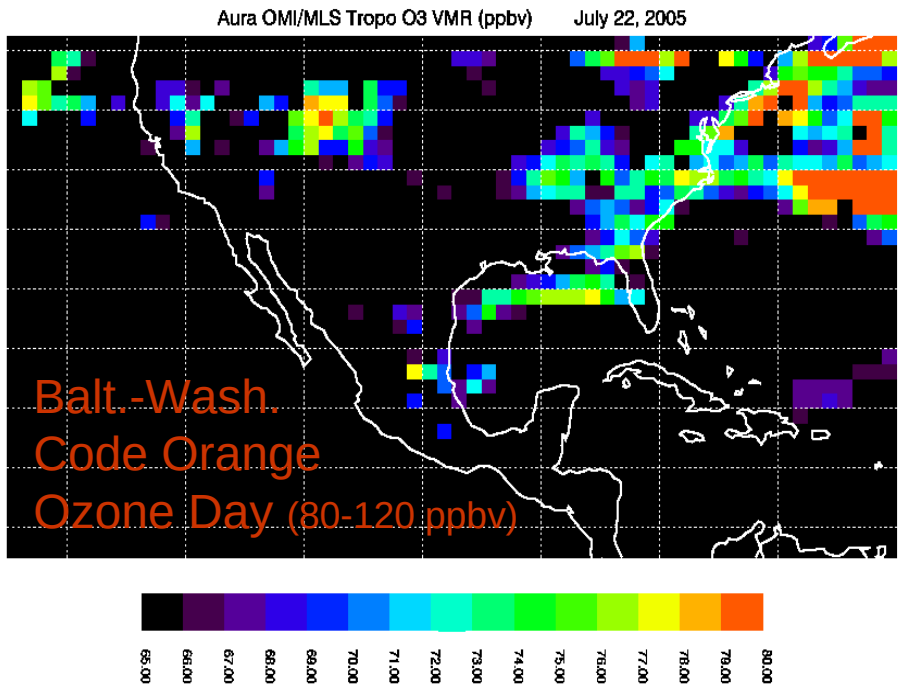
- **Regional air quality modeling – how can OMI data help?**

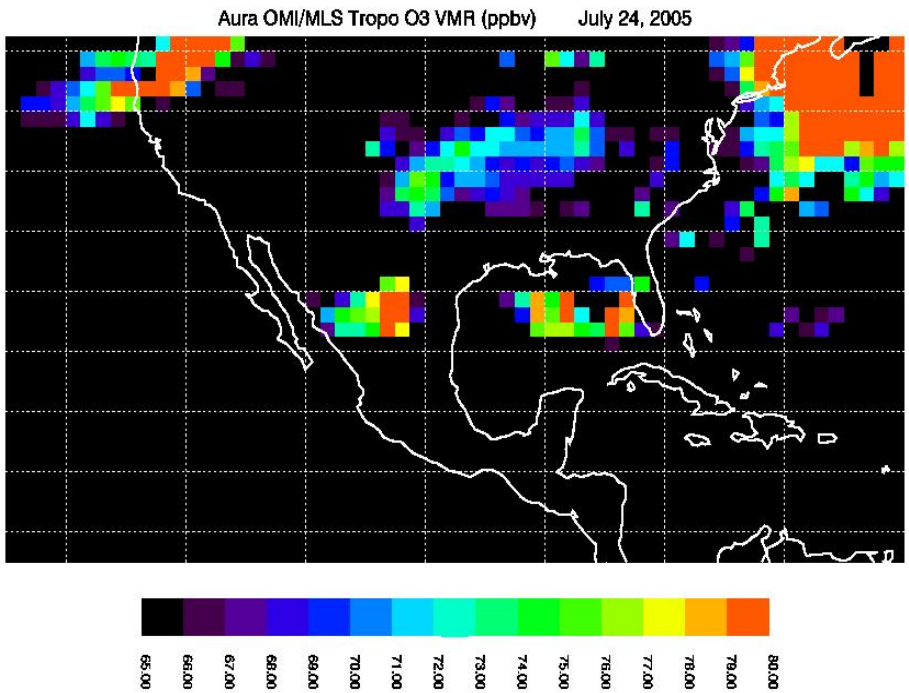
  CMAQ examples

  Assimilation and its application

Things We Would Like to Do with OMI Data

- Trace tropospheric O_3 episode development and transport (inter-regional and intercontinental)
- Examine tropospheric NO_2 plumes in relation to O_3 episode development
- Improve source inventories for anthropogenic NO_x
- Improve estimates of lightning NO_x production
- Examine HCHO contribution to O_3 episodes
- Improve source inventory for isoprene
- Use OMI column O_3 data in global data assimilation
- Use global O_3 data assimilation as initial and boundary conditions for regional models such as CMAQ


Aura OMI/MLS Tropo O3 VMR (ppbv) July 22, 2005
Balt.-Wash.
Code Orange
Ozone Day (80-120 ppbv)
65.00 66.00 67.00 68.00 69.00 70.00 71.00 72.00 73.00 74.00 75.00 76.00 77.00 78.00 79.00 80.00


Aura OMI/MLS Tropo O3 VMR (ppbv) July 24, 2005
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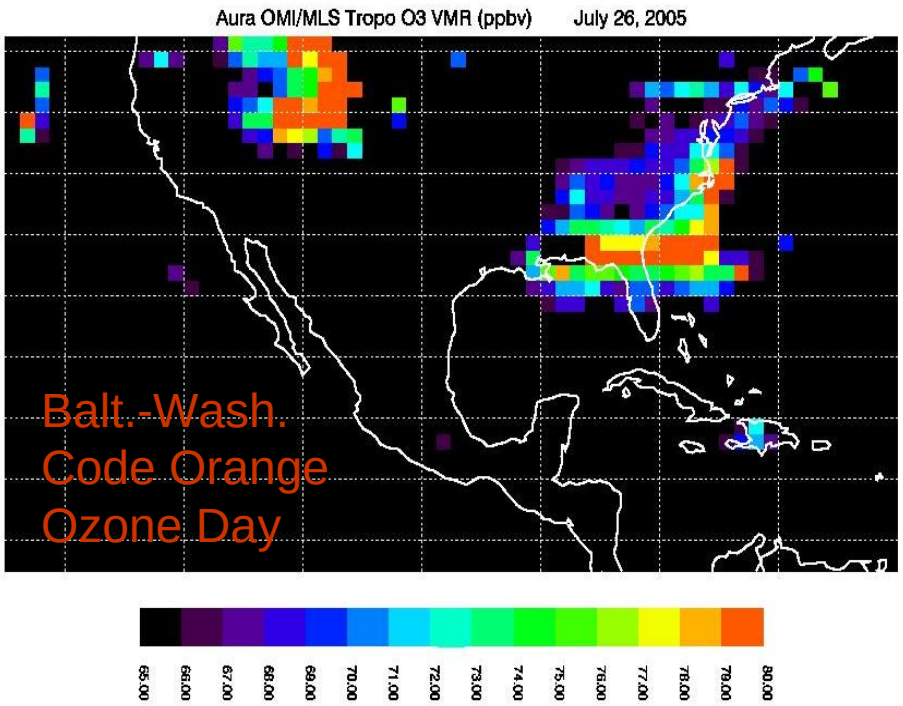
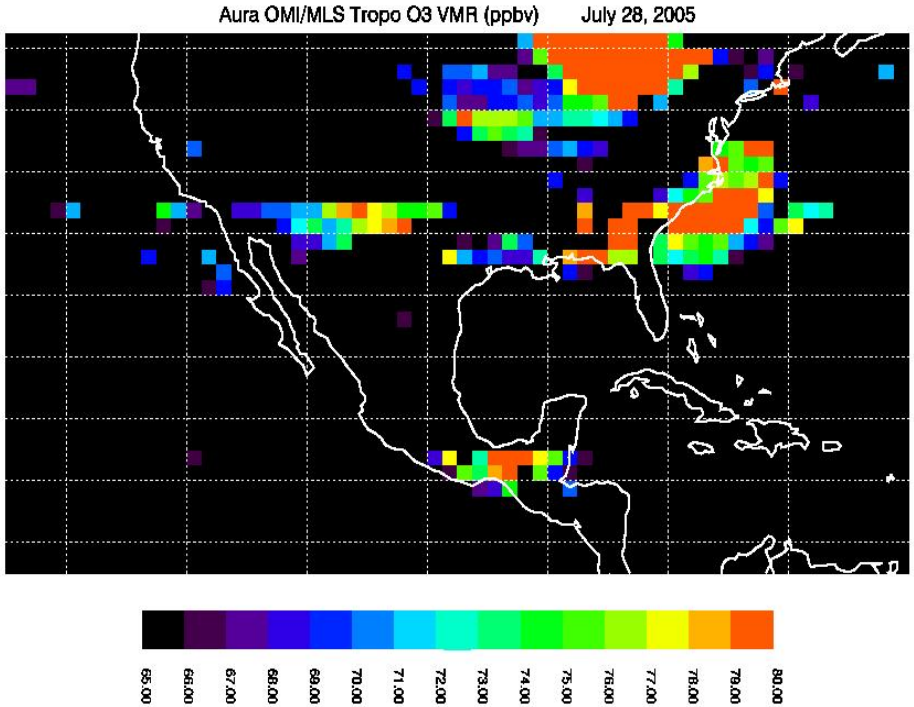
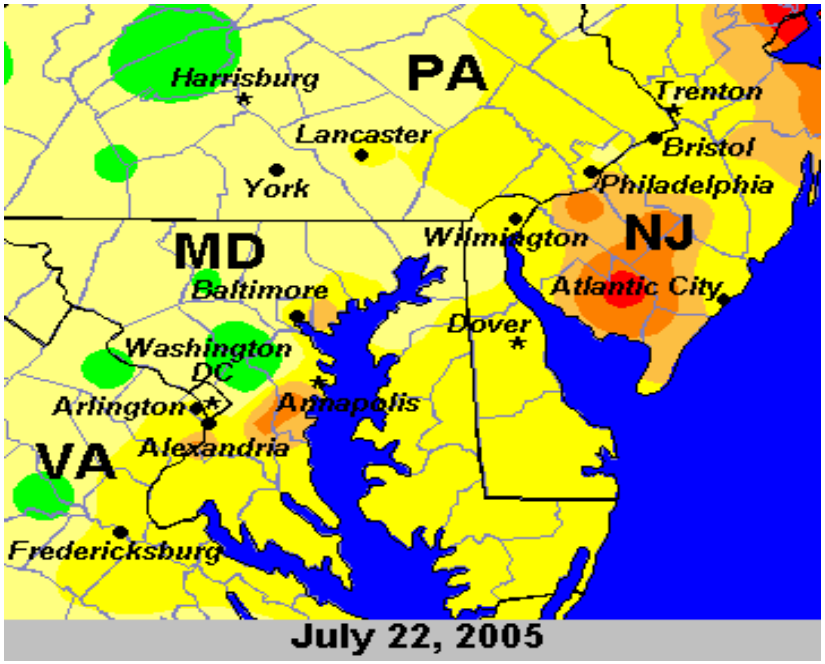
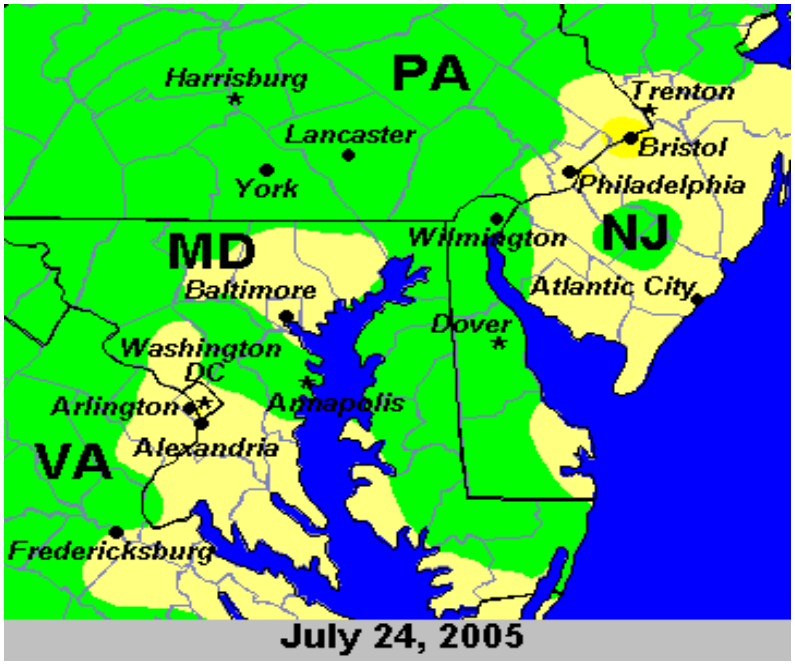
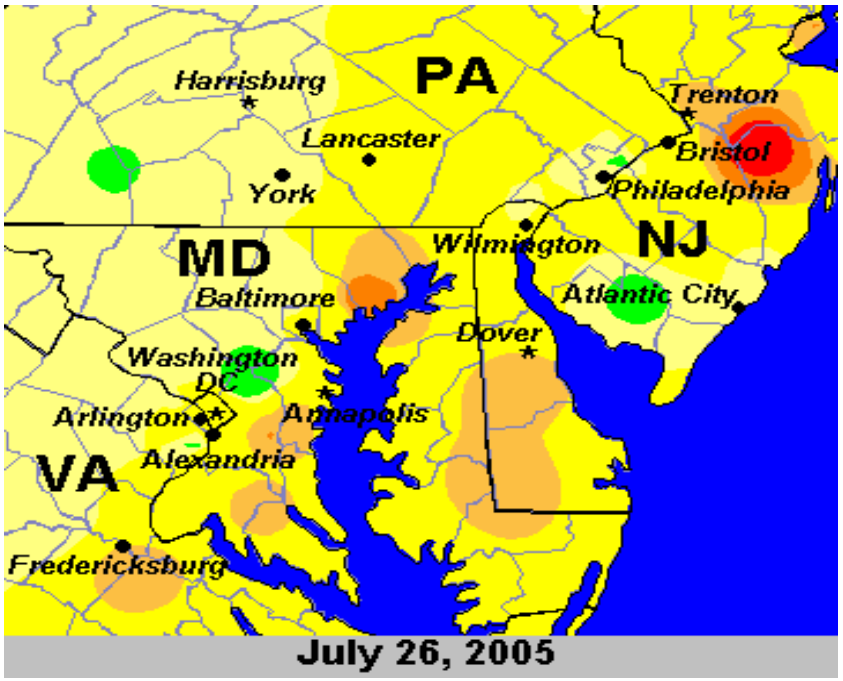

Aura OMI/MLS Tropo O3 VMR (ppbv) July 26, 2005
Balt.-Wash.
Code Orange
Ozone Day
65.00 66.00 67.00 68.00 69.00 70.00 71.00 72.00 73.00 74.00 75.00 76.00 77.00 78.00 79.00 80.00

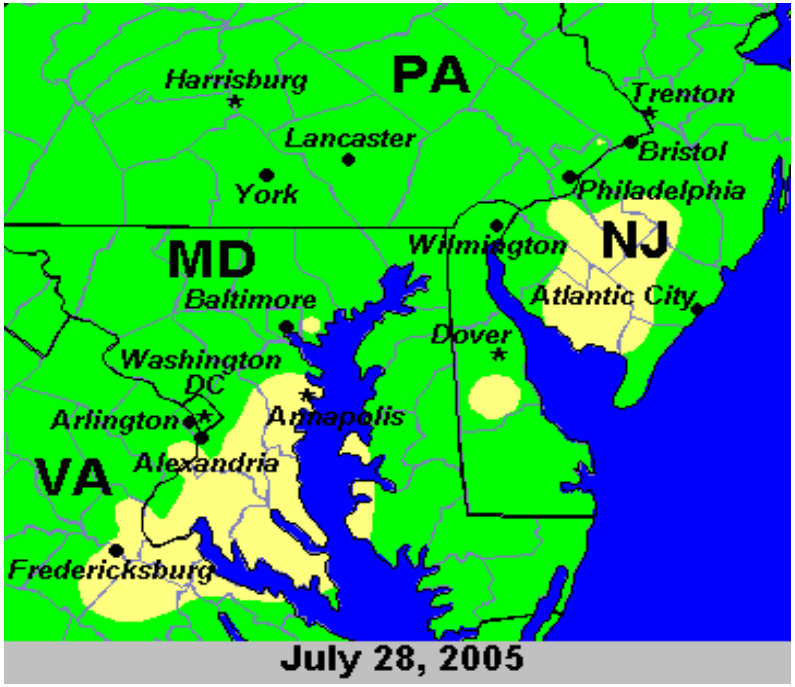

Aura OMI/MLS Tropo O3 VMR (ppbv) July 28, 2005
65.00 66.00 67.00 68.00 69.00 70.00 71.00 72.00 73.00 74.00 75.00 76.00 77.00 78.00 79.00 80.00

Surface Observations of Ozone

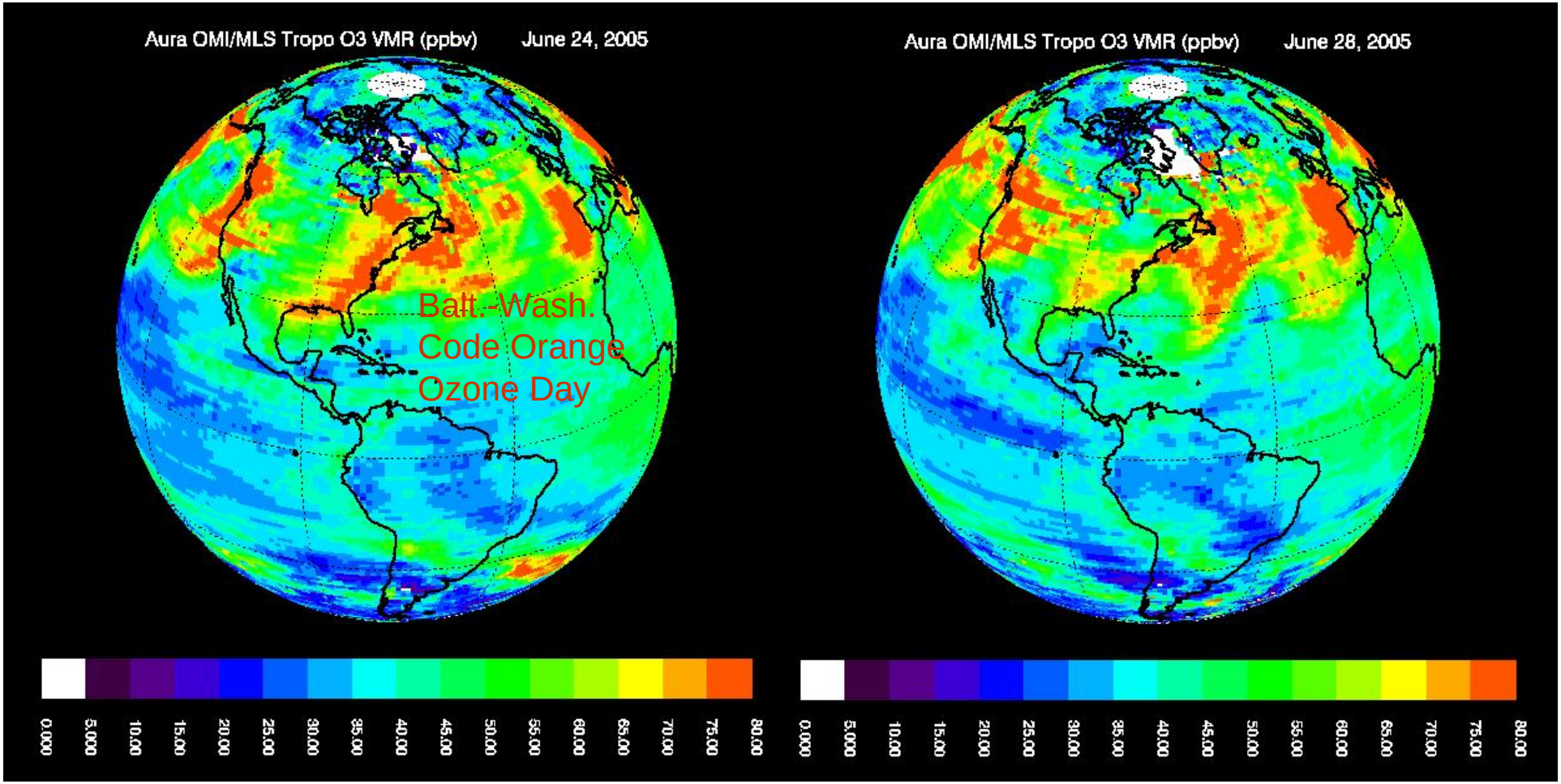




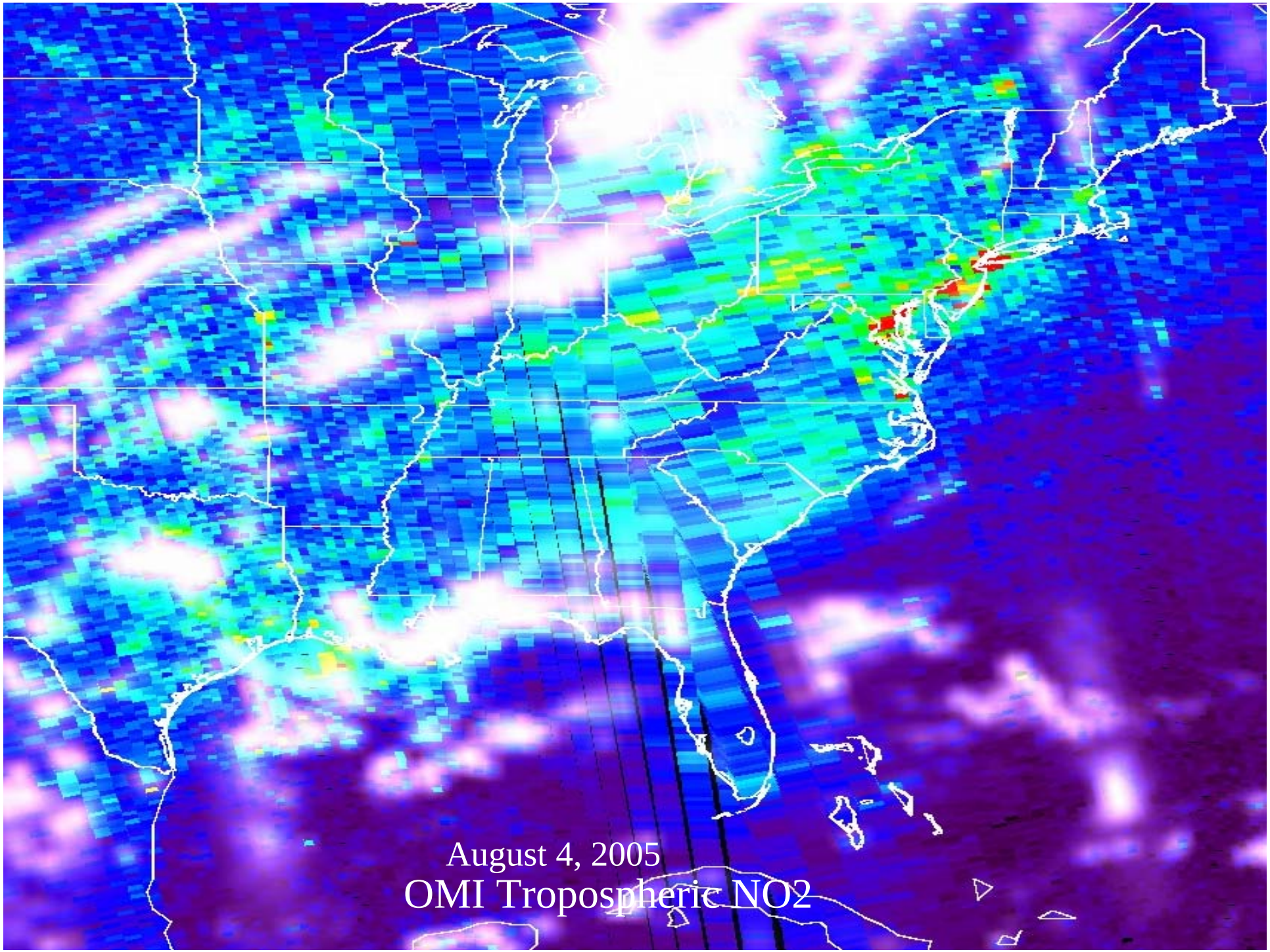


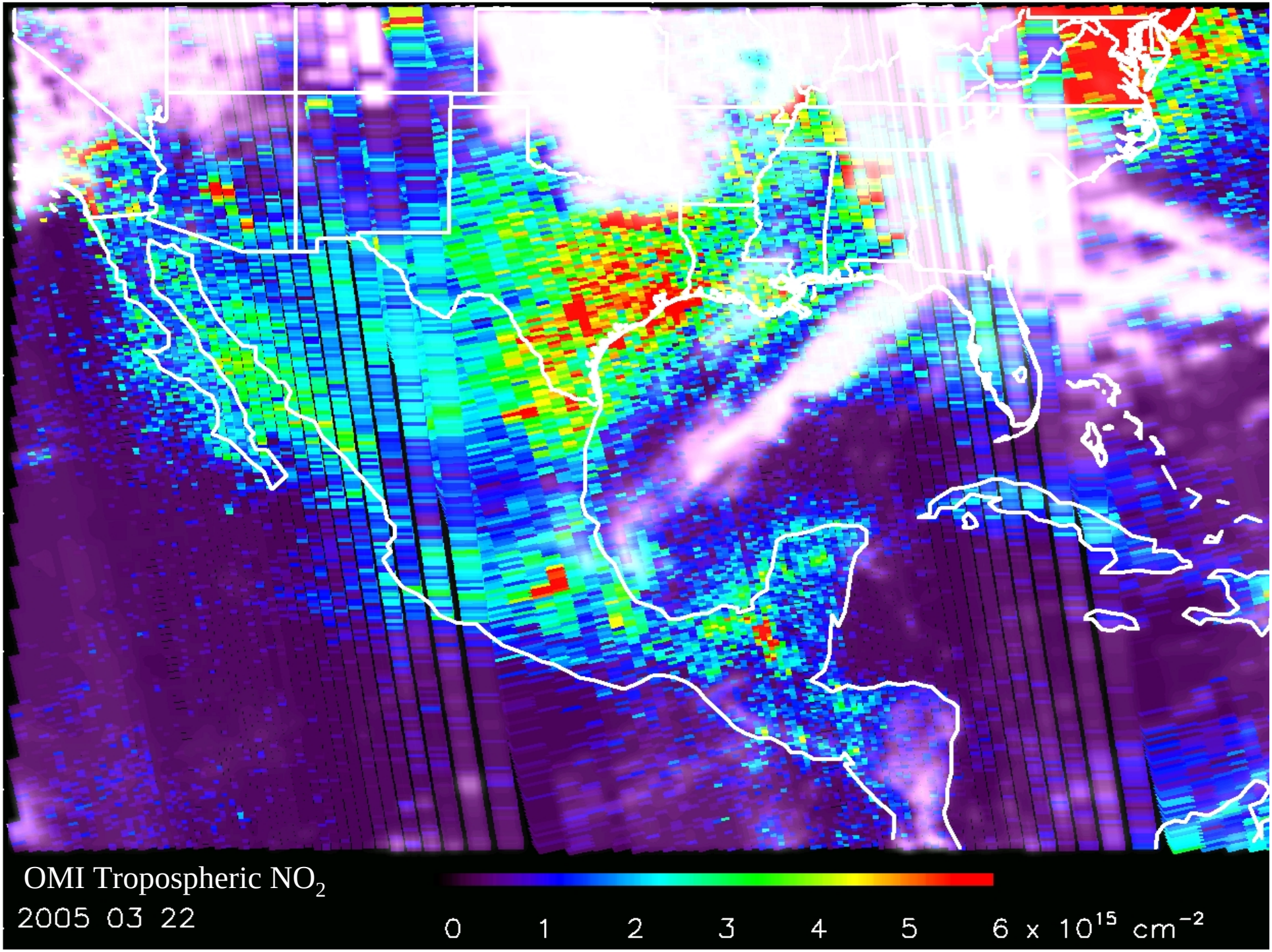


Daily Global Maps of Tropospheric Ozone from OMI and MLS

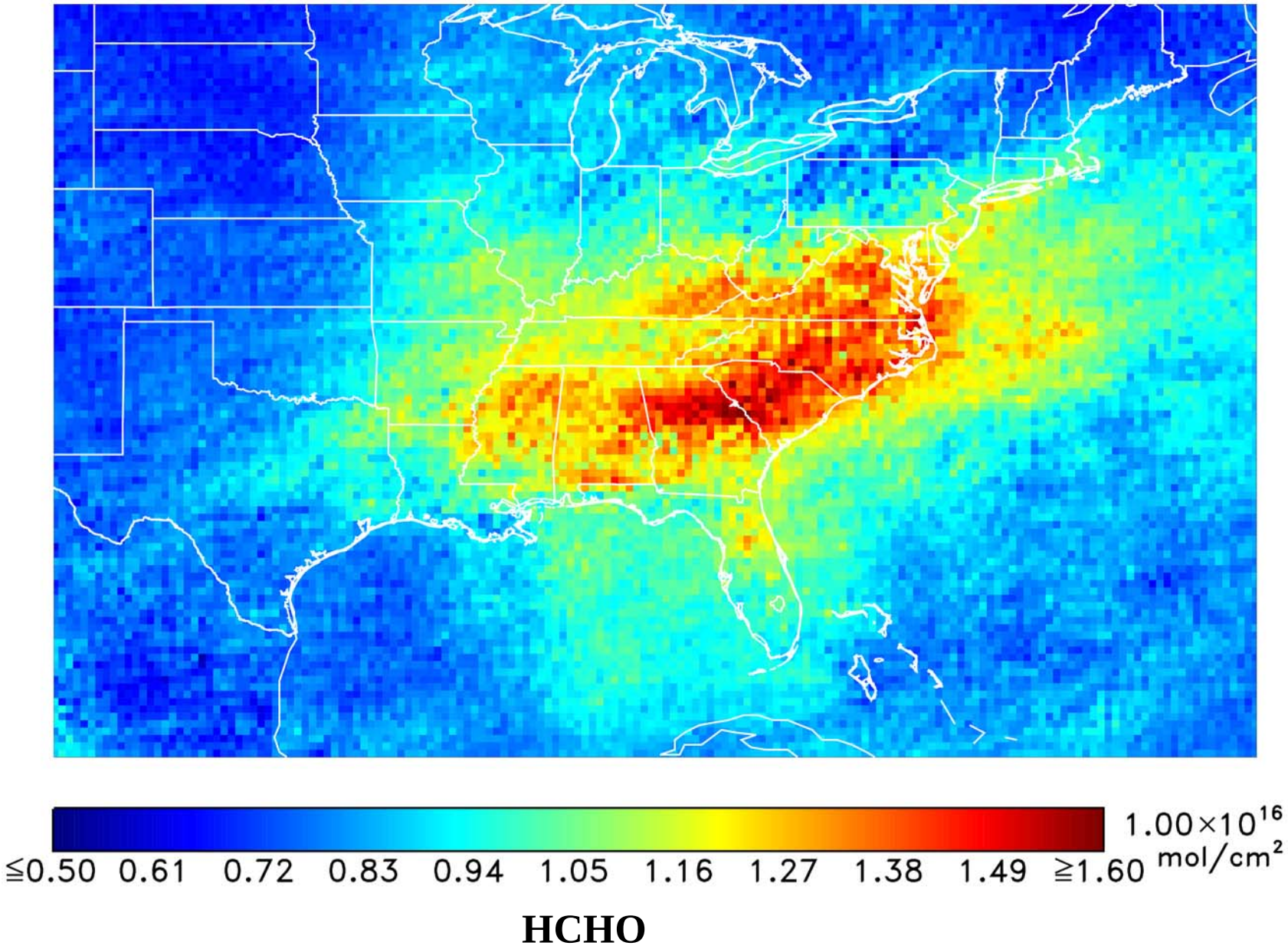


Code Orange Day – 80-120 ppbv O_3


August 4, 2005
OMI Tropospheric NO2


OMI Tropospheric NO_2
2005 03 22
0 1 2 3 4 5 6 x 10^{15} cm^{-2}

OMI Formaldehyde -- July 2005 Monthly Mean

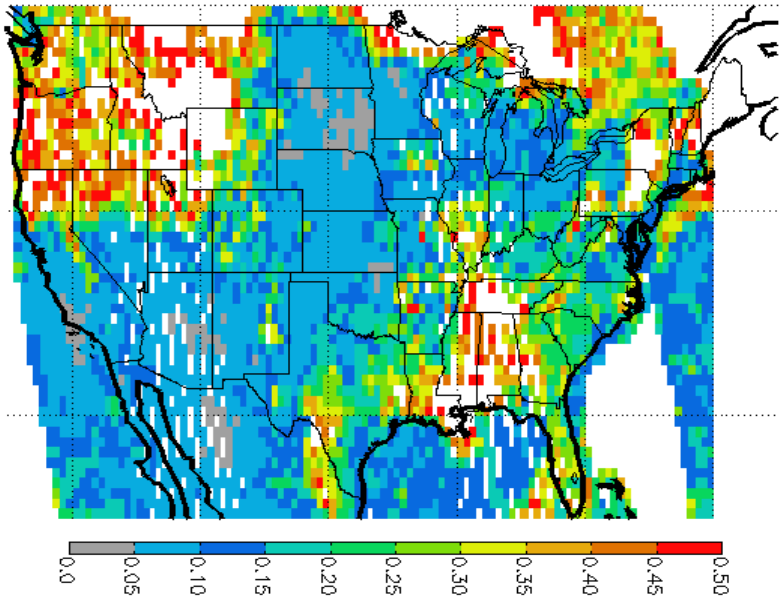


Things We Would Like to Do With OMI Data

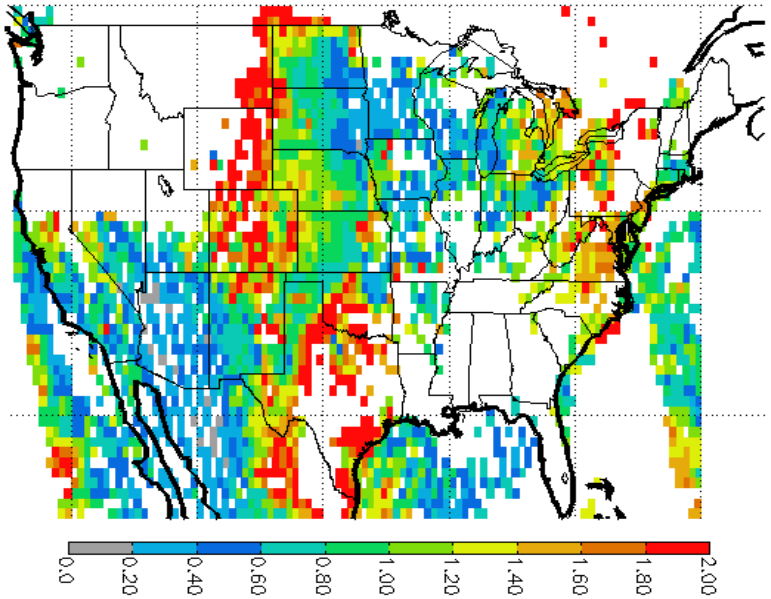
- Trace regional aerosol episode development and transport – dust, smoke, and sulfate/nitrate/organics haze
- Identify the magnitude of aerosol extinction and the relative contributions from absorption and scattering
- Determine whether OMI anthropogenic SO_2 plumes can be related with OMI scattering aerosol plume development

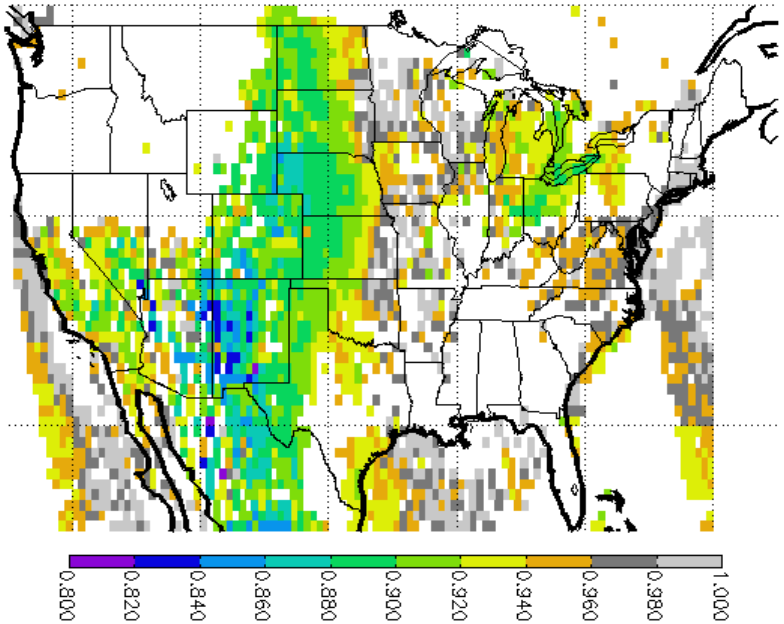
June 6, 2005

Reflectivity

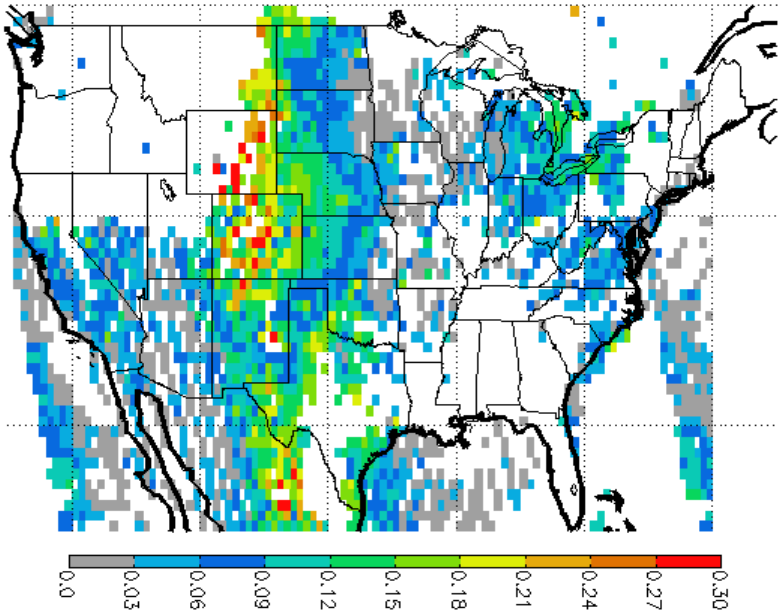


Extinction Optical thickness (388nm)





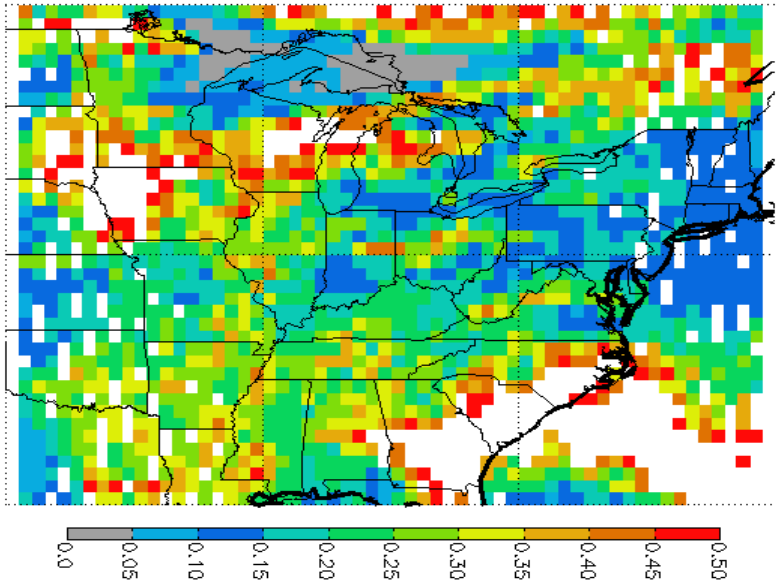
Single Scattering Albedo



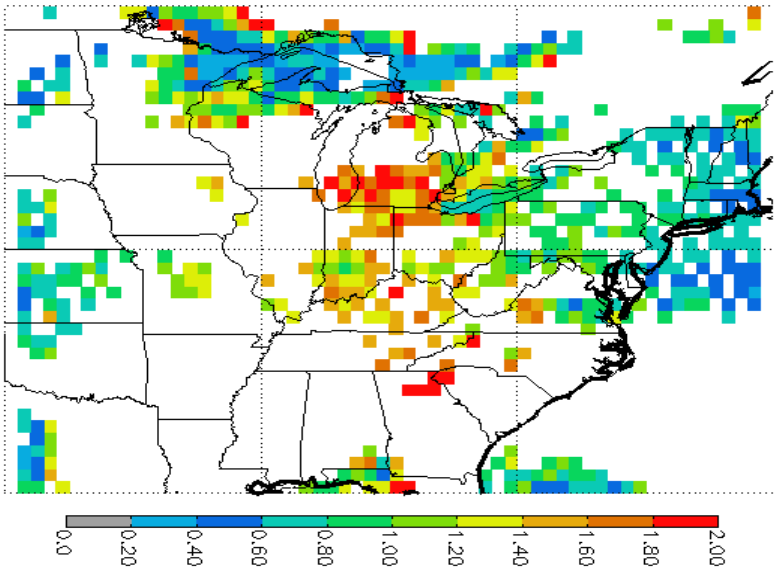
Absorption Optical Depth

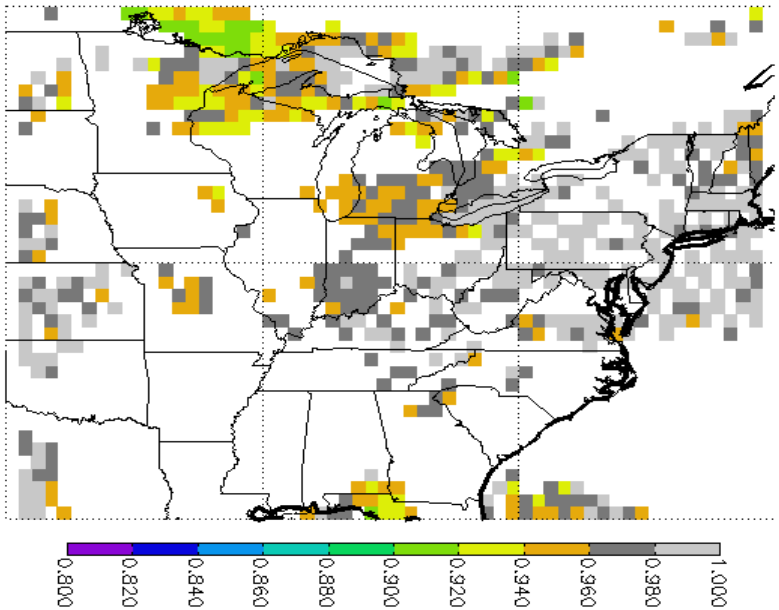
June 25, 2005

Reflectivity

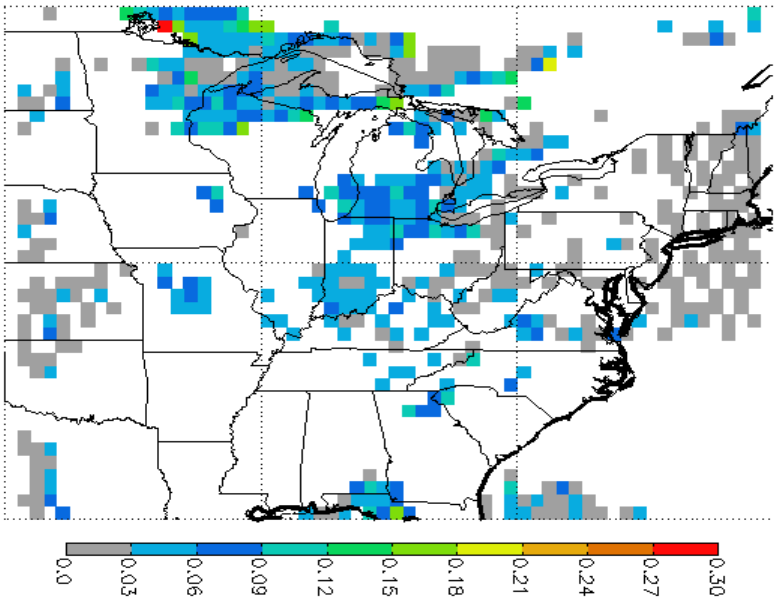


Extinction Optical Thickness (388 nm)

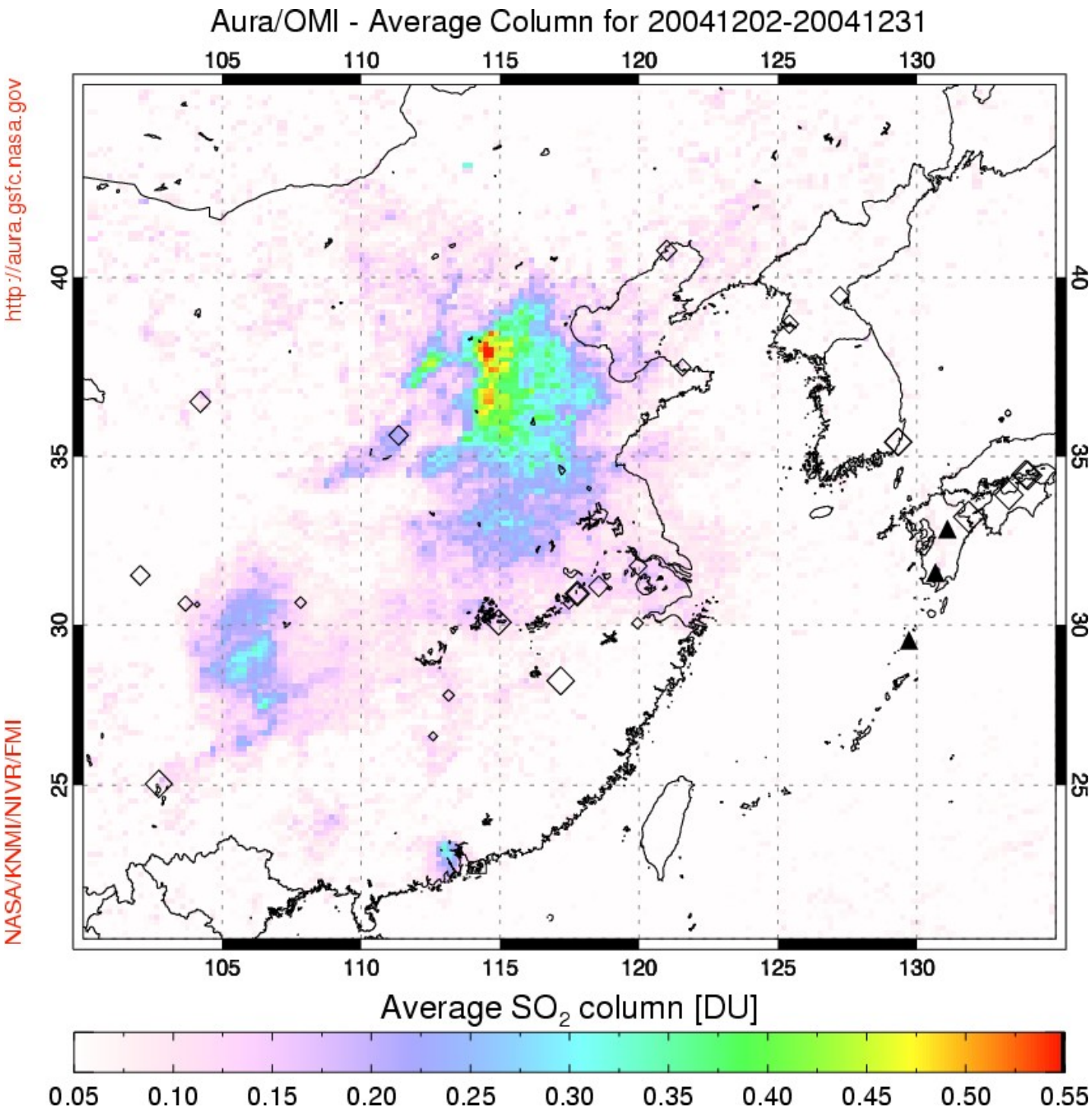




Single Scattering Albedo



Absorption Optical Depth


Aura/OMI - Average Column for 20041202-20041231
http://aura.gsfc.nasa.gov
NASA/KNMI/NIVR/FMI
105
110
115
120
125
130
40
35
30
25
Average SO2 column [DU]
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55

Community Multiscale Air Quality (CMAQ) Model Applications

- National air quality forecasts for ozone – joint effort of US EPA and NOAA – currently run at 12 km resolution
- National air pollution assessments – run by EPA at 12 km resolution
- State/regional regulatory modeling – currently run at 12 km, but would like to go to 4 km.

OMI data at 13 x 24 km is quite compatible with the current model resolution

CMAQ Simulations for 2002

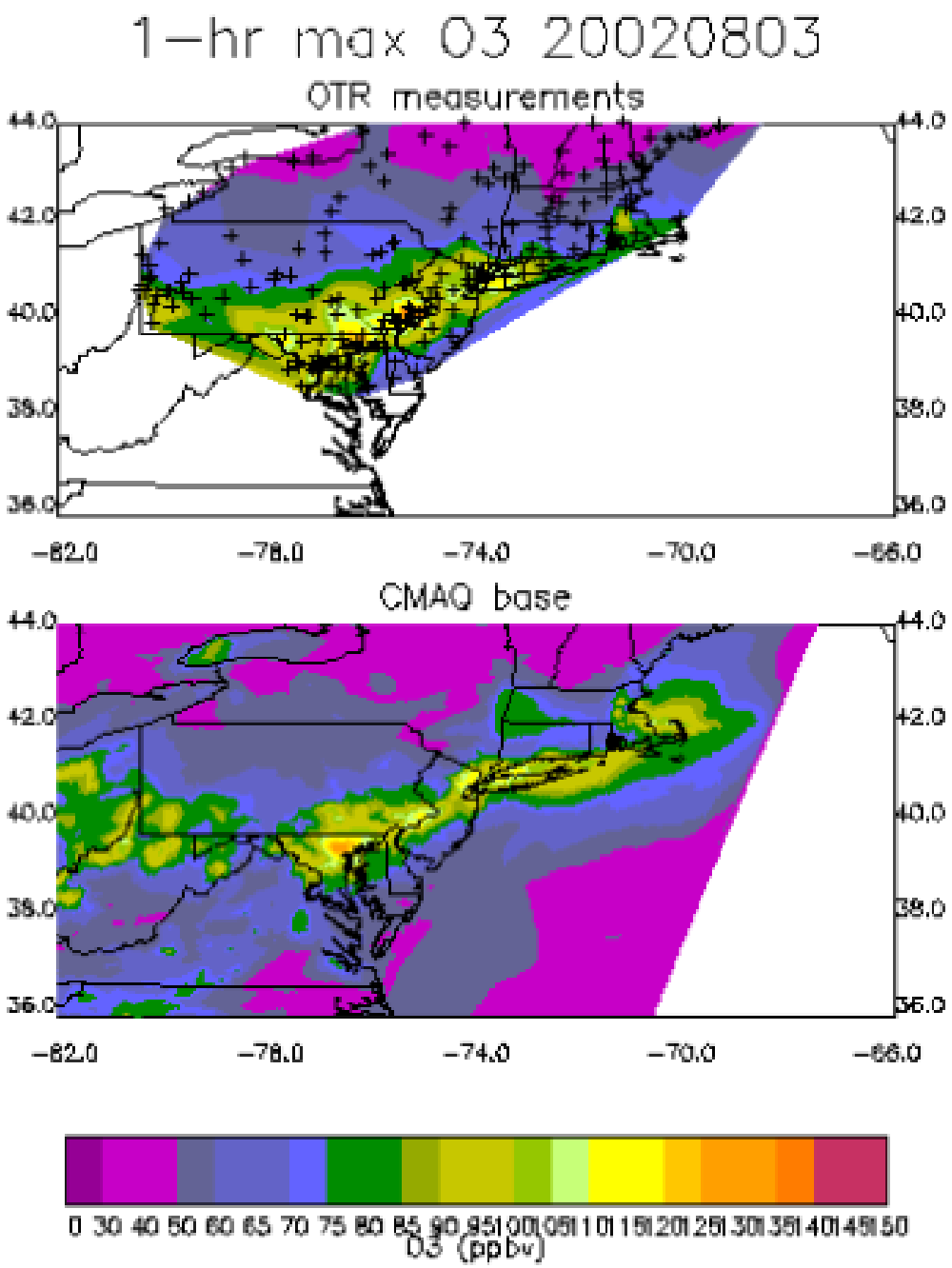
A coordinated photochemical modeling study of the Northeast United States is being conducted for areas designated by the U.S. EPA as being in nonattainment of the 8-hr ozone and 24-hour PM2.5 standard.

CMAQ was used to calculate the distribution of trace gases and PM2.5 over the northeast U.S. for the entire year of 2002.

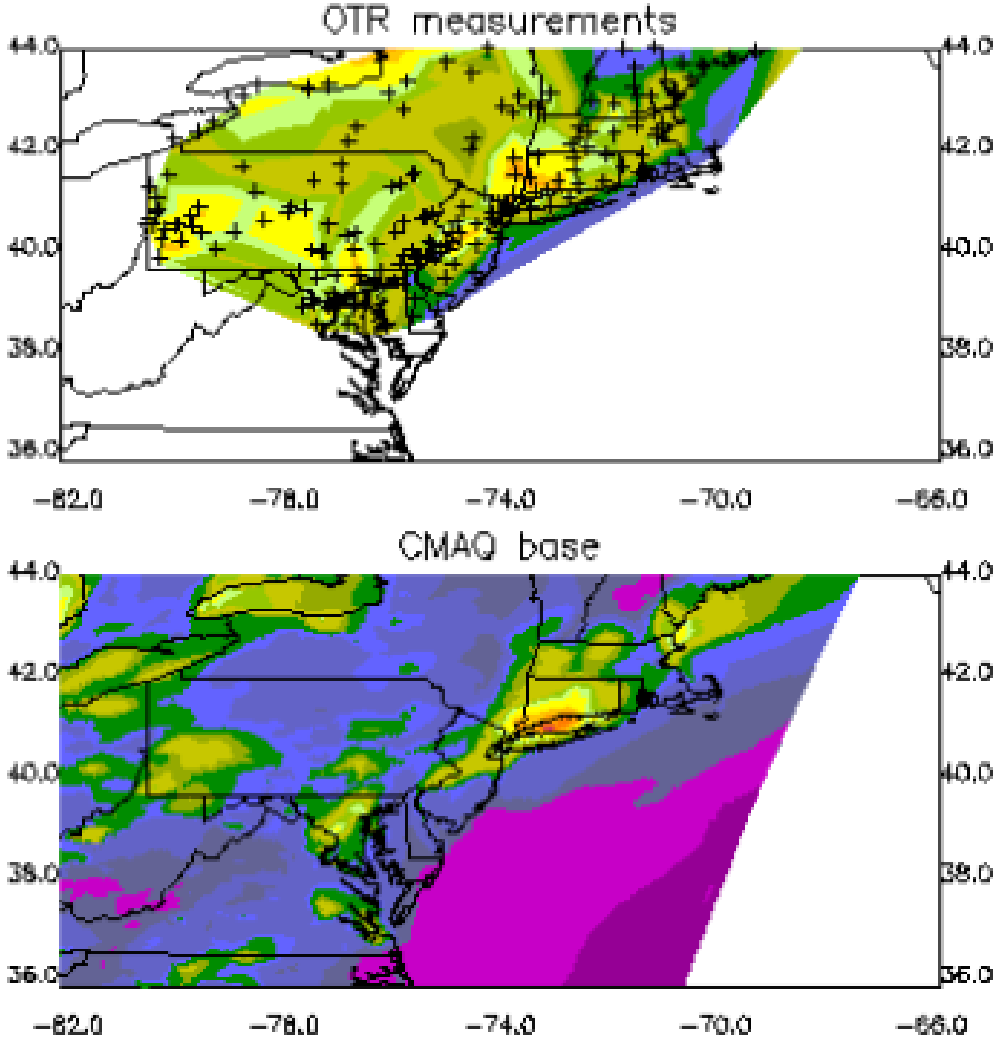
Simulations were driven by meteorological fields from the Mesoscale Model 5 (MM5).

Emissions inventory for 2002 processed by SMOKE algorithm for input to CMAQ.

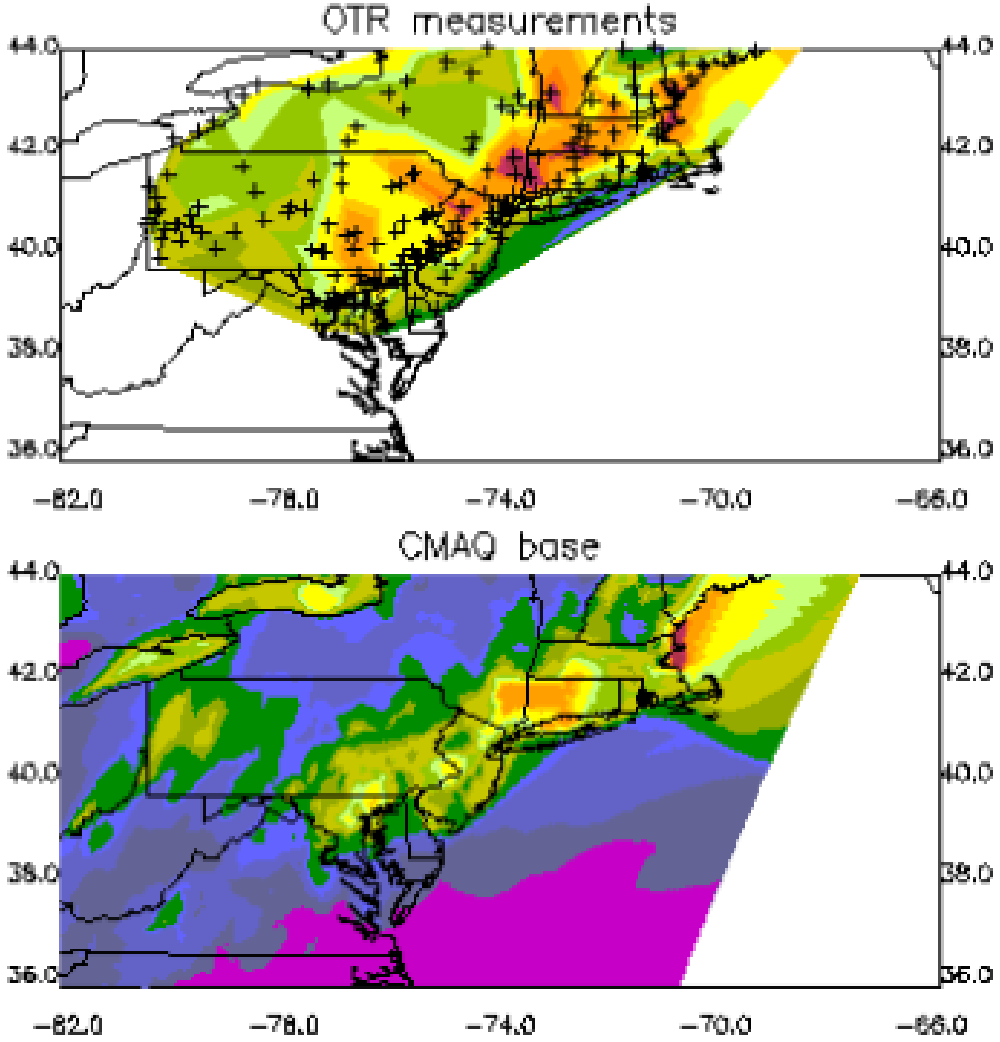
Simulation conducted at 36- and 12-km resolution. Lateral boundary conditions for the 36-km simulation were taken from a simulation with GEOS-CHEM.

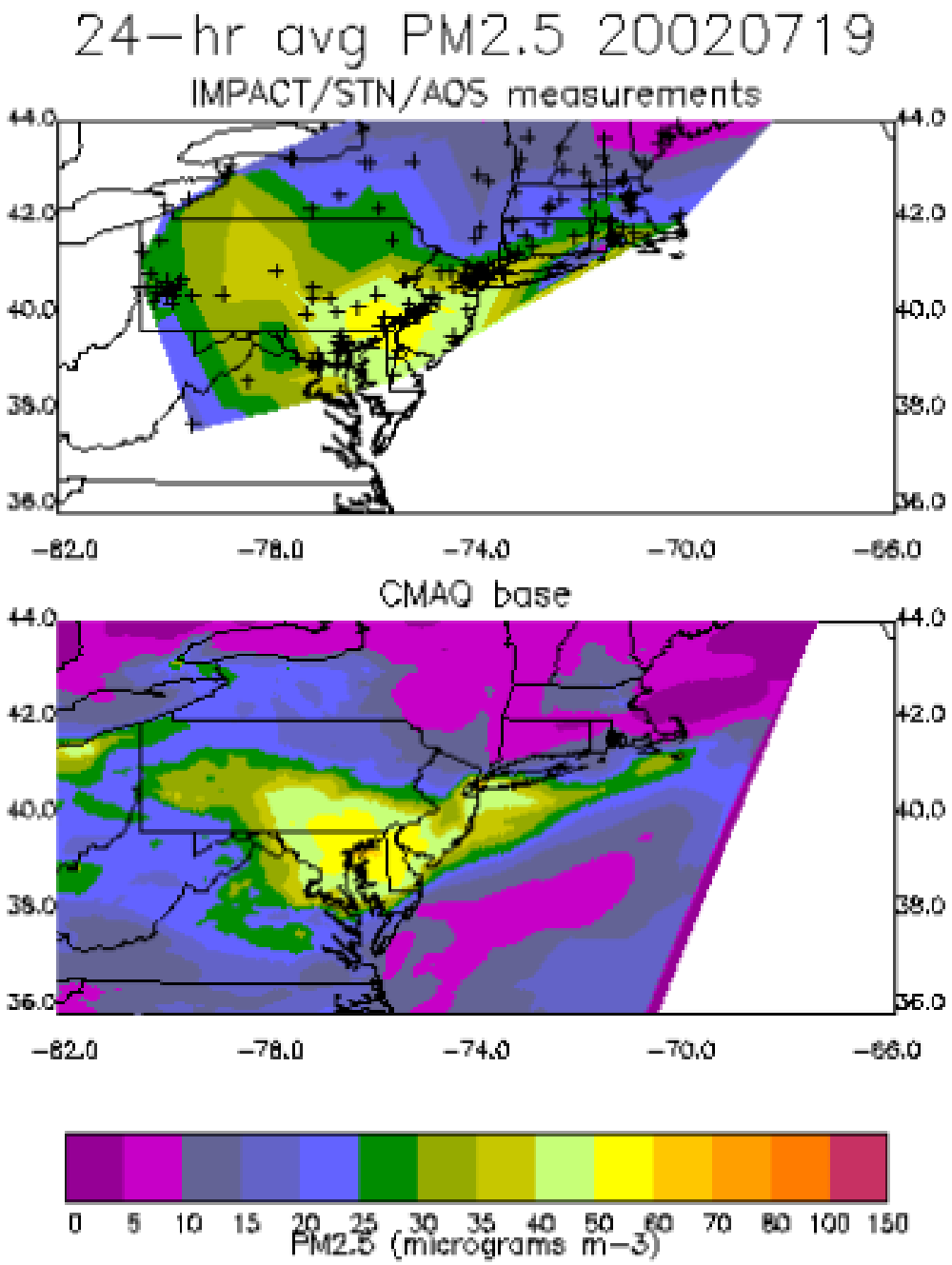

1-hr max O3 20020803
OTR measurements
CMAQ base
44.0
42.0
40.0
38.0
36.0
-82.0
-78.0
-74.0
-70.0
-66.0
0 30 40 50 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150
O3 (ppbv)

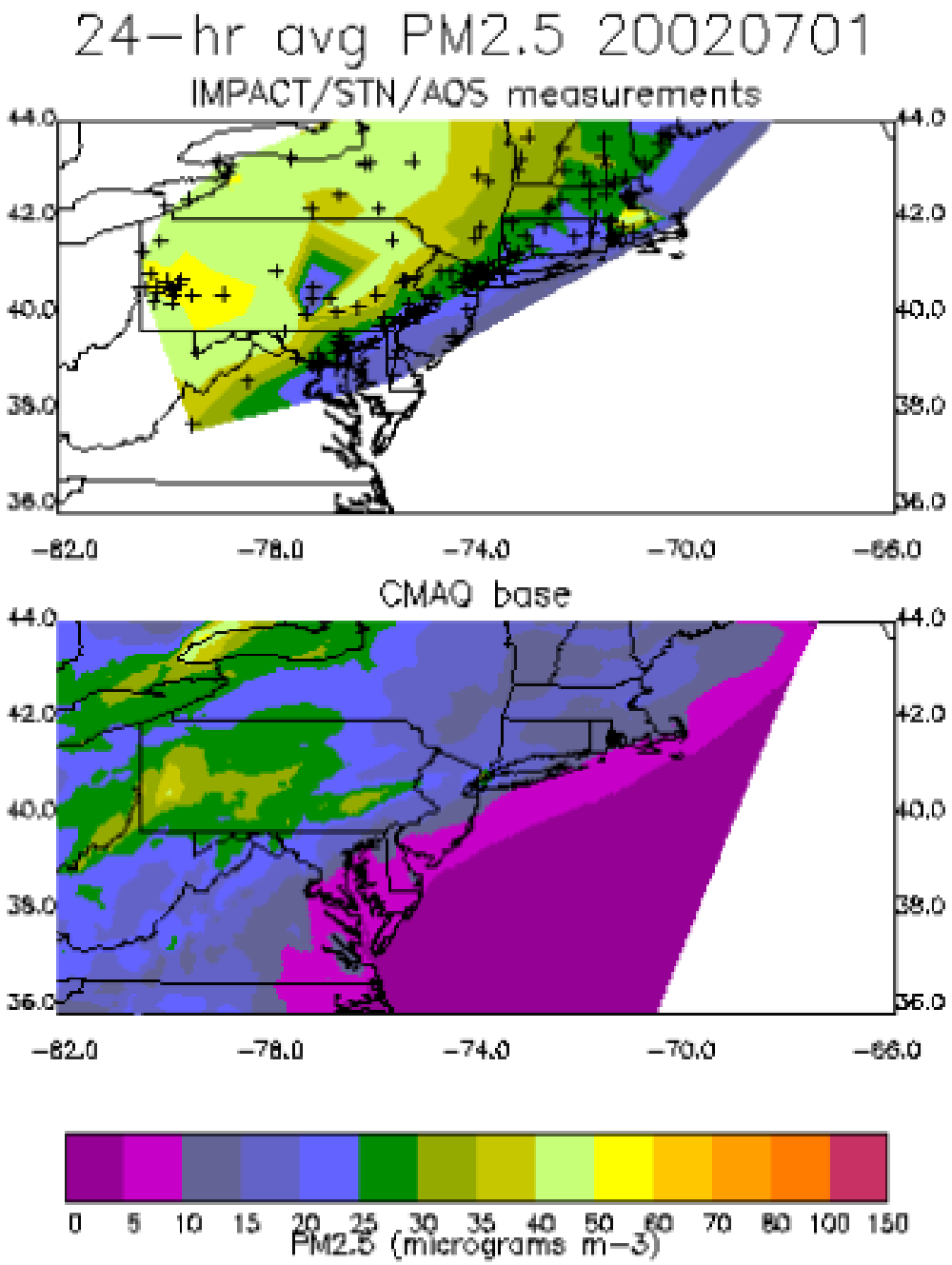
1-hr max O3 20020811



1-hr max O3 20020814




24-hr avg PM2.5 20020719
IMPACT/STN/AQS measurements
CMAQ base
44.0
42.0
40.0
38.0
36.0
-82.0
-78.0
-74.0
-70.0
-66.0
0 5 10 15 20 25 30 35 40 50 60 70 80 100 150
PM2.5 (micrograms m-3)

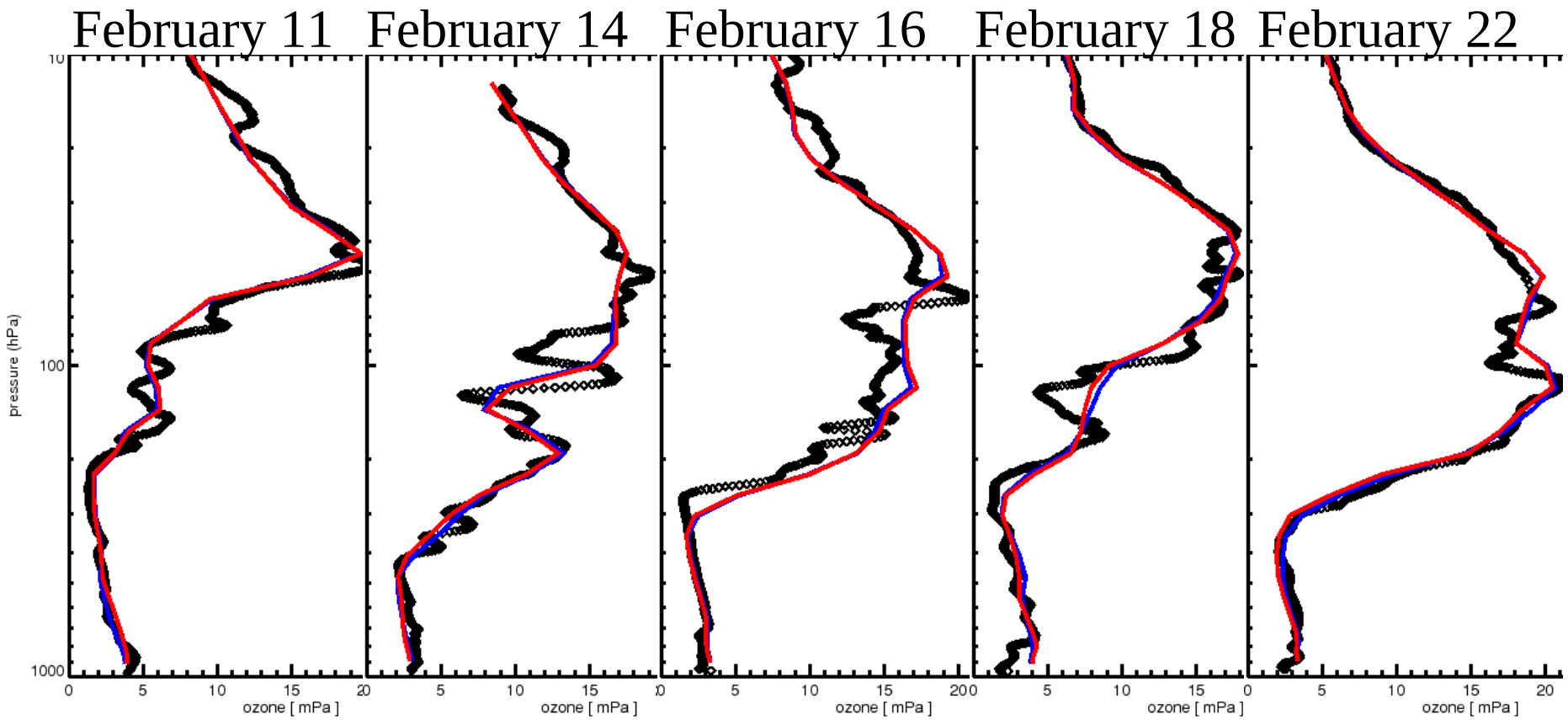

24-hr avg PM2.5 20020701
IMPACT/STN/AQS measurements
CMAQ base
44.0
42.0
40.0
38.0
36.0
-82.0
-78.0
-74.0
-70.0
-66.0
0 5 10 15 20 25 30 35 40 50 60 70 80 100 150
PM2.5 (micrograms m-3)

Potential Modeling Strategy Employing OMI Data

- Assimilation of OMI total column ozone and MLS ozone above 216 hPa into NASA/GMAO GEOS-4 GCM (1 x 1.25 deg) – has been run for Jan-Feb. 2005 by Ivanka Stajner. Model contains parameterized ozone chemistry
- Provide initial and boundary conditions from GEOS-4 for CMAQ
- Run CMAQ air quality forecasts and simulations
- Farther into the future: assimilation of other OMI products (e.g., tropospheric NO_2, TES O_3, etc.)

Preliminary work needed -- Use regional model and aircraft data in conjunction with OMI data to interpret the vertical structure contained in the column information

Comparisons with ozone sondes



- Comparisons with ozonesondes at Payerne indicate that ozone and its temporal variability in the lower stratosphere are well represented in the **assimilation of Aura data**.
- This is needed for credible estimates of tropospheric ozone.

SUMMARY

- Regional tropospheric ozone plumes easily identifiable in OMI/MLS data product
- Intercontinental tropospheric ozone transport suggested
- Urban area contributions to ozone photochemical production from OMI-observed tropospheric NO_2 as well as inter-regional transport
- Major isoprene contribution to formaldehyde strongly suggested

SUMMARY

- In addition to strongly-absorbing dust and biomass burning smoke plumes, regions of highly-scattering regional haze (likely sulfates, nitrates, secondary organics) are also seen in OMI data
- Strong OMI regional anthropogenic SO_2 signals observed

Potential for use of OMI data to improve regional air quality modeling through assimilation in larger-scale models. Assimilation output to be used as initial and boundary conditions for regional air quality models such as CMAQ.