Eta-CMAQ modeling system's capability to provide PM2.5 and aerosol optical thickness forecast

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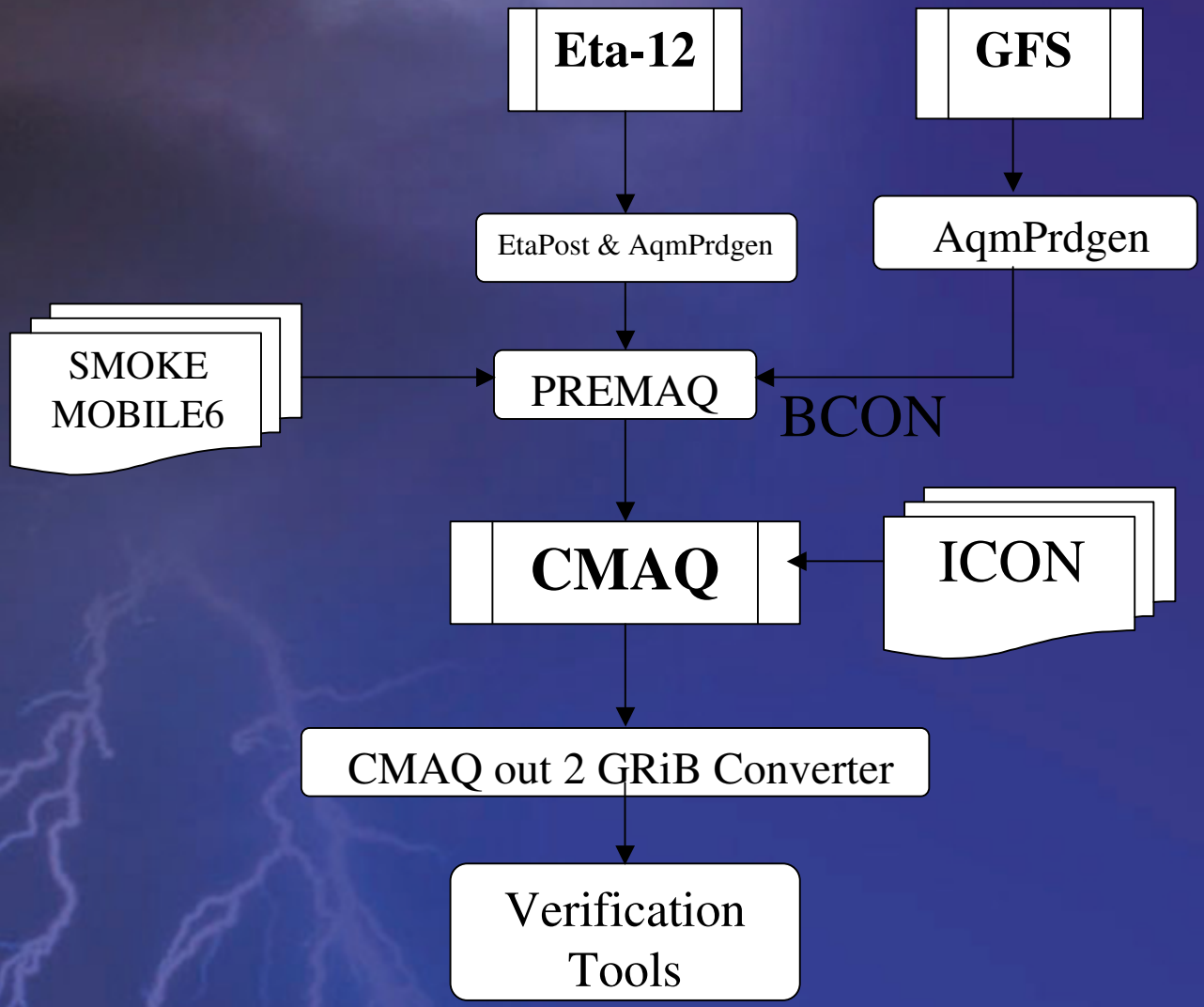
National Air Quality Forecasting
Planned Capabilities

- ***Initial**: 48 hour forecasts of ozone (O_3) : 12z and 6z run*
  - *Develop and validate in North-eastern US by Q4FY04*
  - *Deploy Nationwide by FY07*

- ***Intermediate**:*
  - *Develop and deploy nationwide capability to forecast particulate matter (PM) concentration*
  - *Particulate size ≤ 2.5 microns*

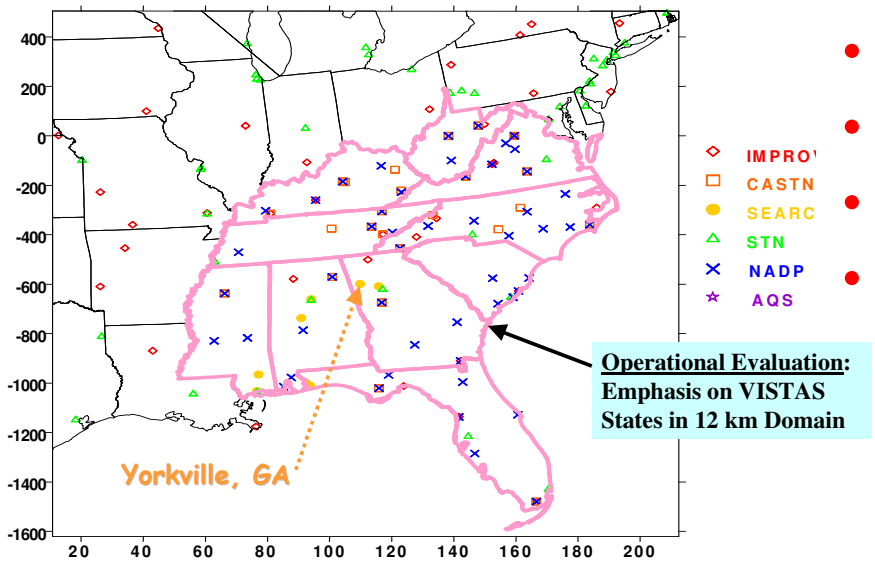
- ***Longer range (within 10 years):***
  - *Extend air quality forecast range to 72 hours*
  - *Include broader range of significant pollutants*

Schematics of the Eta-CMAQ Air Forecasting System

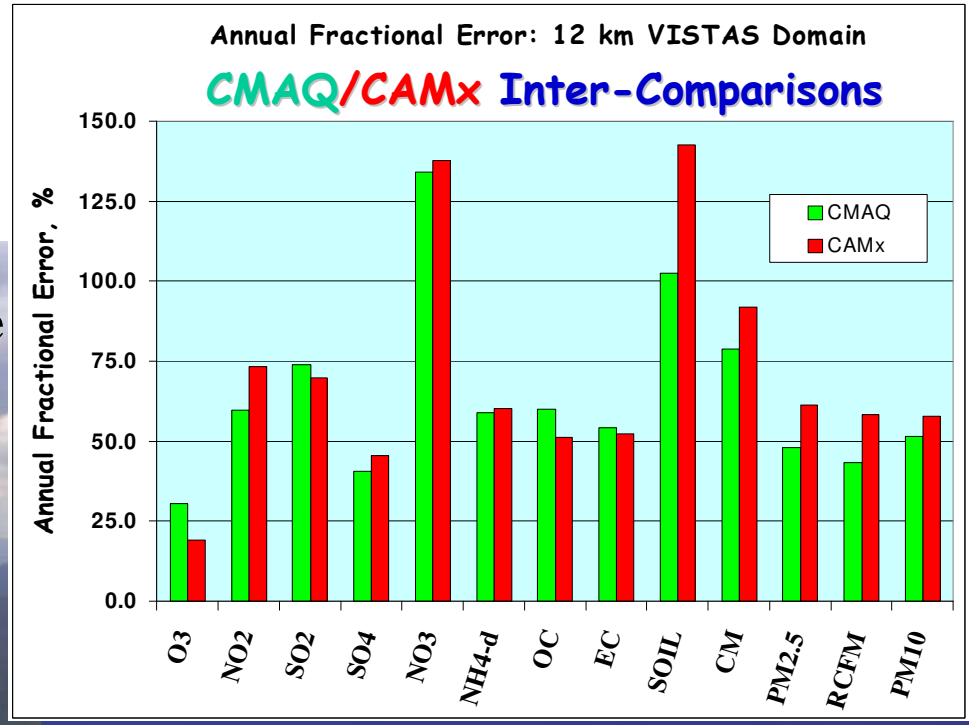


Operational Performance Summary

IMPROVE, CASTNet, SEARCH, STN and NADP Monitors in VISTA Domain (AQS monitors not shown – too many!).



- Good: SO4 and EC
- Good-Fair: PM2.5 and PM10
- Fair: NH4
- Fair-Poor OC and CM
- Poor NO3 and Soils



CMAQ Operational Evaluation Over the VISTAS Domain: 2002 Annual Episode

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Ralph Morris -- ENVIRON International Corporation
Gail Tonnesen -- University of California, Riverside
Patricia Brewer -- VISTAS Technical Coordinator
James Boylan – Georgia Dept of Natural Resources

Models-3 CMAS Conference
18-20 October 2004
Chapel Hill, NC

Derivation of AOT used:

$$AOT = \int_{0}^{ModelTop} B_{sp} \, dz$$

Where B_{sp} is the aerosol extinction coefficient in km^{-1}

z is altitude in km. CMAQ calculates B_{sp} through Q_{ext}, the Mie extinction efficiency

$$B_{sp} = \frac{3\pi}{2\lambda} \int_{-\infty}^{\infty} \frac{Q_{ext}}{\alpha} \frac{dV}{d\ln\alpha} d\ln\alpha$$

Where $\alpha = \pi D / \lambda$

D is the particle diameter

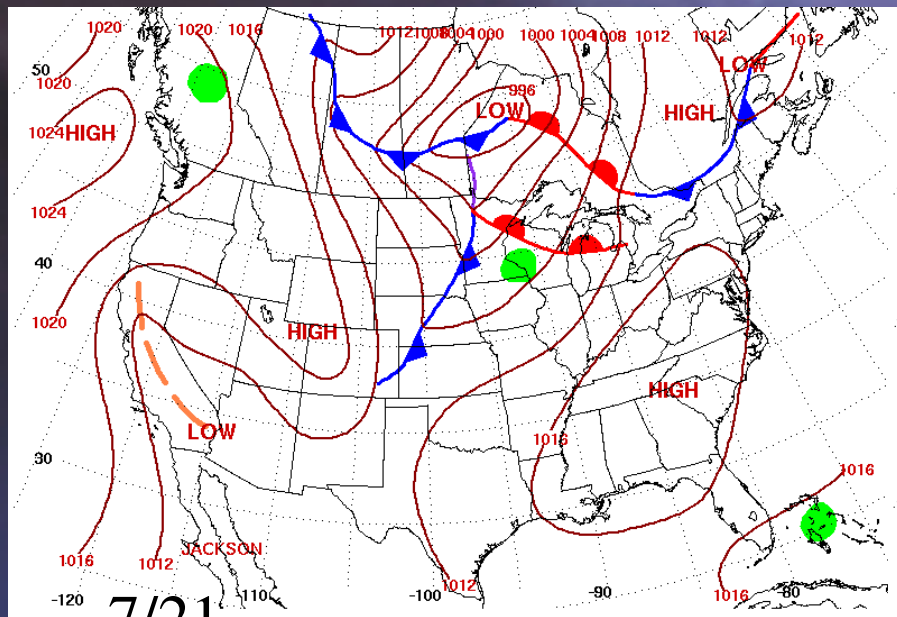
V is the volume of the particle and

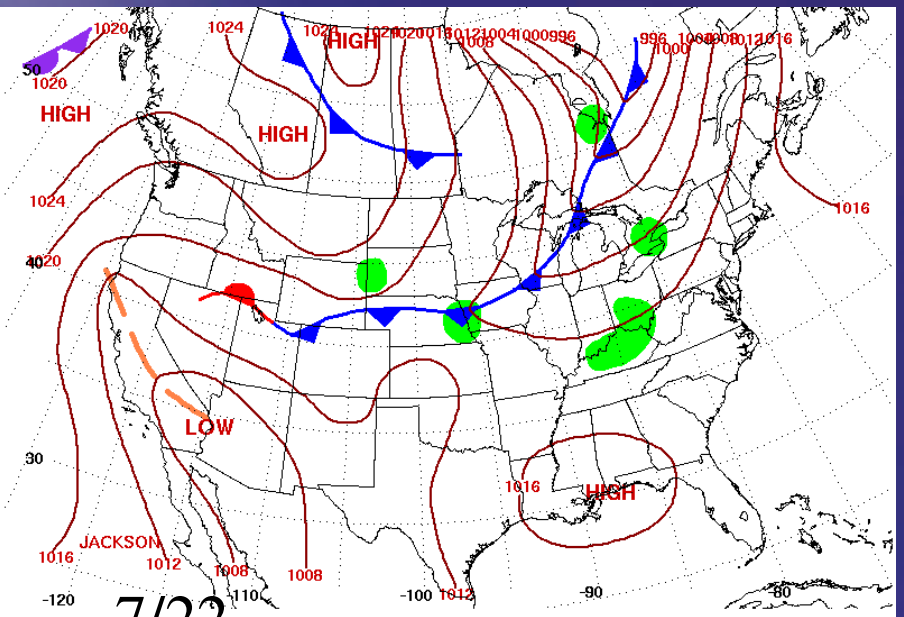
λ is the wavelength of the incident light

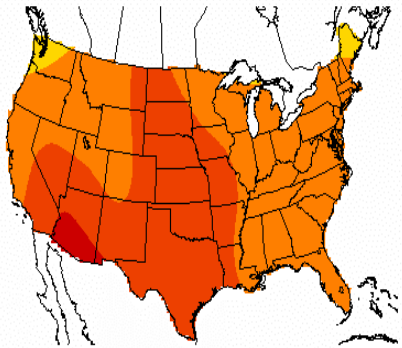
Variable Name of the Aitken (i) and Accumulation (j) mode species

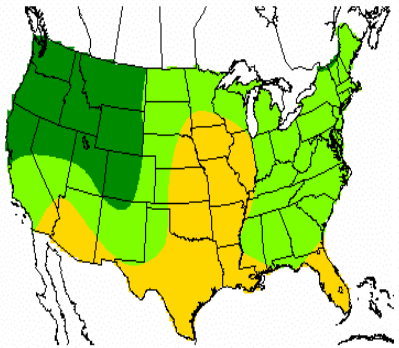
Description of species	i mode	j mode
Sulfate mass	ASO4I	ASO4J
Ammonium mass	ANH4I	ANH4J
Nitrate mass	ANO3I	ANO3J
Anthropogenic secondary organic mass	AORGAI	AORGAJ
Primary organic mass	AORGPAI	AORGPAJ
Secondary biogenic organic mass	AORGBI	AORGBJ
Elemental carbon mass	ACEI	ACEJ
Unspecified anthropogenic mass	A25I	A25J
Water mass	AH2OI	AH2OJ

Weather conditions on July 21 and 22, 2004



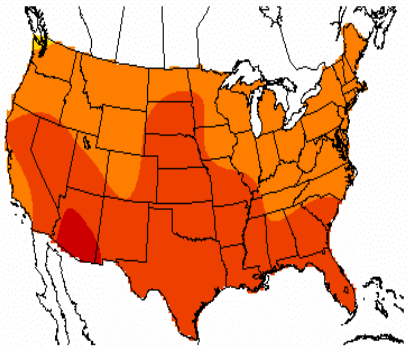


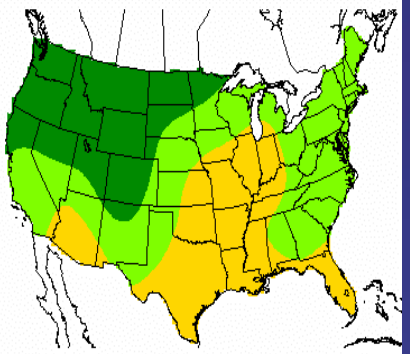




Maximum Temperature Minimum Temperature

0 10 20 30 40 50 60 70 80 90 100

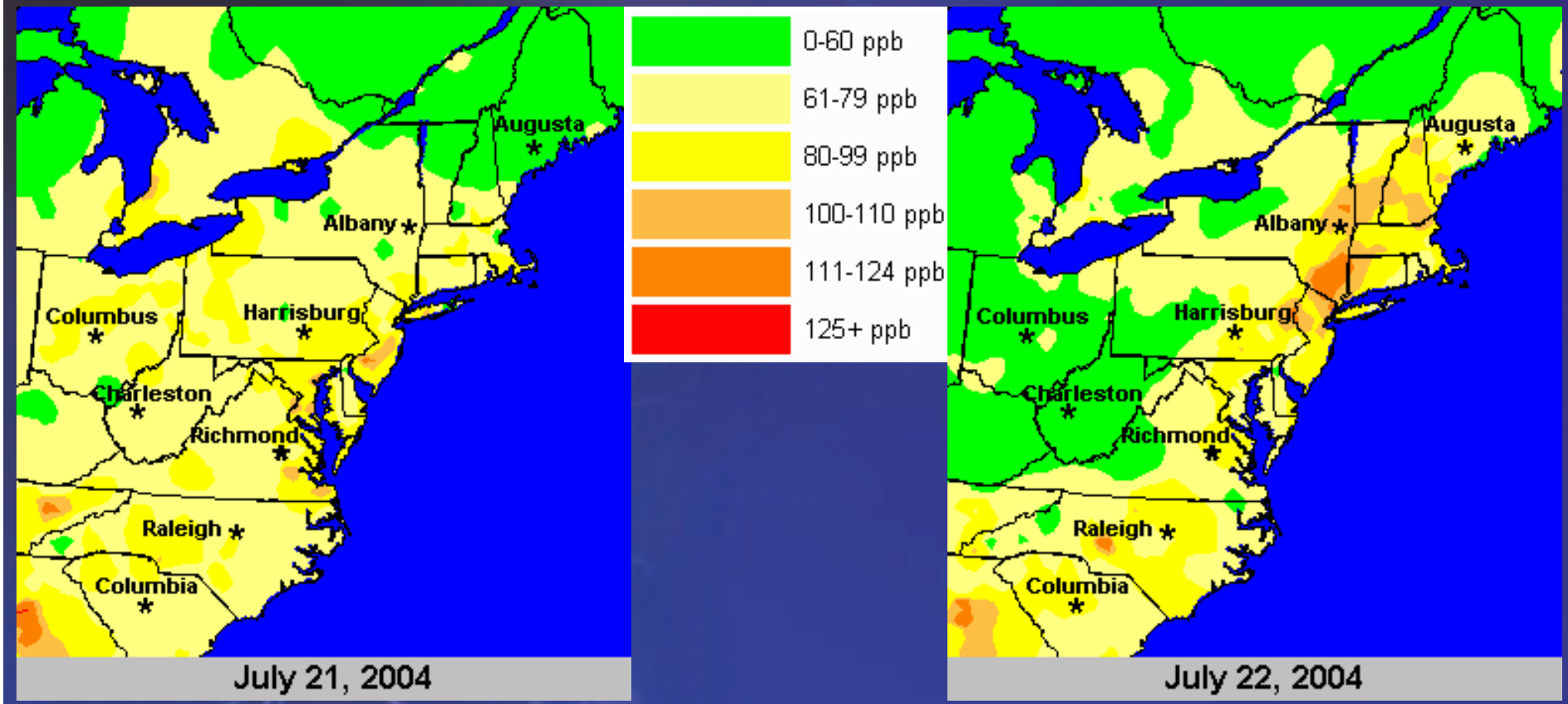




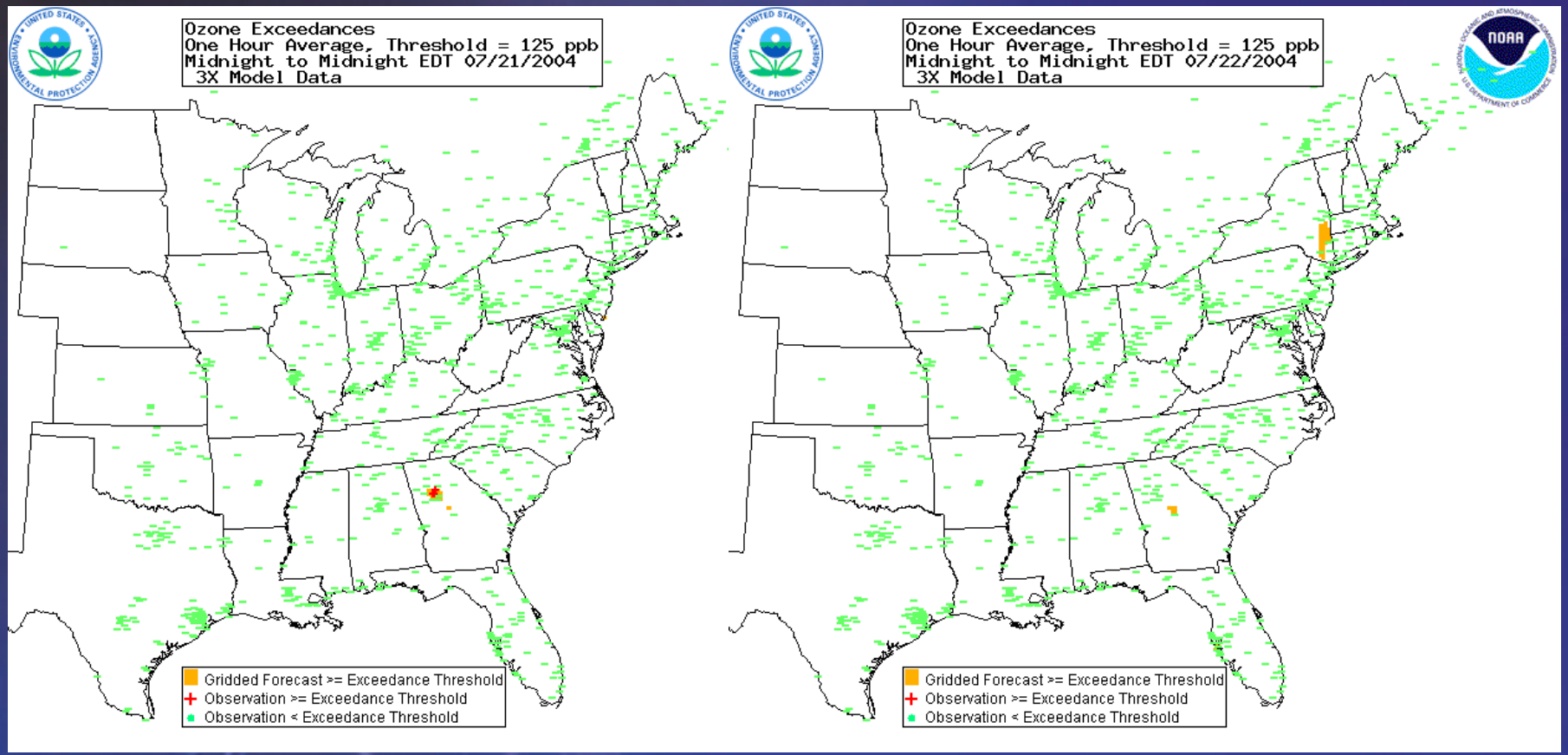
Maximum Temperature Minimum Temperature

0 10 20 30 40 50 60 70 80 90 100

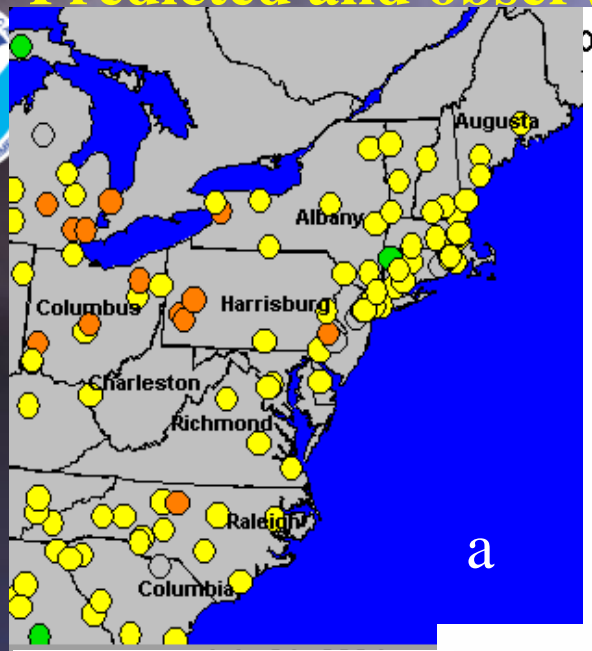
1 h average maximum surface O3 on 7/21 & 7/22



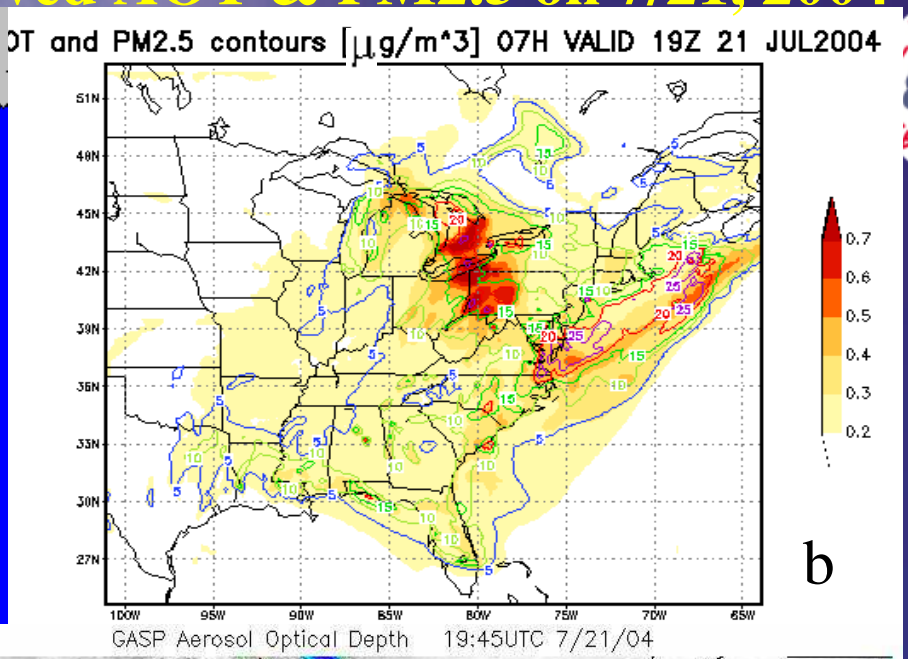
Daily 1 h averaged maximum surface O3 for 7/21 & 7/22



Predicted and observed AOT & PM2.5 on 7/21, 2004



a



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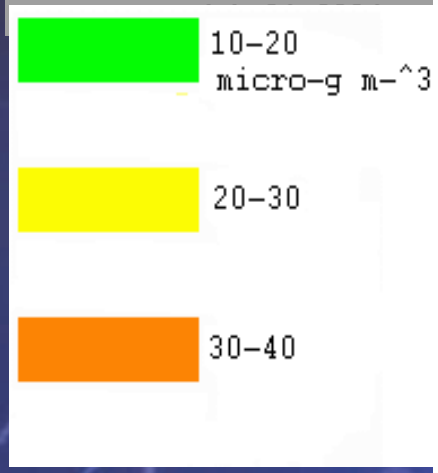
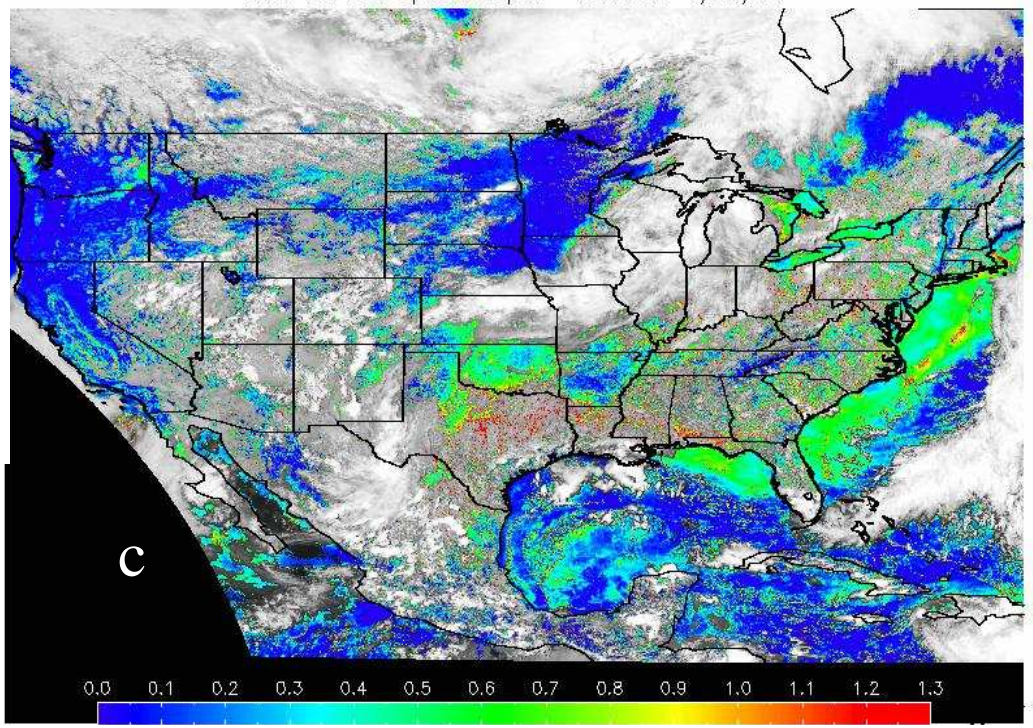
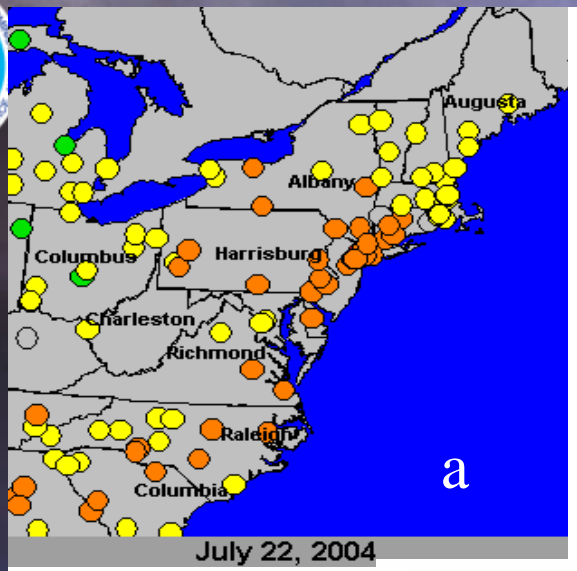
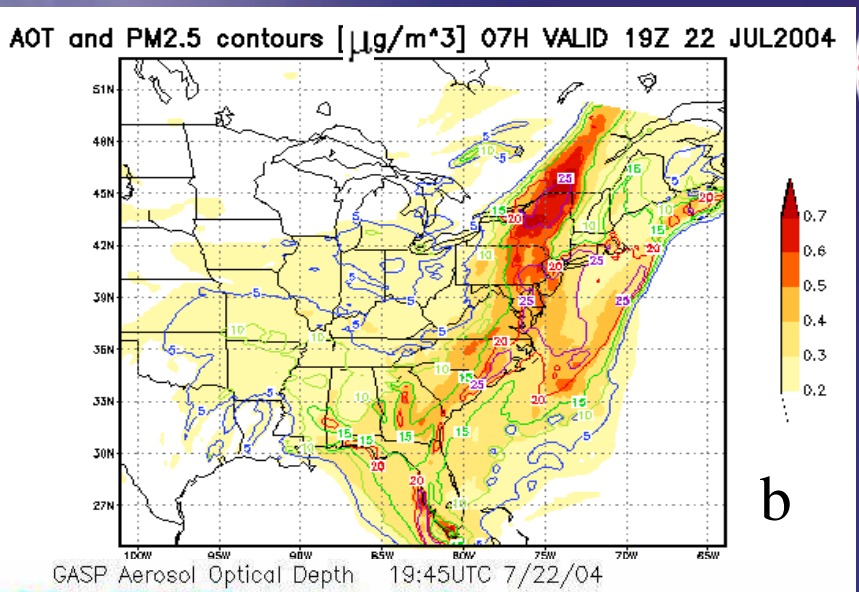


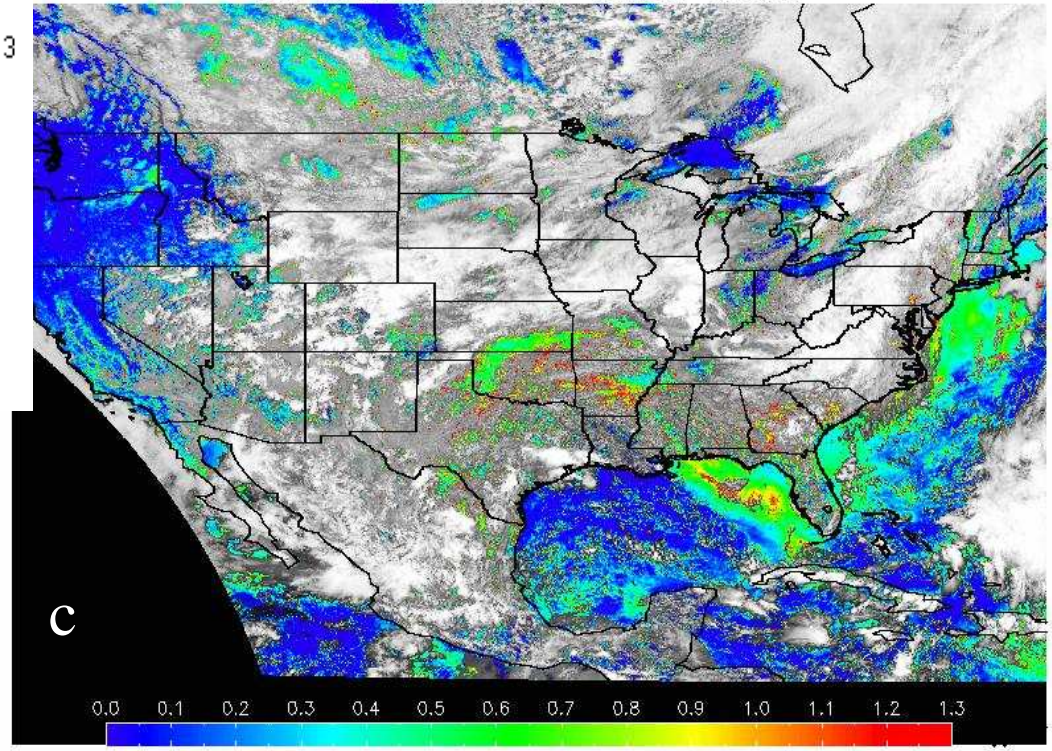


c

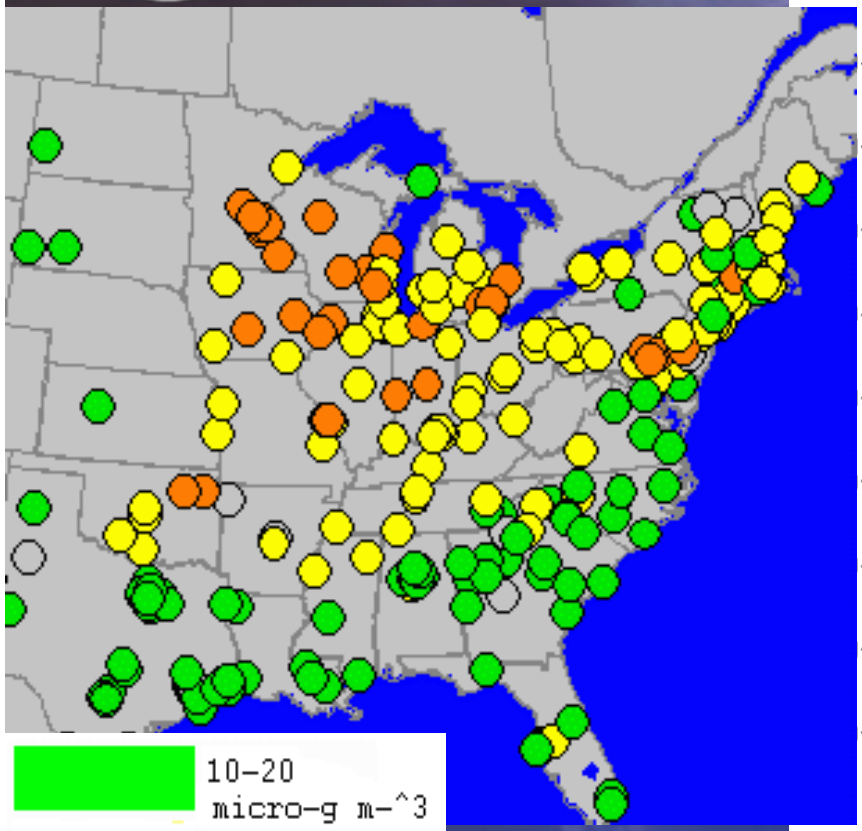
Predicted and observed AOT & PM2.5 on 7/22, 2004







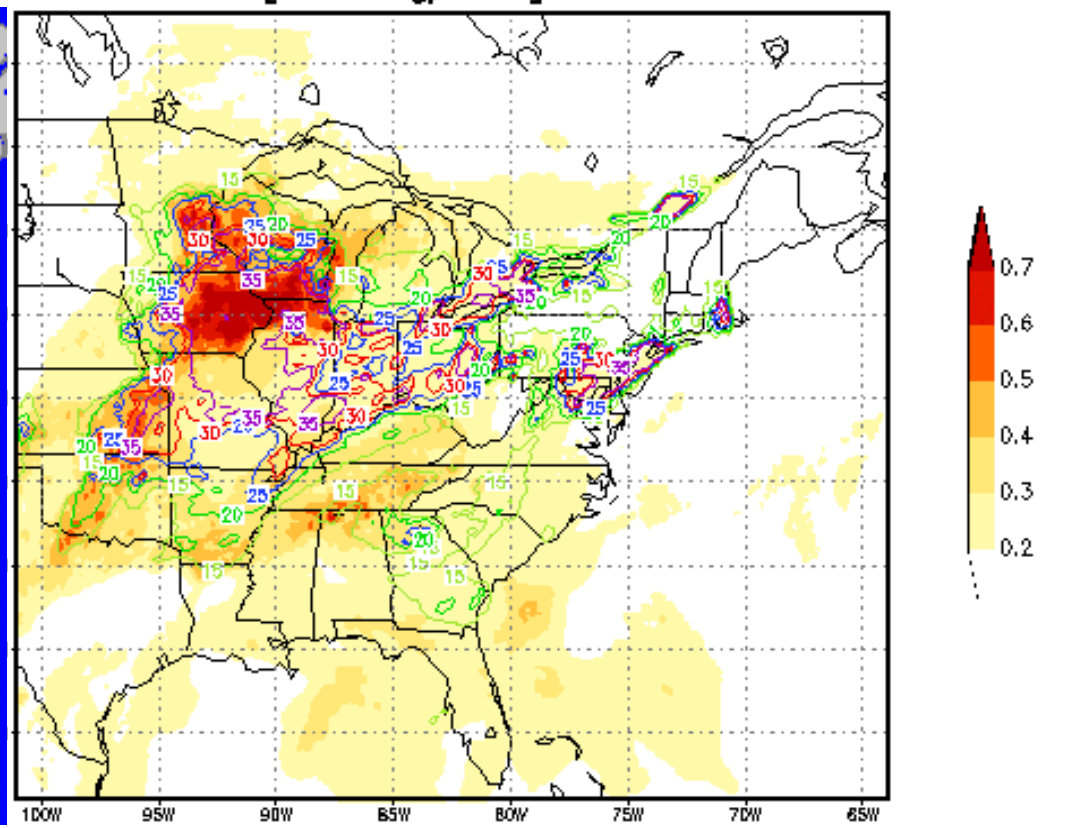
Predicted and observed AOT & PM2.5 at 19UTC 2/1, 2005



10–20 micro-g m-^3

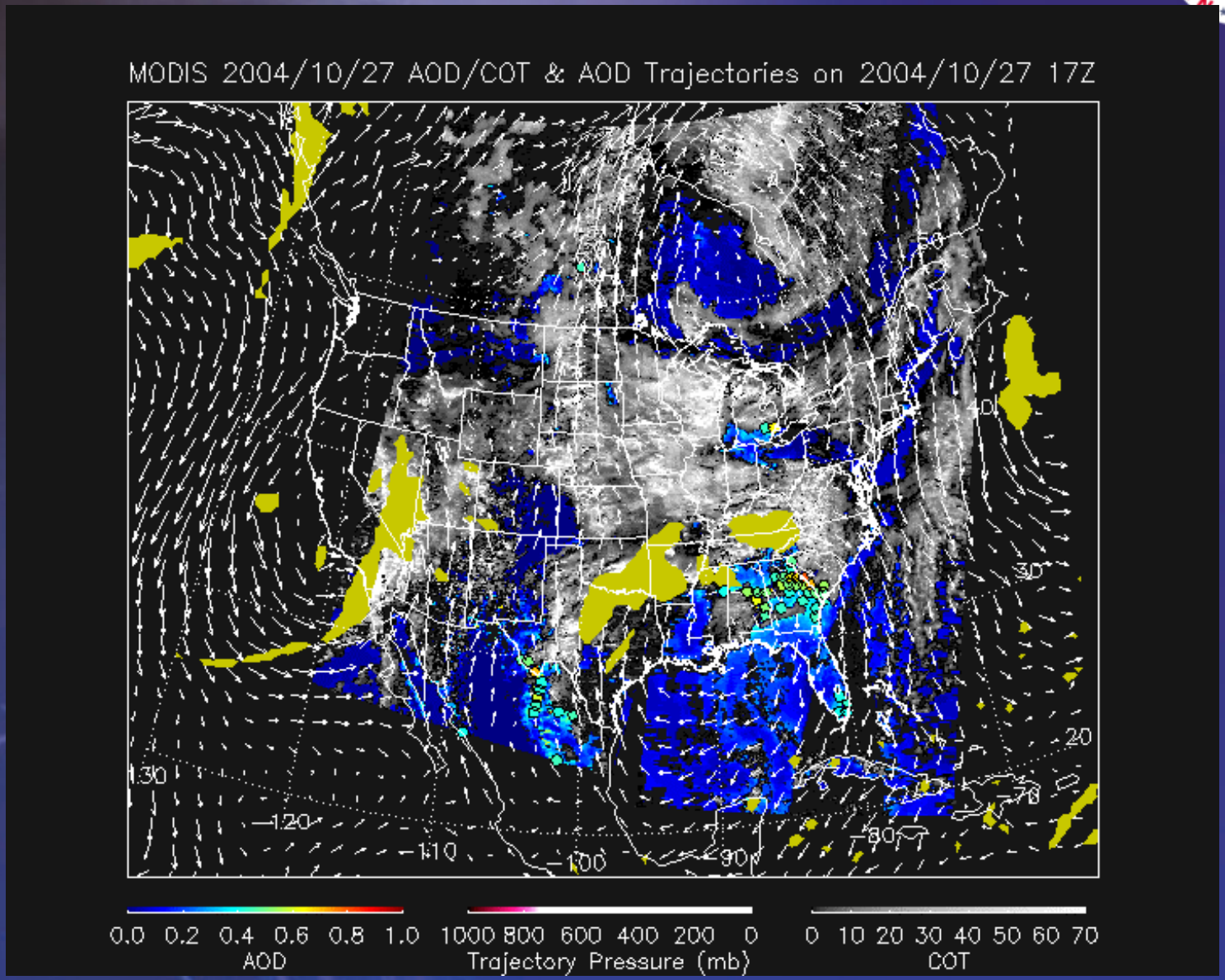
20–30

30–40

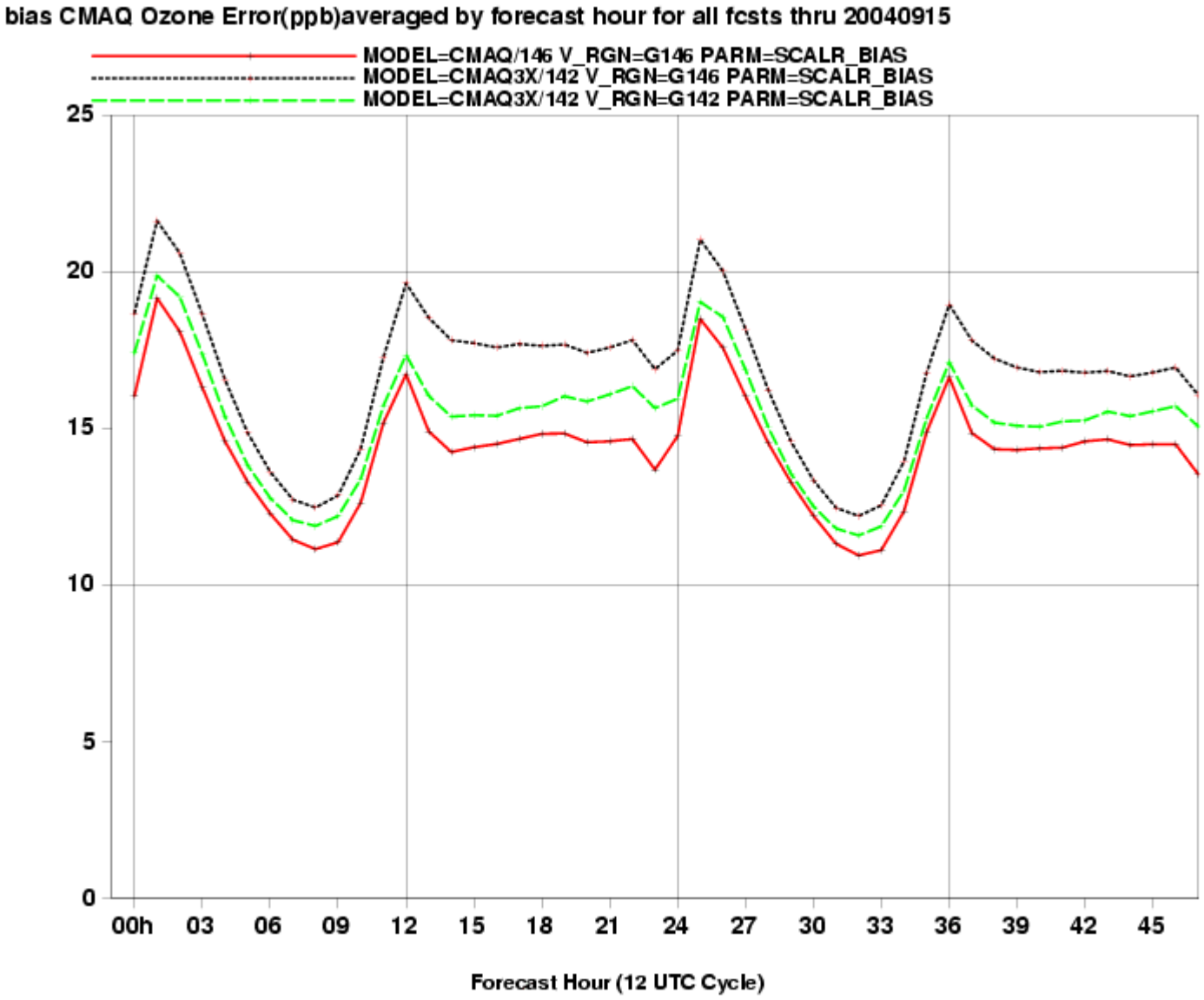


MODIS polar-orbiting satellites measuring only once a day

http://idea.ssec.wisc.edu/index.php



Air Quality Verification System applied for surface O3



Summary

- The NOAA/EPA AQFS had been used to make a rough estimate of surface level PM2.5 and AOT for a pollution episode occurred in July, 2004
- Results have been qualitatively compared against AIRNOW's PM2.5 observations and AOT imageries obtained from the GOES Imager
- Verification tools aimed at utilizing NOAA's FVS systems are under development

Ozone Depletion Mechanism:

Day Time

$O_3 + NO_2 \rightarrow NO_3 + O_2$

$O_3 + N_2 \rightarrow NO + N + O_2$

$O_3 + NO \rightarrow NO_2 + O_2$

$OH + O_3 \rightarrow HNO_2 + O_2$

$VOC + O_3 \rightarrow$ hydrocarbons + [inorganic oxides]

Night Time:

$O_3 + NO \rightarrow NO_2 + O_2$