# NOAA's Air Quality Program

## Science for Decision-Makers


**Jim Meagher**

**Air Quality Program Manager**

*Applications of Environmental Remote Sensing to Air Quality and Public Health*

May 8-9, 2007, The Bolger Center, Potomac, MD

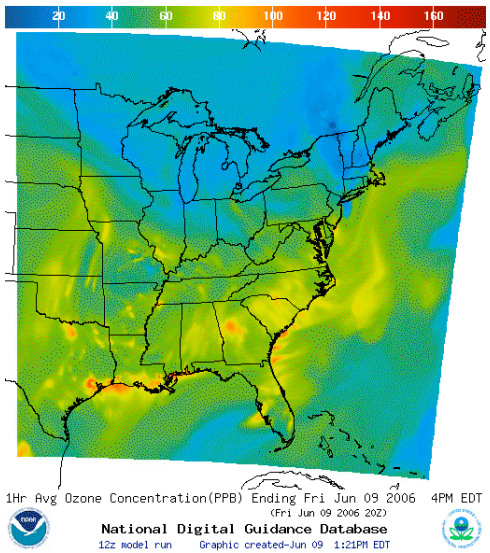
# Air Quality Decision-Makers…

## Air Quality Managers

- Federal Policies

- State & Local Management Strategies

## The Public

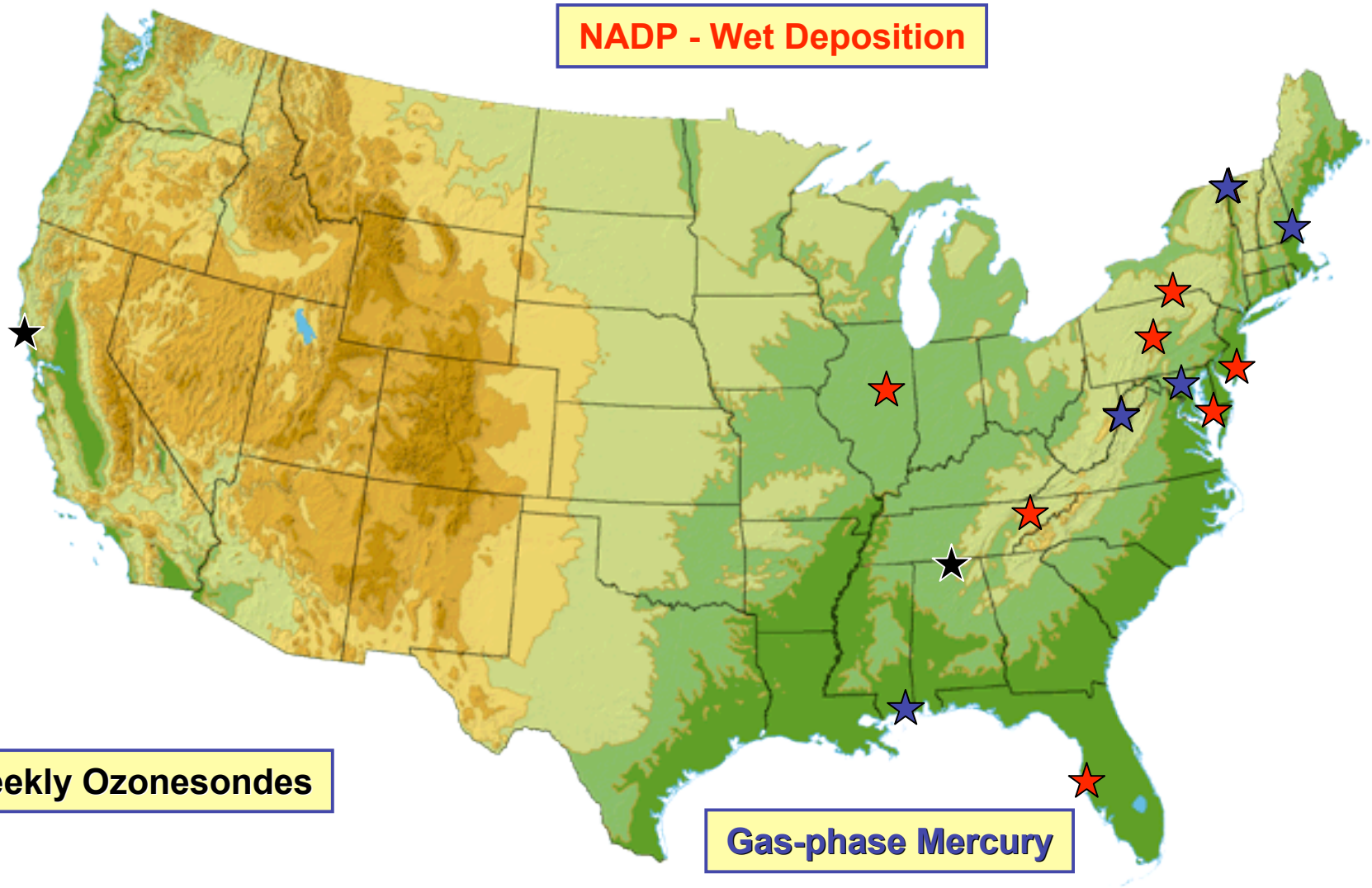



# Outline

## A Quick Survey of NOAA's Air Quality Program

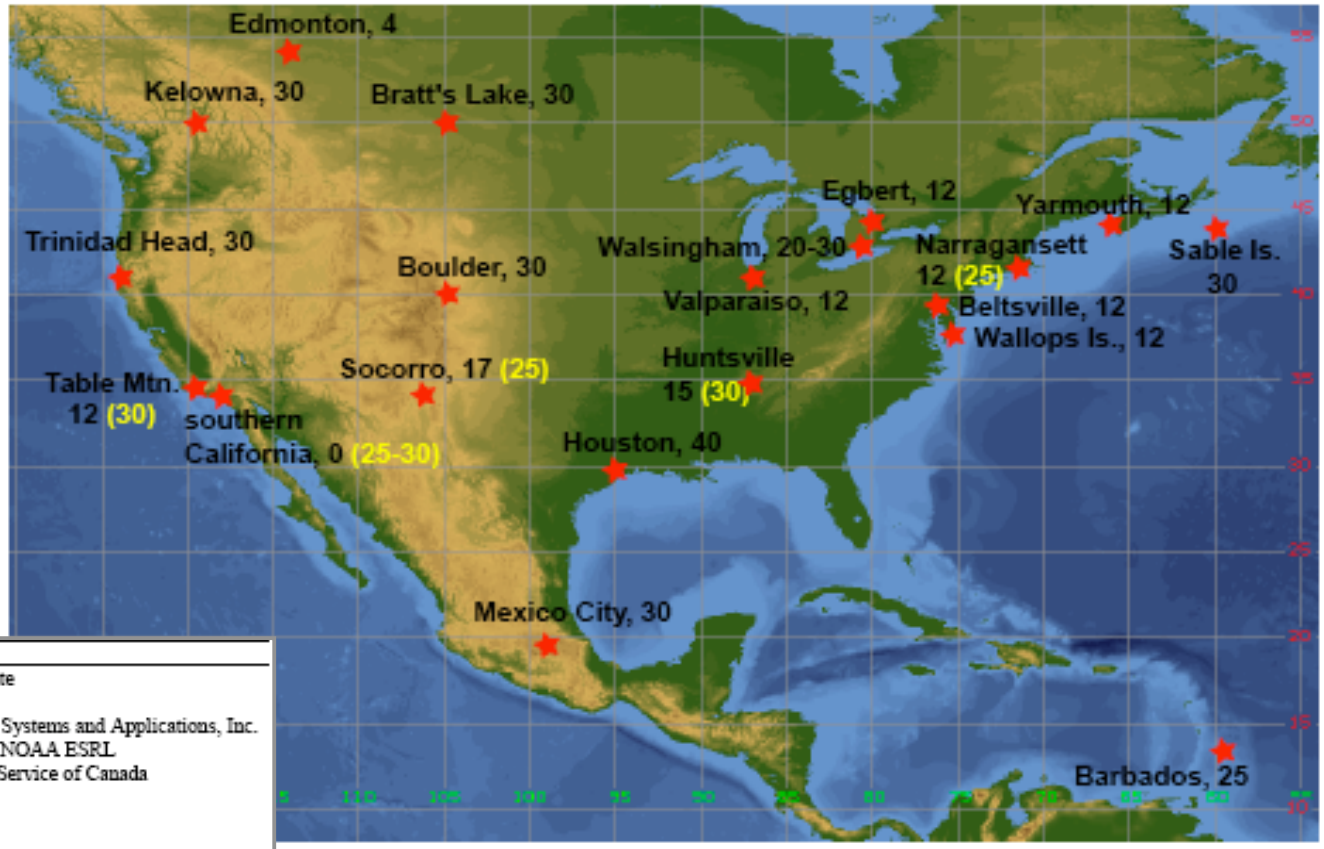
- Air Quality "monitoring" at NOAA - Atmospheric composition and deposition
- Regional air quality assessments with examples from…
  - Southeast
  - Texas
  - New England
- Using satellites for "top-down" emission inventory verification
- Air quality forecasting
  - Operational capability
  - Future products - future plans

# Air Quality "Monitoring" at NOAA



# Ozonesonde Network

## August 2006

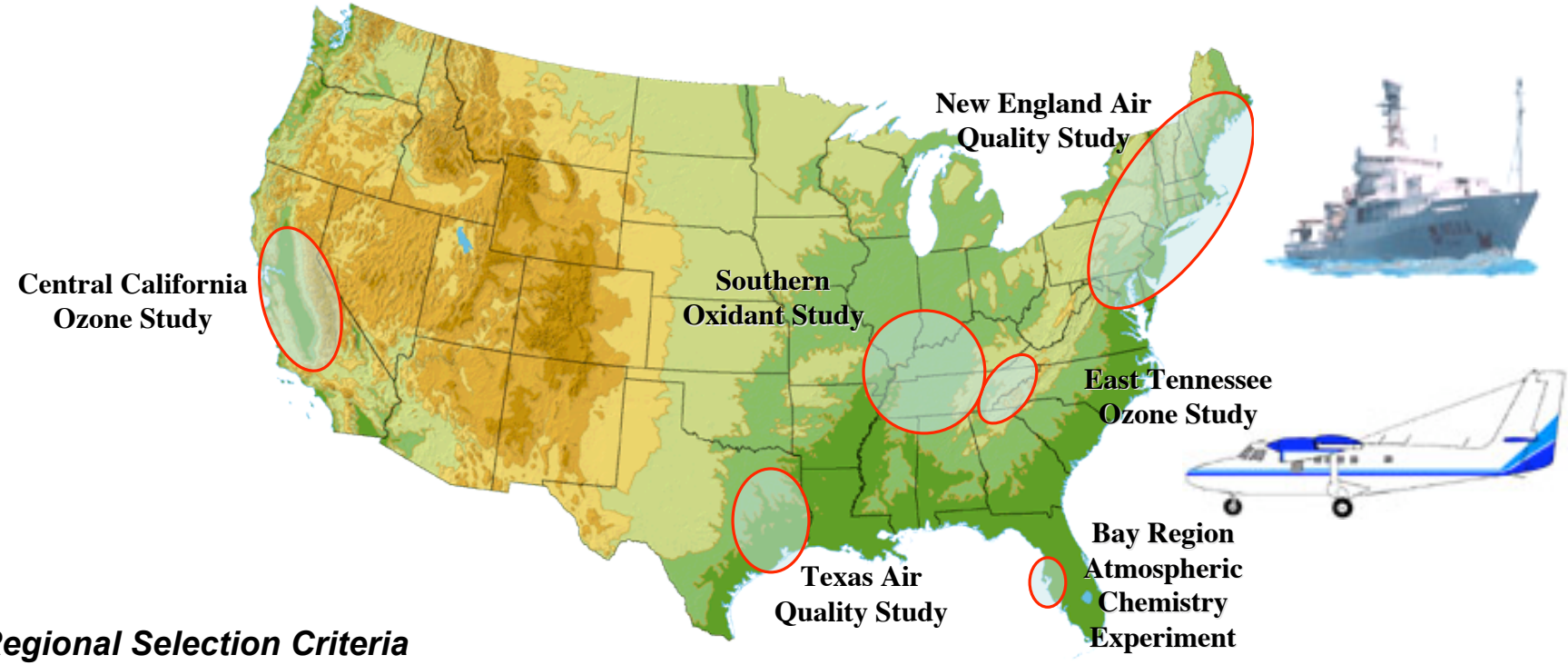



| Participants in IONS, August 2006 | Affiliation |
|---|---|
| Anne Thompson | NASA/Penn State |
| Sam Oltmans | NOAA ESRL |
| Jacquelyn Witte | NASA/ Science Systems and Applications, Inc. |
| Owen Cooper | U of Colorado / NOAA ESRL |
| David Tarasick | Meteorological Service of Canada |
| Michael Trainer | NOAA ESRL |
| Jim Meagher | NOAA ESRL |
| Stuart McDermid/Thierry Leblanc | NASA JPL |
| Gary Morris | Valparaiso University |
| Mike Newchurch | University of Alabama - Huntsville |
| John Merrill | University of Rhode Island |
| Mauvendra Dubey/Lars Kalnajs | Los Alamos National Laboratory/ U. Colorado |
| Trevor Carey-Smith | Meteorological Service of Canada |
| Gerry Forbes | Environment Canada |
| Frank Schmidlin | NASA: Wallops Space Flight Facility |
| Bryan Johnson | NOAA ESRL |
| Tony VanCuren | California Air Resources Board |
| Terry Keating | USA EPA |
| Everette Joseph | Howard University |

**Found a persistent Summer ozone maximum in the upper troposphere above the Southeast - Cooper et. al., JGR**

# Regional Air Quality Assessments

## Understand Key Atmospheric Processes Responsible for Poor Air Quality








***Regional Selection Criteria***

- Severity of the problem
- Emission mix
- Meteorology / topography
- AQ forecaster needs

***Schedule***

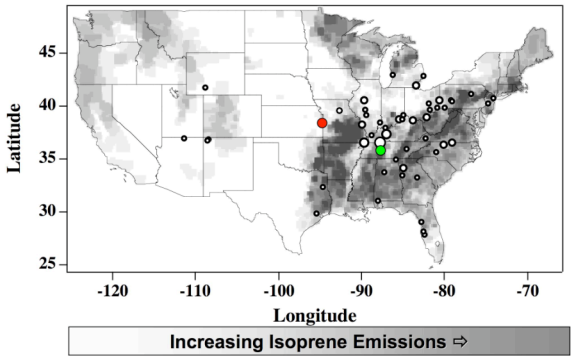
- Every two years (2004, 2006, 2008, 2010…)

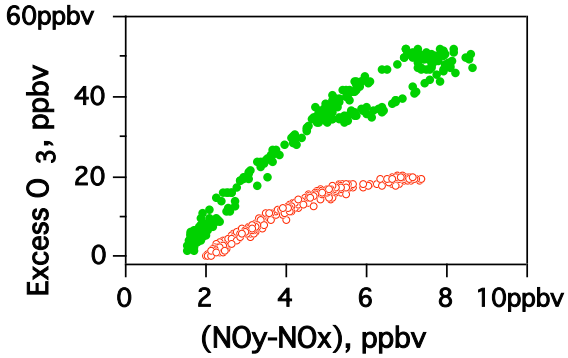
# SOS Highlight

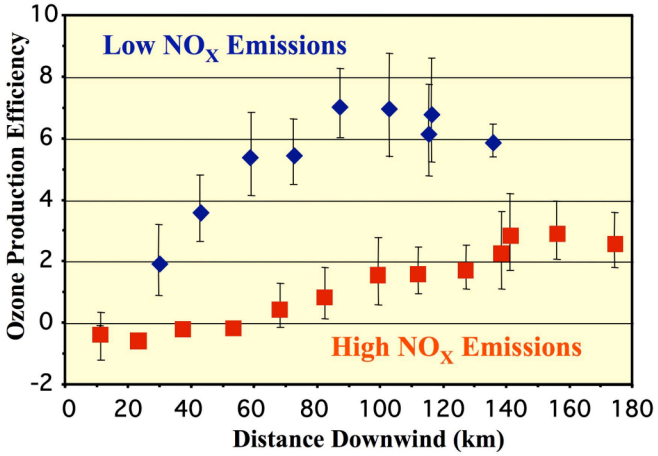
## All $NO_X$ is not Created Equal

### Emission Rate Matters

Ozone production efficiency does not scale with $NO_X$ emission rate. Power plants with high $NO_X$ emission rates produce fewer ozone molecules for each $NO_X$ molecule emitted compared to plants with lower emission rates.



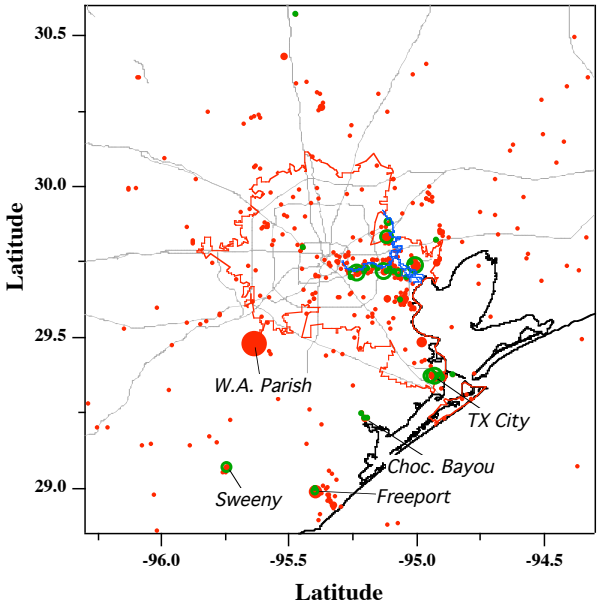

### Location Matters

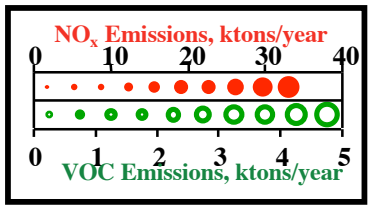
For power plants with similar NOX emission rates. Ozone production efficiency was found to be higher in areas with abundant vegetation (forests)

# Highlights

## Emission Inventories

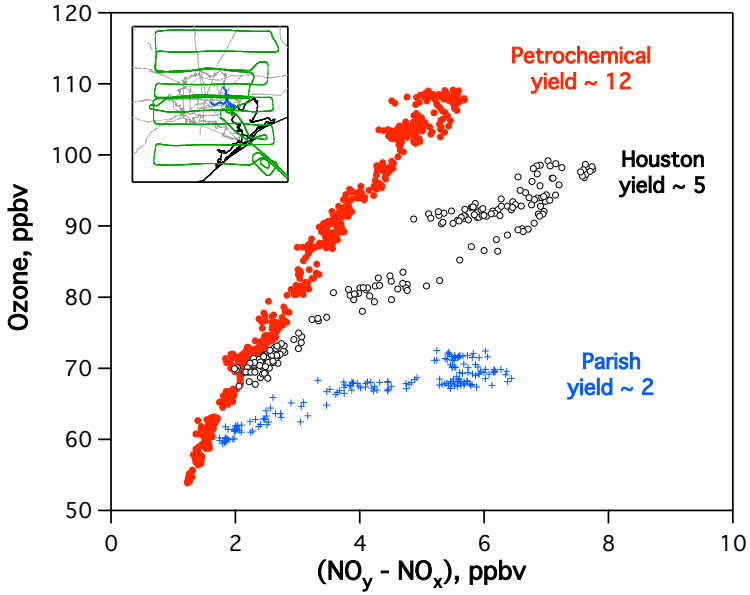
Emission inventories for petrochemical facilities underestimated reactive VOC emissions by 1 - 2 orders of magnitude



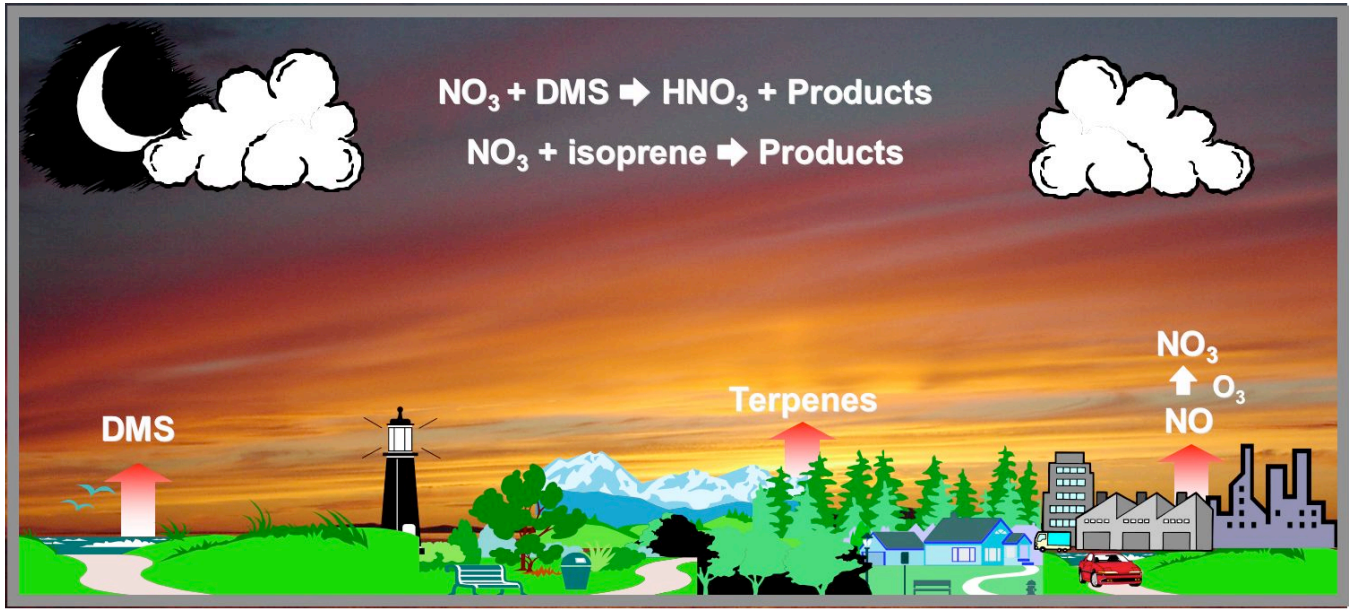




## Rapid Ozone Formation

Co-emission of reactive VOCs and $NO_X$ from petrochemical facilities results in rapid and efficient ozone formation downwind



# ICARTT Highlight




$NO_3 + N_2O_5$ can be a significant contributor to the nocturnal $NO_X$ budget

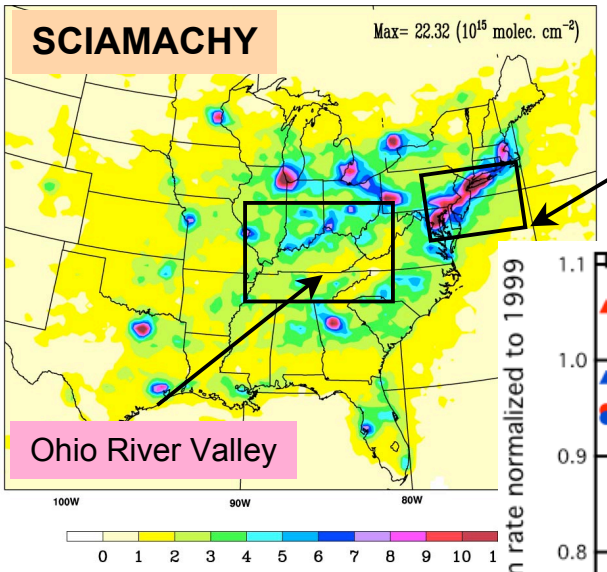
- $NO_3$ Measured in excess of 0.4 ppb
- $N_2O_5$ Measured in excess of 3 ppb

$NO_3$ anticorrelated with reactive "organics"

- Over land - isoprene
- Over water - DMS

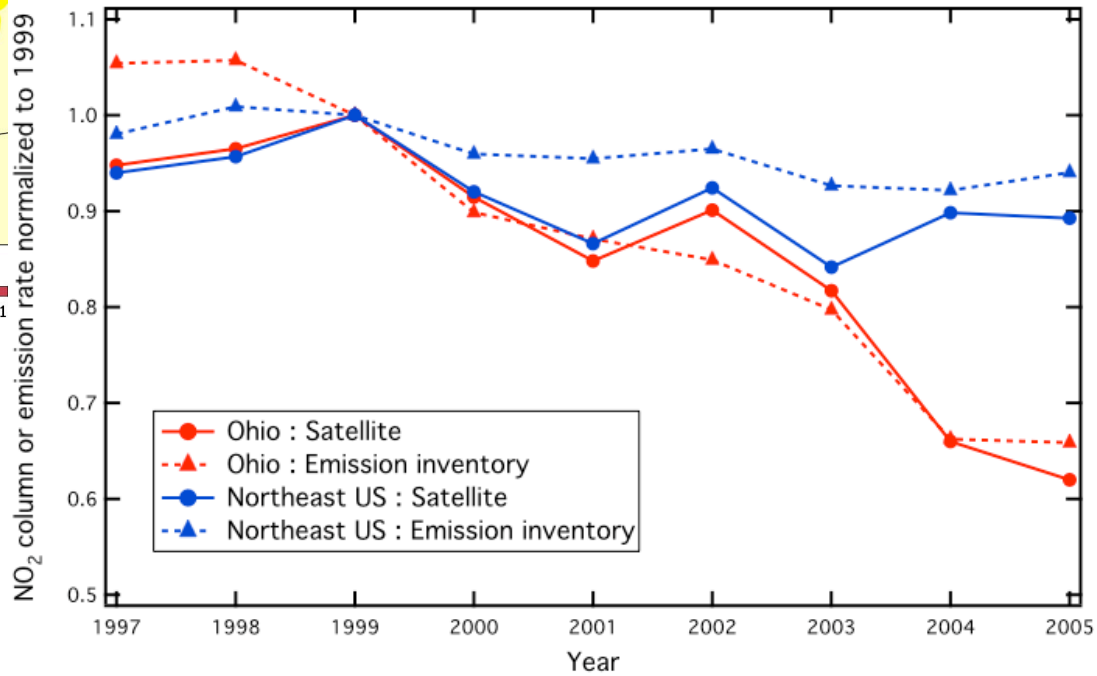
**Nocturnal $NO_X$ Chemistry key factor in next day's air quality**

# Year-to-Year Trends in Eastern US Satellite $NO_2$ and Emissions




Northeast Urban Corridor

*Summer 2004 (June-August) Averages*




- **Satellite $NO_2$ columns**: GOME (1997-2002) & SCIAMACHY (2003-2005)
- **Bottom-up $NO_x$ emissions** trend derived from monthly CEMS reports assuming all other $NO_x$ sources constant at summer 1999
- June-August averages
- 1997-2005 trends normalized to 1999 value

*Similar trends in satellite $NO_2$ columns and $NO_x$ emissions*

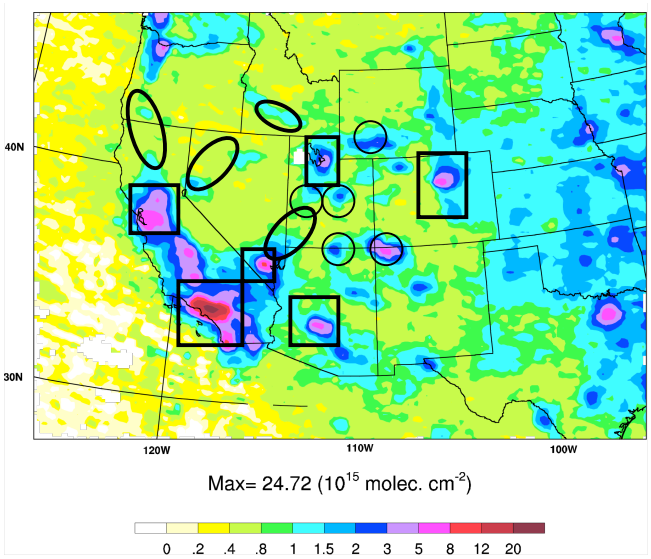
- *Power plant $NO_x$ controls have decreased $NO_2$ columns*
- *Mobile $NO_x$ emission changes smaller than power plant emission decreases*

*S.-W. Kim et al. (2006), Satellite-observed US power plant $NO_X$ emission reductions and their impact on air quality, Geophys. Res. Lett., 33, L22812, doi:10.1029/2006GL027749*

# Analysis of Western US $NO_x$ Sources with SCIAMACHY

***SC***anning ***I***maging ***A***bsorption spectro***M***eter for ***A***tmospheric ***CH***artograph***Y***
- launched in March 2002 on ENVISAT
- horizontal resolution: 60 × 30 km$^2$
- samples entire globe every 3 days at ~10:30 local time

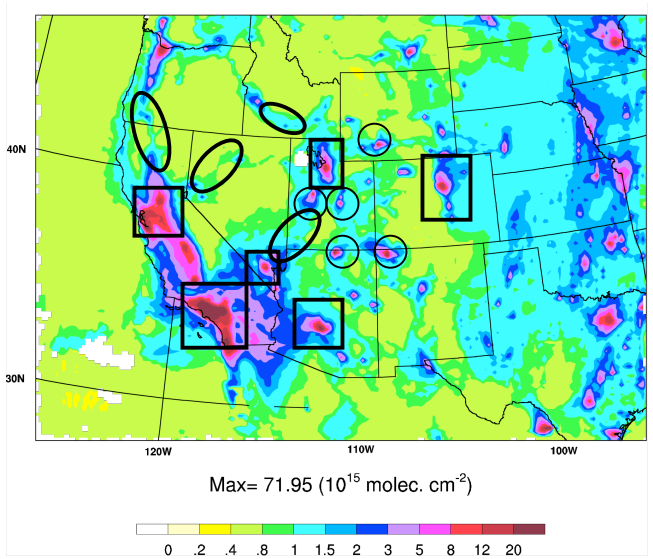
Summer 2005 SCIA $NO_2$ Columns




Power plants
Isolated highways
Urban areas

SCIAMACHY

July 2005 WRF-Chem $NO_2$ Columns




- *SCIAMACHY & WRF-Chem comparisons on Western US domain*
  - ➢ *Isolated power plants with no $NO_x$ controls: understand retrieval of point source signals*
  - ➢ *Isolated interstate highways and urban areas: evaluate emission inventory and monitor changes*
- *Apply Western US findings from satellite-model comparisons to entire nation*

# National Air Quality Forecast Capability

## *End-to-End Operational Capability*

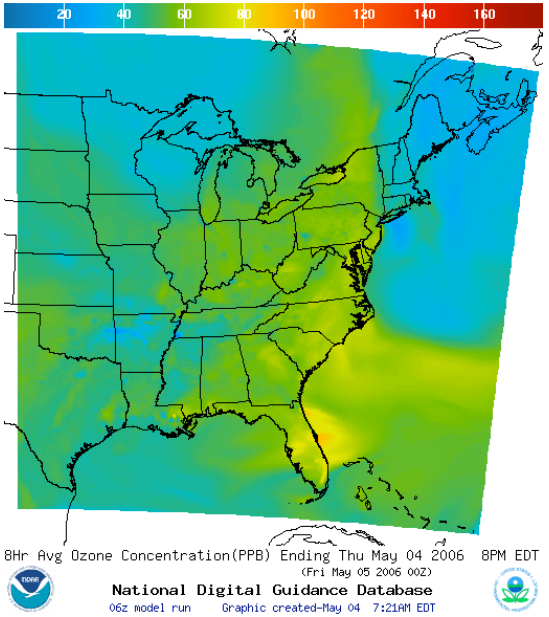
### Model Components: Linked numerical prediction system

***Operationally integrated on NCEP's supercomputer***

- *NCEP mesoscale NWP: WRF-NMM*
- *NOAA/EPA community model for AQ: CMAQ*

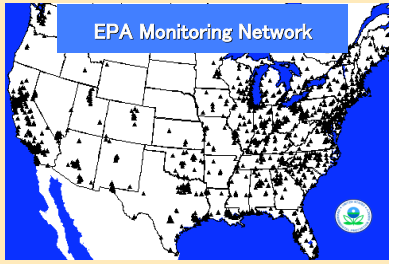
***Observational Input:***

- *NWS weather observations*
- *EPA emissions inventory*



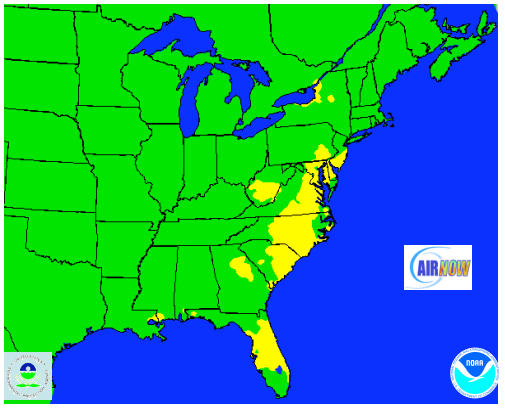

### Gridded forecast guidance products

- *On NWS and EPA servers*
- *Updated 2x daily*




### Verification basis

- *EPA compilation: ground-level ozone obs*
- *NESDIS GASP product: smoke*



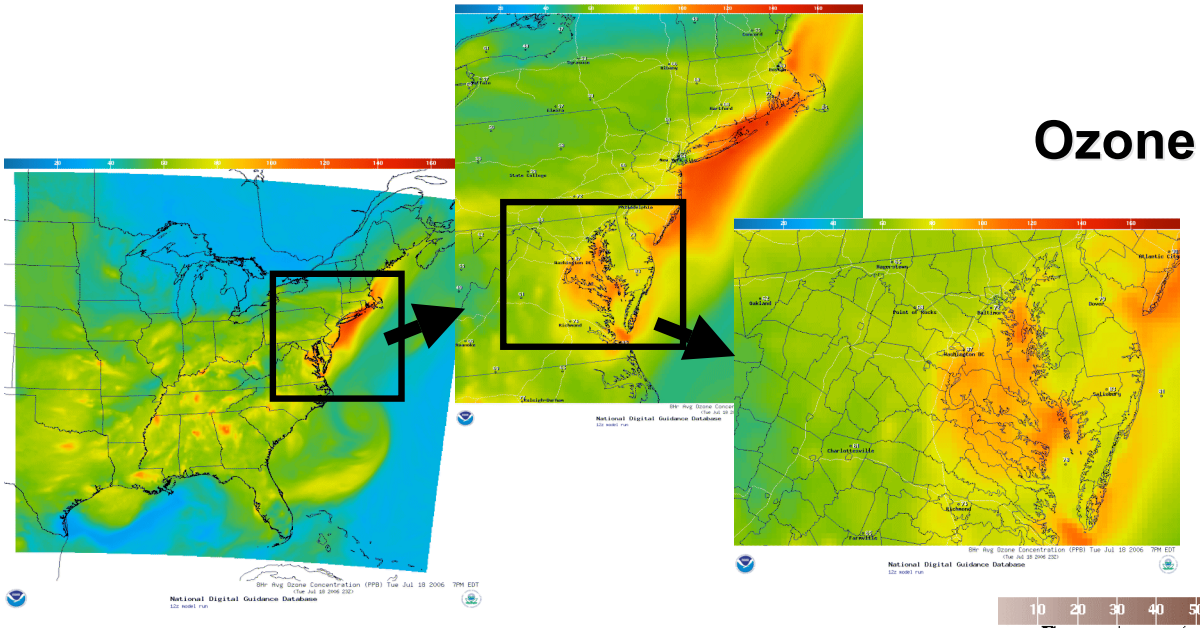

AQI: Peak May 4

### Customer outreach/feedback

- *State & Local AQ forecasters coordinated with EPA*
- *Public and Private Sector AQ constituents*

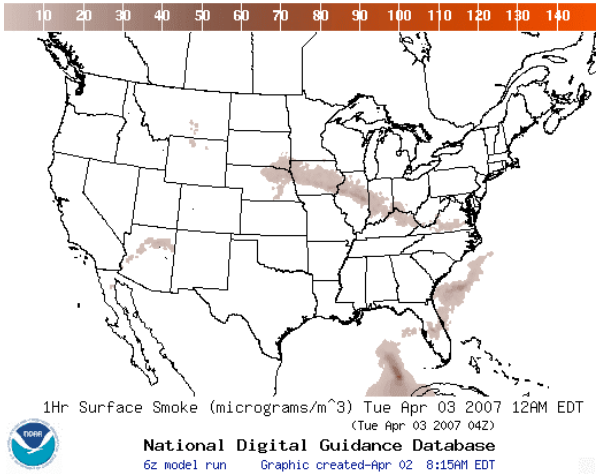
# Operational AQ forecast guidance

## www.weather.gov/aq



Ozone for Eastern US

**Smoke Products Implemented March, 2007**

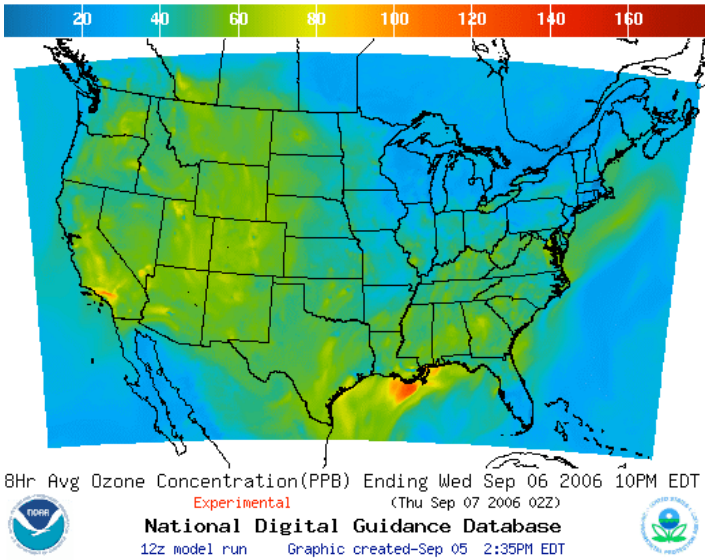



**Further information: www.nws.noaaa.gov/ost/air_quality**

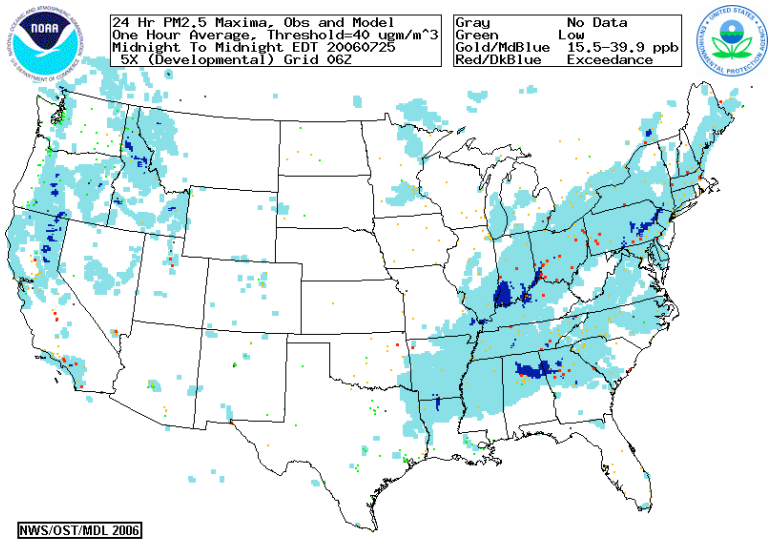
# New/Expanded Products in the Pipeline

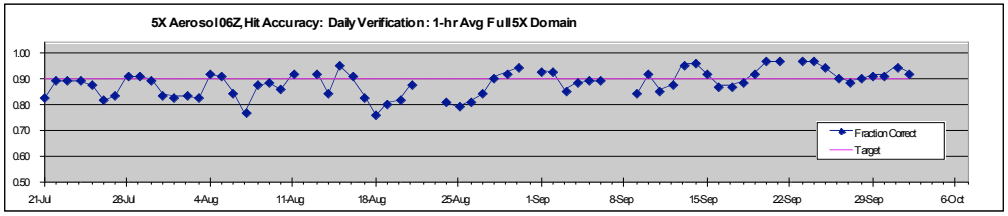
## Experimental Products:

### *Coast-to-coast Ozone*




## Preliminary Aerosol Predictions:




**www.weather.gov/aq-expr**

# National AQF Capability:
## *Targets for 2007 and Longer-Term*

**Ozone forecast guidance (WRF-CMAQ)**

- **Improving day-to-day performance, especially in the west**
- **Transitioning experimental CONUS predictions to operations (2007)**
- **Further development:**
  - Closer coupling of AQ with WRF prediction; examine impacts of vertical resolution, vertical mixing treatments, horizontal boundary conditions…
  - Testing over all 50 states; day 2 and beyond

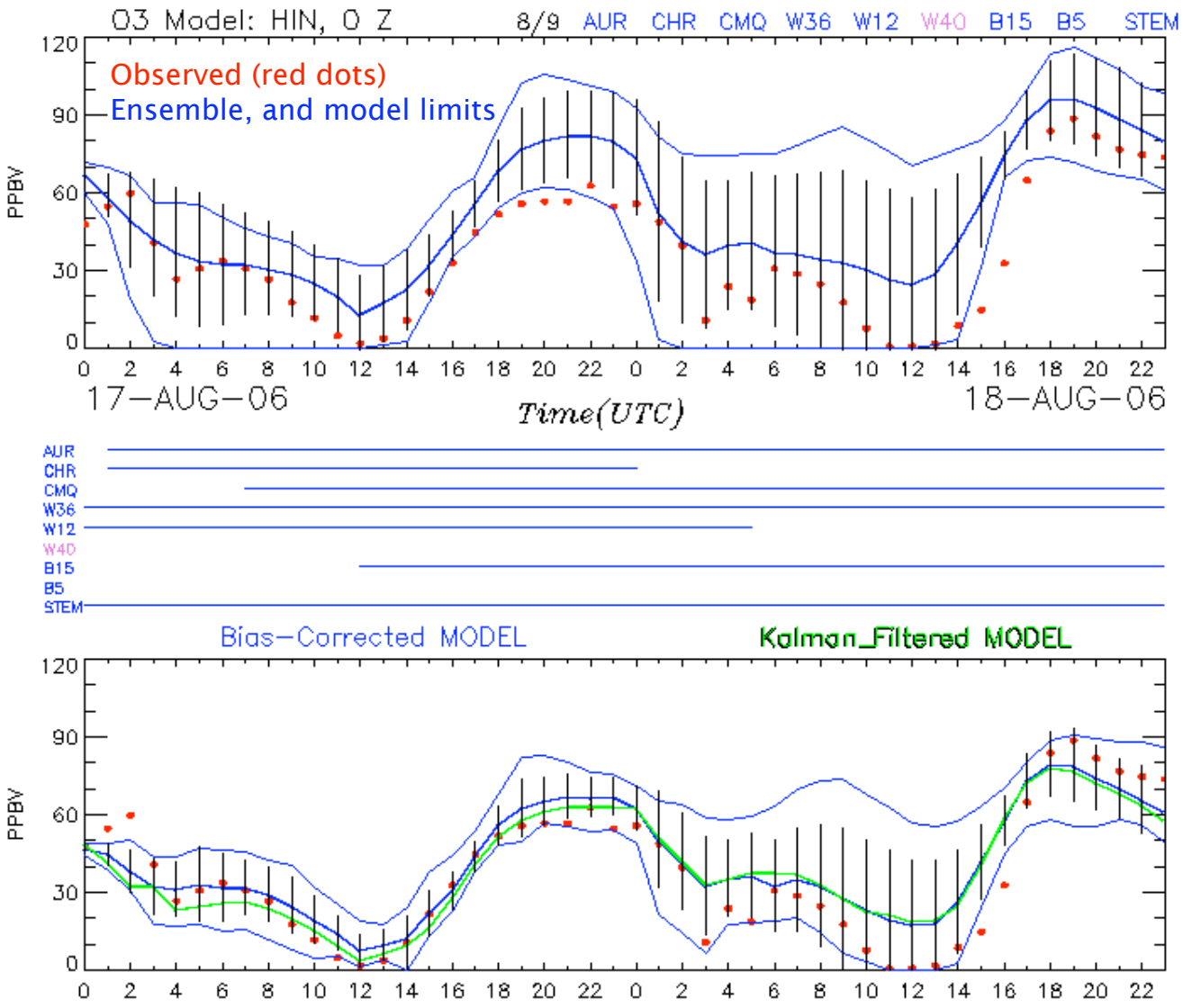
**Particulate matter components:**

- **Smoke from large fires: implemented over CONUS in operations (3/07)**
  - Planning for experimental testing in AK, HI
- **Further development:**
  - Objective satellite products for verification
  - Aerosols predictions from anthropogenic source emissions in inventories: continued development/testing/analysis

# Post Processing

## Ensembles and Bias-Corrections

$O_3$ ensemble sometimes has bias




Bias corrected ensemble refines forecast further

No advantage of Kalman filter over simple bias correction technique

# NOAA's Air Quality Program

## Linkages and Leverages

**Strategic Partnerships:**

**Internal - Across NOAA Line Offices (OAR, NWS, NESDIS, NMAO)**

**External - EPA, DOE, NASA, NSF, State and Local Programs, Universities, Private Sector, International - Facilitated through AQRS, NARSTO, WMO, etc.**

**Scientific Connections:** **Assessments ← Process Studies → Forecasting**

**End - to - End Approach:** **Research to Operational Products (Forecasts, Assessments)**