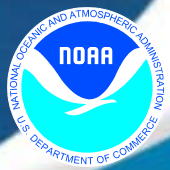


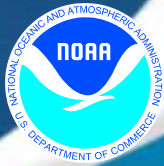
# **NOAA's Air Quality Forecasting Activities**

**Steve Fine**

**NOAA Air Quality Program**



# Introduction



# Planned Capabilities

## ➤ *Initial: 1-day forecast guidance for ozone*

- Develop and validate in Northeastern US September, 2004
- Deploy Nationwide within 5 years

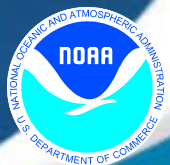
## ➤ *Intermediate (4-7 years):*

- Develop and test capability to forecast particulate matter (particle size  $\leq$  2.5 microns) concentrations

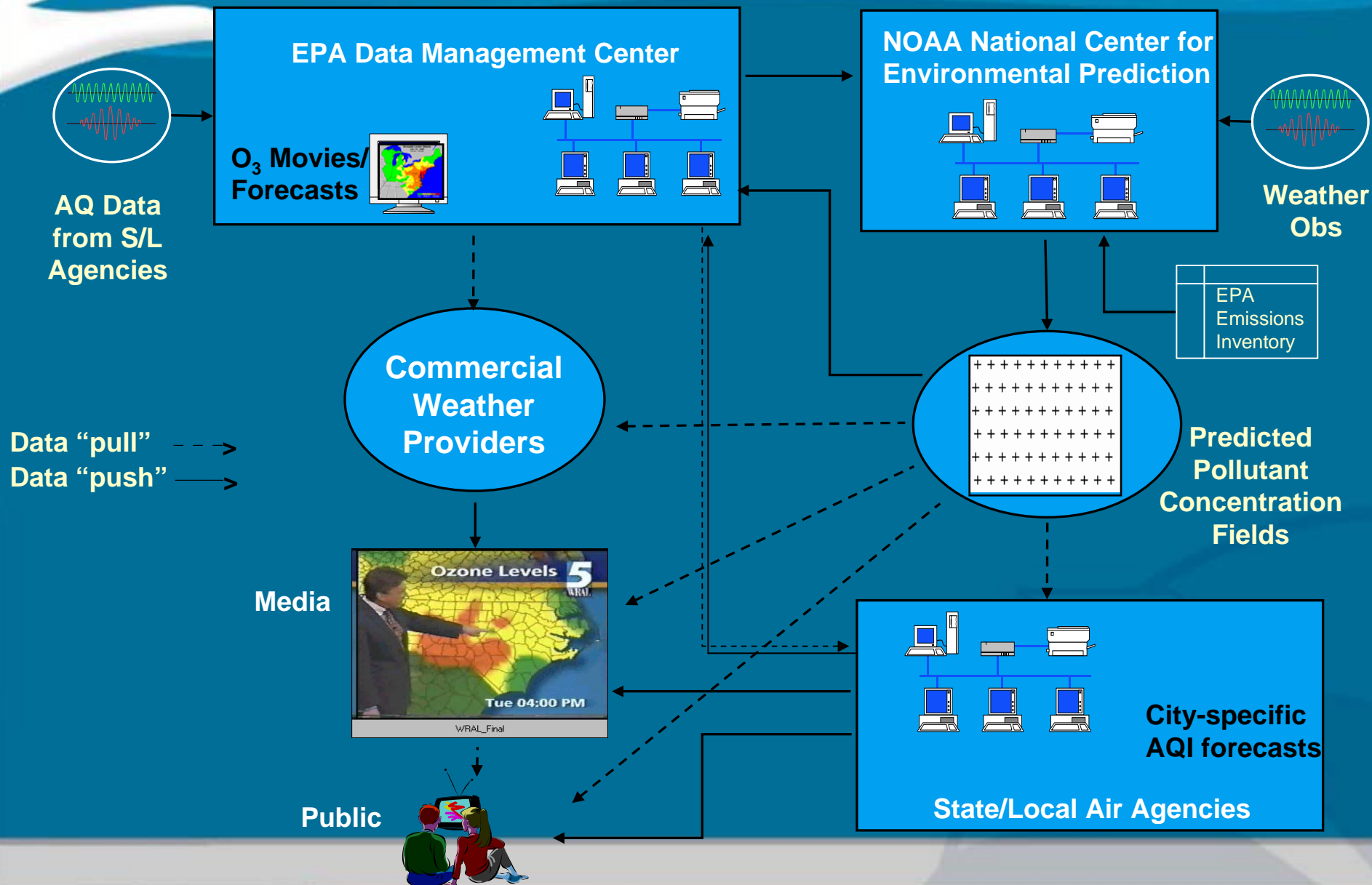
## ➤ *Longer range (within 10 years):*

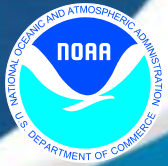
- Extend air quality forecast range to 48-72 hours
- Include broader range of significant pollutants





# Collaborative Effort





# Responsibilities

## ➤ **NOAA**

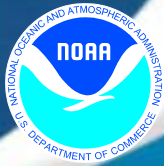
- Develop & evaluate tools for national AQ forecasting
- Provide operational forecast guidance for pollutant concentration fields, with national coverage

## ➤ **U.S. EPA**

- Maintain current national emissions inventories
- Maintain national air quality monitoring databases
- Disseminate/interpret national AQ forecast info.

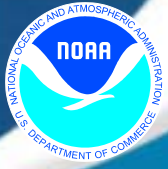
## ➤ **State/Local Governments**

- Provide state/local emissions and AQ monitoring data
- Provide local AQI forecasts/alerts

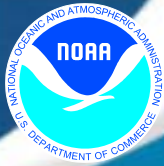


## Benefits

- ***AQ forecast guidance enables individuals and communities to limit harmful effects of poor AQ.***
  - Reduce exposure to unhealthful conditions
  - Reduce severity of unhealthful events
- ***Numerical guidance***
  - Improves basis for alerts of unhealthy AQ conditions:
    - *Predicts onset, duration, and severity of poor AQ*
  - Provides hour-by-hour prediction with continuous, consistent (12km resolution) coverage

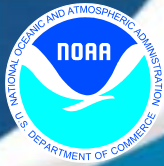


# Operational Forecast Guidance



## Current Status

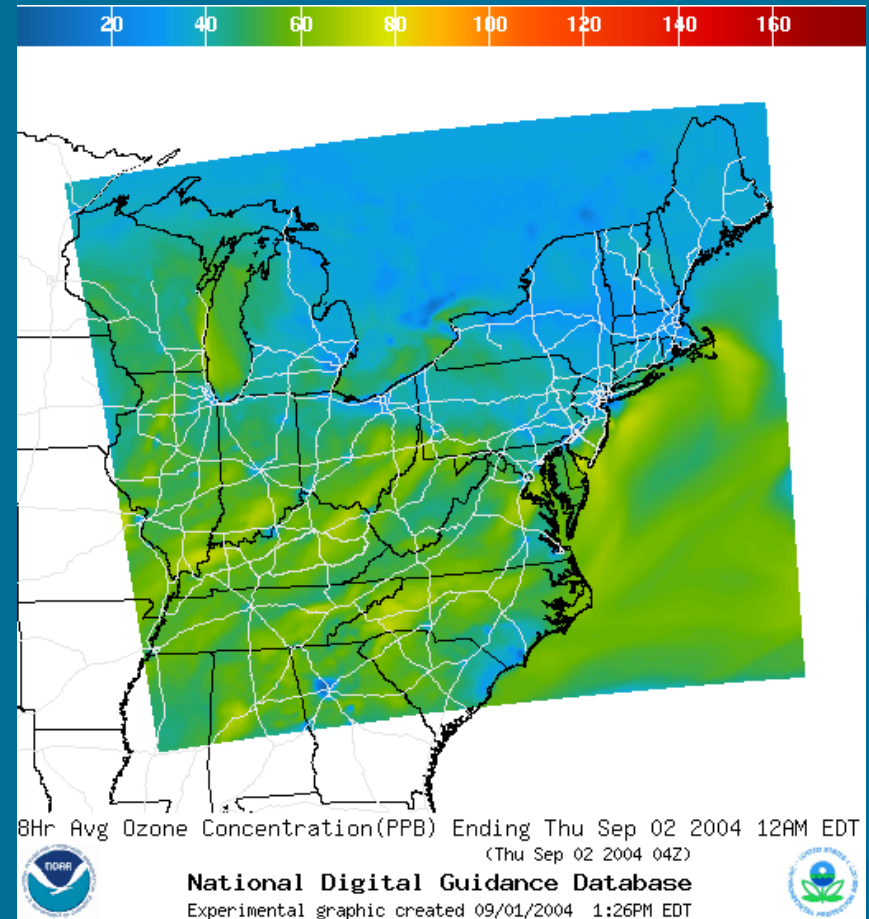
- *Development, testing, and integration of AQ forecasting system started in 2003*
- *Operational deployment for the Northeast U.S. in September*



# Operational Forecast Guidance

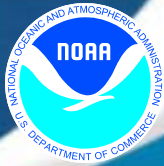
- **Ground-level ozone**
- **12km grid cells**
- **1h- and 8h-averages**
- **Two runs per day:**

<b>Cycle Start</b>	<b>12 UTC</b>	<b>6 UTC</b>
<b>Available By (EDT)</b>	<b>1:30 p.m.</b>	<b>9 a.m.</b>
<b>Valid thru midnight</b>	<b>Next day</b>	<b>Next Day**</b>



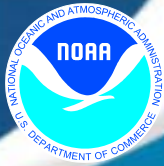
\*\* 1-hr avgs now available thru 2 a.m.

<http://weather.gov/aq>



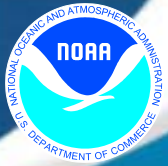
# Initial Operational System

- ***Meteorology: Eta-12km model***
  - Driven by entire suite of NWS weather observations; GFS
- ***Emissions inventory***
  - Use EPA standard inventory as base
  - Updated for 2004: point, area sources, and mobile
  - Simplified calculation of temperature-dependent emissions
- ***AQ model: CMAQ***
- ***Verification data: EPA AIRNOW surface O3 data***
- ***Models run operationally on NCEP's supercomputer facility***



# Community Multiscale Air Quality Model (CMAQ)

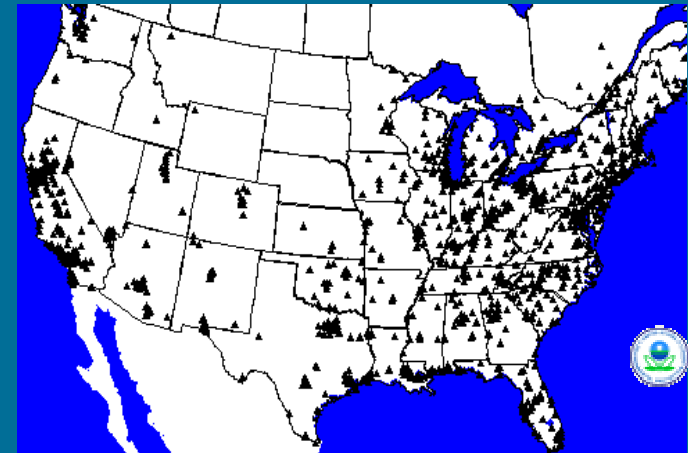
- *Eulerian; urban to intercontinental scales*
- *Modular—variety of options for chemistry, aerosols, etc.*
- *Developed by NOAA & EPA with EPA funding for evaluating air quality strategies*
- *Community support*
- *Operational forecasting configuration*
  - 12km grid cells
  - 22 layers, top at 100mb
  - Carbon Bond 4 chemistry
  - Aerosol capabilities disabled

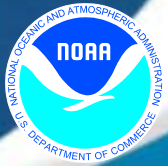


# Evaluation

- *Expert review of system design/updates*
- *Objective evaluation of accuracy relative to observations*
- *Focus group of state/local AQ forecasters uses forecast guidance and provides feedback*
- *Input from AQ constituents; public and private sector*

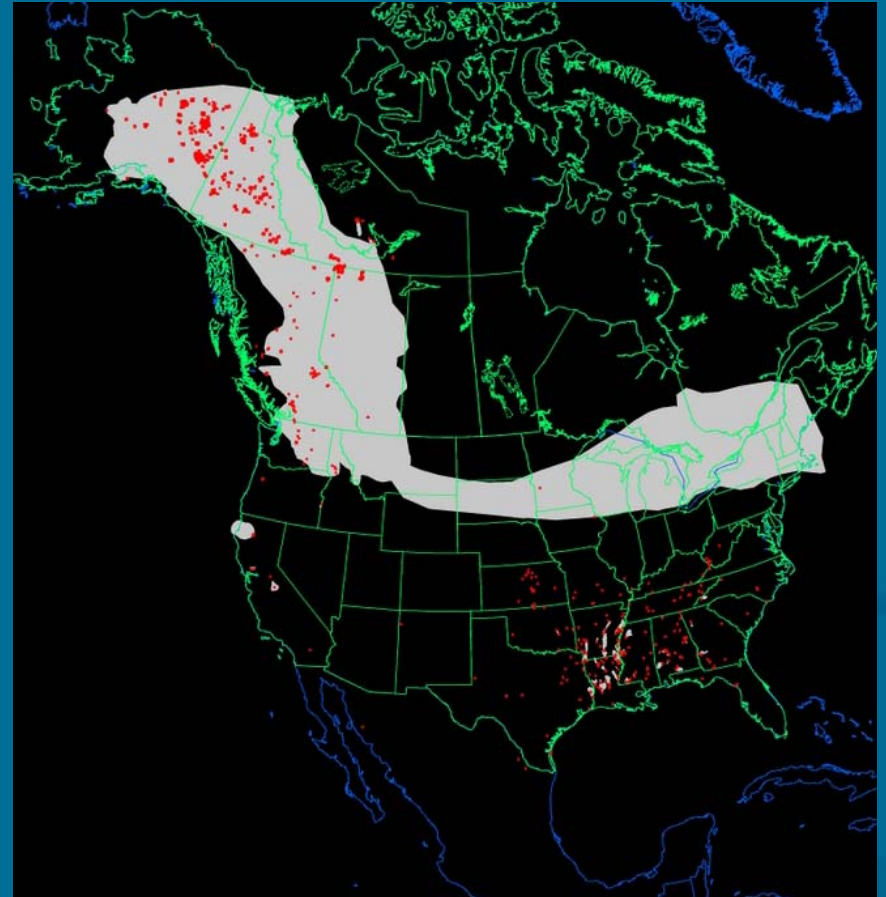
Ozone Monitoring Network

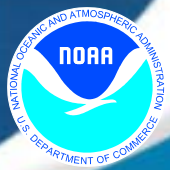




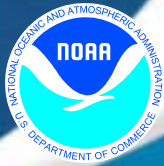
# Hazard Mapping System

- *Fire locations estimated from multiple satellites*
- *Analysts integrate estimates of fire locations and observations of smoke*



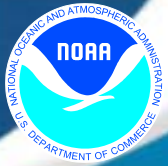


# Upcoming Operational Capabilities



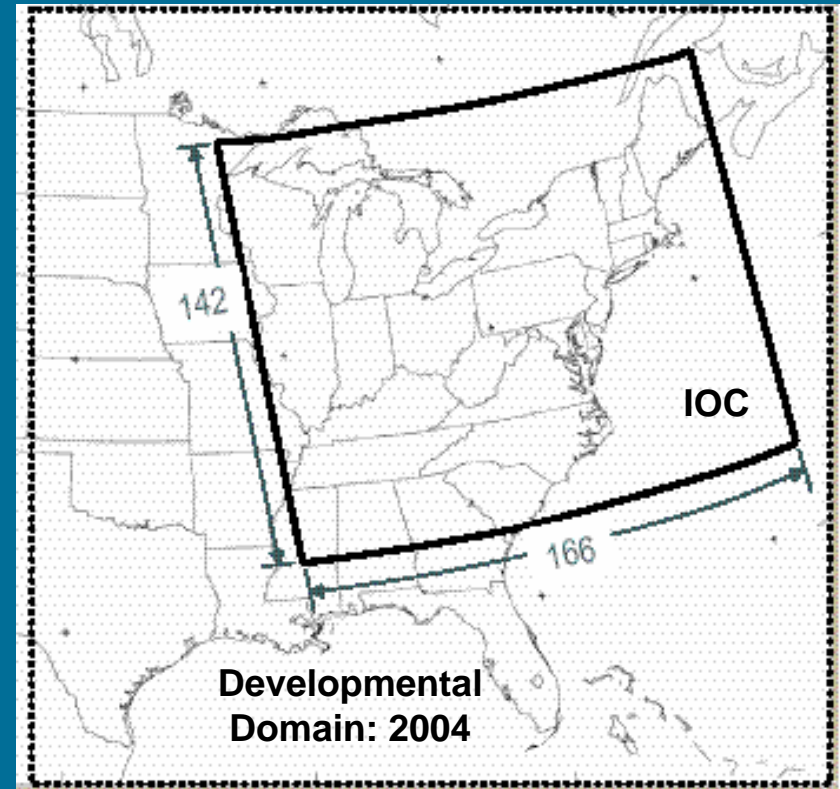
# Meteorological Model Changes

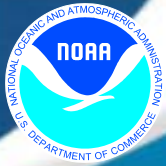
- *Air quality model driven by operational meteorological forecast model*
- *Changes anticipated in 2005*
  - Higher resolution model grid
  - Weather Research and Forecasting Model (nonhydrostatic mesoscale core) becomes operational



# Expanded Air Quality Domain

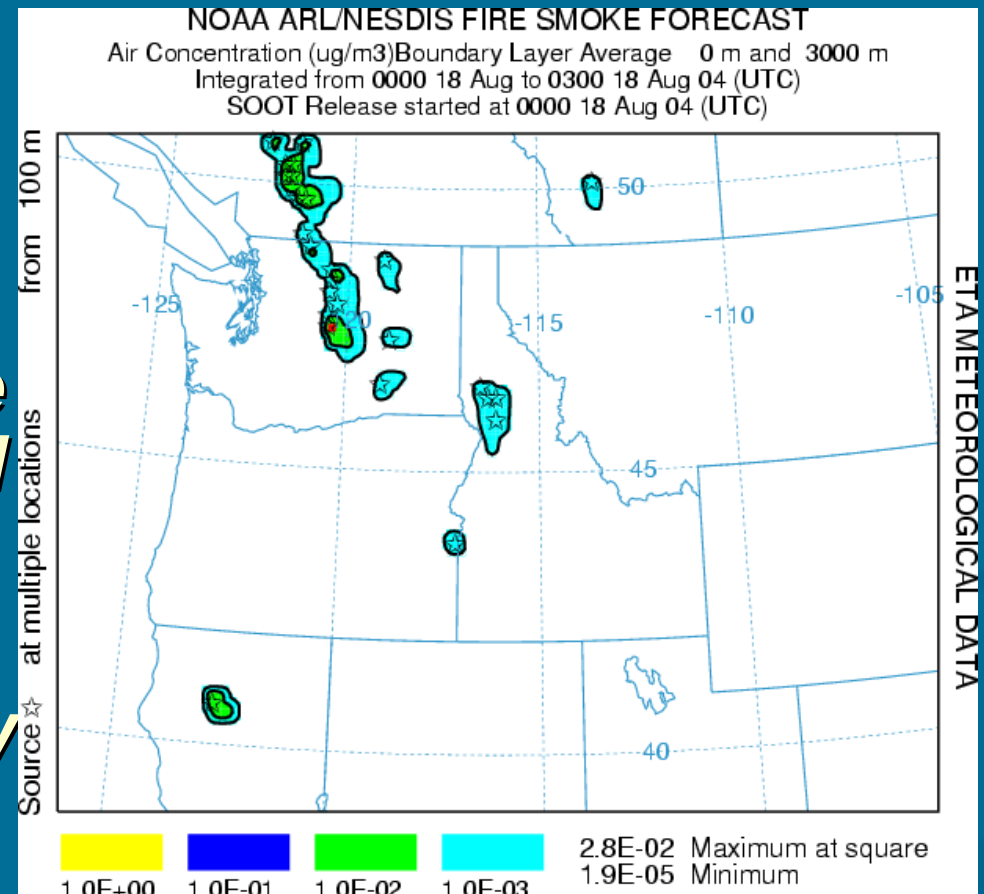
- *Began twice daily developmental test runs June 1*
- *If initial evaluation looks promising, experimental production for expanded domain to begin by June, 2005*
- *Pending successful testing of experimental products, implement into operations 2005-2006*
- *(Separate runs with aero.)*



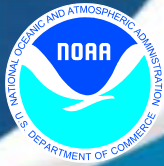


# Smoke Forecasting Demo Project

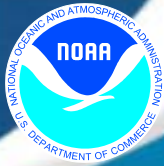
- *HMS Fire locations*
- *Fixed fraction of area burning, emissions, and fire decay rate*
- *HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) Model*
- *Incorporating BlueSky emissions*
- *Moving towards operational status*



<http://www.arl.noaa.gov/smoke/forecast.html>



# Air Quality Forecasting Research

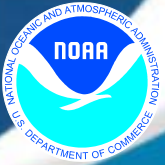


# Support NWS Operational AQ Forecast Capabilities

## ➤ **Goals**

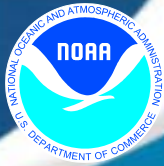
- **Continue improving existing capability**
- **Expand**
  - *Geographic domain* ⇒ *National*
  - *Species* ⇒ *O3, PM2.5, and ?*
  - *Lead time* ⇒ *2-day forecast*

➤ ***Provide prototype modeling systems to NWS two years prior to implementing into operations***



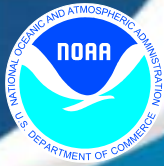
# Research Areas

- *Model Evaluation*
- *Process Studies*
- *Model Development*
- *Data Assimilation and Other Observation-Based Improvements*
- *Observing System Evaluation*
- *Socio-Economic Benefit Analysis*



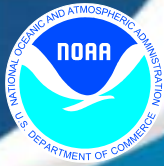
# Evaluation of Prototype Modeling Systems

- *Operational evaluation*
- *Diagnostic evaluation*
- *Sensitivity studies*
- *Identify priorities for improvements*



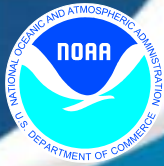
## **Model Intercomparison for NEAQS-2004**

- ***A Unified Regional Air-quality Modelling System (AURAMS)***
- ***Canadian Hemispheric and Regional Ozone and NO<sub>x</sub> System (CHRONOS)***
- ***Operational CMAQ***
- ***Multiscale Air Quality Simulation Platform-Realtime (MAQSIP-RT) – 45km, 15km***
- ***STEM-2K3***
- ***WRF/Chem - V1 @ 27km, V2 @ 27km, V2 @ 12km***



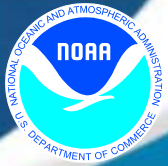
# Process Studies

- *Boundary layer*
- *Land-surface processes*
- *Coastal processes*
- *Aerosol formation and transformation*
- *Aerosol effects on radiation*
- *Improved chemical mechanisms (e.g., heterogeneous)*



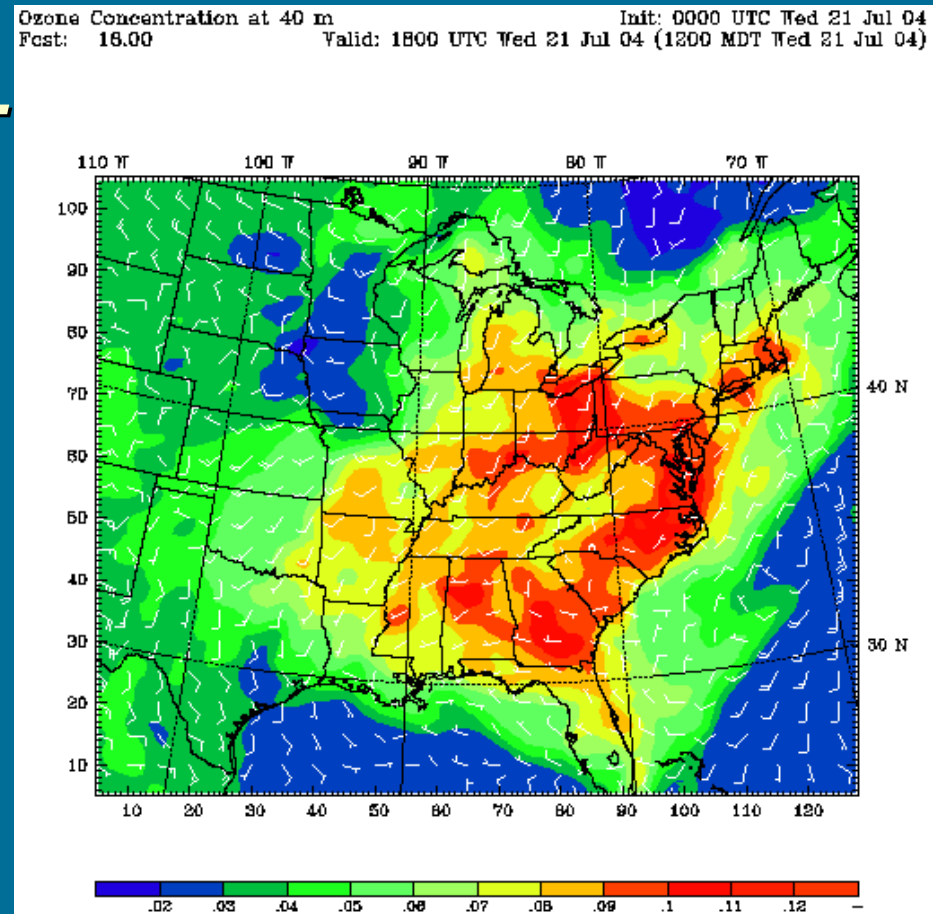
# Model Development

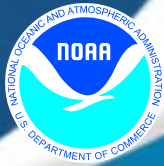
- *Cloud models, including aqueous-phase*
- *Aerosol formation and transformation*
- *Approaches for reducing biases and uncertainties (e.g., ensemble techniques)*
- *Incorporate advanced emissions models*
- *Integration of advancements*
- *Computational optimization*



# WRF/Chem Activities

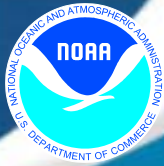
- *Experimental runs*
- *Study sensitivity to met-chemistry coupling frequency*
- *New convective transport scheme*
- *Carbon Bond-IV and SAPRC mechanisms*
- *Model of Aerosol Dynamics, Reaction, Ionization, and Dissolution (MADRID)*





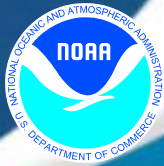
## Data Assimilation and Other Observation-Based Improvements

- *Evaluate and implement approaches for*
  - Observing air quality and fire characteristics
  - Improving O<sub>3</sub>, PM, & precursor boundary conditions
  - Ingesting/Assimilating O<sub>3</sub> & PM observations



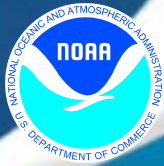
# Observing System Evaluation

- *Determine which observed parameters (chemistry, space/time distribution) have significant effect on predicted AQ*
- *Evaluate potential of existing systems, where necessary develop new prototype systems*
- *Conduct observing system simulation experiments*
- *Evaluate prototype observing system and its contribution to forecasting*



# Socio-Economic Benefit Analysis

- *Refine estimates of the value to society of air quality forecast improvements*



## Summary

- *Recently began producing operational forecast guidance*
- *Testing new and improved products that could become operational during the next two years*
- *Some research in progress; much more remains to be done*