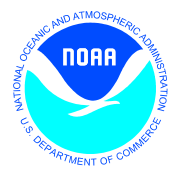


# **NOAA-EPA's National Air Quality Forecast Capability**

**Operational Readiness Review: September 3, 2004  
Brief to NWS Director**



# Purpose of Readiness Review

***Obtain Corporate approval for planned initial implementation of the Air Quality Forecast Capability***



# Outline

- **Background**
  - *Air Quality Forecast Program Goals, Planned Capabilities*
  - *Implementation Schedule*
- **Review operational readiness**
  - *Readiness Criteria (OST)*
  - *Objective verification (NCEP)*
  - *Subjective feedback (OCWWS)*
  - *Production readiness (OCIO)*
  - *Summary (OST)*
- **Polling of Senior Leadership**
- **Recommendation**



# Background



# National Air Quality Forecasting

## *Vision and Strategy*

### *Vision*

***National Air Quality Forecast Capability which provides the US with ozone, particulate matter and other pollutant forecasts with enough accuracy and advance notice to take action to prevent or reduce adverse effects***

### *Strategy*

***Work with EPA, State and Local Air Quality agencies and private sector to develop end-to-end air quality forecast capability for the Nation***

# National Air Quality Forecasting *Planned Capabilities*

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

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



## ***Intermediate (5-7 years):***

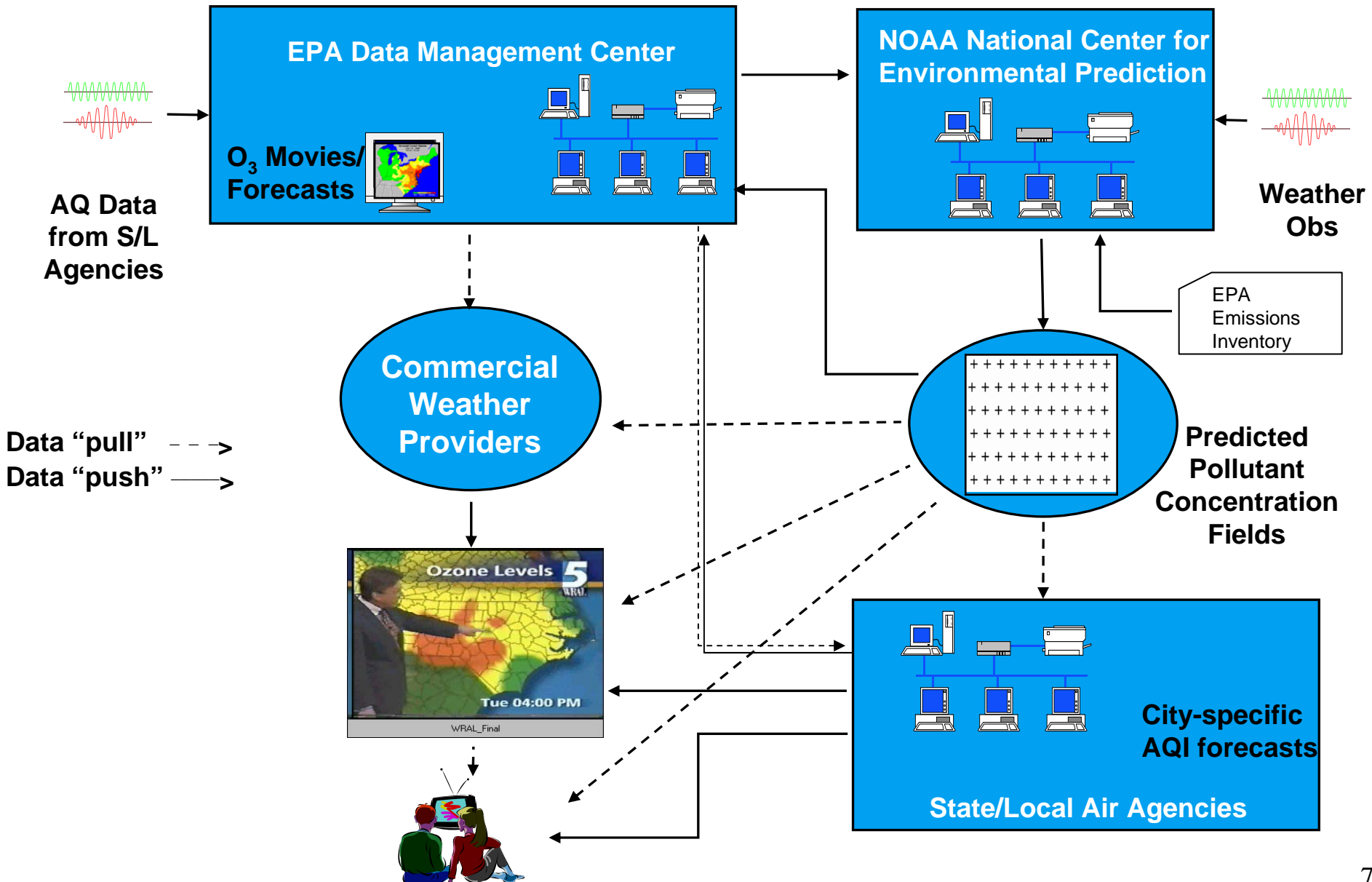
- Develop and test capability to forecast particulate matter concentration
  - Particulate size  $\leq 2.5$  microns

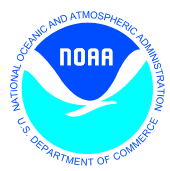
## ***Longer range (within 10 years):***

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



# Initial Operational Capability: *EPA + NOAA IT Links*





# National Air Quality Forecast Capability

## *Initial Operational Capability (IOC)*



### ***Linked numerical prediction system***

Operationally integrated on NCEP's supercomputer

- *NCEP mesoscale NWP: Eta-12*
- *NOAA/EPA community model for AQ: CMAQ*

Observational Input:

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

### ***Gridded forecast guidance products***

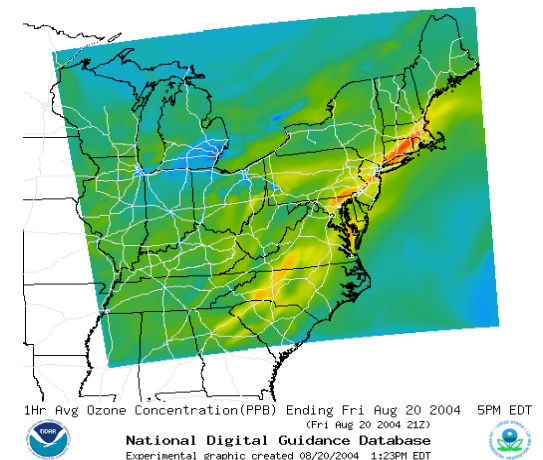
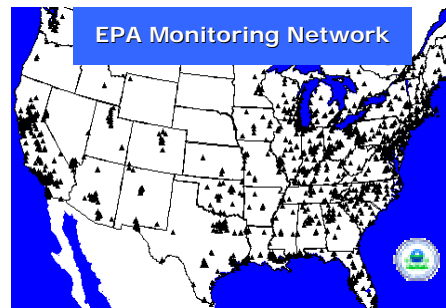
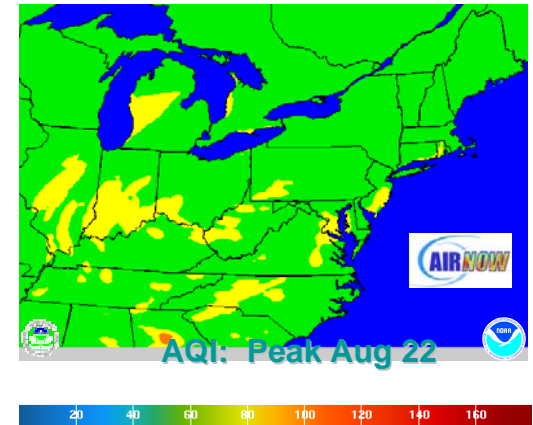
Delivered to NWS Telecommunications Gateway  
and EPA for users to pull 2x daily

### ***Verification basis***

EPA ground-level  
ozone observations

### ***Customer outreach/feedback***

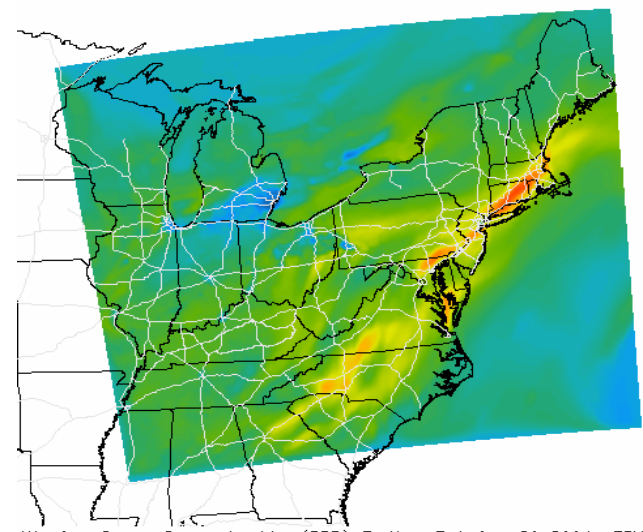
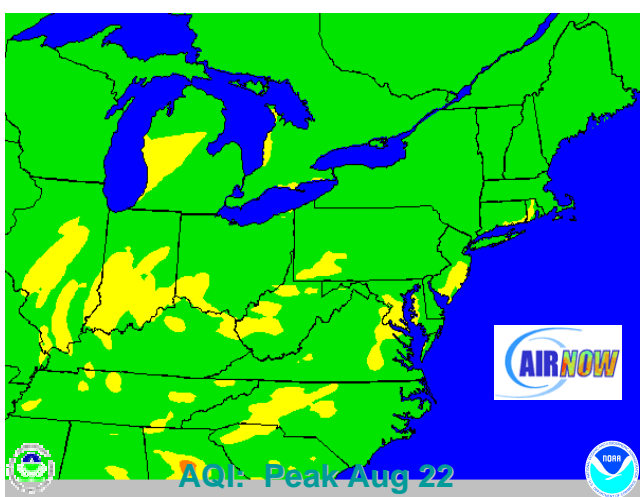
State & Local AQ forecasters coordinated with EPA  
Public and Private Sector AQ constituents





# Product Description: IOC

- **Gridded hour-by-hour predictions of ground-level ozone concentrations. 1-hr and 8-hr averages.**
  - Concentration parts per billion (ppb) and categorical.
  - Posted on TOC ftp server: GRIB files.
    - Graphic display also available experimentally on NDGD
  - Categorical provided for EPA use/display.
- **2X daily predictions extend through midnight of following day.**
  - Model hours 1-48, for 12 UTC (primary) and 6 UTC (update) cycles.
- **Initial Domain: NE US.**



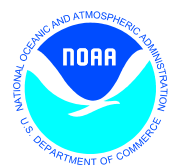
1Hr Avg Ozone Concentration(PPB) Ending Fri Aug 20 2004 5PM EDT  
(Fri Aug 20 2004 21Z)







# Review of Operational Readiness



# Initial Operating Capability: Operational Readiness Criteria Summary

<b>Criterion</b>	<b>Lead</b>	<b>Metric</b>	<b>Dates</b>	<b>Status 9/04</b>
<b>Objective Evaluation: Accuracy</b>	<b>NCEP</b>	<b>&gt; 90 %</b>	<b>6/1/04 – 8/15/04</b>	C
<b>Subjective Feedback</b>	<b>OCWWS</b>	<b>Positive on balance</b>	<b>6/03 – 8/04</b>	C
<b>Production Readiness</b>	<b>OCIO, NCEP</b>			C
<b>On-time delivery</b>		<b>&gt; 95 %</b>	<b>6/1/04 – 8/15/04</b>	C
<b>Back-up</b>		<b>In place</b>	<b>6/1/04</b>	C
<b>Data retention</b>		<b>In place</b>	<b>6/1/04</b>	C
<b>Near-real time verification</b>	<b>NCEP</b>	<b>In place</b>	<b>6/1/04</b>	C
<b>Final go/no go decision</b>	<b>NWS</b>		<b>09/04</b>	G

**Key**

Complete	On schedule	At risk	Remedial Action Required
----------	-------------	---------	--------------------------



# Objective Verification (NCEP)

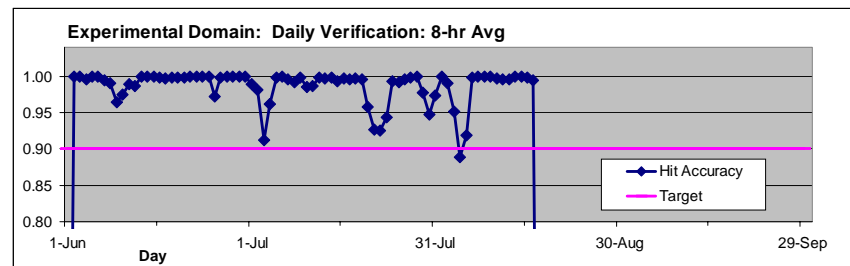
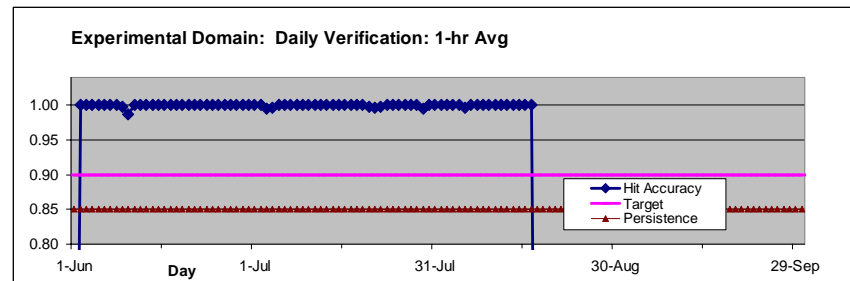


<b>Criterion</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>Objective Evaluation: Accuracy</b>	<p><b>Correctly predict exceedance and non-exceedance of ozone concentration threshold metrics, during the 24-h valid forecast period, on 90% or more days</b></p> <p><b>Threshold metrics:</b></p> <p><b>1-hr avg &gt; 124 ppb</b></p> <p><b>8-hr avg &gt; 84 ppb</b></p>	<b>6/1/04 – 8/15/04</b>	C

## Summary Performance:

**June 1- Aug 15, 2004**

- Exceeds target
- Reflects clean conditions



# Objective Verification: (NCEP)

## Improved Performance with 2004 Model Upgrades

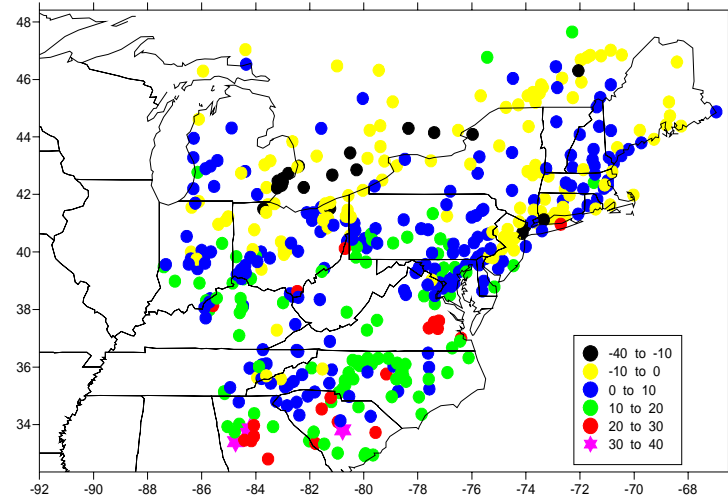
Test case comparison:  
2003 August 12-19

### 2003 Configuration

Representative BIAS in max 1-hr values

Most stations: -40 to +30 ppb

Range: -40 to 40 ppb

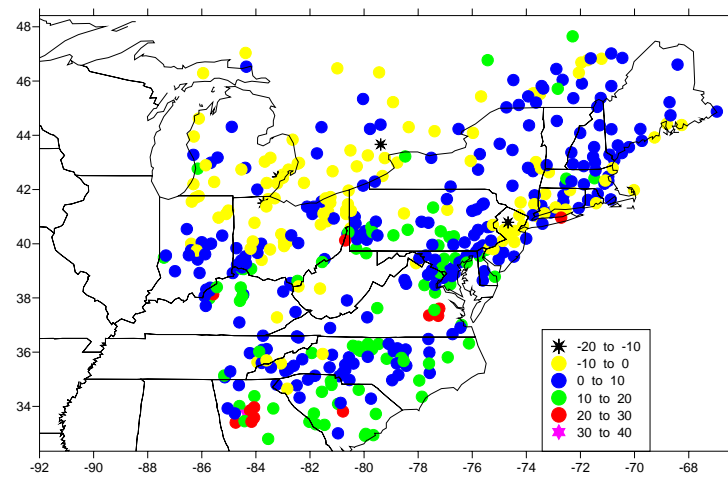


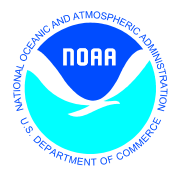
### 2004 Configuration

BIAS reduced in max 1-hr ozone concentration

Most stations: -10 to 20 ppb

Range: -20 to 40 ppb





# Objective Verification (NCEP) *Overall Performance - Summer 2004*

## ***Exceedance predictions***

- Exceed target

## ***Hourly predictions:***

- Over IOC domain (NE US) in 2004, daytime overprediction bias: ~ 8 ppb
  - *Nighttime overprediction bias larger than daytime; larger nighttime errors in southern areas*
    - Nighttime errors don't impact forecasts for elevated ozone; overnight ozone values are low

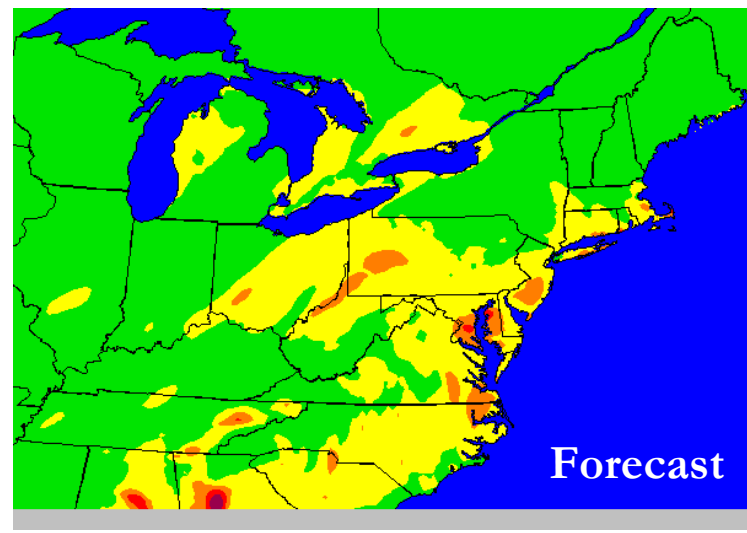
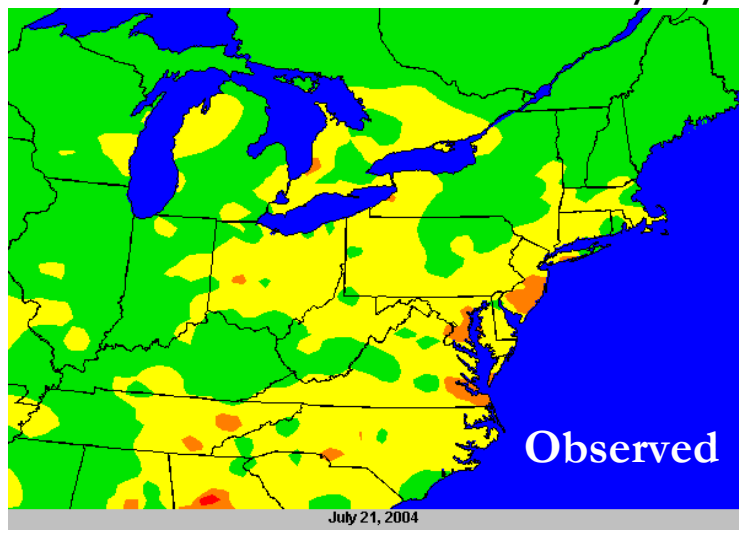
## ***Timing and Location of high ozone episodes***

- Generally well represented

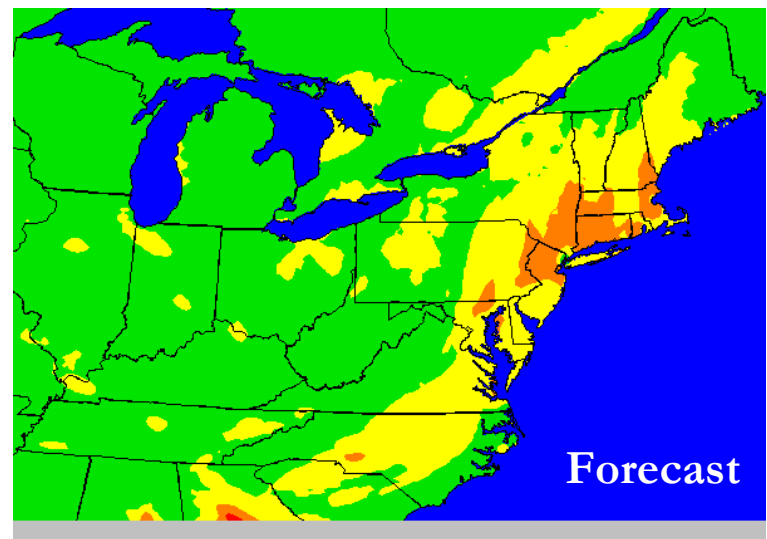
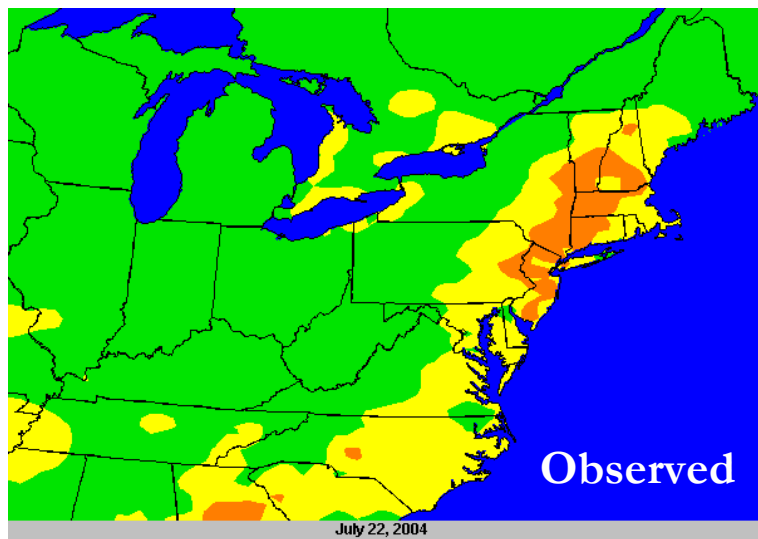
# Objective Verification (NCEP)

## July 21, 2004 12Z CMAQ forecast

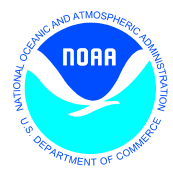
### 7/21/04 8 hour Peak Ozone



### 7/22/04 8 hour Peak Ozone







# Subjective Feedback (OCWWS)



<b>Criterion</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>Subjective Feedback</b>	<b>External feedback from State/Local AQ forecasters support product as helpful.</b> <b>Other feedback: internal, constituent, general public: On Balance, positive</b>	<b>6/03 – 8/04</b>	<b>C</b>

## Feedback Sources:

- **Constituent group**
- **State and Local AQ forecasters**
  - *comments, statement of need*
- **Other responses/comments on experimental products**



# **Subjective Feedback: (OCWWS)** ***Other responses/comments on experimental products***



***“This has become one of the primary tools used to produce air quality forecasts in the northeast US.”***

*– Anne McWilliams EPA*

***“Ozone patterns looks reasonable although slightly high values”***

*– local AQ forecaster*

***“This is a very useful map! I will use it in my classroom to educate students on air quality. It would be nice if it covered the entire U.S. “***

*- External User 8/24/04*



# Production Readiness



<b>Criterion</b>	<b>Lead</b>	<b>Metric</b>	<b>Dates</b>	<b>Status 9/04</b>
<b>On-time delivery</b>	<b>OCIO</b>	<b>Forecast guidance available by 1730 UTC (primary) and by 13 UTC (updated) &gt; 95%</b>	<b>6/1/04 – 8/15/04</b>	<b>C</b>
<b>Back-up</b>	<b>OCIO</b>	<b>In place</b>	<b>6/1/04</b>	<b>C</b>
<b>Product archiving</b>	<b>OCIO</b>	<b>In place</b>	<b>6/1/04</b>	<b>C</b>
<b>Near-real time verification</b>	<b>NCEP</b>	<b>In place</b>	<b>6/1/04</b>	<b>C</b>



# Production Readiness (OCIO)

## On-time delivery



<b>Criterion</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>On-time delivery</b>	<i>Forecast guidance available by 1730 UTC (primary) and by 13 UTC (updated) &gt; 95%</i>	<i>6/1/04 – 8/15/04</i>	C
<i>Guidance delivery</i>	<i>Forecast guidance delivered to TOC and sent to EPA/AIRNOW by 1725Z (primary) and by 1255Z (updated) &gt; 95%</i>	<i>6/1/04 – 8/15/04</i>	C
<i>Guidance Back-up</i>	<i><u>Initial:</u> Primary forecast backed up with morning update forecasts.</i>  <i><u>End-state:</u> NCEP backs up as part of NCEP model backup by Jan 05; back-up products available by 1930Z (99%)</i>	<i>6/1/04</i>	C
<i>EPA monitoring observations delivered on time</i>	<i>Delivered by TOC to NCEP/NCO within 5 minutes of receipt from EPA/AIRNOW: target 13 UTC</i>	<i>6/1/04</i>	C
<i>IT infrastructure Back-up</i>	<i>CCS, TOC and comms links from CCS to TOC fully backed up. Reliability of comms link from TOC to RTP (AIRNOW) &gt; 99.99%.</i>	<i>6/1/04</i>	C

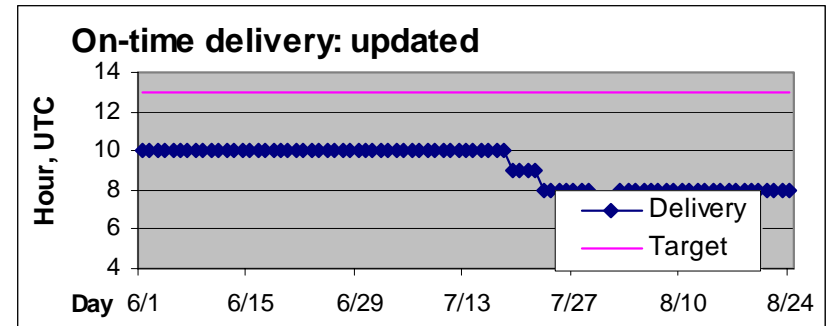
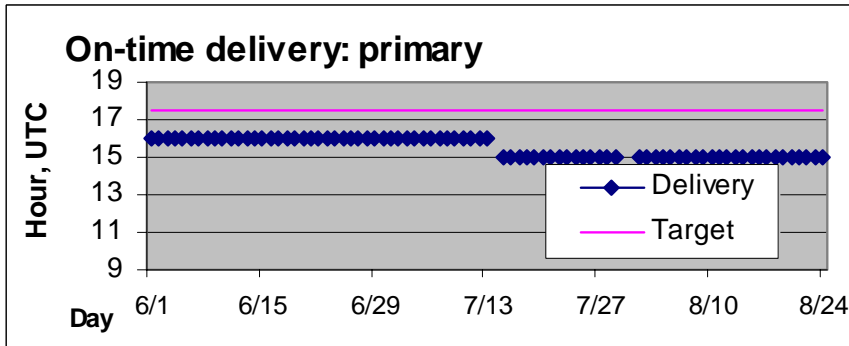


# Production Readiness (OCIO)

## *On-time delivery*

### ***–On-time Delivery of Guidance and Observations:***

- *Guidance delivered to TOC FTP server on time*



- *EPA BUFR ozone observations delivered on TOC/RTP T1 directly to NWSTG; routinely switched through NWSTG to NCEP within 5 minutes of receipt*

### ***–IT infrastructure Back-up:***

- *CCS fully redundant*
- *TOC systems fully redundant*
- *Redundant dual-path CCS-to-TOC ATM circuit, TOC-to-RTP*
- *AIRNOW T1 link contracted at 99.99% availability*



# Production Readiness (OCIO) *Data Retention*



<b>Criterion:</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>Data retention</b>	<i>Operational forecast guidance archived for 5 yrs at NCDC.</i>	<b>6/1/04</b>	<b>C</b>

– *Operational forecast guidance archived for 5 yrs at NCDC.*

- *Tape format and retrieval.*
- *FY04: GRIB1 files only, for products for ground-level ozone concentrations and ozone categories.*
- *FY05: GRIB2*

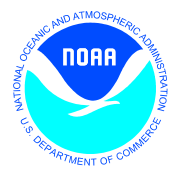


# Production Readiness (NCEP)

## Near-real time verification

<b>Criterion</b>	<b>Metric</b>	<b>Dates</b>	<b>Status</b>
<b>Near-real time verification</b>	<i>Daily; for 24-hour forecast interval midnight-to-midnight by 48 hours after end of forecast interval.</i>	6/1/04	<b>C</b>

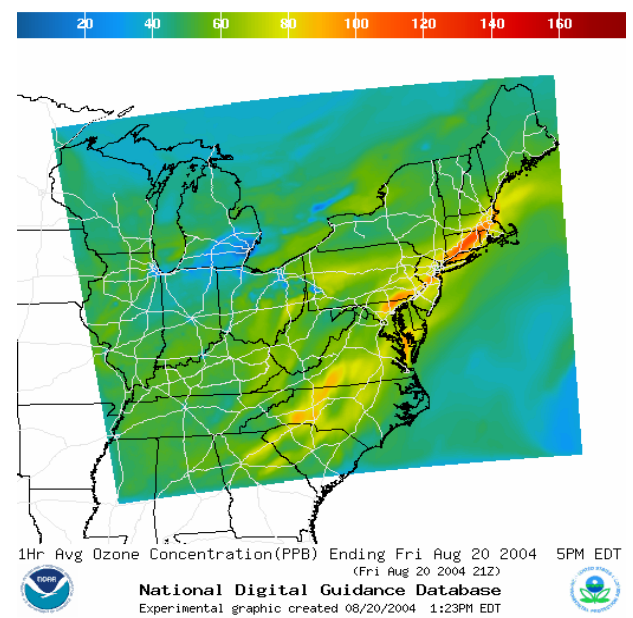
- Verification Statistics:** *Compiled and maintained by NCEP & MDL and updated on a daily basis*
- Availability:** *model developer group*
- Seasonal summary:** *available on AQ program web site (public)*
- Weekly verification:** *reports on operational performance measures provided by NCEP & MDL to OST PM*
- AIRNOW data:**
  - Formatted as WMO standard BUFR files*
  - EPA sends daily to NCEP observation database used for model verification and assimilation (future) by 13:00 UTC*



# Summary:

## Experimental Production of AQ forecast guidance for IOC

- **September 3 Status: Ozone levels**  
.....generally clean...
  - Model running well, bias reduced from FY03 testing
  - Several episodes of moderately elevated ozone levels observed. Timing/location predicted; concentration overpredicted
- **Objective verification:**
  - Accuracy performance targets achieved
- **Subjective feedback:**
  - Generally positive
  - Focus group forecasters providing additional feedback; additional feedback links posted on graphical display sites
- **Production readiness:**
  - Forecast guidance available on time
  - Backup, data retention and verification demonstrated







# Future Science Infusion

## ***NOAA planning for the expansion of the AQ forecast capability to***

- National coverage of ozone predictions
- Addition of particulates forecast guidance
- Extended forecast range

## ***Continuing R&D required***

- OAR and EPA working actively with NWS to provide prototype capabilities for pre-operational development, testing experimental production, and implementation

## ***Assuring quality with science peer reviews:***

- Design review of major system upgrades (initial, 2004 upgrades)
- Diagnostic evaluations with field campaigns and evaluations
- Publication of T&E in peer-reviewed literature



# Summary

## Operational Readiness

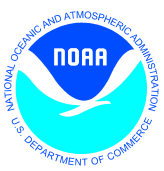
<b>Criteria</b>	<b>Metric</b>	<b>Dates</b>	<b>Status 9/04</b>
<b>Objective Evaluation: Accuracy</b>	<b>&gt; 90 %</b>	<b>6/1/04 – 8/15/04</b>	C
<b>Subjective Feedback</b>	<b>Positive on balance</b>	<b>6/03 – 8/04</b>	C
<b>Production Readiness</b>			C
<b>On-time delivery</b>	<b>&gt; 95 %</b>	<b>6/1/04 – 8/15/04</b>	C
<b>Back-up</b>	<b>In place</b>	<b>6/1/04</b>	C
<b>Data retention</b>	<b>In place</b>	<b>6/1/04</b>	C
<b>Near-real time verification</b>	<b>In place</b>	<b>6/1/04</b>	C
<b>Final go/no go decision IOC</b>		<b>09/04</b>	G

Key

Complete	On schedule	At risk	Remedial Action Required
----------	-------------	---------	--------------------------



# Polling of Senior Leadership



# Polling of Senior Leadership

- **NCEP: Product quality, production readiness**
- **CIO: Production readiness**
- **OCWWS: Service readiness**
- **OST: Overall readiness for S&T Upgrade**
- **NOAA AQ PM: Program Manager's Assessment**



# Deployment Recommendation

***Recommend:***

***NWS deploy Air Quality Forecast Guidance into operational product suite***



# Back Up



# Criteria for Operational Check-in of Air Quality Forecast Guidance Products



## 1. Objective

- **Objective Verification scores:**

- Accuracy of predicting of exceedance and non-exceedance of ozone concentration threshold metrics during the 24-h valid forecast period correct on 90% of days, where threshold metrics are:
- -hr avg > 124 ppb
- 8-hr avg > 84 ppb

## 2. Subjective

- External feedback from (a) S/L forecasters (b) general public support product as helpful.
- Other feedback: internal, constituent – On Balance, positive

## 3. Production Readiness

- **Run-time reliability : On-time delivery**
  - Forecast guidance delivered to TOC by 1725Z (primary) and by 1255Z (updated) > 95%
- **Back-up:**
  - **Guidance Back-up.**
    - Initial: Primary forecast backed-up with morning update forecasts.
    - End-state: NCEP backs up as part of NCEP model backup by Jan 05; back-up products available by 1930Z (99%)
  - **IT infrastructure back-up.**
    - CCS, TOC and comms links from CCS to TOC, fully backed up. Reliability of comms link from TOC to RTP (AIRNOW) > 99.99%.
- **Verification. Daily; for 24-hour forecast interval midnight-to-midnight by 48 hours after end of forecast interval.**
  - Compiled and maintained by NCEP/MDL and updated on a daily basis
  - Availability: model developer group.
  - Seasonal summary: available on AQ program web site (public)
  - Weekly verification reports on operational perf measures provided by NCEP/MDL to OST PM
- **Data retention.**
  - Operational forecast guidance archived for 5 yrs at NCDC. Tape format and retrieval.
  - FY04: GRIB1 files only, for products for ground-level ozone concentrations and ozone categories.



# Initial Operating System: FY 03 - FY 04

## Overview: *Development, Testing, Integration*



<b>Task</b>	<b>Lead</b>	<b>Dates</b>	<b>Status 7/04</b>
<b>Model Development</b>	<b>NOAA/NWS and NOAA/EPA/ORD</b>	<b>09/02 – 05/03</b>	<b>C</b>
<b>Model Upgrades</b>	<b>NOAA/NWS and NOAA/EPA/ORD</b>	<b>10/03 – 05/04</b>	<b>C</b>
<b>Acquire/implement IT Resources</b>	<b>NOAA/NWS</b>	<b>02/03 – 09/03</b>	<b>C</b>
<b>Model Integration</b>	<b>NOAA/NWS and NOAA/EPA/ORD</b>	<b>04/03-06/03</b>	<b>C</b>
<b>Model Testing/optimization</b>	<b>NOAA/NWS</b>	<b>06/03 – 09/04</b>	<b>G</b>
<b>Experimental production</b>		<b>06/04 – 09/04</b>	<b>G</b>
<b>Develop/implement required verification</b>	<b>NOAA/NWS and NOAA/EPA/ORD</b>	<b>10/02 – 06/04</b>	<b>C</b>
<b>Develop required product archiving</b>	<b>NOAA/NWS</b>	<b>04/03 -- 09/04</b>	<b>C</b>
<b>Final go/no go decision</b>		<b>09/04</b>	<b>G</b>

Key Complete On schedule At risk Remedial Action Required





# **Subjective Feedback: (OCCWS) *State and Local AQ forecasters***



## ***Statement of Needs (EPA AIRNOW Workshop Feb. 2004)***

### ***Short-Term:***

- **Ground-level ozone forecast guidance.**
- **Northeast U.S. domain**
- **Next day guidance available by 1:30 pm EDT; Morning update by 9:00 am**
- **Include 1-hour and 8-hour averages and daily maxima**
- **12km grid resolution**

### ***Long-Term:***

- **Additional Pollutants, especially Particulate Matter**
- **Nationwide coverage**
- **Extended at least 2 days**
- **Higher resolution grids to 2.5 km**