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

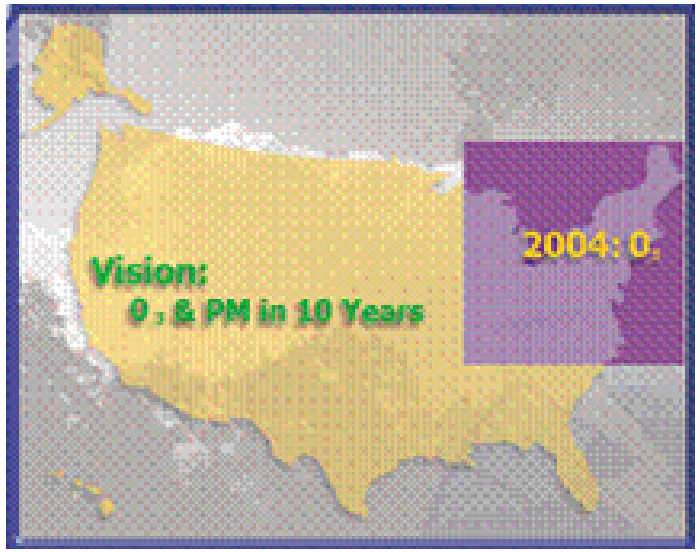
Strategy

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 ≤ 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

EPA Data Management Center

O_3 Movies/ Forecasts

NOAA National Center for Environmental Prediction

AQ Data from S/L Agencies

Weather Obs

EPA Emissions Inventory

Commercial Weather Providers

Predicted Pollutant Concentration Fields

Data "pull" - - ->

Data "push" ——>

City-specific AQI forecasts

State/Local Air Agencies

National Air Quality Forecast Capability
Initial Operational Capability (IOC)

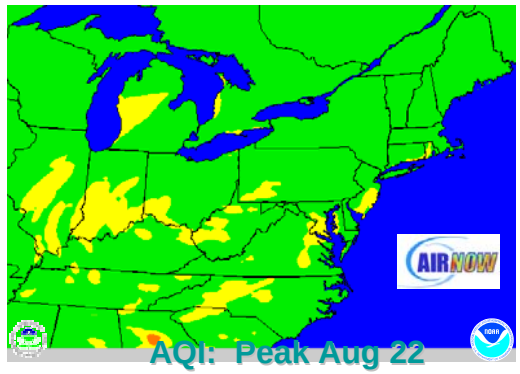
Linked numerical prediction system

Operationally integrated on NCEP's supercomputer

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

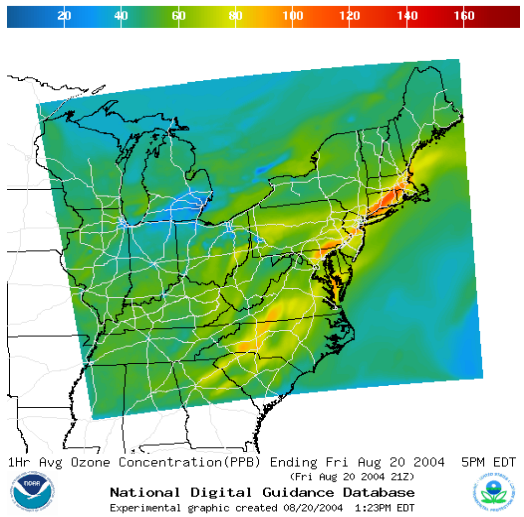
Observational Input:

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



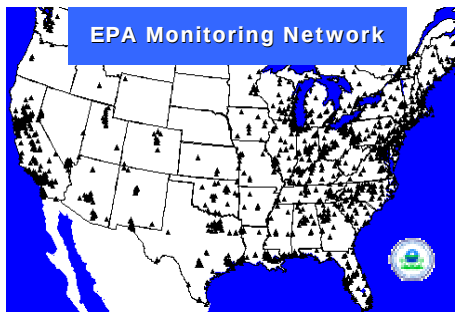
Gridded forecast guidance products

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



Verification basis

EPA ground-level ozone observations



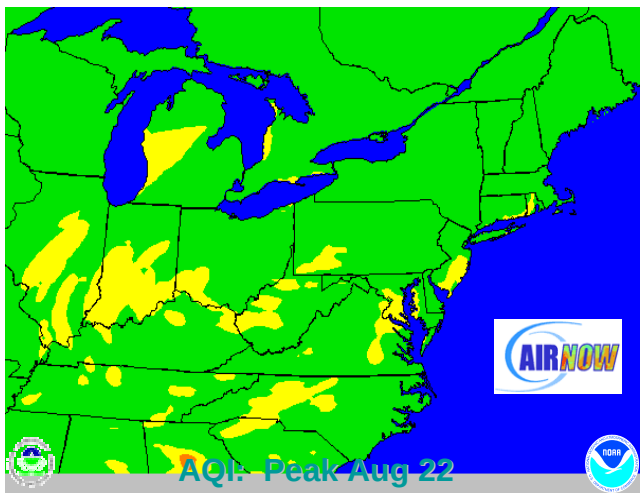
Customer outreach/feedback

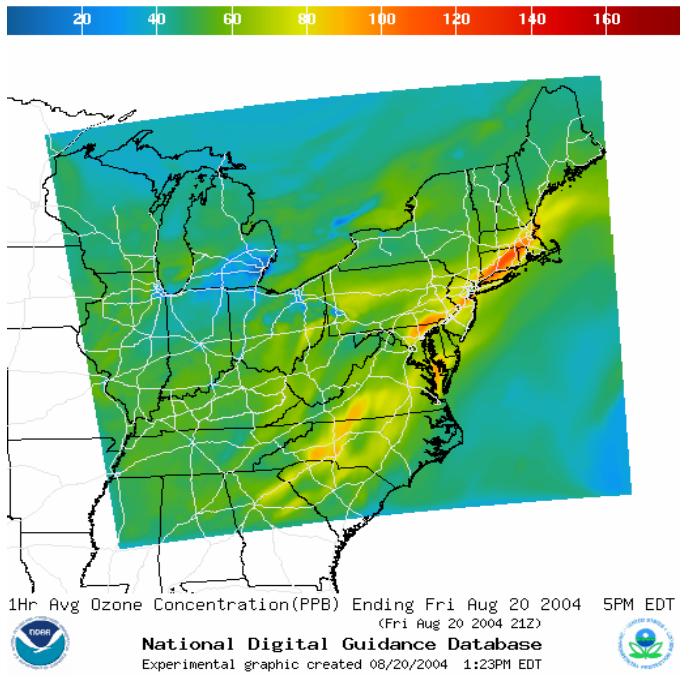
State & Local AQ forecasters coordinated with EPA

Public and Private Sector AQ constituents

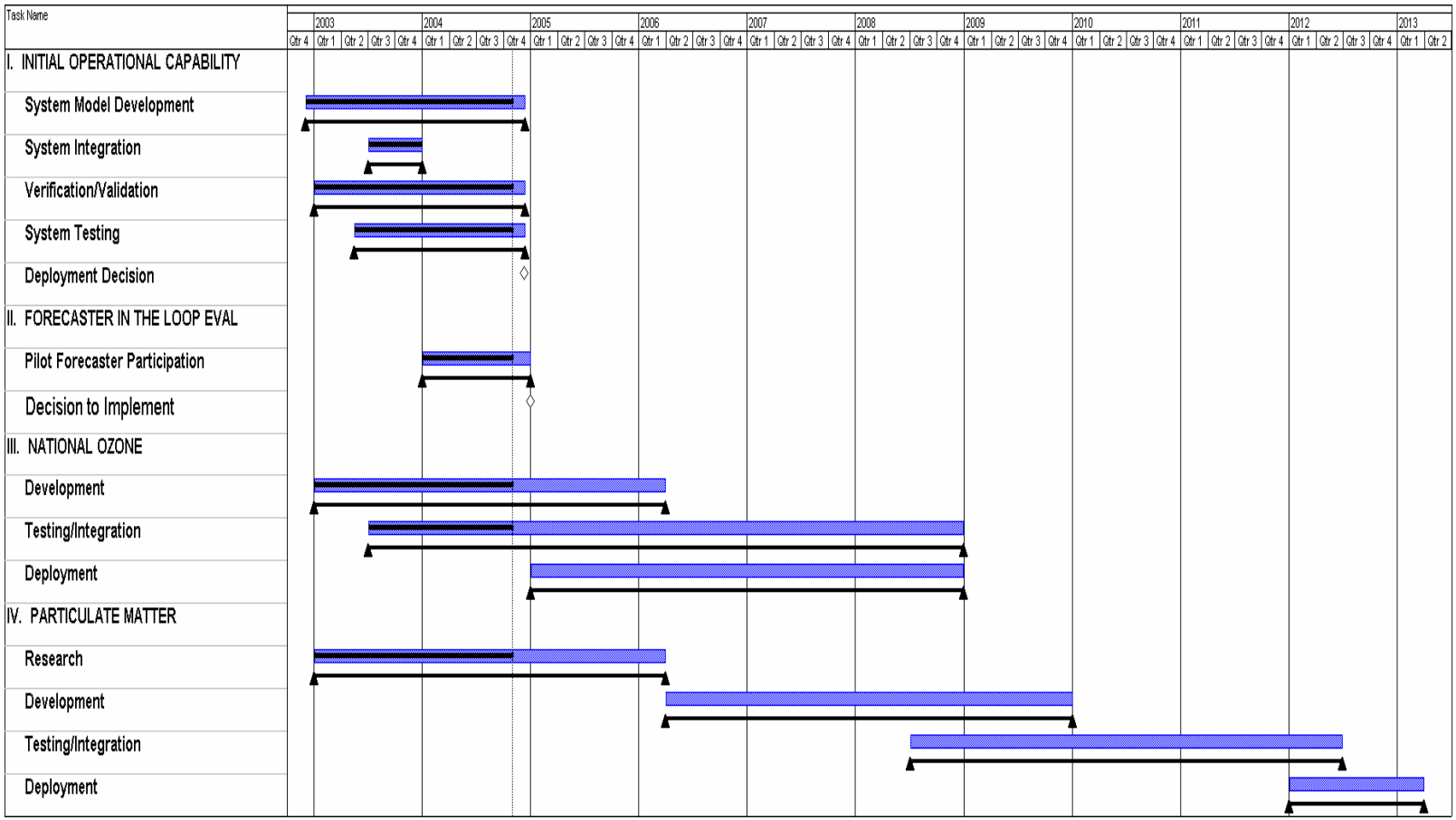
Product Description: IOC

- **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.**





Air Quality Forecast Capability
Implementation Schedule



Task Task Completion Baseline Milestone

Review of Operational Readiness

Initial Operating Capability:
Operational Readiness Criteria Summary

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

Key	*Complete*	*On schedule*	*At risk*	*Remedial Action Required*

Objective Verification (NCEP)

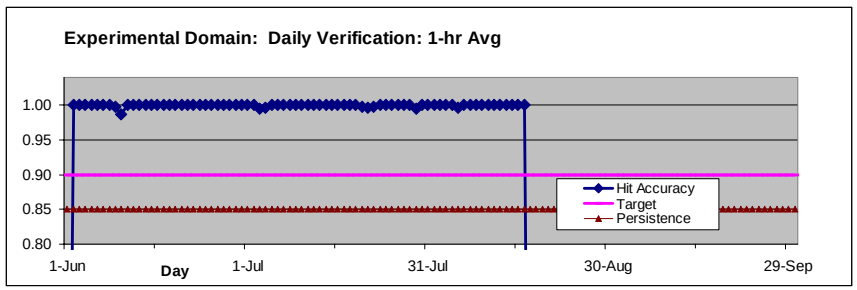
Criterion	Metric	Dates	Status
Objective Evaluation: Accuracy	Correctly predict exceedance and non-exceedance of ozone concentration threshold metrics, during the 24-h valid forecast period, on 90% or more days Threshold metrics: 1-hr avg > 124 ppb 8-hr avg > 84 ppb	6/1/04 – 8/15/04	C

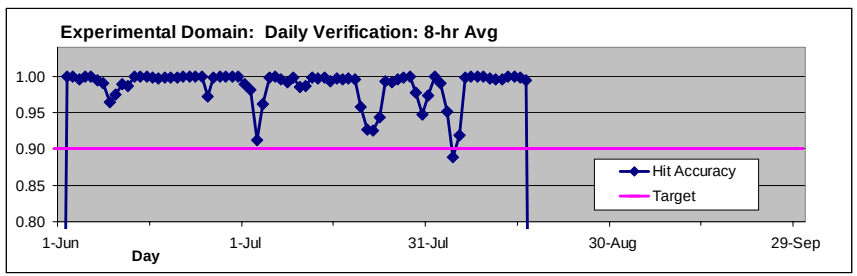
Summary Performance:

June 1- Aug 15, 2004

- Exceeds target

- Reflects clean conditions





Objective Verification: (NCEP)
Improved Performance with 2004 Model Upgrades

Test case comparison:

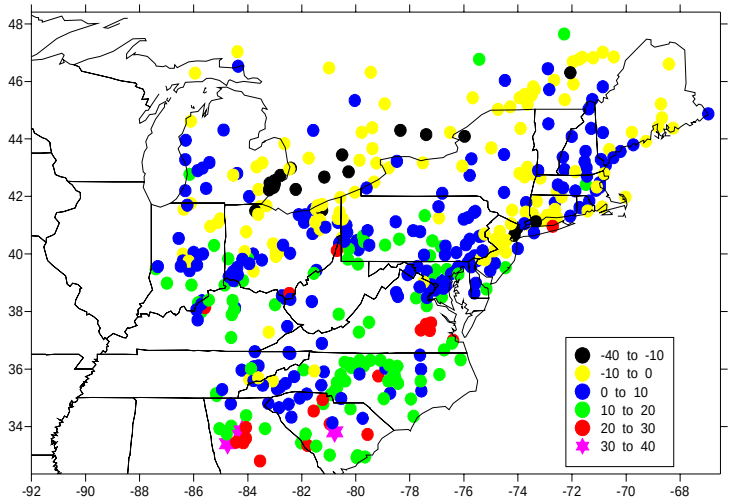
2003 August 12-19

2003 Configuration

Representative BIAS in max 1-hr values

Most stations: -40 to +30 ppb

Range: -40 to 40 ppb

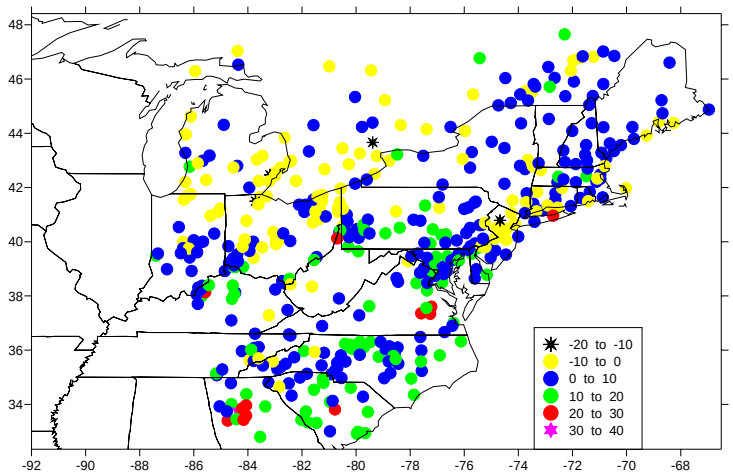


2004 Configuration

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**

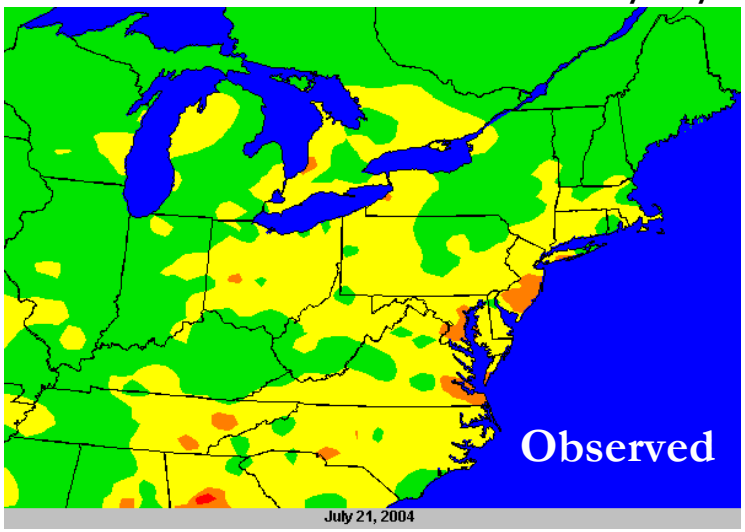
Timing and Location of high ozone episodes

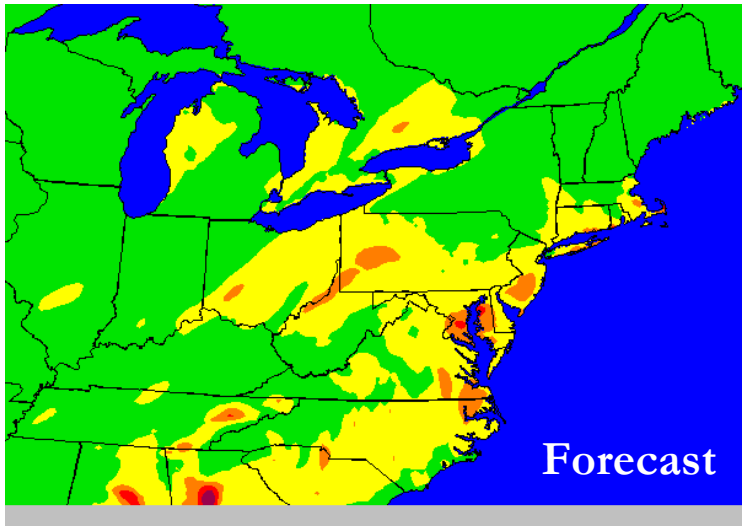
- **Generally well represented**

Objective Verification (NCEP)

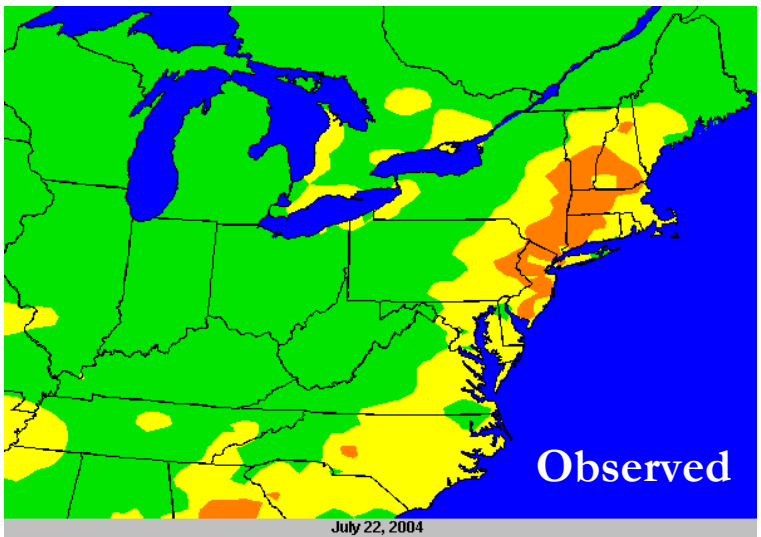
July 21, 2004 12Z CMAQ forecast

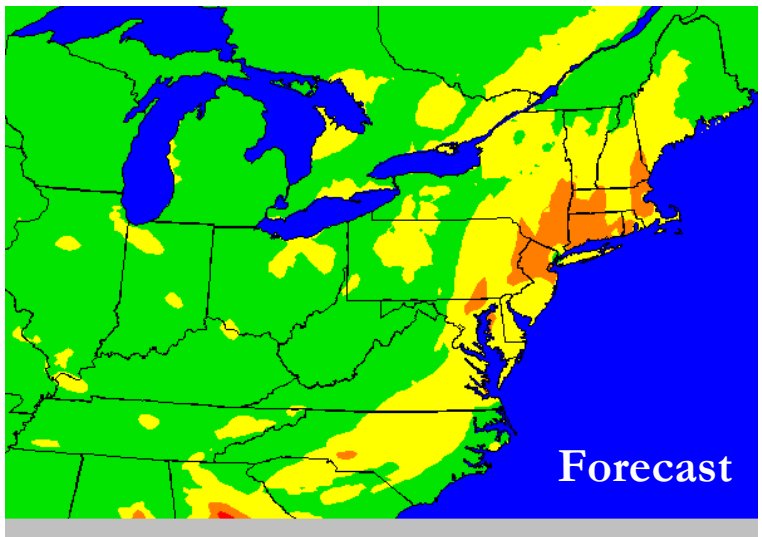
7/21/04 8 hour Peak Ozone





7/22/04 8 hour Peak Ozone





Subjective Feedback (OCWWS)

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

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

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

Production Readiness (OCIO)

On-time delivery

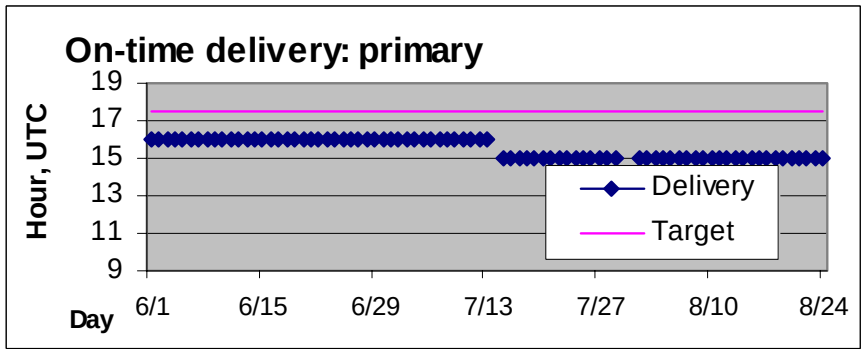
Criterion	*Metric*	*Dates*	*Status*
On-time delivery	*Forecast guidance available by 1730 UTC (primary) and by 13 UTC (updated) > 95%*	*6/1/04 – 8/15/04*	C
Guidance delivery	*Forecast guidance delivered to TOC and sent to EPA/AIRNOW by 1725Z (primary) and by 1255Z (updated) > 95%*	*6/1/04 – 8/15/04*	C
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%)*	*6/1/04*	C
EPA monitoring observations delivered on time	*Delivered by TOC to NCEP/NCO within 5 minutes of receipt from EPA/AIRNOW: target 13 UTC*	*6/1/04*	C
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%.*	*6/1/04*	C

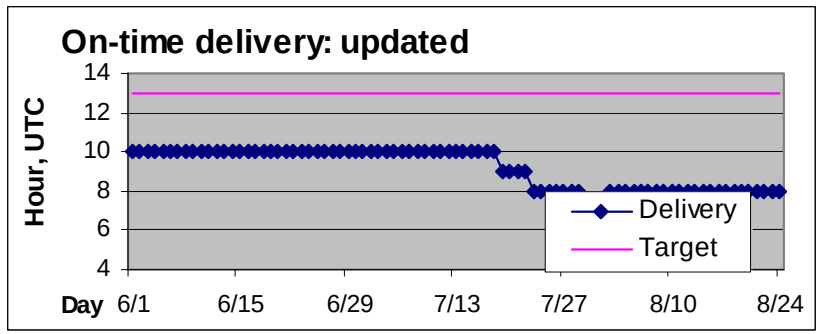
Production Readiness (OCIO)

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

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

– ***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

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

–***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)*

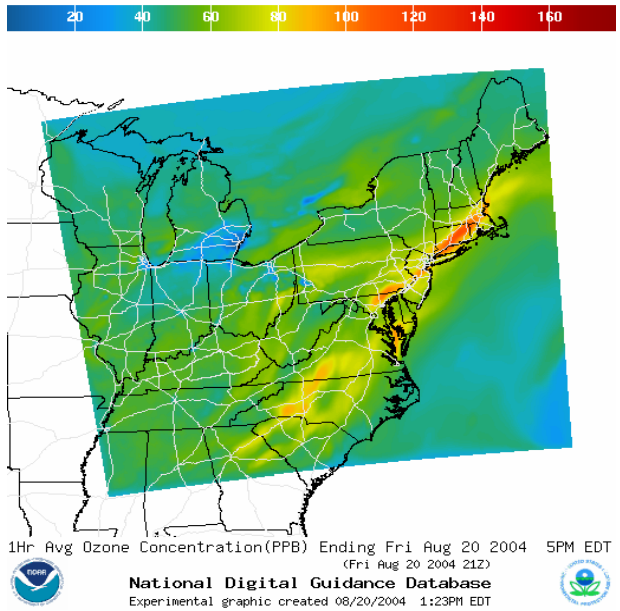
–***Weekly verification****: reports on operational performance measures provided by NCEP & MDL to OST PM*

–***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:** G
  - *Accuracy performance targets achieved*
- **Subjective feedback:** G
  - *Generally positive*
  - *Focus group forecasters providing additional feedback; additional feedback links posted on graphical display sites*
- **Production readiness:** G
  - *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

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

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

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**