NATIONAL AIR QUALITY FORECASTING CAPABILITY: FIRST STEPS TOWARD IMPLEMENTATION

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ABSTRACT

Following Congressional direction, NOAA's National Weather Service (NWS) is implementing a National Air Quality Forecast Capability. During summer 2003, NWS began integrating and testing an air quality forecast model system as a first step towards planned operational deployment over Northeastern United States in September, 2004. The prototype forecast capability links a version of the Community Mesoscale Air Quality model, developed by NOAA/EPA researchers, with the Eta mesoscale weather prediction model, running operationally at NWS' National Centers for Environmental Prediction. Program strategy involves partnering with EPA, who provides national emissions inventory data to NOAA for the forecast model, as per NOAA-EPA agreements recently signed by DOC and EPA. Under the current concept of operations, NWS will issue gridded numerical Air Quality predictions as forecast guidance. This guidance will serve as a standard tool, ultimately Nationwide, for public and private, state and local forecasters who provide tailored air quality forecasts for their communities, and EPA who provides interpretive air quality health indices/alerts.

1. Background: Motivation, Strategy, Vision

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Following Congressional direction,[1] NOAA is preparing to implement a new National Air Quality Forecast Capability. Program strategy involves partnership with EPA, as formalized in May, 2003 in interagency agreements[2]: the new capability will combine the nation's weather forecasting with EPA's information on atmospheric pollution to provide daily, hour-by-hour forecasts of air quality. Our vision is to provide forecasts that are accurate and timely enough for people to take action to limit harmful effects of air pollution.[3] NOAA and EPA will work with other federal, state and local partners both in public and private sectors, to provide the most effective air quality forecast information to the public.

2. Overview of Planned Capabilities:

Forecast System, Products: Elements, Schedule, Performance Measures

The air quality forecast capability under development is an integrated system linking the National Weather Service (NWS) numerical weather prediction (NWP) system to the NOAA-EPA developed Community Mesoscale Air Quality (CMAQ) model (Figure 1) to provide next-day forecast guidance, at hourly intervals, at the resolution of the Eta model (currently 12 km grid resolution). The initial system uses as inputs dynamically assimilated weather observations along with air chemistry data from EPA's national emissions inventory, provided in time and space-

[1] Energy Policy Act of 2002; HR 4, SEC 1383.
[2] NOAA-EPA Memorandum of Understanding on
[3] More than 40,000 deaths annually are attributed to poor air quality [Kaiser et al; Science, 2000; Science, 2002] Estimated costs of treating illness caused by poor air quality are $150 billion/yr [ALA;]

averaged format compatible with the AQ forecast system. More background and description of the model system under development is presented by Otte et al.[4] Initially the guidance will provide predicted ground-level ozone, for a domain covering the Northeastern United States (shown in Figure 1). Guidance will be issued twice each day: primary forecasts will be produced prior to 1:30 p.m. EDT, with updates the following morning available before 9 a.m.[5] Scheduled deployment is in September, 2004. Contingent on successful testing and sufficient resources, the domain will be extended nationwide by 2009.

Table 1 summarizes initial operating capability (IOC) guidance products and performance thresholds.

Threshold guidance accuracy is set to exceed the accuracy of persistence forecasts. Based on data from 1996-2002 for cities in the mid-Atlantic region (Ryan, personal communication, 2002), the accuracy of persistence forecasts for predicting a daily exceedance (for purposes of comparison, taken as 1-hour average values greater than 125 ppb O_3 over the course of a day) has been approximately 85 per cent. The threshold accuracy goal for the new NAQF guidance of 90 per cent will provide an improvement over persistence forecasts for the many communities that currently lack other AQ forecast information, as well as for the first time provide routine predictions of the onset (and conclusion) of episodes of poor AQ. Accurate forecast guidance will also improve the basis for state and local forecasters and AQ managers who provide health-based AQ alerts and initiate community action plans such as reducing mass-transit fares on days forecast to have poor AQ. The forecast guidance is needed by early afternoon of the preceding day to be used in community decision-making, requiring timeliness and accuracy measures to be simultaneously achieved.

3. Status

Over the past year, as described below, NOAA/EPA/ORD's CMAQ model has been adapted to run as a forecast model, driven by meteorological fields produce by NCEP's Eta-12 forecast model. As of September, 2003, the CMAQ has been integrated for twice-daily testing on NCEP's operational Central Computing System. Additional processors have been integrated into NCEP's CCS to provide the needed resources to assure completion of operational model runs within the available 2-hour window. Communications and product dissemination infrastructure have been implemented. In parallel, daily AQ forecast model runs are being made to assess model performance and utility during the ozone season. Ozone monitoring data compiled and quality checked by EPA's AIRNOW program are being used to evaluate predictions of surface ozone concentration.

A group of model developers and forecasters are evaluating the test results, so that improvements based on this feedback can be implemented into experimental production in the summer of 2004. A focus group of some twenty state and local forecasters evaluated test output subjectively as daily guidance for forecasting, and reported their evaluations in a standard format to NOAA for use by NOAA and EPA in improving test-model performance. NOAA/EPA/ORD researchers, working with developers at NWS' Meteorological Development Laboratory compared test-forecast ozone concentrations, for both 1-hr and 8-hr averages to monitoring data provided by EPA's AIRNOW program. Over 710 observing stations were used in verification analyses, conducted from July through September 2003. Diagnostic evaluations of predicted concentrations and categorical evaluations of predicted threshold exceedances have been performed. Exceedance thresholds for ozone concentrations are as follows: greater than 124 ppb for 1-hour averaged concentrations and greater than 84 ppb for 8-hour averages. From these analyses, model accuracy statistics and bias have been compiled. In general, model forecasts were consistently high in comparison to the observations, but correlate well with trends in the observations. For the summer 2003 period, the overwhelming number of forecasts and observations did not exceed threshold values.

Experimental products during real-time testing and evaluation, scheduled for June through September, 2004, will be subject to thorough analysis and assessment to provide the basis for a final "go/no go" deployment decision in September, 2004.

[4] Otte et al; in prep

[5] The NAQFC will issue updated guidance each morning. Although relatively few communities issue morning updates to AQ forecasts, it is anticipated that this product may be more widely used by people who are especially sensitive to poor AQ, including respiratory and cardiac patients.

4. Next Steps

Following deployment of the initial operational capability, the domain will be expanded in stages to cover the Nation. This requires testing of an expanded domain in parallel with issuing forecast guidance for the operational domain. The staged expansion is also the framework for implementing model improvements. Planned upgrades, in addition to incremental improvements to optimize model accuracy and performance, include extending the capability to airborne particulate matter forecast guidance (initial deployment in 2009), transitioning the capability from Eta to the WRF system (2007), with on-line AQ modeling implemented by 2009. Forecast intervals will be extended to a second-day and beyond, when the AQ model system achieves sufficient forecast accuracy (exceeding persistence) within the constraints of computing resources and available run-time. Finally, additional pollutants will be added to the forecasts. The timing for these upgrades is contingent on successful pilot demonstrations and on funding availability.

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Table 1. National AQ Forecast Capability Initial Operating Capability in 9/04

Purpose	Provide reliable, consistent AQ forecast guidance in time for people (State and Local air quality managers, public and private sectors) to take action to limit adverse effects
Coverage	Entire Northeastern US in operational in 9/04: initial domain covers westward to Wisconsin and southward to Georgia. Nationwide coverage by FY 09.
Ozone forecasts:	
Spatial Resolution	12 km
Temporal Resolution	Hourly
Availability	Forecast guidance available by 1:30 pm (EDT) for next day
Morning updates	AQ forecast guidance available by 9 am (EDT)
Threshold Performance:	
Accuracy	Daily exceedances vs non-exceedances predicted correctly: 90%
Availability	On-time delivery of guidance: 95%

Figure 1. Model System for Initial Operating Capability

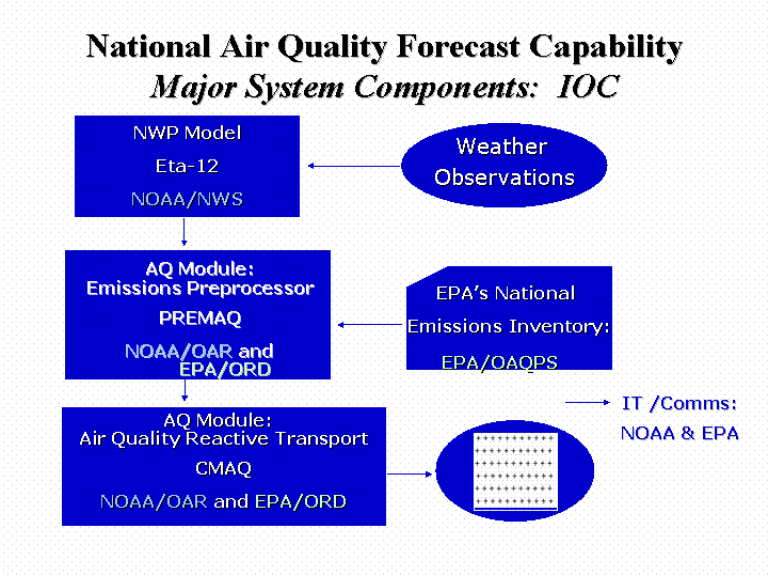

Figure 2. IOC Domain