

Air Quality Forecast Model Evaluation Study during ICARTT/NEAQS-2004

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Goals of AQFM evaluation study:

- I. Identify biases and uncertainties in the photochemical, meteorological and aerosol variables with the various AQ forecast models (AQFMs), thus providing direction toward better AQ forecasts by each forecast center.
- II. Quantitatively characterize the current ability of state-of-the-art AQFMs to predict air-quality and the meteorological conditions contributing to episodes of high O₃ and particulates.
- III. Use comparisons of the AQ forecast models with observations to assess our collective understanding of 4 main research areas (see e.g. <http://www.al.noaa.gov/2004/NOAASciencePlan.pdf>): emissions verification, transport and mixing, chemical transformation, aerosol properties and their radiative effects.
- IV. Provide an accessible archive of observations and forecast results as a reference standard for AQFM model development and improvement in the near future.

Participants within the AQFM evaluation study:

Table I provides the names, a few model details, a contact person and web-site for several model groups that have agreed to participate within the study. Three of the modeling groups will use the same 12 km resolution domain; the CMAQ/ETA operational domain shown in Figure 1 below. The Meteorological Service of Canada model group will have air quality forecasts for two domains, the CHRONOS 21 km resolution model and the AURAMS 42 km model shown in Figure 2 below. All modeling groups have agreed on the importance of using a common emissions data-set. Each modeling group has their own web site that displays their forecast model products, and these will be linked within a ICARTT/NEAQS-2K4 web site administered by NOAA's Aeronomy Lab. Additionally, these participants have agreed to provide data for an independent model evaluation study, or in the case of the University of Iowa, provide their own forecast/observation analysis.

Table 1. Summary Table of Eulerian RAQFMs planned to be included within the model intercomparison study during the NEAQS-2K4 field campaign.

Model Group : Acronym	Horizontal Resolution	Spatial Domain	Constituents : Mechanism	Meteorological Driver	Forecast start/duration
NOAA/NCEP : CMAQ-ETA	12 km	CMAQ-ETA domain	O ₃ chem : CB-IV	ETA offline (hourly)	06Z / 48hr 12Z / 48hr
NOAA/FSL : WRF-CHEM	12 km	CMAQ-ETA domain	O ₃ chem : RADM-2 Aerosols: MADE/SORGAM	WRF online	00Z / 48hr 12Z / 36hr
Met. Service of Canada: CHRONOS	21 km	North America (25°-60° lat)	O ₃ chem : ADOM-2	Met. Serv. of Canada GEM offline (hourly)	00Z / 48 hr
Met. Service of Canada : AURAMS	42 km	Eastern North America (30°-55° N, 65°-100° W)	O ₃ chem : ADOM-2 Aerosols : Sectional-12	Met. Serv. of Canada GEM offline (15min)	00Z / 48 hr
U. of Iowa : STEM-2K3	60,12 km	Entire U.S. (60km res.) Northeast U.S (12 km)	O ₃ chem : SAPRC99 Aerosols : SCAPE II	RAMS offline (3 hrs.)	00Z / 96 hr
Baron AMS – MAQSIP-RT	45,15, 5 km (1-way nests)	NEAQS-2002 domains	O ₃ chem : CB-IV	MM5 offline (half hourly)	00Z / 48hr 12Z / 36hr

Contact Information/Useful Links:

NOAA/NCEP : CMAQ-ETA : Jeff McQueen
jeff.mcqueen@noaa.gov, 301-763-8000 x7226
<http://wwwt.emc.ncep.noaa.gov/mmb/aq/>
 or Ken Schere
Schere.Kenneth@epamail.epa.gov, 919-541-3795
http://www.epa.gov/asmdnerl/aqf_over_us.html

NOAA/FSL : WRF-CHEM : Georg Grell
georg.a.grell@noaa.gov, 303-497-6924
<http://www-frd.fsl.noaa.gov/aq/wrf/>

Meteorological Services of Canada : Wanmin Gong
wanmin.gong@ec.gc.ca, 1-416-739-4883
http://www.msc-smc.ec.gc.ca/aq_smog/chronos_e.cfm

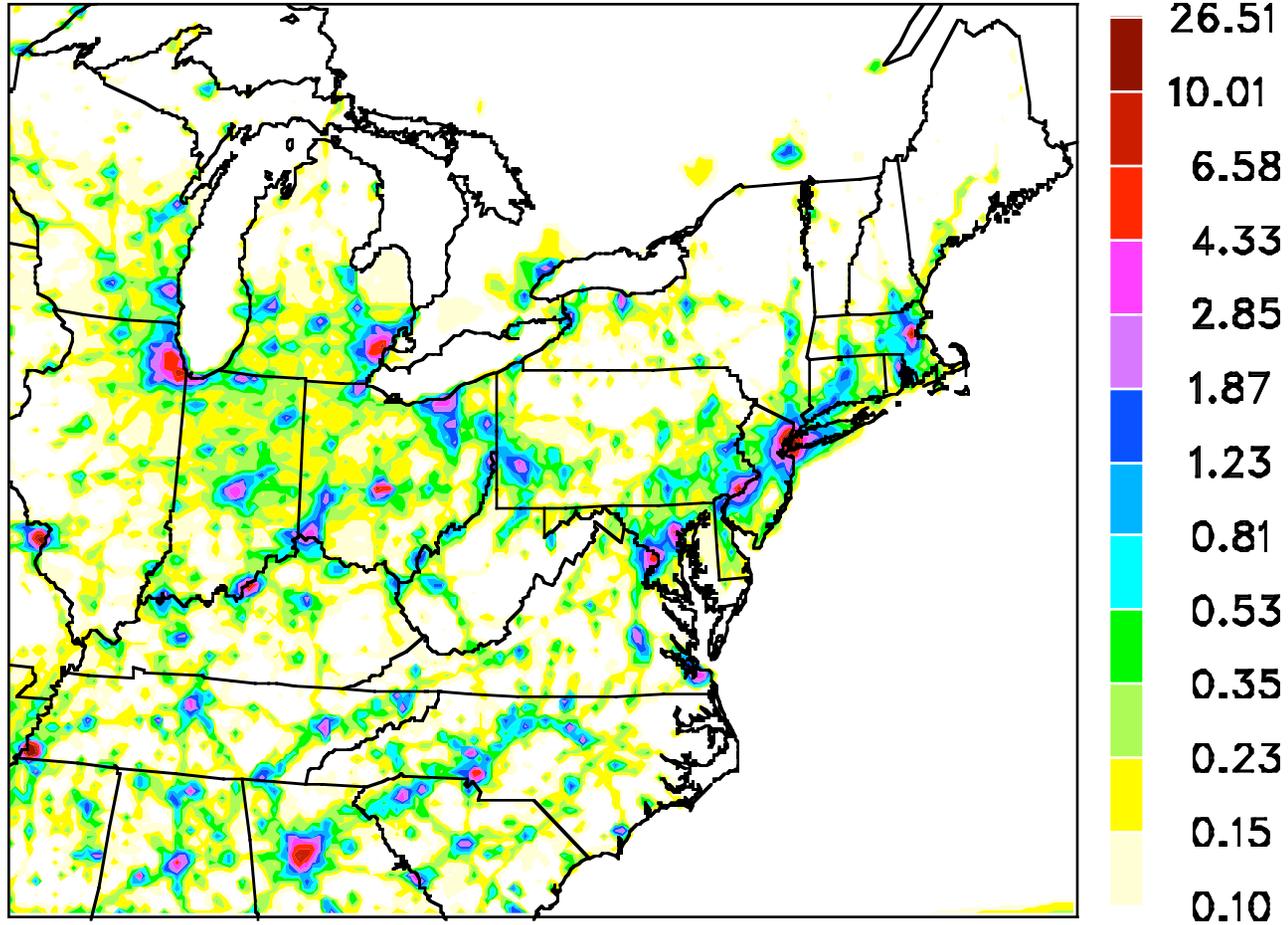
University of Iowa : STEM-2K3 : Youhua Tang
ytang@cgrer.uiowa.edu, 319-335-0264
<http://atmos.cgrer.uiowa.edu/people/ytang>

Baron AMS – MAQSIP-RT : John McHenry
john.mchenry@baronams.com, 919-248-9237
<http://www.baronams.com/products/maqsip>

Initial CMAQ-ETA Grid for 2004

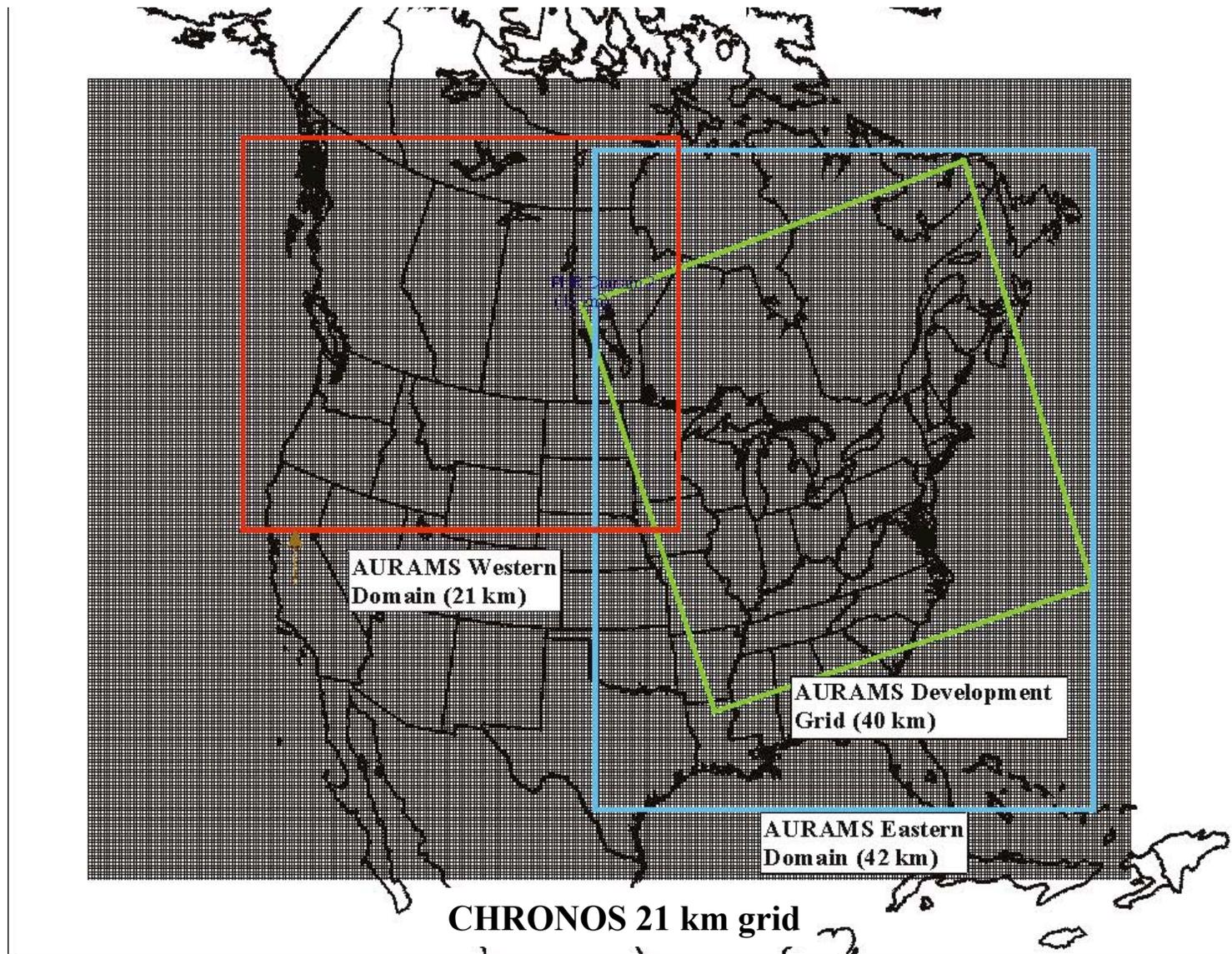
08/06/02 1300GMT NO

(ppbv)



12 km horizontal resolution

Eastern and Western AURAMS Domains



Evaluation study protocol:

A limited set of air-quality and meteorological variables from the AQFM evaluation study participants will be archived at a central location. The Theoretical Group of NOAA's Aeronomy Lab has offered to secure and provide the facilities to do this. This same group will also be archiving the photochemical, meteorological, and aerosol observations collected at several surface monitoring sites, the NOAA RV Ron Brown, and several aircraft operational during the field study, as well as surface O₃ from the EPA AIRNOW network in the U.S. These observations will be available to all AQFM evaluation participants, as well as all participants of the ICARTT/NEAQS-2K4 study. Participants are encouraged to use the observations in their own analysis and model comparisons, but the Theoretical Group of the Aeronomy Lab offers the service of providing password-protected real-time analysis, and limited statistical analysis of AQFM model/observation comparisons.

Based on a similar evaluation study of the NEAQS-2K2 experiment, involving only two modeling groups, but 6 different models, the following data protocol is proposed:

Two data sets are submitted to the archive from each forecast: the first is an hourly time-series of 3-dimensional meteorological and photochemical/aerosol fields, limited to a manageable set of variables, and over a cut-down domain that includes only the region of the Northeast U.S. and Southeast Canada where detailed photochemical and vertical information from the field campaign are available. The second data-set is an hourly time-series of select 2-dimensional surface meteorological and photochemical/aerosol fields that cover the entire model domain.

The following lists give the variables submitted by the AQFMs for NEAQS-2K2:

3-D matrices over cut-down domains:

<u>Photochemical</u>	<u>Meteorological</u>
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O ₃ , CO, NO _x , NO _y	T, p, Q _v , Q _c ,
SO ₂ , isoprene	u,v,w, height

2-D matrices over entire model domains:

<u>Photochemical</u>	<u>Meteorological</u>
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O ₃ , NO, NO ₂	T, Q _v (@ 2 meter), p (surface)
	u,v (@ 10meters)
	accumulated precipitation
	PBL height
	Surface Skin Temperature

In addition to the above variables, the following lists give additional 3-D variables that could be used in analysis of observations that will be available from ICARTT/NEAQS-2K4, or 2-D variables that were used in meteorological evaluations by ETL/NOAA:

3-D matrices over cut-down domains:

PM_{2.5} aerosol mass and speciated PM_{2.5} (elemental and organic carbon, sulfate...etc.)

PM10 aerosol mass
HNO₃, PAN, PPN
NO₃, and N₂O₅ (night-time chemistry)
Speciated VOC (lumped VOC species acceptable, if comparisons to observed VOC unambiguous)
CH₂O, and CH₃CHO

2-D matrices over entire model domains:
PM2.5 aerosol mass
Aerosol optical depth
Accumulated deposition of NO_y and O₃
Column integrated cloud amount
Column integrated rain amount
Short wave and long wave surface radiation fluxes
Surface latent and sensible heat fluxes

The data collected from the various AQFMs will be used for two different projects. The first project involves a real-time analysis of forecast results with observations from various surface-based platforms. These include data from the UNH AIRMAP network, Harvard Forest, the RV Ron Brown, and the EPA AIRNOW O₃ network. Observations and model results were displayed as daily time series, with each AQFM having its own password-protected web page during the NEAQS-2K2 experiment. This will probably be the display format used in the ICARTT/NEAQS-2K4 experiment. The EPA AIRNOW O₃ comparisons would be included as daily comparisons of maximum 1-hr O₃ and/or daily maximum 8-hr average O₃. However the AIRNOW comparisons will be delayed one or two days because of data availability. The EPA/NERL-NOAA/ARL group at Research Triangle Park has agreed to oversee the AIRNOW comparisons, and help make the results available to the ICARTT/NEAQS-2004 participants.

The second project is a more long-term, post-experiment statistical analysis of the various AQFMs. Because all of the forecasts are centrally located, a preliminary analysis (based on the preliminary observations collected during the experiment) would be available 2 to 3 months after the end of the campaign. A more rigorous, and final statistical analysis would be done when final, QA/QC'd data-sets from the various platforms become available (early to late spring of 2005). Although much of the statistical analysis will be bias and correlation statistics for O₃, O₃ precursors, and aerosol, additional correlation analysis (e.g. NO_y versus CO, O₃ versus NO_y minus NO_x) will be useful in addressing research issues such as emissions verification, and photochemical mechanisms. In contrast to NEAQS-2K2, a more focused effort at coordinating the meteorological and photochemical/aerosol evaluations is planned.

Issues remaining before the evaluation project begins:

Finalize protocol for AQFM evaluation study

- a. List of data that will be submitted by each AQFM to the central receiving site
- b. Lateral boundaries of 3-dimensional cut-down data files
- c. Additional surface sites (Pinnacles, Whiteface Mountain, Chebogue Point?)

The real-time display of AQFM results with observations

- a. Can and should aircraft data be included in real-time comparisons?
- b. Which variables to display of AQFM results on web-site
- c. Feasibility and choice of statistical measures to compare in real-time.

Emissions data-sets

- a. NOAA Aeronomy Lab has developed an interim emissions inventory, available since March 25, 2004 for North America
- b. A final version of the Aeronomy Lab inventory, as consistent as possible with the inventory used by CMAQ/ETA, should be available before June of 2004.
- c. Biogenic VOC and NO_x emissions over the same grid are currently being developed with help from NCAR/ACD (Alex Guenther, Christine Wiedinmyer), available the end of April, 2004.
- d. Pre-experiment comparison of emissions used by each AQFM group.

Suggested additional AQ forecast products useful to the field program:

- a. Forecast aerosol optical depth
- b. Forecast cloudiness
- c. Forecast trajectories from major metropolitan areas
- d. Height versus distance cross sections of CO. Distance could be parallel to the mean flow at a given level (e.g. 1000 meter ASL) through Boston.
- e. Depending on available of additional funding, an ensemble forecast, based on the 2-D O₃ fields submitted by each group, will be used to generate an independent O₃ forecast in real-time.
- f. Forecasts of select pollutants (CO, NO_y, O₃, PAN) extending to high altitude (~13 km) for use in flight planning by the NASA DC-8 team.

Upcoming Events:

- 1) Final ICARTT/NEAQS-2K4 field study planning meeting, April 27 to April 29, 2004, Rosen Center, Orlando, Florida. A breakout meeting for the modeling groups is planned for either the 27th or 28th, and a summary of this break-out meeting will be presented to the entire group.
- 2) A dry run of data transfers and web displays is planned for mid May 2004. Fake data-sets from the various aircraft and ship platforms will be generated and posted on designated computer addresses so that down-stream data users can test data transfer scripts, data formats, and other aspects related to the real-time analysis of this summer's campaign.
- 3) Field campaign and AQFM forecast data collection begins: July 1, 2004