NOAA ARL Monthly Activity Report

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Contents

Highlights.

1. Dispersion Study Planned for the Pentagon. A study of dispersion affecting the Pentagon is planned for April/May 2004. Funding for the activity comes from the Department of Defense. A major goal is to evaluate the role of remote probing systems in the context of dispersion forecasting. Several LIDAR systems are to be tested. ARL's Field Research Division (Idaho Falls) will be providing the tracer release, detection and analysis components of the program. ARL's Atmospheric Sciences Modeling Division (Research Triangle Park) is contributing a wind tunnel modeling component. The Atmospheric Turbulence and Diffusion Division is working on accelerating the erection of two DCNet towers on the roof of the Pentagon, so that the new DCNet-HYSPLIT systems can be tested against the tracer data. ARL has arranged the assistance of Argonne National Laboratory, to facilitate the deployment of samplers inside the Pentagon Metro station. Other samplers will be installed inside the Pentagon itself, so as to address the issue of infusion into the building. Three test days are planned, using both a mobile and a stationary release source. Other collaborators include the National Center for Atmospheric Research (NCAR), the University of Colorado (CU), and Coherent Technologies, Inc. (Kirk Clawson, Steve Perry, Will Pendergrass, Bruce Hicks)

2. Bay Regional Air Chemistry Experiment – Nitrate on Large Particles. At the Bay Regional Air Chemistry Experiment (BRACE) data workshop in Tampa Bay, Florida, measurements from the May 2002 BRACE intensive were discussed. One important interpretation of the size-differentiated surface aerosol nitrate data is that nearly all of the particulate nitrate is associated with the coarse fraction and that the mass that is observed in the fine mode is associated with the tail of the coarse mode. The NOAA Twin Otter aircraft data corroborate the general pattern that a majority of the nitrate mass is in the coarse mode. Several interesting photochemical analyses based on the Twin Otter data were presented by the NOAA aircraft campaign team lead. Some data stories are starting to come together that will really challenge MM5, the emissions algorithms, and Community Multiscale Air Quality (CMAQ) Aerosol Inorganic Model (AIM). The upcoming BRACE evaluation using CMAQ-AIM should be a very interesting exercise. The participants also set goals and deadlines for completion of research papers. The articles will be submitted to a journal as a special BRACE issue. Candidate journals include the Journal of Geophysical Research and Atmospheric Environment. (Robin Dennis, Tom Watson, Noreen Poor)

Silver Spring

3. Prototype HYSPLIT Training Website for NWS Weather Forecast Offices. A new website on READY has been designed to be a "one-stop" HYSPLIT portal for NWS forecast offices. The local forecast offices are tasked to provide local emergency responders with an operational HYSPLIT forecast from NOAA NWS/NCEP in the event of an emergency. The website was designed to help the forecasters become familiar with HYSPLIT without having to request a run from NCEP. The forecaster can login to the site and find documentation, training materials, relevant links, and also to be able to run the model. Running the model will make the forecaster aware of what options are available and to know what the limitations of the model results are before they are needed in an emergency. A prototype website is currently being tested by several forecast offices (https://www.arl.noaa.gov/ready/hysplitnws/). Once this testing is complete, all of the WFOs will be given access to the password-protected site. glenn.rolph@noaa.gov

4. Trajectory Cluster Application. ARL is collaborating with the Harvard School of Public Health (HSPH) by running the trajectory cluster program to analyze associations between air pollution and alterations in cardiac autonomic function. It is anticipated that the results will be presented at a meeting of the International Society for Environmental Epidemiology. barbara.stunder@noaa.gov

Oak Ridge

5. Mercury in the Arctic. The Barrow Arctic Mercury Study's International Spring 2004 campaign is now being planned, under the leadership of Steve Brooks. The study involves researchers from Norway, Canada, Denmark, France, Australia, and several institutes in the United States. The U.S. organizations include the University of Alaska at Fairbanks, the Army Cold Regions Environmental and Engineering Laboratory, Oak Ridge National Laboratory, the University of Colorado, and New Mexico State University. brooks@atdd.noaa.gov

6. U.S. Climate Reference Network. New USCRN sites were installed at Lower Rio Grande, Texas; Muleshoe, Texas; Goodwell, Oklahoma; and Cape Charles, North Carolina. hall@atdd.noaa.gov, French, Brewer, Randolph, Bryant, Rutherford, and Boice

Research Triangle Park

7. Air Quality Forecasting. The New England Forecasting Pilot Program of 2002 served as a "test bed" for chemical forecasting. The pilot program enlisted three regional-scale air quality models, serving as prototypes, to forecast O_3 concentrations across the northeastern United States during the summer of 2002. A suite of statistical metrics was identified as part of the protocol that facilitated evaluation of both *discrete forecasts*

(observed versus modeled concentrations) and *categorical forecasts* (observed versus modeled exceedances/non-exceedances) for both the maximum 1-hr (125 ppb) and 8-hr (85 ppb) forecasts produced by each of the models. Implementation of the evaluation protocol took place during a 25-day period (5-29 August, 2002), utilizing hourly O_3 concentration data obtained from over 450 monitors from EPA's Air Quality System network.

Results revealed that no single evaluative measure is sufficient, but rather a suite of measures is required, and that these measures need to be examined spatially, temporally, and over varying concentration ranges, in order to characterize a model's performance. For *discrete type evaluations*, mean and normalized measures of bias and error were chosen. These revealed that: 1) each model (with one exception) overpredicted O_3 concentrations (the mean bias ranged from +1.41 to +9.51 ppb for max. 1-hr; and from -1.16 to +8.31 ppb for max. 8-hr.); and 2) the errors produced by the models were substantial (RMSEs ranged from 14.63 to 21.25 ppb for max. 1-hr; and from 13.04 to 18.18 ppb for max. 8-hr.). Metrics associated with the *categorical type evaluation* revealed that each model was able to achieve an accuracy (A) level of > 90% for the maximum 1-hr O_3 forecast, which was the established goal of the New England Pilot Program. This metric is, however, disproportionately influenced by the very large number of correctly forecast non exceedances. To circumvent this influence, two more stringent measures of categorical performance, the Critical Success Index (CSI) and the Probability Of Detection (POD), were also calculated. These revealed that only a small percentage (between 6 and 36% depending on model and metric) of exceedances can be expected to be forecasted correctly. Of equal concern was the large False Alarm Rate (FAR) associated with each of the three models, which ranged from 64 to 87%.

This evaluation has allowed establishment of a "performance benchmark", from which realistic expectations can now be derived concerning the potential level of performance of air quality forecasting models. Although the results of the three prototype models have shown promise, they also have shown that much work lies ahead as NOAA develops a National Air Quality Forecasting System. (Brian Eder, 919 541 3994)

8. Air Quality Forecast Training in Canada. Dr. Jonathan Pleim was invited to participate in an air quality forecast training workshop in Halifax, Nova Scotia. He gave a 2-hour presentation on the NOAA/EPA Air Quality Model Forecast System. The purpose of the workshop, sponsored by Environment Canada, was to train weather forecasters from local forecast offices across Canada in air quality (AQ) forecasting. In Canada, AQ forecasts are issued from the Meteorological Service of Canada (MSC) offices; therefore, there is a need for operational forecast meteorologists to be trained in AQ forecasting. There were also about five meteorologists from U.S. National Weather Service (NWS) offices. Although United States forecasters will not have the responsibility of issuing AQ forecasts from NWS offices, they felt that this training would help them in answering questions from the public concerning AQ forecasts that are issued to the public by state and local agencies. (Jonathan Pleim, 919 541 1336)

9. Community Multiscale Air Quality (CMAQ) Model. Collaborative work is continuing with the Department of Energy's Sandia National Laboratory (SNL), Albuquerque, New Mexico, to optimize CMAQ and to develop other enhancements. Significant improvements are already seen, relative to the current public release version. The computational efficiency has improved, mainly due to the numerical optimizations made in the aerosol module. SNL is working to improve the interprocessor communication efficiency and to develop a higher performing advection algorithm. They are also investigating methods to speed up the vertical diffusion code, which consumes a significant part of the total CPU time.

The CMAQ code has been ported to an IBM 1600 E-server with 16 8-cpu p655 nodes based on IBM's Power4+ chips and a fast interconnect switch. CMAQ runs successfully and has been benchmarked for various domain decompositions up to 96 processors. The air quality forecast version of CMAQ (AQF-CMAQ) has also been ported to the new platform and successfully benchmarked. Both codes show significant speedups over the current IBM/SP2 platform. It is anticipated that the new E-server will be the workhorse for CMAQ applications for the next few years. (Jeffrey O. Young, 919 541 3929)

10. CMAQ Air Toxics Modeling. The Community Multiscale Air Quality (CMAQ) model was used to support the National Air Toxics Assessment. The CMAQ results describe the transport and fate of several toxic compounds over the continental United States during 2001. The simulated hourly concentrations were interpolated to the United States census tracts and reformatted to support a risk assessment model. The end products were given to EPA's Office of Air Quality Planning and Standards. (William T. Hutzell, 919 541 3425)

11. CMAQ Aerosol Module Development. Exploratory research was conducted to assess the extent to which model results of aerosol composition and concentration would be modified if the modeled aerosol is subjected to the same sampling and analysis procedures that are applied to atmospheric particles. Initial results indicate that a 2-degree temperature difference between the monitoring site and the grid cell average can affect fine particle predictions by 25 percent. An explicit representation of the sampling inlet can reduce fine particle predictions by 25 percent. Accounting for aerosol-phase water that remains on the filter during the laboratory analysis may increase fine particle predictions by 10 percent. These preliminary results indicate that it may be important to post process model results in a way that accounts for ambient sampling and laboratory analysis effects when evaluating model predictions against aerosol measurements. (Prakash Bhave, 919 541 2194)

12. Human Dose Studies. Modeling software has been developed to merge population statistics with air quality to allow estimation of health consequences. The software can account for stochastic uncertainties in parameters, and thus provides a means to assess the uncertainly of results obtained. The software is being extended to allow it to account for within-grid concentration variations. This would allow using it to investigate the consequences of "within-grid" variability on health benefit results of air pollution reduction, and thereby provide a means to investigate the impact and importance of such variability on population exposure assessments. Such investigations could provide ideas on how such variability should be characterized, and when such variability is important, all of which allows tailoring of the "neighborhood-scale" CMAQ enhancements to a pragmatic and useful end. (John S. Irwin, 919 541 5381)

13. Steering Group Meeting for the Arctic Council Action Plan. Russ Bullock attended a Steering Group Meeting for the Arctic Council Action Plan (ACAP) mercury project in Moscow, Russia. The ACAP mercury project, initiated in 2001, is managed by the EPA. Mr. Bullock served as a technical information resource for the steering group and participated in an Experts Group Meeting. The purposes of these meetings were: 1) to complete review of the draft Russian mercury emission inventory report and draft Arctic regional mercury inventory; 2) to initiate discussion toward the development of a framework for a Russian mercury action plan and Arctic region action plan as called for in the terms of the project; and 3) to begin selection of candidate source categories and selection of one or more pilot activities or projects in Russia to reduce mercury emissions. (O. Russell Bullock, 919 541 1349)

14. The Environmental Impact of the World Trade Center Event. The February 2004 Special Issue of the Air & Waste Management Association's *EM* publication on Homeland Security and the Role of Environmental Professionals was devoted to the work done by the NOAA and EPA scientists in assessing the extent of pollution and potential health risks following the September 11, 2001, terrorist attack on the World Trade Center.

Rao, S.T. Homeland security: Managing the risks. 12-13.
Vette, A. *et al.* Environmental research in response to 9/11 and homeland security. 14-22.
Vette, A. *et al.* Air pollution measurements in the vicinity of the World Trade Center. 23-26.
Lorber, M. Assessment of inhalation exposures and potential health risks that resulted from the collapse of the World Trade Center. 27-30.
Perry, S.G. *et al.* Wind tunnel simulation of flow and pollutant dispersal around the World Trade Center. 31-34.

Huber, A. *et al*. Modeling air pollution from the collapse of the World Trade Center and assessing the potential impacts on human exposures. 35-40.
Hicks, B., and J.S. Irwin. Atmospheric transport and diffusion modeling systems for effective emergency response. 41-42.

15. Meteorological Model Evaluation Tool/ MM5 2001 Evaluation. An initial evaluation of the 2001 MM5 annual simulation was completed and the results are summarized below.

1) Errors in temperature during summer are similar to those found in past evaluations. Winter errors are overall large, but when plotted spatially, errors are not excessive over a large portion of the southern and eastern United States. Large winter temperature errors occurred in the Midwest, Appalachians, and Rocky Mountains. These temperature errors are snow-cover related. The MM5 simulated the wind speeds well over land in both the summer and winter. The MM5 did reasonably well in simulating precipitation during the winter, but overpredicted the total precipitation during the summer in portions of the deep south.

2) A clustering of the statistics according to the large-scale weather patterns indicated that model error and bias (temperature) is not significantly influenced by weather patterns in the summer or winter. Additionally, diurnal dependent errors in the meteorology are independent of weather pattern, except during snowy weather patterns, where the minimum temperatures at night are colder relative to the observations, more so than other winter patterns.

3) An evaluation of the MM5 solar radiation estimations indicated that there is a rather large uncertainty (+/- 150 W/m^2) in the insolation around solar noon, which is likely related to errors in the cloud cover. Also, the radiation bias indicates that MM5 is consistently overpredicting (50 W/m^2) the insolation during the day.

4) NOAA wind profiler data were used to examine the simulated diurnal vertical wind profile. The overall vertical distribution of wind magnitude and direction is well-represented by MM5 above 500 m. A relatively well-represented wind distribution in the middle to upper planetary boundary layer (PBL) during the daytime suggests that the PBL height estimates by MM5 are reasonable. A slight negative wind speed bias is noted at night, around 500 m where nocturnal jets typically form. Therefore, MM5 may be consistently underestimating either the height or strength of the nocturnal jet.

5) Overall, the Automated Model Evaluation Tool (AMET) proved to be useful in examining the performance of MM5. The evaluation as a whole showed that the MM5 simulation for 2001 is an acceptable representation of the atmosphere and can be used for the 2001 CMAQ air quality simulations. (Robert Gilliam, 919 553 4593)

16. Model Evaluation. Over the past several years, we have tested and refined a method for characterizing the performance of transport and diffusion models to simulate the average maximum concentration as a function of transport distance downwind. The method is described in the Annex to ASTM D 6589, and it challenges a model to simulate the average maximum concentration as observed in experiments having similar stability conditions at each downwind distance. To facilitate collaboration and to provide a transparent review of efforts conducted to date, the test results involving three dispersion models (AERMOD, ISC, HPDM) with three field experiments (Project Prairie Grass, EPRI Kincaid, EPRI Indianapolis), and the software developed to implement the ASTM test method have been placed on the Atmospheric Sciences Modeling Division's anonymous ftp site (http://www.epa.gov/asmdnerl/ftpinst.html) (subdirectory: irwin/astm) for public distribution. (John S. Irwin, 919 541 5682)

17. Emergency Response Modeling. Concerning how the HYSPLIT modeling system could best be applied to simulate near-field impacts (transport distances of 2 to 50 km), it was decided that near-field roughness effects would not be accounted for with routinely available meteorological forecast data, and that these effects could to a first-order, be approximated by adjusting the turbulence intensities by a user-specified roughness length.

Roland Draxler, NOAA ARL, supplied a routine to implement this idea, and it was successfully tested using the HYSPLIT modeling system as installed at Research Triangle Park, North Carolina. Menus that will facilitate running the HYSPLIT modeling system for near-field application will soon be created. Further work is needed to provide suitable display of the results, and this work will be the topic of future discussions. (William B. Petersen, 919, 541 1376; and John S. Irwin, 919 541 1376)

18. Particulate Matter Model Evaluation Workshop. This workshop was attended by approximately 90 people from around the country with a strong representation from the EPA Regional Offices and the State Regional Planning Organizations. There were 22 oral presentations and 3 discussion sessions covering a variety of issues related to aerosol measurements and model performance evaluations. Presentations are posted at http://www.cleanairinfo.com/PMModelPerformanceWorkshop2004/agenda.htm.

Robin Dennis presented a talk entitled, "Time-Resolved and In-Depth Evaluation of PM and PM Precursors using CMAQ." The value of having hourly measurements was noted. For example, the good agreement between model and measurements for 24-hour elemental carbon (EC) measurements appears to be due to compensating errors between emissions rates (too low) and too rapid nighttime PBL collapse (creating over-predictions at night). A diagnostic measure for inorganic PM, the gas ratio, was presented. The gas ratio indicates whether ambient conditions are nitric acid limiting or are ammonia limiting. The 2003 release of Community Multiscale Air Quality (CMAQ) was shown to perform best on the gas ratio measure. (Robin Dennis, 919 541-2870)

Other invited presentations by Atmospheric Sciences Modeling Division members included:

- P. Bhave. *Postprocessing of Model Output for Comparison to Ambient Data.*
- B. Eder. *Operational Performance Evaluation: CMAQ Summer and Winter Episodes.*
- J. Irwin. *Model Evaluation: Looking for Spatial and Time Averaged Patterns.*
- S. Yu. *Statistics Definitions and Issues: Deriving "Unbiased Symmetric" Metrics.*

(Prakash Bhave, 919 541 2194; Brian Eder, 919 541 3994; John Irwin, 919 541 1376; Shaocai Yu, 919 541 0362)

Idaho Falls

19. CBlast-High Hurricane Planning. The annual CBLAST-Hurricane planning meeting was hosted jointly by NOAA/AOML and University of Miami RSMAS in mid-February. Discussions revolved around analysis plans for last year's data set, deployments for the upcoming hurricane season, and long term plans for continued analysis/measurement campaigns. A request is being made to fund ongoing data analysis for 2005 through NOAA/USWRP. An overview paper for CBLAST-Hurricane, focusing on instrument developments and successes in the 2004 deployment is in preparation and is expected to be completed before this year's deployments. Installation of the BAT probe is tentatively scheduled for May/June time frame, with final testing in early to mid August. jeff.french@noaa.gov

20. Baylor Institute of Air Science (BIAS) Visit. A visit was made to the Baylor Institute of Air Science (BIAS) in Waco, Texas, for discussion involving possible collaboration between ARL scientists and the BIAS group. BIAS operates several aircraft ranging from single engine Cessnas to a Twin Otter. BIAS is interested in shifting the focus of their measurements capability to smaller aircraft, away for the more expensive-to-operate, larger twins. In addition to their Cessnas, BIAS also has a Velocity that they are interested in using for Atmospheric Research. Discussions are ongoing as how ARL and BIAS can work together and utilize each other's strengths for future research studies. jeff.french@noaa.gov

21. INEEL Mesoscale Modeling - MM5 Testing. Testing of the new MM5 configuration for Southeast Idaho continued in February. The model runs seem to have a higher probability of failing on days with active weather, mainly because the NCEP Eta model output is sometimes delayed on these days. The control script used to start

the MM5 runs was modified to allow MM5 to recover from time delays of the Eta data if the delays are not too long. richard.eckman@noaa.gov

Las Vegas

22. Cloud-to-Ground (CG) Lightning Study. Twenty-five years of thunderstorm and lightning data have been summarized for the Desert Rock Meteorological Observatory (DRA). The data base includes thunderstorm days, cumulonimbus (CB) Days, and lightning days. CB days were used as the most general way of identifying those days when thunderstorm activity was likely to have occurred on the NTS. CB days are used because cloud observations are taken every hour and lightning is difficult to see during daytime. There is a dominant summertime peak in thunderstorm activity. These fluctuations are probably related to the surges of tropical moisture from the Gulf of California northward into the desert southwest. This phenomena is being studied by the North American Monsoon Experiment (NAME) scheduled for the summer 2004 and supported by NOAA and the University Center for Atmospheric Research (UCAR). There is a lack of CB activity between November 1 and March 1. (Darryl Randerson, 702 295 1231)

23. Cooperative Institute for Atmospheric and Terrestrial Applications (CIASTA). Mesoscale Modeling - NV-RAMS ran to completion on the University of Nevada-Las Vegas computer system 28 of 29 days (97% completion factor). Data are continuing to be renamed and saved daily, and backed up to CD monthly (3 CDs).