NOAA ARL Monthly Activity Report

March 2006

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Contents

1. Highlight -- Bronze Medal Award. Drs. Ray Hosker and Tilden Meyers of ARL/ATDD (Oak Ridge) were part of the US Climate Reference Network team honored by NOAA at a ceremony in Washington, DC on March 17. ray.hosker@noaa.gov

2. Highlight -- NOAA P3 Installation. Research related to the dynamics of hurricanes is increasingly focusing on turbulent exchange within the developing systems. The research is being conducted by the Hurricane Research Division in Miami, but the instrumentation and measurement capabilities are products of ARL research (originally intended for different aircraft applications). Over the last several years, ARL "Best Available Turbulence" (BAT) probes have been adapted for use on the NOAA P3 aircraft. Following tests conducted last year, further redesign of the probes has been found necessary. Two new hemispherical BAT-Probe sensor heads have now been constructed and calibrated. They are ready for installation. Efforts to log data at the required rate and precision on the current P-3 data system have shown that the existing data acquisition systems are inadequate. Until the systems are upgraded, key components of the data stream will be collected using a separate laptop computer. philip.g.hall@noaa.gov Ed Dumas and David Senn

3. Highlight -- Improved CMAQ Model for Mercury Goes Operational. An interim release version of the Community Multiscale Air Quality (CMAQ v4.5.1) model was delivered for operational and public use to the Community Modeling and Analysis System (CMAS) center. This version of the CMAQ model includes an atmospheric mercury modeling capability. Also included is a beta-version of the Carbon Bond 2005 (CB05) chemical kinetic mechanism, a revised and more explicit version of the earlier CB-IV mechanism used for many years in the CMAQ modeling system. Updates were made to the aerosol partitioning module to increase its numerical stability. In addition, there were minor updates and revisions to aerosols, clouds, transport, and process analysis routines, as well as to the parallel input/output library. shawn.roselle@noaa.gov

Silver Spring

4. HYSPLIT-CMAQ Developments. Several modules have been developed to link the HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) dispersion model (developed by ARL/Silver Spring) with the CMAQ (Community Multiscale Air Quality) Eulerian model (developed by ARL/Research Triangle Park). The linkages are being tested using results generated in recent studies conducted in the Houston area. The work is intended to provide an improved capability for tracking the consequences of individual sources within the larger CMAQ framework. This is of special importance with the growing reliance on CMAQ as the engine providing operational air quality forecasts. The prediction of air quality consequences of forest fires is seen as an especially important application. ariel.stein@noaa.gov

5. Cloud Climatology Study. Work continues on a collaborative study (with NCDC) of changes in cloud ceiling heights and frequencies over the United States since the early 1950s. The analysis addresses changes in daytime low cloud cover using data from NWS and US military stations and considers the effects of the introduction of automatic surface observing systems during the 1990s and other changes in observing practices. dian.seidel@noaa.gov

6. Homeland Security -- IMAAC. The Interagency Modeling and Atmospheric Assessment Center (IMAAC) is intended to be the "clearing house" for dispersion forecasts generated by many practitioners in the event of an emergency of national importance. The interim IMAAC is located at Lawrence Livermore National Laboratory. At this time, the permanent home of the IMAAC is being considered. There are several options available. One option that is highly favored in some quarters is to arrange for two IMAACs, one on the west coast and another on the east. A central consideration, regardless of the final IMAAC configuration, is the way in which the NCEP capabilities can be integrated into the overall process. The planned collocation of ARL with NCEP in the new NOAA complex at College Park (MD) offers an especially interesting possibility, recently explored in some detail by the Site Survey Team set up by the Department of Homeland Security specifically for this purpose. During a recent visit by the Team to the NCEP/Camp Springs operational facilities, Barbara Stunder provided a briefing on ARL roles and responsibilities regarding dispersion modeling and emergency response. barbara.stunder@noaa.gov

Oak Ridge

7. URBANet. A meeting was held at the Center for Geographic Information Sciences (CGIS) at Towson State University, Towson, MD, to discuss work to be accomplished under the recent MOU between ARL and Towson State University. The meeting was very successful, and several areas of common interest were discovered. In particular, CGIS manages an advanced data analysis and presentation system to provide guidance to the Maryland Emergency Management Agency (MEMA) in real time, which would benefit from the pre-calculated HYSPLIT model runs that are performed every hour and made available at the ATDD DataViewer website. Further cooperative work will be performed in the future. ed.dumas@noaa.gov and Will Pendergrass

8. East Tennessee Ozone Study (ETOS). The ETOS meeting planned for mid May has now taken shape. There is considerable interest in ETOS, especially within State and Federal political circles. ETOS has already shown that ozone affecting the Great Smoky Mountains National Park derives substantially from precursors transported from far upwind. It now remains to investigate the consequences of this long range transport component of the local ozone exceedance problem, and to explore options available to local authorities. In preparation for the 2006 field season, ATDD's ozone sensors are being tested extensively. david.senn@noaa.gov

9. Mercury in the Southeast. Studies of the emissions of gaseous mercury from bare soil, grass and pavement over an entire year have been completed. The work took place in Tuscaloosa, AL, in collaboration with workers from the University of Alabama and Oak Ridge National Laboratory. Relationships have been developed between the flux from each surface and major meteorological parameters. Annual average fluxes were: bare soil -- 6.48 ng m^{-2} hr^{-1}; pavement -- 0.02 ng m^{-2} hr^{-1}; and grass -- 0.28 ng m^{-2} hr^{-1}; with summer fluxes being the greatest. The bare soil displayed the largest difference between evening and daytime fluxes, particularly during spring and summer. A summer range from evening low of 12 ng m^{-2} hr^{-1} to daytime high of 30 ng m^{-2} hr^{-1} was typical. Diurnal flux variation was greater than seasonal flux variation for all surfaces. The fluxes from all surfaces were positively correlated with temperature and solar radiation. There was a consistent negative correlation with relative humidity for all four seasons. A paper on "Diurnal and seasonal trends in total gaseous mercury flux from three urban ground surfaces," by M.C. Gabriel, D.G. Williamson, H. Zhang, S.B. Brooks, and S.E. Lindberg is now in press at *Atmospheric Environment*. steve.brooks@noaa.gov

10. Ceilometers for Air Quality Application. ATDD installed a ceilometer on the rooftop of the Post Office near Madison Square Garden during the New York City Urban Dispersion Project. Typically, ceilometers measure cloud height, but the goal of this installation was to explore the utility of the ceilometer for determining the convective mixing height. However, there appears to be an additional application. Good correlation was found during dry conditions between the ceilometer's near-range backscatter and PM10 (10 µm particles) concentration measured *in situ*. PM10 data were obtained from the New York Department of Environmental Conservation to explore the possibility of remote sensing of particulates by this means. laureen.gunter@noaa.gov

Research Triangle Park

11. Collaboration with NOAA's National Centers for Ocean Science. As an outcome of the June 2005 NOAA/EPA Scientist-to-Scientist Meeting, the ASMD has started to collaborate with the NOAA National Centers for Ocean Science Center for Coastal Monitoring and Assessment (CCMA) to study nutrient inputs to U.S. coastal waters. The plan is to investigate the linkages between wet and dry nutrient (nitrogen) deposition and spatio-temporal variability of satellite-derived chlorophyll estimates for U.S. coastal waters for a target region off the coast of North Carolina. Monthly-averaged total nitrogen deposition estimates from the three-year (2001–2003) Chesapeake Bay CMAQ runs have been provided to CCMA. The initial effort will involve analysis of 36 months of atmospheric total-nitrogen deposition outputs from CMAQ and CCMA re-processed SeaWIFS (Sea-viewing Wide Field-of-view Sensor) chlorophyll imagery to determine overall climatological sensitivity and patterns of association of these scale-dependent outputs. SeaWIFS provides satellite-based ocean color to enable characterization of surface chlorophyll concentrations. The North Carolina target region was chosen to minimize the effect of direct runoff. Previous work found an association between near-coastal riverine direct runoff and chlorophyll concentrations. The two multi-year monthly-averaged data sets can be used to improve understanding of coastal implications related to nutrient inputs and nutrient enrichment, assimilative capacity, and frequencies and magnitudes of phytoplankton response in coastal waters. robin.dennis@noaa.gov

12. WRF Atmospheric Chemistry Model (WRF-Chem). The relative advantages and disadvantages of on-line versus off-line coupling of the dynamics and chemistry in air quality modeling systems is a current topic of discussion. Off-line coupled modeling systems compute the meteorological dynamics in advance and store the resulting 3-dimensional fields at specified time intervals. These stored fields are then used as input to drive the chemical transport model. Compared to off-line coupling, on-line coupling has several advantages. On-line coupling allows for bidirectional feedback between the meteorology and chemistry during the simulation; it significantly reduces possible temporal biases introduced by relatively infrequent storage of the previously-computed meteorological variables; and it eliminates potential errors due to grid interpolations between the dynamics grid and the chemistry grid. However, on-line coupling has one potentially major disadvantage. The meteorological dynamics fields must be recomputed for every simulation, even if the user is only making a small change to the chemistry module and the meteorological conditions have not changed. Current air quality prediction systems mostly utilize an off-line approach. An example of an on-line air quality model is the Weather Research and Forecasting Atmospheric Chemistry model (WRF-Chem), which consists of chemistry code integrated into the WRF-ARW model. The WRF-Chem program source code has been provided to ASMD for research in coupled air quality modeling system methodologies (thanks to Drs. Georg Grell and Steve Peckham of ESRL, Boulder). The WRF-Chem code has been installed on the Division's High Performance Computing and Communication Center (HPCC) computers. A successful WRF-Chem 24-h simulation of the air quality for a late December 2005 northeastern United States storm event was completed. A study of the WRF-Chem code architecture is under way. jerry.herwehe@noaa.gov

13. CMAQ Model - Air Quality Forecasting. Significant progress has been made in the air quality forecasting system to develop a proof-of-concept, coupled Community Multiscale Air Quality model that provides two-way interaction between the meteorological and chemical parts of the modeling system. The new capability reduces the end-to-end cpu time for operational use. jeff.young@noaa.gov

The physics and software framework of the Weather Research and Forecasting (WRF) model (http://www.wrf-model.org/) currently supports two meteorological dynamics cores: the Advanced Research WRF (ARW) core and the Nonhydrostatic Mesoscale Model (NMM) core. The WRF-NMM core was developed by NOAA/NCEP, with a focus on efficient real-time numerical weather prediction applications. It is intended to replace the current operational Eta model with WRF-NMM as the North American Mesoscale (NAM) model during the summer of 2006; thus, this change will make WRF-NMM the meteorological driver for the Community Multiscale Air Quality (CMAQ) chemical transport model utilized in the operational NOAA/NWS Air Quality Forecast Guidance effort. To conduct in-house research on the WRF-NMM modeling system, the latest versions of these components (WRF-NMM SI v2.1.2, WRF-NMM model v2.1.2, and WRFpost v1.0) were installed on ASMD's High Performance Computing and Communication Center (HPCC) Linux computer clusters. Two 24-h test simulations for the eastern United States (one beginning at 12 UTC on January 23, 2005, and the other at 12 UTC on October 6, 2005) were successfully completed. jerry.herwehe@noaa.gov

In preparation for the 2006 forecast season, testing of the linkage between the Weather Research and Forecasting-Non-Hydrostatic Mesoscale Model (WRF-NMM), which is undergoing rigorous testing at the National Weather Service, and the Community Multiscale Air Quality (CMAQ) model is being performed through analysis of simulations for retrospective cases. Initial tests indicated lower simulated surface ozone compared to previous runs driven by the Eta model. The differences were found to arise from relatively higher ozone deposition velocities, which in turn, were related to changes in the land-surface model in WRF-NMM. Additional testing with newer versions of the WRF-NMM model is underway. rohit.mathur@noaa.gov; tanya.otte@noaa.gov; jonathon.pleim@noaa.gov

14. Coupling of CMAQ and HYSPLIT Models. Item 4 above refers to the continuing effort to integrate ARL's two major modeling activities, CMAQ and HYSPLIT. Recently, extensive analyses have been performed using the coupled system. Concentrations generated by the CMAQ model and from trajectories determined by HYSPLIT have been used to assess the impact of recent NO_x point-source emission reductions on ozone concentrations in the eastern United States. The on-going analysis effort involves investigating transport of pollutant concentrations downwind of selected point sources that exhibit notable NO_x emission differences between the base and emission reduction simulations. In work conducted so far, forward trajectories were generated by the HYSPLIT model using the same meteorological fields applied in the CMAQ simulations. Results indicated that after traveling aloft overnight, trajectory positions were often several hundred kilometers downwind of the sources. Ozone levels aloft, at the elevated trajectory levels, were predicted to be considerably higher than surface ozone values. Thus, elevated reservoirs of higher ozone, as well as NO_x, were available for vertical mixing downward to the surface during the course of the morning period of the next day. Model results also showed surface layer ozone concentrations increased rapidly during the morning to become comparable to ozone values at the elevated heights of the trajectories, although ozone concentrations in the base simulation increased faster and remained greater at the trajectory endpoint locations both aloft and at the surface compared to the emission reduction simulations. james.godowitch@noaa.gov

15. Linking Air Quality and Human Exposure Models. To illustrate how air quality models can be used to provide inputs to human exposure models, ASMD staff (in collaboration with the EPA Office of Research and Development) recently demonstrated an example of an integrated air quality and exposure modeling system, for Philadelphia, Pennsylvania. In this example, results from CMAQ simulations at 4-km resolution were used as an input to EPA's Stochastic Human Exposure and Dose Simulation (SHEDS) model for benzene. SHEDS was applied to provide annual exposures for the population by accounting for the actual demographic characteristics of persons in the region, and simulating human activities performed and locations visited using the hourly ambient concentrations from the CMAQ simulation. vlad.isakov@noaa.gov

16. Regional Climate Model Evaluation. Efforts continued in March on the analysis of MM5 regional climate model output as part of the Climate Impacts on Regional Air Quality (CIRAQ) project. Principal component analysis was used to analyze the main modes of variability of the regional climate model sea-level pressure pattern. Earlier, only the mean sea-level pressure patterns between the model and reanalysis were compared. Principal component analysis allows more exploration of major weather patterns and how these patterns contribute to the overall sea-level pressure variability. Initial results indicate that several of the simulated sea-level pressure patterns in the winter are similar to what is typically observed, but the frequency of occurrence is different in many cases, especially for the eastern United States. In the summer, the major observed pattern in the eastern United States, the Bermuda High, is not well simulated by the climate model. The climate model does simulate a few of the major synoptic weather patterns in the winter and spring, but not necessarily with the correct frequency. Analyses of sea-level pressure as well as a link to temperature and ventilation index patterns are underway. robert.gilliam@noaa.gov

Idaho Falls

17. Tracer Developments. Tracer technology underpins much of the research carried out at Idaho Falls. As mentioned last month, there is an ongoing effort to improve the detection of alternative tracer materials so that the reliance on sulfur hexafluoride (SF6) can be reduced. SF6 is a strong greenhouse gas, and even though the amount used in atmospheric tracer experiments is minimal in comparison to leakage rates from industrial uses, it is appreciated that the use of SF6 might become unpopular. This month was spent running perfluorocarbon tracer (PFT) samples from last year's New York dispersion study to gain experience in PFT analysis. A specific goal was to see if there were any possible interferences between PFTs and SF6. Although there was no appearance of a definitive problem, there were some unexpected peaks that appeared in samples collected far downwind. A NOAA Technical Memorandum documenting FRD's participation in the New York City study was completed. roger.carter@noaa.gov, Debbie Lacroix, and Jason Rich

18. Extreme Turbulence Probe. The "ET Probe" is an outgrowth of instrumentation developed by ARL to permit research into the surface energy balance and air-surface exchange. It turns out that the ARL technology has a lot of potential applications. ARL scientists have been courted by many groups that want to make use of the new technology, and a number of research partnerships have evolved as a result. Each of these partnerships has resulted in advances in the technologies used in the ET probe. There is considerable satisfaction in the reality that other research programs have been supporting the development of specialized instrumentation intended for application in mainstream ARL research.

Hurricane researchers have been among the strongest supporters of ET probe development. As a result of this interaction, a manuscript entitled "A Pressure-Sphere Anemometer for Measuring Turbulence and Fluxes in Hurricanes" has been submitted for publication in the Journal of Atmospheric and Oceanic Technology. This manuscript describes the design of the ET probe. The focus of the research collaboration is now shifting to the data collected in the 2004 hurricane season. In parallel, work continues on using the refined ET probe and its siblings in ARL research on turbulence, dispersion, and air-surface exchange. richard.eckman@noaa.gov

19. Smart Balloon. Another example of the way in which ARL's specialized developments awaken interest in other disciplines is with the "smart balloon." This is an outgrowth of the extensive work on atmospheric tracer technology, for which ARL is exceedingly well known. However, the smart balloon offers several opportunities for studies that have excited the air quality community. It permits chemical studies of parcels of air as they migrate and evolve over considerable distances, up to many thousands of km. In concept, releasing a few of these smart balloons at he same time could provide intriguing information on chemical reaction rates in the atmosphere, as well as on the rates at which dispersion dilutes the original concentrations. In anticipation of the use of several smart balloons in the Texas air quality studies planned for later this year, the shell of the smart balloon has been redesigned, to make assembly, disassembly and bladder insertion an easier and faster operation. randy.johnson@noaa.gov

20. Idaho Mesonet Activities. The Idaho Mesonet operated by ARL contains sensors that are unusual and possibly unique, as a part of the ARL research program to learn how to optimize surface tower measurements for dispersion applications in complex terrain. Many of the towers have Pressurized Ionization Chambers (PICs) for measuring radioactivity. These sensors are owned by the State of Idaho, but their data are included in the Mesonet data stream as part of a collaborative agreement between the State and FRD, and the data are available for ARL research. Recently, there have been problems with the PIC data being misused by outside organizations that have access to the Mesonet data through NOAA/MADIS (Meteorological Assimilation Data Ingest System). FRD therefore plans to restrict access to the PIC data, but this restriction will have no effect on access to the data meteorological component of the data stream. It is now proposed to send only a sanitized subset of the mesonet data to MADIS, which will then become the data source for external organizations. kirk.clawson@noaa.gov and Rick Eckman

Las Vegas

21. DIVINE STRAKE. Divine Strake is a study now being planned, involving the controlled explosion of a large quantity of commonly available materials. It is anticipated that the explosion will seem much like a surface nuclear explosion. The ARL dispersion mesonet is currently being reconfigured to provide an optimal dispersion forecast capability. Two new meteorological towers were installed in the vicinity of experimental ground zero (GZ). Another station has been relocated to avoid predicted blast over pressures. Furthermore, two additional stations were installed, on hilltops south and southwest of GZ. The data obtained will be integrated with the observations from the entire mesonet, to provide input to the dispersion forecasts that will be provided by the ARL team working in collaboration with the operational site management. Dispersion forecasts will be updated every 15 min during test operations. gerry.fleming@noaa.gov and Paul Rogers

SORD research meteorologists are also developing the required software and graphics displays for improved and more comprehensive operational use. During test operations, all required meteorological data and dispersion calculations will be displayed to test management in real time on wide screens in the test operations center (CP-1) on the Nevada Test Site. An additional safety focus will be on the prediction, detection, and warning of cloud-to-ground lightning within 10 miles of the GZ.