# NOAA ARL Monthly Activity Report

# November 2006

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**Air Resources Laboratory**

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## Highlights

***1. Highlight – ARL Leadership of NADP Science.*** Maggie Kerchner (ARL staff member at the NOAA Chesapeake Bay Office) is starting a one-year term as Chair of the National Atmospheric Deposition Program (NADP), the long-running nation-wide multi-agency program that has provided the historic basis for trend detection in deposition following emissions changes. This continues the historic ARL association with NADP, since the inception of the program three decades ago.

Steven Brooks is also heavily involved, especially now that NADP is becoming increasingly focused on atmospheric Mercury. Steve is a review board member and report author for the NADP Mercury Deposition Network. At the request of NADP, electronic versions of ARL's mercury site operators' manual and quality assurance (QA) procedures manual have been provided, along with the latest copies of the software for mercury data analysis and QA. These will provide a basis for the development of procedures and software for the evolving national dry-deposition network for mercury. steve.brooks@noaa.gov

***2. Highlight – Likely Impact of Climate Change on Regional Air Quality.*** Three exploratory five-year simulations using the CMAQ model have been conducted. One simulation represents air quality under current climatic conditions, one simulation represents future air quality (ca. 2050) using current levels of anthropogenic emissions, and one simulation represents future air quality with anthropogenic emissions controlled in a manner consistent with the Intergovernmental Panel on Climate Change (IPCC) A1B scenario. Comparison of current period model results with data from the Air Quality System (AQS) database of ambient observations indicates a significant positive bias in simulated maximum daily 8-h average ozone concentrations. For the 2050 simulation with current levels of anthropogenic emissions, summertime ozone concentrations increase 2–5 ppb in Texas and parts of the eastern United States. By contrast, for the future simulation with controlled emissions, substantial decreases (greater than 5 ppb and reaching 15 ppb) are seen throughout the United States, indicating that the large emissions reductions envisioned under the A1B scenario more than counteract the increase in ozone concentrations due to climate change alone. These results were presented at the recent *Workshop on Uncertainty in the U.S. EPA Assessment of the Impact of Global Change on U.S. Air Quality, November 1-2, 2006,* in Durham, North Carolina. chris.nolte@noaa.gov, and Alice Gilliland

***3. Highlight – Earth and Sky Science Advisor.*** Dian Seidel has been invited to serve as a Science Advisor for Earth and Sky, a daily radio and online program addressing science topics. Science advisors provide ideas for stories and perspectives on topics of interest to Earth and Sky and its listeners. dian.seidel@noaa.gov

**Air Resources Laboratory Headquarters, Silver Spring**

***4. Trend Analysis of Mercury Wet Deposition.*** Data from the Mercury Deposition Network (MDN) indicate a statistically significant downward trend in precipitation mercury concentration and wet mercury deposition for sites located in the northeastern USA (including the Upper Midwest) from the period 1998 to 2005. Declines in mercury concentration and deposition were on the order of 2% to 4% per year for the northern sites as a group. At the same time MDN sites located in the southeastern USA showed no significant trends. It appears that the downward trend in concentration and deposition at the northern and midwestern sites may be linked to decreased regional and local anthropogenic Hg emissions; this link is not well established because the mercury emissions record is limited. EPA emissions inventory data suggests a moderate decline in mercury emissions for southern regions and a more significant decline in northern regions from 1996 to 1999. However, data for emissions more recent than 1999 are not yet available.

Characteristics of low and high deposition (and concentration) storms were also examined. For this analysis, two Pennsylvania sites and a site in Wisconsin received special attention. High deposition storms for all 3 sites often were from air masses that were somewhat slow moving, where 72-hr back trajectories (start height 500 m and 1000 m) extended less than 600 km away from the site. Another common trait was that high deposition storms often had air mass trajectories from the south or southwest. Other wind directions tended to correlate with low concentrations and deposition amounts – especially a western or northern component in the source of the air masses, except for one of the Pennsylvania sites located downwind of Pittsburgh and presumably influenced by emissions from that city. Many of the low concentration and deposition storms

exhibited marine air mass origins. This study has been a collaboration with the Institute for Ecosystem Research at Cornell University. mark.cohen@noaa.gov

***5. NOAA Atmospheric Mercury Meeting.*** On November 14-15, ARL organized and hosted a meeting regarding atmospheric mercury research, involving scientists from NOAA and from several NOAA-sponsored programs. The ~20 participants discussed issues relating to atmospheric measurements, atmospheric process research (lab and field-based), and atmospheric modeling. The discussions yielded a number of promising opportunities for productive collaboration. mark.cohen@noaa.gov

***6. NOAA Report to Congress on Mercury in the Great Lakes***. In response to a Congressional mandate, ARL has prepared a Report to Congress on mercury contamination in the Great Lakes. The report is undergoing intra- and inter-agency review. In July 2006 the report was submitted by the Department of Commerce to the Office of Management and Budget (OMB) for review. OMB in turn sent it out to numerous agencies for review. In September 2006, NOAA ARL received comments from OMB and other agencies. A detailed new draft of the report was completed in October 2006, along with a detailed responsiveness summary describing what was done (or not done) in response to each comment. The new draft of the report includes a number of new features, including updated trend information for a number of Great Lakes mercury parameters. The draft was sent from NOAA to DOC in November 2006. It is expected that DOC will send the report back to OMB in December 2006. mark.cohen@noaa.gov

***7. NOAA Plume Prediction Center.*** A draft plan was prepared to support the establishment of a NOAA Plume Prediction Center to provide oversight of NOAA's research and operations related to plume dispersion forecasting. The center's scope would encompass all scales from local incidents to large international events. A meeting was held with representatives of other line offices to finalize the draft plan and formulate a possible implementation strategy. All ARL Divisions are involved. roland.draxler@noaa.gov

***8. HYSPLIT Updates.*** Several sections of the graphical user interface were modified to simplify the model's configuration for more complex simulation scenarios. One major update now permits setting the anisotropy of the turbulence for urban simulations based upon some preliminary conclusions drawn from the DCNet observational network. roland.draxler@noaa.gov

***9. US Government Review of IPCC Fourth Assessment Report.*** Dian Seidel is serving on the Expert Panel Executive Committee of the US Government Review Panel for the Fourth Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC, Working Group I (WGI) on The Physical Science Basis). The committee's charge is to review the IPCC WGI FAR for the Department of State, and the review is being coordinated by the US Climate Change Science Program Office. The IPCC FAR WGI is scheduled for release early in 2007. dian.seidel@noaa.gov

***10. AMS IIPS Committee.*** Julian Wang has been elected to serve as a member of the American Meteorological Society (AMS) Interactive Information and Processing Systems (IIPS) Program Committee for Meteorology, Oceanography, and Hydrology. His term extends from 2007 to 2010. The AMS IIPS Committee is responsible for planning and organizing AMS IIPS activities and conferences. julian.wang@noaa.gov

***11. Forest Fire System with Expanded HYSPLIT-Chemistry Modeling.*** A preprocessor to derive time-varying estimates of forest fire particulate matter emissions from GOES images was developed. This preprocessor was applied for a case study in September 2005. The results show that the HYSPLIT model incorporating this preprocessor correctly predicts the location of the smoke plume, and yields improved estimates of concentrations (relative to results based on the usual "Blue-Sky" emissions estimates). However, the model still under-predicts the PM2.5 concentrations by a factor of two. Two different

simulations were performed using 100 m and 2000 m as release heights, showing that the results are not sensitive to changes in this parameter. However, a separate test based on the Alaskan fire of 2004 showed closer agreement with observations when it was assumed that the PM2.5 emissions were uniformly distributed in the vertical between 3000 m and 6000 m. ariel.stein@noaa.gov

**Atmospheric Turbulence & Diffusion Division (ATDD), Oak Ridge**

***12. East Tennessee Ozone Study (ETOS).*** Initial plans for the 2007 ETOS Workshop are being developed. In order to broaden the workshop's technical scope, the event title has tentatively been changed to the Tennessee Regional Air Quality (TRAQ) Workshop. latoya.myles@noaa.gov, Will Pendergrass, and Gabrielle Ridenour

***13. Regional Flux Measurements – the Global Energy and Water Cycle Experiment (GEWEX).*** ATDD operates a small number of research sites where air-surface exchange rates are routinely measured. The intent is to step past the historic focus on intensive studies in well-behaved daytime conditions by providing a continuous record of all of the key variables. The research is in close collaboration with host organizations that provide routine maintenance, but nevertheless visits by ATDD experts are infrequently necessary. During November, Tim Wilson and Mark Heuer visited the NOAA/ATDD GEWEX flux tower installations at Champaign, IL, Cottonwood and Brookings, SD, and Columbia, MO. As necessary, the installations were reinstrumented and new soil moisture probes were installed at various soil depths from 0.05-1 m. The Cottonwood site is on a semi-arid grazing grassland located about 18 miles to the east of Wall, SD on the edge of the SD Badlands. It is operated in collaboration with South Dakota State University in Rapid City (51 miles to the west). Other SD locations are in the Black Hills Pine Forest Reservation and the in the Brookings grassland. The intent is to study surface-related changes in similar climate conditions. tim.wilson@noaa.gov, Mark Heuer, Tilden Meyers, and Tom Wood

A tree-bole temperature probe is in development. It will sample a radial profile (0, 2, 4, 8, and 16) cm into a tree trunk, but can be shortened to 8 cm for smaller trees. The circuit boards have been fabricated, and a mold for casting the probe in epoxy resin will soon be completed. Tree bole temperature and its temporal variation indicate the amount of heat stored in the vegetation. It is also a parameter for stem respiration. d.l.senn@noa.gov and Tilden Meyers

***14. Threatmap***. ARL continues to develop "Threatmap," an automated system to use NOAA dispersion forecasts in planning for possible terrorist attacks on urban areas. Threatmap is a mainstream asset provided by NOAA to the Department of Homeland Security. It continues to be developed, in close collaboration with the operational DHS end users. Plans to upgrade the Threatmap web server and to update the map service have been completed and are being implemented. The new web service should be available by the beginning of the year. ed.dumas@noaa.gov, Will Pendergrass, and Tom Wood

***15. UrbaNet.*** Plans for collaboration with GIS developers at Towson University are now evolving rapidly. The intent is to provide a GIS capability in standardized format that captures all of the key features of the UrbaNet ARL dispersion and plume forecasting systems. A Rapid Response Tool (RRT) dispersion-model system has recently been installed at Towson. ed.dumas@noaa.gov and Will Pendergrass

The existing RRT systems make full use of data gathered by the ARL DCNet/UrbaNet tower arrays. Use of data from other sources (from the AWS Convergence Technologies array, in particular) is currently being explored. Software has been developed to facilitate collection of multiple days of meteorological data from AWS sites which surround a selected ARL tower/UrbaNet site. The software has been upgraded to provide a helpful graphical user interface.

A slide presentation describing application of model output statistics to forecasts of urban dispersion has been revised in response to review. The current version is considerably more accessible to the general interest reader. It will soon be available on the UrbaNet site. ron.dobosy@noaa.gov

***16. U.S. Climate Reference Network.*** ARL scientists continue to work with NCDC colleagues on the development of the USCRN and on the interpretation of data obtained from it. USCRN data are screened by ARL/ATDD quality control systems and are then made available through the server ftp.atdd.noaa.gov/. The database, CRNSites, on NCDC's server was updated and checked for consistency and accuracy. It contains instrument characteristics for each site along with a record of events which affect data quality. New events are identified from ATDD's field crews, NCDC's Anomaly Tracking System, and email messages. An equipment data base is maintained at ATDD listing past and current locations, repair history, and current status for all equipment. lynne.satterfield@noaa.gov

The interaction with NERON is currently a major issue in the weekly management teleconferences among USCRN collaborators. tilden.meyers@noaa.gov, Mark Hall, Michael Black, Brent French

***17. Completion of BRACE Studies.*** Analysis has been completed of ARL's meteorological and chemical measurements during 21 flights by the NOAA Twin Otter Aircraft in May 2002 over the Tampa area, as part of the Bay Region Atmospheric Chemistry Experiment (BRACE). One or more vertical profiles were flown during each flight both over land and over the Gulf of Mexico. The analysis has made full use of data collected by staff of the Environmental Technology Laboratory (ETL; now part of NOAA's Earth System Research Laboratory (ESRL)), who deployed three surface-based 915-MHz radar wind profilers equipped with radio acoustic sounding systems (RASS) as a part of the BRACE program. Additional sounding data were collected by the National Weather Service Office in Tampa (NWS/TBW). The aircraft measurements of temperature, dew point, potential temperature, ozone, and condensation nuclei have been scrutinized, and in combination with the profiler and sounding data, have been used to determine the structure of the boundary layer over the Tampa Bay region and the temporal and spatial changes that occurred in that structure during representative flights. A manuscript on the assessment of boundary layer variations in the Tampa Bay Area during the BRACE study (by R.L. Gunter), has been accepted for publication in a BRACE special issue of Atmospheric Environment. laureen.gunter@noaa.gov

**Atmospheric Sciences Modeling Division (ASMD), Research Triangle Park**

***18. CMAQ-Mercury Model.*** Tests were conducted with the Community Multiscale Air Quality (CMAQ) v4.5.1 mercury model to investigate its simulation of relatively high wet deposition flux in winter as compared to summer. Compared to the wet deposition fluxes reported by the Mercury Deposition Network (MDN), tests conducted at Lamar University found CMAQv4.5.1 overestimates mercury wet deposition by almost a factor of four in January 2001, and underestimates by about 30% in July 2001 when using initial condition/boundary condition data sets derived from an older version of the global-scale GEOS-Chem model. Much of the relative overestimation in January can be attributed to two external factors: 1) high boundary air concentrations of mercury prescribed by the GEOS-Chem model, and 2) the MDN sampling equipment's inability to capture snowfall. Nonetheless, there appears to be a strong sensitivity to temperature in the simulated concentration of mercury in precipitation. Using the temperature dependence equation in CMAQ, the Henry's Law constants of $HgCl_2$ (the assumed major component of reactive gaseous mercury, or RGM) decreases by about a factor of two for every 10 C increase in temperature. To test the sensitivity of the simulated Hg wet deposition to changes in the Henry's constant, a 1-day simulation for July 1, 2001, was performed with the Henry's constant for $HgCl_2$ increased by a factor of 10. Hg wet deposition was increased by up to 12 times in the grid cells with precipitation. This is somewhat surprising, since the normal partitioning of $HgCl_2$ is already very strongly towards the liquid phase even at expected summertime temperatures. One would expect that nearly all $HgCl_2$ would be incorporated into cloud water and be subject

to wet deposition with the normal value for its Henry's constant. Investigation into this puzzling behavior is continuing. o.russell.bullock@noaa.gov

***19. CMAQ Model-Secondary Organic Aerosol.*** Division scientists and EPA collaborators have been working together to improve CMAQ predictions for secondary organic aerosol (SOA) species. The EPA collaborators have made measurements in Research Triangle Park, North Carolina, throughout the 2003 calendar year, of molecular markers in the particle phase that serve as tracers for SOA that originated from (i) aromatic compounds, (ii) monoterpenes, (iii) sesquiterpenes, and (iv) isoprene. CMAQ simulation results spanning the 2003 year for the same location have been analyzed and compared with the measurements. These comparisons reveal that the model is unbiased for total carbon (TC) during January–April and October–December. From May–September, the modeled TC concentrations are a factor of two lower than observations on average. Reasons for this disagreement are presently being explored, but it is already clear that for the cool months of January–April and October–December, the good agreement between modeled and measured TC is due in part to compensating errors in the model -- overestimates of monoterpene SOA and underestimates of primary carbon. prakash.bhave@noaa.gov

***20. CMAQ Studies of the Impact of Point Source $NO_x$ Emission Controls.*** Results of CMAQ model simulations from a matrix of modeling scenarios designed to reveal the separate effects of $NO_x$ emission reductions and differences in meteorological conditions on daily maximum 8-h ozone concentrations between 2002 and 2004 are being examined. Forward trajectories emanating from major point sources exhibiting substantial $NO_x$ emission reductions have been computed. Process analysis terms are being extracted from model grid cells along the trajectory paths in an effort to assess differences in the magnitude of the various contributing processes in a Lagrangian framework, as a function of distance downwind of select point sources. The impacts on ozone production efficiency (OPE) and differences in the vertical profile of various nitrogen species are also being examined for areas downwind of the Ohio River Valley source region. james.godowitch@noaa.gov

***21. Satellite Data Assimilation***. A collaborative project has developed with the University of Alabama in Huntsville and National Aeronautics and Space Administration/Marshall Space Flight Center to implement several techniques using satellite data for improving physical representations in air quality modeling systems. Initial effort is directed towards modifying MM5, WRF and CMAQ to make use of satellite derived products (including albedo, emissivity, and insolation estimates from GOES and MODIS), and for using such data to specify photolysis rates. The next stage will be to develop new techniques to use satellite derived surface temperature for indirect soil moisture nudging similar to the current scheme using 2-m air temperature and humidity for soil moisture nudging that was described by Pleim and Xiu (2003). A small contract with the University of North Carolina at Chapel Hill has been set up to assist in model modifications and testing. jonathon.pleim@noaa.gov

***22. Peer Review of Community Multiscale Air Quality (CMAQ) Modeling***. The Community Modeling and Analysis System (CMAS) Center is coordinating an expert peer review of recent developments in air quality modeling by the Division. The presentation portion of the review will occur in Research Triangle Park, North Carolina, during December 18-20, 2006. The emphases of this review will be on the modeling and interaction of meteorological, physical, and chemical processes of the Community Multiscale Air Quality (CMAQ) modeling program, as well as the applications and evaluations. Seven expert reviewers will examine the quality, productivity, scientific relevance, and strengths and weaknesses of the components of the modeling program, bearing in mind the Division's focus on the development of modeling tools that can be transitioned to operational use. A final report from the peer review committee is expected to be submitted by CMAS to the Division by April 2007. william.benjey@noaa.gov

***23. Fire Emissions.*** A method is being developed to estimate emissions from biomass burning. The idea is to use satellite detections of biomass burning as a way to augment and enhance incomplete and inaccurate ground-based reports of fire activity. By combining information from satellite and ground-based reporting of biomass burning, notably from wildland fires, we hope to develop an improved method for estimating emissions. Previous methods were quite extensive, very costly, and not very timely. We plan to use the existing 2002 emissions inventory as a check for our new methodology. The new method has three components: 1) process data from one or more satellite products to develop a list of "fire detects" for the period of interest; 2) derive a fire activity database using the "fire detects" and ground-based information; and, 3) develop emission estimates from fire size activity information based on fuel loading and emission factors. We plan to use August 2002 as the first month for "testing" the method. george.pouliot@noaa.gov

***24. UrbaNet – Data Assimilation Tests.*** Tests of model improvements from expanded data assimilation for the Washington, DC area have focused on August 17-18, 2005. The MM5 model is being used for these tests. During the selected period, a "bay breeze" propagated inland to a north-south line roughly aligned with the National Weather Service surface observational sites. These sites are at DCA (Reagan National) and BWI (Baltimore-Washington International) airports. The following sensitivity test runs at a 4-km grid size were completed during November:

(1) 05Aug17: no nudging, 12 UTC start time
(2) 05Aug17_obs: observational nudging more entire model simulation, 12 UTC start time
(3) 05Aug17_obs_6h: observational nudging for the first six hour with AWS and DCNet data, the last seven hours run in forecast mode, 12 UTC start time
(4) 05Aug17_obs_dcnet: same as (3) but using only DCNET data
(5) 05Aug17_obs_half: same as (3) but using only one observational site per grid cell
(6) 05Aug17_18Z: no nudging, 18 UTC start time

During the next month, Division scientists will continue to analyze the sensitivity of MM5 predictions with the use of the UrbaNet surface observations. thomas.pierce@noaa.gov and Tanya Otte

**Field Research Division (FRD), Idaho Falls**

***25. UrbaNet/Urban Dispersion Program.*** The URBAN 2000 experiments were conducted in the complex urban and topographical terrain of Salt Lake City in stable nighttime conditions. This setting resulted in the realization of some plume dispersion complications that can arise due to the interaction of complex terrain and mountain-valley flow dynamics, drainage flows, synoptic effects, and urban canopy affects, all within a nocturnal boundary layer. It was found that plume dispersion can be significantly different than what might be expected based upon the available wind data and that it is problematic to rely on any one urban area wind measurement to predict or anticipate dispersion. Some of the anomalies observed include extremely slow dispersion, complicated recirculation patterns, flow decoupling and plume dispersion apparently independent of the measured local winds, and possible upwind diffusion. An initial draft manuscript, "Analysis of Plume Dispersion in a Nocturnal Urban Boundary Layer in Complex Terrain, Salt Lake City, URBAN 2000", is in the final stages of preparation. dennis.finn@noaa.gov

***26. Smart Balloon.*** Development of the Smart Balloon has been discontinued, following receipt of the news that the Congressional earmark that has been funding the work was not included in the budget for FY07. randy.johnson@noaa.gov

***27. Perfluorocarbon Tracer Analysis Development.*** The perfluorocarbon tracer (PFT) analysis development focused on further evaluating the analysis system concentration dynamic range of the species PDCB, PMCH, and m-PDCH. Additional testing has confirmed that the three species yield responses at concentrations of up

to 1 ppm although the response becomes decidedly nonlinear. A more realistic, practical upper limit is probably in the range of a few hundred thousand pptv. The lower detection limit is something less than 10 pptv but has not been precisely determined due to the lack of an appropriate in-house low-level concentration standard. Further tests using ambient air samples from New York City will determine if there are possible interferences that might adversely affect application of the method. dennis.finn@noaa.gov

**Special Operations and Research Division (SORD), Las Vegas**

***28. UrbaNet – Las Vegas:*** Discussions with DOE and NNSA have commenced, in preparation for the proposed installation of an UrbaNet tower at the DOE site in suburban Las Vegas. This tower would represent an extension of the existing ARL complex terrain research mesonet in Nevada, from the Nevada Test Site into the urban sprawl at its southeastern corner. darryl.randerson@noaa.gov, Walt Schalk, Karen Balecha

Discussions with other groups are also continuing. A draft Memorandum of Agreement is being discussed with the Las Vegas Fire & Rescue Service. The Clark County School District requested (and has now received) detailed information about the proposed Test-Bed meteorological towers. kip.smith@noaa.gov