NOAA ARL Monthly Activity Report

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Contents

1. Highlight – Smart Balloon Featured. See the cover of the November issue of the Bulletin of the American Meteorological Society. For additional information, see Item 17 below. randy.johnson@noaa.gov

2. Highlight – Community Modeling and Analysis System (CMAS) Conference. The 5th Community Modeling and Analysis System (CMAS) Conference was held October 16-18, 2006, in Chapel Hill, North Carolina. About 200 people from 13 countries participated in the conference that included 62 presentations and 35 posters. Dr. Larry Reiter, Director, National Exposure Research Laboratory, Environmental Protection Agency (EPA), presented the keynote address on air quality and human exposure. Mr. Timothy Keeney, Deputy Assistant Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration (NOAA), gave a special presentation on NOAA-EPA collaboration on air quality research.

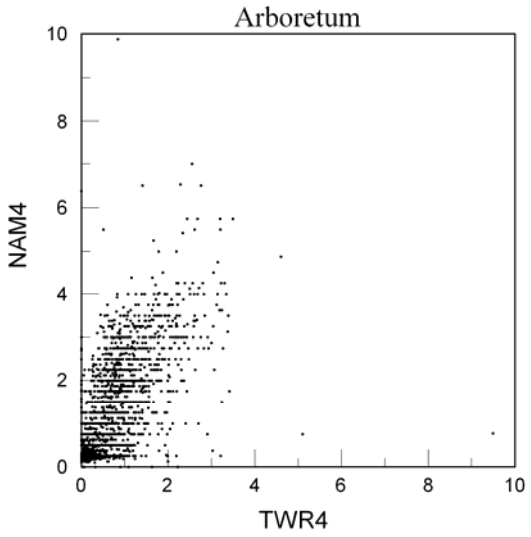
The conference addressed a broad range of topics related primarily to the Community Multiscale Air Quality (CMAQ) model:

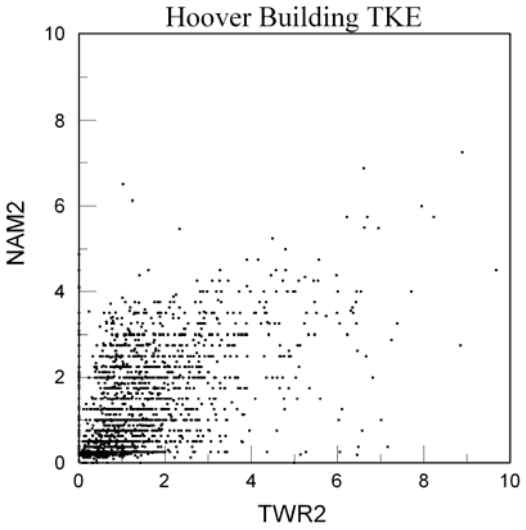
- Advances in modeling systems (model development)
- Analysis methods and tools
- Air quality forecasting
- Regulatory modeling studies
- Emission inventory modeling and analysis
- Fine-scale and urban modeling
- Chemical data assimilation
- Climate-pollution interactions

A highlight of the conference was the introduction of new versions of CMAQ (version 4.6), the Meteorological Chemical Interface Processor (MCIP version 3.2), and the Sparse Matrix Operator Kernel Emission (SMOKE) model (version 2.3) through the CMAS support center. In addition, proposed contributions from the external modeling community were described during the conference, such as aspects of chemical mechanisms and tracking Lagrangian trajectories. The list of participants, extended abstracts, and presentations of the conference are available on-line at http://www.cmascenter.org/conference/2006/agenda.cfm . The 6th CMAS conference is planned for October 2007. william.benjey@noaa.gov

Air Resources Laboratory Headquarters, Silver Spring

3. HYSPLIT TKE Parameterization versus DCNet Data. One dispersion option within HYSPLIT is to use turbulent kinetic energy (TKE) values to compute the turbulent velocity variances for particle dispersion. HYSPLIT then partitions the TKE into horizontal and vertical components, using recently published theoretical values of the ratio of horizontal to vertical turbulence. For stable and neutral conditions, this ratio is expected to be near three. In unstable conditions the relationship is more complex. To evaluate the utility of the TKE values derived from the NCEP NAM model, meteorological fields at 3-h intervals from the lowest 12-km NAM model level at the grid point near the center of Washington D.C. were saved for one year. Scatter diagrams of the NAM TKE and the corresponding 15 min DCNet TKE are shown below for two of the measurement sites.





At the Hoover building, near the center of the downtown area, the preponderance of the predictions indicates little bias, but with under-prediction of the highest TKE values. In contrast, at the more suburban/rural location, the National Arboretum, the NAM model has a clear bias toward over-prediction.

The data indicate a need to modify the partitioning between horizontal and vertical turbulence. The measured ratio of horizontal to vertical turbulence is closer to six rather than the previously assumed value of three. All sites except one DCNet site support this conclusion. The ratio of six is closer to the value reported in some turbulence studies from the early 1970's. The stability dependence of this ratio remains uncertain, but it is clear that the greatest differences among the sites occur at night and are most likely due to slight differences in the urban topography surrounding each tower. roland.draxler@noaa.gov

4. US Cloudiness Study. A study has been completed of National Weather Service and US military ground-based observations of cloud ceiling, identifying periods of homogeneous data that can be used for climate trend estimation. Trends in cloud ceiling height and frequency have been documented and related to changes in precipitation and surface temperature and humidity. A manuscript on "Changes in cloud ceiling occurrence frequencies and ceiling heights over the United States since the early 1950s" by Bomin Sun, Tom Karl (NOAA/NCDC) and Dian Seidel is currently in revision prior to publication. dian.seidel@noaa.gov

5. Double Tropopause Study. Temperature profiles in extratropical regions often exhibit multiple tropopauses. Characteristics of double tropopauses have been studied in considerable detail, using data from radiosondes, ERA40 reanalysis, and GPS radio occultation temperature profiles. A paper on "Observational characteristics of double tropopauses" by Bill Randel (NCAR), Dian Seidel, and Laura Pan (NCAR), has been submitted to the Journal of Geophysical Research-Atmospheres. dian.seidel@noaa.gov

Atmospheric Turbulence & Diffusion Division (ATDD), Oak Ridge

6. Second Texas Air-Quality Study (TexAQSII). ATDD involvement in the Texas Air Quality II Study concluded with the removal of mercury sensors from the Moody tower on the University of Houston campus. Mercury measurements ran from August 6 to October 14. The collected dataset showed gaseous elemental mercury in the typical urban range of 1.5 ng m^{-3} to 5.0 ng m^{-3}. Reactive gaseous mercury reached highs of about 60 pg m^{-3} during afternoons. Fine particulate-bound mercury peaked in the early mornings (~ 0400), typically reaching about 80 pg m^{-3}. Analysis of the data has yet to be completed. steve.brooks@noaa.gov

7. Mercury Sensor Deployments. A mercury speciation system has been installed at the Clean Air Status and Trends Network (CASTNET) site in the Beltsville Agricultural Research Center, near Washington, DC. The site at Grand Bay, Mississippi, has been upgraded by the addition of ancillary trace gas measurements. steve.brooks@noaa.gov, winston.luke@noaa.gov

8. Multi-Scale Dispersion Collaboration with Jackson State University. A meeting was held at the Trent Lott Geo-Spatial & Visualization Research Center at Jackson State University (JSU) to discuss an evolving collaborative atmospheric dispersion project between ARL and JSU. Research update

presentations were given by faculty and staff of the Lott Center and the Department of Chemistry. The project investigators traveled to the Mississippi Gulf Coast to visit existing Mississippi Mesonet sites in Pascagoula and Agricola and to investigate potential sites for two new meteorological towers. Meetings to discuss potential sites were held with representatives from the Harrison County Emergency Management and Homeland Security Agency and the Gulf Islands National Seashore. Several county-managed sites along the main north-south route (U.S. Hwy 49) were photographed and characterized during the trip. The new meteorological towers are being assembled at ATDD and will be operated by the Lott Center. latoya.myles@noaa.gov

9. Mobile Flux Platform Development. Official FAA approval has been granted to the upgrading of the NOAA Twin Otter's flux measuring capability, with the installation of a boom extending forward from the nose. This boom will be the mounting point for ARL's "Best Airborne Turbulence" (BAT) probe. philip.hall@noaa.gov

10. UrbaNet Progress. Two new UrbaNet measurement stations were installed in the National Capital Region (NCR) testbed area. The first is at RFK Stadium, and the second is located at Fort A. P. Hill, Virginia. There are now 11 stations in the Washington, DC region, with further installations planned for the next months. Statistical analysis of UrbaNet data is currently in progress, with an emphasis on assessing the utility of persistence forecasts. chris.vogel@noaa.gov

Each ARL UrbaNet site can now be easily linked with standard weather data from surrounding sites of AWS Convergence Technologies, Inc. (AWS) through software completed in October. ron.dobosy@noaa.gov

A web site has been created to display images of AWS and ASOS/AWOS wind data for the entire US, as well as for Washington D.C. and Las Vegas. See http://dataviewer.atdd.noaa.gov. ed.dumas@noaa.gov, will.pendergrass@noaa.gov

Atmospheric Sciences Modeling Division (ASMD), Research Triangle Park

11. Community Multiscale Air Quality (CMAQ) Model-Multipollutant Model. Work was initiated on combining the modeling capabilities within the Community Multiscale Air Quality (CMAQ) model for photo-oxidants, particulate matter, air toxics, and mercury into a single model system, as has been requested by the Environmental Protection Agency's Office of Air Quality and Planning Standards. Individual source codes from the separate model versions have been compared and merged. The chemical reaction lists were also merged as well as related files. shawn.roselle@noaa.gov

12. Effect of NOx Emission Reductions on Ozone in the Eastern United States. Results of CMAQ photochemical simulations for 3-month summer periods during 2002 and 2004 revealed discernable decreases in daily maximum 8-h O_3 in a broad area downwind of a major point-source region (*i.e.*, Ohio River Valley (ORV)) which experienced dramatic reductions in the nitrogen oxide (NO_x) emissions after implementation of the NO_x SIP Call program. The point-source NO_x emission reductions caused substantial decreases in NOx concentrations aloft. Model results also revealed evidence of decreases in ozone concentrations in the residual layer aloft in downwind areas of the eastern United States during southwesterly flow cases. Trajectory analysis results showed that sites

downwind of the ORV region experienced the greatest decreases in maximum 8-h O_3. Another interesting finding was that greater decreases in O_3 values tended to occur at higher concentrations, a desirable benefit of the NO_x control program. More detailed analyses of model outputs are currently being pursued to investigate the effects on various physical and chemical processes. In particular, the differences between the base case and NO_x reduction modeling scenario results in the ozone chemical production, vertical mixing, and deposition processes of O_3 are being investigated to increase our understanding of the relative contributions of these various processes on ozone formation, ozone production efficiency (OPE), and ozone accumulation**.** james.godowitch@noaa.gov

13. Climate Impact on Regional Air Quality (CIRAQ) Program. Five years of simulations using the Community Multiscale Air Quality (CMAQ) model have been conducted to represent air quality under current climatic conditions. Comparison of 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. This positive bias is larger than the bias typically seen in CMAQ simulations. However, the configuration of CMAQ used for CIRAQ, using meteorology derived from a global climate model, is somewhat different from the standard modeling configuration used for retrospective air quality simulations. Further investigation revealed that much of the enhanced bias is due to the use of the SAPRC99 chemical mechanism, which produces more ozone within CMAQ than the commonly used Carbon Bond-IV (CB-IV) mechanism. These and other CIRAQ results were presented at the *Climate Change Science Program (CCSP) Synthesis and Assessment Product (SAP) 3.2 Workshop, October 30-31, 2006*, at the National Oceanic and Atmospheric Administration's Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey. chris.nolte@noaa.gov, alice.gilliland@noaa.gov

14. UrbaNet – Using a Dense Mesonet to Improve Mesoscale Model Forecasts. Methodologies are being developed to optimize the use of observations from a dense mesoscale network ("mesonet") to improve mesoscale model forecast initialization, verification, and interpretation. The focus of this work is to incorporate mesonet data from the Meteorological Assimilation Data Ingest System (MADIS) data portal to generate short-term (~6-h) forecasts for the Washington, DC, metropolitan area. This research is a part of the UrbaNet research program. Several case studies have been identified that feature meso-gamma-scale phenomena that could be more fully described by the additional surface observations. Initial MM5 simulations showed slight and subtle improvements in the forecast meteorological fields when observation nudging toward more than 350 observations was used for dynamic initialization. Additional sensitivity studies are planned, as are investigations of other methodologies to best use the data. tanya.otte@noaa.gov, thomas.pierce@noaa.gov

15. Wind Tunnel Simulations of Near-roadway Dispersion. As an integral part of the multi-laboratory Near Roadway and School Infiltration Research Initiative, a wind-tunnel study has been initiated to determine how roadway configurations and nearby structures affect the distribution of traffic-related pollutant concentrations within a few hundred meters of major urban roadways. Six-lane divided highway models (at 1:150 scale) have been constructed for scenarios including (1) flat terrain, (2) flat terrain with sound barriers or vegetation near roadways, (3) elevated highways (*i.e.*, highways on a ridge relative to surrounding terrain), and (4) road cuts (*i.e.*, highways depressed relative to surrounding terrain). The experiments will be conducted in the wind tunnel with a

simulated urban boundary layer (surface roughness on the order of one meter full scale and a boundary layer depth on the order of 300 meters). With the initial focus on the influence of the roadway structures themselves, no specific buildings will be included in the immediate vicinity of the roadway in this first phase. Future study phases will be designed to examine single and multiple building influences on near roadway dispersion as may be particularly important for urban highways through densely-populated, heavily built areas. Characterization of the mean flow and turbulence fields in the approach boundary layer is currently in progress. Measurements in and around the various roadway scenarios will begin in November. These include flow visualizations, velocity/turbulence, and tracer concentrations from a uniform line-type source in the roadway. steven.perry@noaa.gov, David Heist

Field Research Division (FRD), Idaho Falls

16. UrbaNet – Model Output Statistics. Further progress was made in determining how Model Output Statistics (MOS) might be applied to forecasting winds and turbulence in urban areas. Normally, MOS forecasts are generated by using a linear regression based on both model outputs and local field observations. However, recent changes at the NWS open up some other opportunities for generating an urban MOS-type forecast. NWS forecasts are now being digitized on a 5 km × 5 km horizontal grid as part of the National Digital Forecast Database (NDFD). Rather then developing an urban MOS forecast based on one specific numerical model (e.g., GFS or NAM), better results might be obtained by treating the NDFD as a composite "model" for inclusion in a MOS approach. A potential benefit of using the NDFD is that it incorporates the local expertise at the NWS forecast offices. Further work will be required to determine if the NDFD winds really meet the needs of the UrbaNet program. richard.eckman@noaa.gov

Research continued on the Salt Lake City URBAN 2000 data set. The experiments were conducted in stable, nocturnal conditions ranging from those dominated by a well-established drainage flow regime to those significantly affected by synoptic scale influences. Preliminary results suggest that topography plays a dominant role in controlling plume dispersion in the downtown area and nearby suburbs in these conditions. The local topography both guided the drainage flows and affected the wind field in the downtown area. Plume movement was often observed to be contrary to the measured winds, especially winds measured at higher elevations above the surface. The goal is to consolidate this research into draft manuscript form for eventual submission for journal publication. dennis.finn@noaa.gov

17. Smart Balloon. In an effort to decrease weight and simplify operation of the smart balloon, a larger helium pressure relief valve is being developed to serve as the flight termination or cut-down mechanism. The current cut-down mechanism of the smart balloon has been a thin diaphragm with a resistance wire around the parameter. The diaphragm is at the top of the helium bladder and is activated when a high current is sent through the thin resistance wire causing the diaphragm to melt around the perimeter. The diaphragm is pushed out of the way by internal balloon pressure and pulled by an external spring so the helium is able to freely flow out of the internal balloon bladder. The new larger helium pressure relief valve will use a pinch mechanism similar to one already in use, but with larger components that will allow it to work with a 0.625" diameter hose rather than the present 0.25" diameter hose. If the new valve works well for this function, the same type of valve will be used as an air ballast release valve. A larger valve for the ballast release will allow quicker

response to precipitation or other factors that may cause the balloon to descend below the desired operating elevation. randy.johnson@noaa.gov

18. Perfluorocarbon Tracer Analysis Development. Recent emphasis has been on (1) extending the dynamic range of concentrations available for measurement and (2) evaluating the possibility of successfully measuring more PFTs in addition to PDCB and PMCH as described in last month's report. First, while a more comprehensive evaluation is still necessary, tests have shown that it is likely that measurements can be made at concentrations up to at least 100,000 pptv. The analysis method had previously been tested at concentrations up to 250 pptv. Second, it was established that m-PDCH could also be measured without adding excessively to the run time. The analysis method used is similar to that described in the September monthly report with adjustments of the isothermal temperature (to 170^{o} C), gas flow rates, and other operational parameters. The total run time is about 5½ minutes for the three analytes listed. Attempts to include a fourth PFT, PMCP, were not successful due to the fact that it elutes very close to PDCB unless some very time consuming steps are taken. dennis.finn@noaa.gov

19. Coupling with Operations – The October INL Tornado Warning. Late in the afternoon of October 4, a tornado warning was issued for the southern portion of the Idaho National Laboratory site by the Pocatello National Weather Service. The Warning Communications Center (WCC) immediately notified INL facility emergency managers, and indicated that two specific facilities would likely be affected. FRD staff had already been tracking the thunderstorm with our new radar display and storm tracking capability incorporated into the iWatch software that had been recently acquired from Weather Decision Technologies in Norman, OK. The iWatch software also includes a real-time lightning strike map from the United States Lightning Protection Network, a private company also located in Norman. Our analysis showed that the two facilities identified by the WCC would not be affected, but that a third facility would instead be affected. WCC was appropriately notified. FRD personnel monitored the storm closely, and maintained close contact with the WCC. In fact, the storm passed close to the third area, as predicted by the FRD systems.

A subsequent meeting was held on October 11 at FRD to discuss severe weather warnings for INL and FRD's responsibilities and capabilities. In attendance were personnel from the Pocatello National Weather Service and emergency management personnel from Battelle Energy Alliance. It was decided that NWS would be the primary source of warnings for the INL, since FRD is not a 24/7 operation. However, FRD would refine the NWS warnings and transmit that information to the WCC when appropriate and when FRD is appropriately staffed. NWS would also refine its warnings for the INL. We are working with NWS to incorporate those features in their warnings. kirk.clawson@noaa.gov

Special Operations and Research Division (SORD), Las Vegas

20. UrbaNet – Las Vegas Urban Air Quality Study. Discussions have started on the extension of the ARL mesonet into the Las Vegas area, now identified as the second test bed of the UrbaNet program. It is likely that a new tower will be located at the site of the DOE Nevada Operations Office. darryl.randerson@noaa.gov