NOAA ARL Monthly Activity Report

December 2006

Richard S. Artz, Acting Director
Air Resources Laboratory

Contents

1. Highlight -- AMS Annual Meeting. Final preparations were made for the 87th Annual Meeting of the American Meteorological Society, in San Antonio, TX, January 14-18, 2007. The theme of the meeting is "Bridging the Studies of Weather and Climate." The event features 28 conferences and symposia, 5 short courses, 11 Town Hall Meetings, over 100 exhibitors, and many other special events, including a focus on environmental justice and diversity, as part of the commemoration of Martin Luther King. With Mary Cairns, Dian Seidel is serving as co-chair of the meeting. dian.seidel@noaa.gov

2. Highlight -- ARL Forest Fire Plume Forecasting System to be Tested by NCEP. Analysis of the results from a series of coupled HYSPLIT-CMAQ runs corresponding to the Alaskan forest fires of 2004 shows that the coupled models statistically outperform alternative modeling systems having constant boundary conditions. It has become clear that the effective release height of the smoke plumes is a key factor when calculating the long-range transport and dispersion of smoke plumes. This coupled modeling system will be tested at the National Weather Service's National Centers for Environmental Prediction, for possible operational implementation. ariel.stein@noaa.gov

3. Highlight -- Satellite Data Improve NO_x Emissions Estimates. A method has been developed, based on the discrete Kalman filter inversion technique, for using satellite nitrogen dioxide (NO_2) column observations to check for biases in current emission inventories of nitrogen oxides (NO_x). To calculate sensitivities of the NO_2 column to NO_x emissions, a technique based on the use of the Community Multiscale Air Quality (CMAQ) model has been developed. This approach advances the previous inverse methodology by combining the strengths of several earlier methods. The new method was tested using various pseudodata or synthetic scenarios, and promises to be a robust and computationally efficient procedure for evaluating and refining NO_x emission estimates with satellite observations and the CMAQ model. As satellite data retrieval techniques continue to improve, such top-down inverse modeling could lead to reductions in the uncertainty of emissions inventories used in regional scale air quality models. sergey.napelenok@noaa.gov, Alice Gilliland and Rob Pinder

Air Resources Laboratory Headquarters, Silver Spring

4. HYSPLIT Interface for Emergency Response. A new simplified HYSPLIT interface was developed especially for short-range emergency response applications. The GUI contains the minimum number of choices to configure, run, and display a simulation. Automated access to meteorological data is an integral part of the interface. If the meteorological data are already saved on the PC, it takes only 30 seconds from starting the GUI to the display of the dispersion plume. roland.draxler@noaa.gov

5. Dust Storm Forecasting Extended to North African Origins. A system for predicting dust storms (based on HYSPLIT and using the dust emission formulations developed by Dale Gillette, ARL/ASMD) was initially developed for the Middle East after the Kuwait war, and was subsequently extended to applications in China (the Gobi Desert). It has now been refined to estimate the impact of long-range transport of dust originating from northern Africa, affecting southern Spain. The forecast is now being produced daily, using meteorological data from NOAA's Global Forecast System (GFS) model with 0.5 x 0.5 degree horizontal resolution. The length of the forecast is 72 hours. Dust emission is estimated using the concept of a threshold friction velocity that depends on surface roughness. This surface roughness is correlated with soil properties. A dust emission rate is computed for each model grid cell when the local wind velocity exceeds the threshold velocity for the soil characteristics of that emission cell. The dominant mechanism for the PM10 emission is "sand-blasting." ariel.stein@noaa.gov

6. Warming Troposphere and Surface, and Cooling Stratosphere in 2006. Based on RATPAC (Radiosonde Atmospheric Temperature Products for Assessing Climate) radiosonde data through December, 2006 appears to have been the third warmest year on record for the global troposphere between 850 and 300 mb, although not as warm as 2005. Data also show that 2006 was the coolest year on record globally in the stratosphere and the second coldest in the Southern Hemisphere extratropics in the RATPAC dataset. Jim Angell's radiosonde temperature data from December 2005 to November 2006 shows similar results for the troposphere, but less stratospheric cooling, with 2006 only the fourth coldest year globally and second coldest year in the north temperate zone. Other radiosonde and satellite data also show less cooling in the stratosphere than is seen in RATPAC. Although the year as a whole was not outstanding, RATPAC results indicate that last

summer was the second warmest globally in the troposphere and the warmest in the deep tropics, and fall was the warmest on record for the troposphere.

Trends in tropospheric temperature since 1958 are 0.13-0.15 K/decade (0.12-0.16 for 1979-2006), with a much larger low-stratospheric cooling of 0.43-0.55 K/decade for 1958-2006 and 0.70-0.85 for 1979-2006. In Angell's surface temperature data, based on a 54-station network, temperatures for the meteorological year December 2005 through November 2006 were also of near-record warmth, the third warmest globally and fourth warmest in the tropics, with the north polar region exceptionally warm in both 2005 and 2006. melissa.free@noaa.gov and Jim Angell

7. Double Tropopause Climatological Study. A study of "Observational characteristics of double tropopauses" by William J. Randel (NCAR) , Dian J. Seidel (NOAA/ARL) and Laura L. Pan (NCAR) has been accepted for publication in J. Geophys. Res. The paper is a comprehensive analysis of observational characteristics of double tropopauses based on radiosondes, ERA40 reanalysis, and GPS radio occultation temperature profiles. Double tropopauses are associated with a characteristic break in the thermal tropopause near the subtropical jet, wherein the low latitude (tropical) tropopause extends to higher latitudes, overlying the lower tropopause. Tropopause statistics derived from radiosondes and GPS data show good agreement, and GPS data allow mapping of double tropopause characteristics over the globe. The occurrence frequency shows a strong seasonal variation in midlatitudes, with most frequent occurrences in winter. Over the extratropics, the occurrence frequency is substantially higher for cyclonic circulation systems. Few double tropopauses are observed in the tropics. Ozone measurements from balloons and satellites show that profiles with double tropopauses exhibit systematically less ozone in the lower stratosphere than those with a single tropopause. Together with the meteorological data, the ozone observations identify double tropopauses as regions of enhanced transport from the tropics to higher latitudes above the subtropical jet cores. dian.seidel@noaa.gov

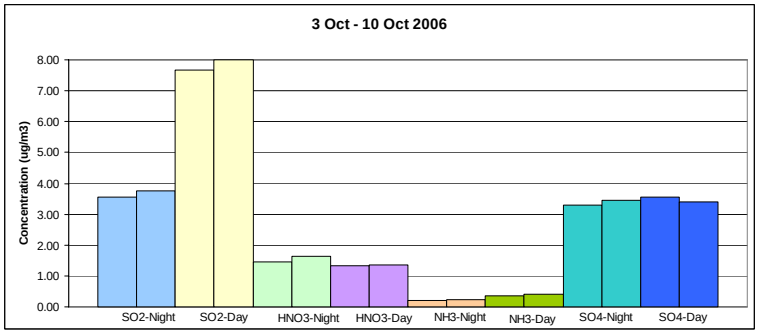
Atmospheric Turbulence & Diffusion Division (ATDD), Oak Ridge

8. Gulf Coast Dispersion Regimes. ATDD is collaborating with the Trent Lott Geospatial and Visualization Research Center at Jackson State University to study multi-scale dispersion along the Mississippi Gulf Coast. Two meteorological towers were installed about 15 km and 25 km from the coast at Gulfport, Mississippi to help assess atmospheric dispersion along the general evacuation direction when hurricanes strike. A sonic anemometer on each 10-m tower measures the three components of wind at 10 Hz. A propeller vane measures mean horizontal wind. Additional instruments measure air temperature and relative humidity. The sites are planned for long-term use. The data are to be used to refine modeling at a more local scale than is typical, accounting for coastal meteorology that cannot yet be predicted well. These developments will make use of the capabilities of the Lott Center. randy.white@noaa.gov, T. Meyers, W. Pendergrass, and L. Myles

9. Carbon Dioxide Sequestration. The microclimate conditions of energy, water, and carbon flux during 2006 are being assessed for the two forest-tower sites at Oak Ridge, Walker Branch Watershed (WBW) and Chestnut Ridge Environmental Study Site (CHESS), through careful analysis of leaf litter falls. Litter has been collected over the year at the two sites, separated by about 5 km along Chestnut Ridge on the Oak Ridge Reservation. Preliminary analysis indicates about 0.7 kg m-2 of litter produced by the forest stands around WBW compared with about 0.5 kg m-2 around

CHESS. This difference in litter fall essentially parallels the difference between the peak leaf area index values over the growing season of 2006 at the two tower sites. tim.wilson@noaa.gov, T. Meyers, M. Heuer, and D.L. Senn

Sampling of selected atmospheric gases and aerosols at the Chestnut Ridge site began in September 2006. Annular denuder systems are deployed weekly to measure day/night concentrations of sulfur dioxide (SO_2), nitric acid (HNO_3), ammonia (NH_3), and $PM_{2.5}$ sulfate (SO_4^{2-}) and nitrate (NO_3^-). Preliminary data for the Fall 2006 season are currently under analysis. The accompanying figure is a snapshot of data from one week of sampling. Replicate samples (which are shown in the same color) exhibit excellent agreement and support the accuracy of the measurement system. latoya.myles@noaa.gov, S. Klemenz, and T. Meyers



10. Climate Reference Network Research Program. A new temperature/humidity test chamber system has been developed, and relevant software has been written and successfully tested. The new software runs on the same Linux machine as the temperature calibration bath system that has been in use for several years at ATDD. Simultaneous operation of the temperature calibration bath and the temperature/humidity chamber is now possible. ed.dumas@noaa.gov, M. Black, and M. Hall

Staff of Oak Ridge Associated Unversities, working with ATDD researchers, have installed new USCRN sites at Batesville, AR and Bronte, TX. USCRN annual maintenance was performed at Hilo and Mauna Loa, Hawaii. michael.black@noaa.gov, M. Boice, D. Bryant, J. Burris, D. Dunn, B. French, M. Hall, D. Haire, B. Randolph, and M. Rutherford

Processed data are available via ftp.atdd.noaa.gov/. Data are routinely transferred to the National Climatic Data Center (NCDC) by this path after being validated by ATDD. The primary 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. Such events are identified from ATDD's field crews, NCDC's Anomaly Tracking System, and email reports. lynne.satterfield@noaa.gov

11. East Tennessee Ozone Study (ETOS). Following the success of the ETOS 2006 Science Workshop, plans for a 2007 workshop are underway. A meeting was held to discuss conference logistics, such as location, venue, and session themes. Suggestions for possible workshop steering committee members were also noted. Selected remarks and presentations from the ETOS 2006 Science Workshop are available online at the following website:
http://www.atdd.noaa.gov/Research_Page_Additions/ETOS_additions/etosworkshop.htm
latoya.myles@noaa.gov, W. Pendergrass, and G. Ridenour

In previous field studies, ETOS has found that the development of a completely self-contained atmospheric ozone monitoring system would be beneficial. The ATDD "Hitchhiker" aircraft

sampling system appears to be especially appropriate. Hitchhiker consists of a small ozone monitor, a data logger, a GPS system, a self-contained power supply, and an optional AirLink data modem. Hitchhiker is designed to be easily flown in a small airplane where it can be treated as baggage and placed in a baggage compartment. All of the equipment, including the power source, is contained in a rugged nylon tool bag. In operation, a 1/4" air sampling tube exits the bag with its inlet located to sample the outside air. Depending on the aircraft, the system is flown with a small GPS antenna that can be removed from the bag for better communication. The data collected and recorded in the data logger includes ozone concentration, altitude, and GPS position once every two seconds. A Technical Report describing the Hitchhiker Ozone Monitoring System is scheduled to be completed in January. d.l.senn@noaa.gov

12. The Oak Ridge Mesonet. To assist in the development of dispersion models applicable in complex terrain, the Regional Air Monitoring and Analytical Network (RAMAN) was set up in the 1990s. RAMAN has 17 sites reporting wind, temperature, humidity, and precipitation over East Tennessee from the Cumberland Plateau to the Great Smoky Mountains and from Morristown to Sweetwater. Earlier deficiencies in data continuity and quality have been mostly resolved through improvements in communication, power feeds, and data logging equipment. Further upgrades are planned, as the programs making use of RAMAN observations have grown from the initial meteorological applications to air quality. tilden.meyers@noaa.gov

13. UrbaNet – Use of Local Data. A major goal of the UrbaNet program is to develop protocols for using local routine data from non-standard sources in refining predictions of low-altitude dispersion. A popular wind sensor used in non-NOAA networks is the "Junior" propeller anemometer made by R.M. Young Company. An intercomparison between an R.M. Young Junior anemometer and a sonic system was conducted in December to assess the ability of the mechanical system to adequately measure wind speeds below 1 m/s. Data were collected both in real-weather conditions and in the ATDD wind tunnel. Data are still being analyzed. ed.duman@noaa.gov, W. Pendergrass, and R. White

In parallel with the investigation of instrument performance, work continues on the development of methods for refining models so that local situations can be addressed with confidence. To these ends, the use of the MOS (Model Output Statistics) approach seems especially promising. MOS is a technique that has been used in operational weather forecasting for over 30 years to extend the applicability of larger-scale models to a particular site. It appears promising for relating wind and mixing forecast by an operational model to wind and mixing near street level in a city where hazardous materials are spreading. A background description of the technique and its relation to problems of dispersion in an urban area has been prepared and will be published on ATDD's UrbaNet web site upon review. A pilot version of MOS application is planned for development for the National Capital Region during FY 2007. ron.dobosy@noaa.gov

A number of additional sites around Washington DC are now required, to test the usefulness of data from non-NOAA networks. To this end, partnerships with private and government institutions, both civilian and military, continue to be fostered. Also, the utility of short-term persistence forecasts is being assessed using data which continue to accumulate from the UrbaNet network. chris.vogel@noaa.gov

Atmospheric Sciences Modeling Division (ASMD), Research Triangle Park

14. New York City Urban Dispersion Model Evaluation. As a part of the ARL participation in the research program initiated with the multi-agency New York urban dispersion field study of 2005, ASMD has been evaluating fine-scale models for urban environments. Two major field campaigns were conducted in Midtown Manhattan during 2005, resulting in a quality-assured database of urban winds (from 12 surface anemometers) and tracer dispersion (from 64 surface concentration monitors). The modeling team is now conducting model evaluation studies using these data and a building database (originally produced by Vexcel Corporation in 2001) that Division scientists had extensively revised and updated. Computational fluid dynamics software has been used to simulate urban meteorology and tracer transport with 1 meter resolution for several of the intensive observation periods from the Midtown Manhattan field studies. It is planned to compare these modeling results with modeling result from other collaborators. Each local urban scale model being evaluated has some different features, both in the resolved scale and the physical process modules.

The model evaluation plan (involving a number of participants in the programs, and coordinated by the Department of Homeland Security's program manager) is to complete the present two "setup" simulations, followed by four "blind" simulations of the Midtown Manhattan field studies. The "setup" simulations allow the use of meteorological and tracer field data in setting up the model simulation. The "blind" simulations will be conducted with only the meteorological data being provided to the modelers to assist in defining model boundary conditions. A goal of these model evaluation studies is to assess the accuracy of fine-scale computational fluid dynamics modeling in complex urban building environments, and their possible role in supporting homeland security. alan.huber@noaa.gov

Field Research Division (FRD), Idaho Falls

15. Perfluorocarbon Tracer Analysis Development. Classical atmospheric dispersion research studies have used sulfur hexafluoride (SF_6) as a tracer gas. Unfortunately, SF_6 is a powerful greenhouse gas, and even though the amounts used in dispersion studies are trivial in comparison to leakage from industrial processes, it remains desirable to find alternative tracer materials. Perfluorocarbons (PFCs) offer considerable benefits, but the analysis of samples is more demanding. To position ARL strongly within the dispersion research community, a lengthy exploration of possible measurement techniques was initiated some years ago. A new method has been developed and is now being tested using ambient air samples from New York City. The results demonstrated that there were no interferences at the retention times corresponding to the PFT species PDCB and PMCH. There was a weak interference associated with m-PDCH that would likely raise the detection limit for this species from less than 10 pptv to the range of about 20-30 pptv. These results also indicate that it will be possible to use this 3-tracer analysis method in real-world applications. The next step is to attempt shortening the analysis time from just under 6 minutes to about 3 minutes by using two shorter columns. dennis.finn@noaa.gov

16. Expanded Collaboration with DOE in Idaho. In early December, FRD staff met with Idaho National Laboratory (INL) representatives to discuss areas in which the Department of Energy (DOE) and NOAA may have common research interests related to the Idaho National Laboratory and its field site. One potential area of collaboration is unmanned aerial vehicles (UAVs). INL

runs a testing center that focuses on smaller, low-cost UAVs. Rather than manually controlling the aircraft with a radio link, the INL group has developed computer technology that allows the aircraft to fly autonomously on predetermined flight plans. Such an aircraft outfitted with a miniature gust probe may prove to be highly useful to NOAA for providing low-cost turbulence and air-quality measurements in the boundary layer. INL also runs a Critical Infrastructure Test Range that works on homeland security issues related to protecting physical infrastructure. This test range may prove useful to NOAA's research activities in urban dispersion modeling. richard.eckman@noaa.gov and Kirk Clawson

17. UrbaNet – Uncertainties in Dispersion Measurements. Studies of the uncertainties in measurements of atmospheric turbulence have potential significance in applications where field instrumentation supplies data to be used in dispersion calculations, as is one specified goal of UrbaNet. After a hiatus of several months, further work has been completed that uses Bayesian statistical modeling to estimate the uncertainty in turbulence measurements by different instruments. This work partly stems from the development of the ET probe, when the ET turbulence statistics were being compared with similar statistics from sonic anemometers. If one cannot put error bars on the statistics, it is difficult to determine whether two turbulence instruments are providing statistically equivalent observations. However, the approach has broader applications for interpreting turbulence measurements. In the current work, the Bayesian approach is being tested using sonic anemometer data. richard.eckman@noaa.gov

18. Mesonet Data Yield Refined Cluster Analysis Forecasting Method. A new forecasting tool is being developed to help aid in predicting winds across the INL. This tool is based on a cluster analysis technique, using data from the Idaho mesonet operated by ARL. As a result of the analysis, eight unique cluster centers have been found to account for over 99% of the regional wind flows surrounding the INL. The new tool matches the current wind field to the closest cluster center and applies the probabilistic percentages of when the current cluster will likely transition into another cluster over time. The tool is solely based on pattern recognition and how the current wind pattern compares to climatology. This tool is already becoming an asset and a valuable tool for FRD meteorologists. roger.carter@noaa.gov, Neil Hukari, and Jason Rich

Special Operations and Research Division (SORD), Las Vegas

19. UrbaNet – Las Vegas Testbed. Plans for the proposed Las Vegas testbed continue to evolve, with ongoing discussions with the NWS, the Desert Research Institute, Bellagio Resort, St. Viator School, Clark County Fire Department, Las Vegas Fire & Rescue, and Clark County School District. Memoranda of Understanding are being prepared, in anticipation of the installation of a tower array like that of DCNet in the National Capital Region.

The associated model development program is making extensive use of the ARL dispersion mesonet in Nevada. In the last month, the land use component of the models has been modified, resulting in a noticeable improvement in boundary layer forecasts of wind, temperature, relative humidity, and dewpoint. kip.smith@noaa.gov