NOAA Air Resources Laboratory
Quarterly Activity Report

(July – September 2010)

Contents

Highlights

1. Particulate Matter National Ambient Air Quality Standards (PM NAAQS). Dr. Marc Pitchford is part of the EPA Integrated Scientific Assessment (ISA) Team that has been selected to receive an Office of Research and Development 2009 Bronze Medal Award for their accomplishments. In 2007, EPA invited Dr. Pitchford to work with them by providing technical expertise on visibility that was not available among their staff. His role on the PM ISA team entailed review and synthesis of policy-relevant scientific literature on the visibility effects of PM. This work is documented in chapter 9 of the final report, December 2009. Preparation of the ISA is the first in a series of steps in EPA's periodic review of and possible revisions to the NAAQS. He is currently working with EPA on the subsequent steps in the process that may lead next year to a revised PM NAAQS that would be specifically developed to protect the public welfare from visibility impacts. marc.pitchford@noaa.gov

2. Participation in Atmospheric Mercury Research Intensive at the Grand Bay NERR. From July 29-August 14, 2010, ARL scientists participated in an intensive atmospheric measurement project at the ARL mercury monitoring station in the Grand Bay National Estuarine Research Reserve (NERR) in Moss Point, Mississippi. The intensive was designed to answer key questions in atmospheric mercury research, including an assessment of the importance of transport from the upper troposphere in influencing mercury concentrations at the surface; the role of halogen compounds in mercury transformations; and the chemical identities of individual Reactive Gaseous Mercury (RGM) species.

For the research intensive, routine measurements of mercury species, meteorological parameters, and ancillary trace gas and aerosols at the site were supplemented with measurements of Hg^0 and RGM fluxes; event-based precipitation collection, and experimental dew collection for mercury analysis (Canaan Valley Institute). Halogen species in the atmosphere were measured via mass spectrometry (Georgia Institute of Technology), and mercury isotopes were measured in particles and in precipitation samples (Florida State University). In addition, Grand Bay NERR scientists facilitated the measurement of mercury concentrations in biota and in water and sediment samples at various locations within the reserve. Scientists from the University of Miami collaborated with scientists and staff from the University of Tennessee Space Institute (UTSI) to measure Hg^0 reactive gaseous mercury species aloft using a UTSI light aircraft. ARL provided support measurements of SO_2, O_3, and condensation nuclei aboard the aircraft to aid in air mass identification and evaluation, and launched ozonesondes from the NERR site to document the chemical and physical structure of the troposphere and lower stratosphere. Finally, ARL scientists used a newly developed version of a HYSPLIT-based mercury transport, chemistry and deposition model to simulate mercury concentrations at both the NERR and along the flight tracks, and the combined surface and aircraft data sets will be used for extensive *post hoc* model evaluation. For More information see: http://www.arl.noaa.gov/GBNERRmercury.php. winston.luke@noaa.gov, Steve Brooks.

Air Resources Laboratory – Headquarters

3. Performance Evaluation and Sensitivity Studies of the NOAA National Air Quality Forecasting Capability to Investigate Model Bias Issues. Comparison of the experimental and operational

forecast systems reveals a consistent bias between ozone distributions generated by the two forecast systems where the experimental track, utilizing the Carbon Bond 2005 (CB05) chemical mechanism, routinely generates higher ozone mixing ratios across the domain and larger biases as compared to surface measurement networks. An investigation into the causes of the bias between the models was performed to determine the mechanistic causes of the differences in ozone produced by the two forecast systems. The reactive nitrogen recycling reactions included in CB05, but not included in Carbon Bond IV (CB-IV), are shown to account for the majority of additional ozone produced in the experimental forecast system. In addition, sensitivity simulations of the experimental system to the changes in dry deposition velocities and boundary conditions were performed. Results show that use of more realistic boundary conditions and dry deposition velocities which account for satellite-derived forest canopy heights substantially reduces model high ozone biases over the southeast US and Rocky mountain regions. Experimental simulations also demonstrate some skill for Particulate Matter with diameters less than 2.5 μm ($PM_{2.5}$) forecasting corresponding to changing synoptic conditions, but exhibit significant overestimation in winter and underestimation in summer. daewon.byun@noaa.gov

4. Modeling Air Quality Impact of the Deepwater Horizon Oil Spill in the Gulf of Mexico. The oil spill, which began on April 20, 2010 from a well at the ocean floor following the explosion and subsequent sinking of the Deepwater Horizon offshore oil platform, has caused serious environmental concerns. Air quality concerns arise once the oil reaches the ocean surface. Smoke from burning oil gathered on the surface of the water and evaporative emissions from oil spread over the ocean surface can affect air quality. The amount of surface oil and emissions factors for controlled oil burning and evaporative hydrocarbon emissions are quite uncertain. Evaporative emissions are approximated into the area source emissions of hydrocarbons utilizing the NOAA surface oil forecast. The emission factors for crude oil burning over water have been compiled by reanalyzing data from previous in-situ ocean oil burning measurements, Environmental Protection Agency (EPA) emission factor documents, and Energy Information Administration (EIA) fossil fuel emission report. The simulation results with the bottom-up emissions have been compared with available observations and plume height estimates by the Multi-angle Imaging SpectroRadiometer (MISR) satellite. Community Multiscale Air Quality (CMAQ) simulations have been performed to assess the impacts of the oil spill on regional air quality with specific focus on ozone, $PM_{2.5}$ and benzene. Simulations with a wide range of emission scenarios have been performed to bound air quality impacts of the spill, subject to the uncertainties in the oil flow rate from the well. daewon.byun@noaa.gov

5. Modeling Studies of Secondary Organic Aerosol Formation. Considering that the whole complexity of the processes and factors involved in secondary organic aerosol (SOA) formation has not yet been completely understood, there is a need to isolate the chemical contribution in three-dimensional photochemical models from other SOA formation origins. Measurements made under controlled environmental conditions, such as those performed in a smog chamber, offer a unique opportunity to study the chemical processes leading to SOA production. Therefore, comparison with chamber data allows the evaluation of the chemical processes of SOA formation simulated by the chemical and aerosol modules used in the Community Multiscale Air Quality (CMAQ) model. In order to investigate the formation processes of SOA in a smog chamber we configured CMAQ as a multiphase 0-D box model with the initial conditions of temperature, humidity, solar radiation and chemical concentrations measured at the EUropean PHOtochemical REactor (EUPHORE) chamber.

The evolution of the concentration of each measured chemical has been modeled and compared for each experiment using the current chemical configuration of the developmental National Air Quality Forecast Capability (CB05-AERO4) as well other gas-phase chemical mechanisms such as CB-IV and Statewide Air Pollution Research Center 99 (SAPRC-99) and the AERO5 aerosol module. The comparison of the SOA formation along with the consumption of precursors with different initial NOx and VOC concentrations as measured in the smog chamber determines if the chemical mechanism used in the CMAQ model can reproduce not only the maximum SOAs but also their formation rate. ariel.stein@noaa.gov

6. Risk Assessment of Toxics from Sea-surface Burning of Oil from the Deepwater Horizon Spill. An atmospheric modeling analysis was carried out by ARL to estimate the regional air concentrations and deposition of a group of toxic pollutants arising from the burning of oil on the sea surface. The work was done at the request of the EPA to support a risk assessment being conducted related to the exposure of the general public to those pollutants. The simulations were done with a special version of the HYSPLIT model configured to simulate semi-volatile pollutants (HYSPLIT-SV) and were carried out in several phases as new information became available over time. In addition, fine-scale meteorological data were also provided to EPA for complementary modeling that they were conducting in support of the same risk assessment. The ARL work was performed in an evolving, time-sensitive situation, and required close collaboration with the EPA. A joint EPA-NOAA manuscript has been prepared and submitted for journal publication. This work and the accompanying risk assessment are expected to be released to the public in the coming weeks. mark.cohen@noaa.gov, Roland Draxler, Richard Artz.

7. HYSPLIT Training Workshop. A new training script was developed for the University of Huelva (Spain) workshop by utilizing multiple meteorological data sets and actual emissions and air concentration measurements so that more realistic simulations can be conducted. This new approach will be a prototype for a yet-to-be developed tutorial based upon one of ARL's tracer experiments. The workshop was conducted from 27-29 September. roland.draxler@noaa.gov

8. HYSPLIT Modifications. A considerable number of modifications and enhancements have been made to the online HYSPLIT capability used by the National Weather Service Forecast Offices (WFOs) to provide assistance to local emergency managers. Some of these changes were requested by a few WFOs who have been testing the capability and also by the developers from the University Corporation for Atmospheric Research COMET (Cooperative Program for Operational Meteorology, Education and Training) program who are creating training materials for the WFOs. Other changes were inspired by events that highlighted existing program limitations. For instance, an option was added to force the particle size bin redistribution by expanding the predefined particle sizes into multiple bins assuming a linear distribution of cumulative mass with the log of increasing particle size. An unlimited number of bins can be defined. This new feature improves the simulations by producing smoother concentration patterns for those events that have a large range of particle sizes such as volcanic eruptions or nuclear detonations. glenn.rolph@noaa.gov

9. ***ARL Delivered HYSPLIT Dispersion Model System Volcanic Ash Upgrade to National Weather Service/National Centers for Environmental Prediction (NWS/NCEP).*** This upgrade was inspired by issues raised following the eruption last spring of the Eyjafjall volcano in Iceland, in which European air traffic was stopped for days, was coordinated through the NOAA Volcanic Ash

Working Group, and followed a briefing to NCEP Management. The main new feature is a simple method to adjust the modeled downwind ash cloud position to better agree with satellite analyses; then the forecast is made from that adjusted ash cloud position. Other new capabilities that were in the HYSPLIT system, but not operationally available for the volcanic ash runs at NCEP, include an option to enable or disable wet deposition, more readily handle time varying eruption heights, and more efficiently simulate long-lived eruptions. barbara.stunder@noaa.gov, Roland Draxler

10. Cloudiness Trends in the U.S. Work began on a project to improve understanding of trends in cloudiness in the U.S. using ground-based observations. Data from military weather stations has been downloaded and processed. The project will include data from selected National Weather Service and airport stations as well as satellite data and other sources of information, and involve assessment of homogeneity of the cloud data. melissa.free@noaa.gov

11. Summer Intern. Dian Seidel mentored Elizabeth Jung, summer intern in the NOAA/Smith-5 Colleges internship program on a research project studying climate variability of the tropical cold point tropopause. dian.seidel@noaa.gov

Atmospheric Turbulence and Diffusion Division

12. Historical Climatology Network's Modernization (HCN-M) Goal Met. The CRN/HCN-M group met a difficult, high-profile goal this quarter by installing 50 new HCN-M sites (for a total of 60 installed sites) despite many delays for site approval, site-access approval, and similar impediments. This goal had become an explicit performance goal, not only for HCN-M, but for NWS, and for NOAA. The accomplishment was noticed at very high levels. mark.e.hall@noaa.gov

13. Climate Reference Network (CRN) Updates The CRN team installed two new remote sites in Alaska. The team visited the other six Alaska sites for annual maintenance , as well as 17 others in the lower 48 states. The team logged a total of 399 staff days on the road from July through September. mark.e.hall@noaa.gov

14. Atmospheric Mercury. ARL atmospheric mercury sensors are deployed onboard the research ship, RRS Discovery, as part of GEOTRACES, a NOAA cooperative international study to examine the biogeochemistry of the world's oceans. Melanie Witt from Oxford University is operating the sensors in addition to analyzing mercury in the ocean water column. Data from the cruise will be used to study atmospheric mercury concentrations over the southern oceans and to explore opportunities to obtain funding for subsequent cruises. steve.brooks@noaa.gov

15. Twenty Years of Atmospheric Integrated Research Monitoring Network (AIRMoN). A seminal record of dry deposition estimates for environmentally significant species: ozone, sulfur dioxide, and nitric acid, has been transferred to ASCII files on modern media. Data from 17 sites over the continental U.S. from 1984-2004 are now conveniently available at ARL Headquarters for research or historical baseline purposes. latoya.myles@noaa.gov, L. Satterfield

16. Texas Renewable Energy Study. In accordance with a Cooperative Research and Development Agreement (CRADA) between ARL and Duke Energy, ATDD has operated boundary-layer instrumentation on the Ocotillo Wind Farm near Big Spring, Texas since July. The suite consists of

a surface-energy-balance station and a 30-m tower fitted at five levels with sonic anemometers and shielded thermometers. The Monin-Obukhov similarity theory parameterized by the local micrometeorological measurements is hypothesized to provide a more robust forecast of hub-height (80-m) wind than the power law currently in use. Wind turbines have a limited range of wind speed within which they operate efficiently. Their profitability is strongly related to the accuracy of a 24-hr wind forecast made in the morning for the day's energy trading. chris.vogel@noaa.gov, W. Pendergrass, R. White, R. Meyer

Field Research Division

17. ET Probe. Two Extreme Turbulence probes were deployed in the Florida Keys in July and August. One probe was deployed on a navigation light on the Atlantic Ocean side of the Keys. The second probe was installed on a navigation marker in Florida Bay. These probes have spikes on top to deter perching birds, which were a significant problem last year. So far the spikes appear to be largely successful; however, the birds have still caused problems by leaving droppings all over the solar panels used to power the probes. This is the first year in which all the deployed probes are fully self-sufficient both for power and remote communication. Cell-phone modems are used to communicate with the probes and have been largely reliable. The probes still have some hardware-reliability issues in the harsh South Florida summer environment. Future upgrades will need to focus on replacing some components that do not appear to be as robust as advertized. richard.eckman@noaa.gov, Roger Carter, Tom Strong, Shane Beard, Randy Johnson

18. Weather/Hurricane In- situ Sea Surface Probe (WHISSP) Project. Work continues on a balloon-based observing system that could be advected into the eye of a hurricane and stay in the eye at the ocean surface for a long period of time. Our balloons plus a spare have been prepared for test launching by modifying the balloon and installing the "WISDOM (Weather In-Situ Deployment Optimization Method) sonde" environmental protection enclosure that protects the sonde from any water damage. Each balloon was inflated with helium and the net lift was monitored for 18 days to determine if there was a leak in any of the balloons. None were found to have a leak. Two balloons have also been modified to permit the insertion of the sonde inside the balloon with only the lower portion of the sonde enclosure and antenna protruding below the balloon. Several days of testing will be necessary to determine helium loss rate.

Hawaii is being considered as one of the possible test balloon launch sites but would require a different satellite and possibly necessitate taking the satellite receiver and antenna to Hawaii. We have also contacted the Charleston, North Carolina National Weather Service office concerning the use of Tybee Island, Georgia or the surrounding area as a balloon launch location. The office said that this area would be a good location for the launches if we waited for the passage of a cold front, which occurs more frequently later in the year. We have decided to wait until mid-October or later when cold fronts pass on a weekly basis. They can typically forecast these events about three days in advance. randy.johnson@noaa.gov

19. Big Southern Butte Fire Weather Research. The U.S. Forest Service (USFS) headed the Big Southern Butte field study to develop a database for testing and improving wind models in complex terrain for wild fire applications. FRD's participation in this field study began on June 2, with the deployment of 4 sonic anemometers, and terminated on September 13 when the 4 sonics were

removed from service. In between, FRD participated in two intensive measurement periods during which two mobile sodars and a radar wind profiler were deployed to measure the upwind approach flow to the butte to complement the other measurements being made. These two intensive measurement periods ran from July 15-18 and August 31 to September 2. The other measurements included an array of over 50 anemometers deployed by the USFS across the butte for the entire experimental period, the standard suite of NOAA/Idaho National Laboratory mesonet measurements, plus two additional sodars and an upwind vertical sonic anemometer profile provided by the USFS and Washington State University for the intensive periods.

FRD will provide the USFS with data from the 4 sonic anemometers, 2 sodars, mobile radar wind profiler, NOAA/INL mesonet, and WRF model output covering the experimental period. Based upon a cursory examination, most of the data appear to be good except for some sodar data from the first test and a period of time for the sonic anemometer that was deployed atop the butte. That was related to a bad battery and the dependence on solar power. dennis.finn@noaa.gov, Shane Beard, Tom Strong, Rick Eckman, Jason Rich

20. DOE Wind Forecast Improvement Study. FRD's participation in the Big Southern Butte Fire Weather Research Study proved to be a valuable opportunity to do a shakedown test of the sodars slated for use in the wind energy field studies in 2011. During the first test from July 15-18 problems were discovered in both FRD sodars. The Radian sodar was last deployed 7 years ago and it was learned that a power supply on it had failed in the interim. The Atmospheric Systems Corp. minisodar was found to have a corroded contact in its ASP unit. Both of these problems were rectified prior to the second deployment. The wind profile data now being generated by both units now appears to be a generally good and accurate portrayal of the wind. They have been redeployed to a site on the INL where their measurements can be compared with the measurements from the permanent sodar installation, permanent radar profiler, and nearby tower data to make a more rigorous assessment of the quality of the sodar measurements prior to their deployment in the upcoming wind energy studies. dennis.finn@noaa.gov, Shane Beard, Tom Strong, Rick Eckman, Jason Rich)

21. High Resolution Rapid Refresh (HRRR) Model Collaboration with ESRL. FRD is now collaborating with the Global Systems Division at ESRL on obtaining output from the HRRR model. This model runs hourly with a 3 km horizontal grid spacing and provides forecasts out to 15 hours. Automated scripts have been developed to transfer a subset of the HRRR output to FRD on an hourly basis. The model forecasts are being compared with observations from the NOAA/INL Mesonet. rick.eckman@noaa.gov

Special Operations and Research Division

22. Particulate Matter (PM) Policy Assessment. Marc Pitchford completed the Second Review Draft of the PM Policy Assessment document, posted it to EPA's web site with hard copy and electronic versions distributed to the Clean Air Science Advisory Committee (CASAC) for review. Marc is a significant contributor to the policy assessment on the topic of visibility effects of PM (chapter 4), which concludes that current national air quality standards are not adequate to prevent visibility impacts. It recommends use of a 1-hour averaged speciated PM2.5 mass-calculated light extinction based standard that would apply to all daylight hours with relative humidity not exceeding

90%. The Policy Assessment includes recommendations for a range of levels for consideration in a new standard and how frequently those levels could be exceeded without violating the standard. Following CASAC and public review of this document, a final document will be prepared and a formal proposal by EPA will be made in the fall, which leads to final action by the EPA Administrator in 2011. Marc Pitchford attended the EPA Clean Air Science Advisory Committee (CASAC) meeting in July to hear their review comments on the Policy Assessment for the Review of the Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS), Second Review Draft (June, 2010). marc.pitchford@noaa.gov

23. Urban Visibility Assessment. The Final Draft Urban-Focused Visibility Assessment was completed and made public by EPA this week. Marc Pitchford is one of the primary authors of this document that combines visibility preference public survey study results to determine what visibility levels are detrimental to the public, with ambient monitoring data to determine typical visibility levels in 15 major urban areas in order to determine whether visibility is a public welfare issue that is not adequately addressed by current Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS). The assessment also investigates the efficacy of possible NAAQS standards using alternative indicators, forms, levels and averaging times. marc.pitchford@noaa.gov

24. Federal Radiological Monitoring and Assessment Center (FRMAC). Walt Schalk attended a meeting of the FRMAC Operations Working Group in Las Vegas. Updates from the Department of Health and Human Services, Department of Energy, the Center for Disease Control, and the EPA were presented as well a review of exercises and lessons learned in the past year. walter.w.schalk@noaa.gov

25. Consequence Assessment. Kip Smith and Walt Schalk participated in a National Nuclear Security Administration (NNSA)/Nevada Site Office (NSO) emergency response exercise and the pre-exercise tabletop drill. This exercise involved a terrorist created nuclear device detonation in downtown Las Vegas. Smith and Schalk were the Consequence Assessment Team (CAT) for the NSO Emergency Operations Center (EOC) and ran fallout dispersion models, provided plots and dispersion/consequence assessment advice, and weather data and forecasts to the NSO Emergency Manager. In addition, the EOC was relocated from the North Las Vegas Support Facility to the Emergency Management Center at the Nevada Test Site. Information provided included plume path, radiation dose estimates, shelter in place and evacuation advice, and weather data. walter.w.schalk@noaa.gov and Kip Smith

26. Air Quality Permit Modeling. Kip Smith performed modeling work in support of a modification to the Nevada Test Site (NTS) Air Quality Operating Permit. The Open Burn/Open Detonation Model was run for a proposed explosive testing and training facility. The modeling results showed that explosions at the new facility would be extremely unlikely to contribute to an exceedance of the National Ambient Air Quality Standards for O_3, NO_2, SO_2, CO, or PM10 outside the NTS. (kip.smith@noaa.gov)

27. Other.

SORD completed the move out of the former Electronics Shop building in Mercury, NV at the Nevada National Security Site (NNSS, formerly the Nevada Test Site, NTS). The electronics shop

capability and technician were moved to the Desert Rock Observatory and is now co-located with the Meteorological Technician field office. This move consolidates field operations and provides some cost savings.

Walt Schalk led a video teleconference roundtable discussion on Generation X in the OAR workforce. This was a part of the project for the Intergenerational Work Environment Team of the Leadership Effectiveness and Awareness Program (L.E.A.P.), an OAR Leadership year-long course. Data from this and two other VTCs will be reviewed and information will be presented to OAR Senior Management. An interim update will be presented at the next combined meeting in October.

ARL 4th Quarter Publications List

***Published this quarter**:*

Seidel, D.J., C. O. Ao, and K. Li (2010), Estimating climatological planetary boundary layer heights from radiosonde observations: Comparison of methods and uncertainty analysis, J. Geophys. Res., 115, D16113, doi:10.1029/2009JD013680.

***Accepted this quarter**:*

Free, M., The seasonal structure of temperature trends in the tropical lower stratosphere, Journal of Climate. The paper describes a strong seasonal difference in stratospheric cooling in the tropics, with up to 1 K/decade greater cooling in boreal winter than in spring. The paper also examines the relationship between that cooling and winter warming trends in the Arctic stratosphere, and finds that the trends are not consistent for different time periods. melissa.free@noaa.gov

Sun, B., A. Reale, D. J. Seidel, and D. C. Hunt, Comparing radiosonde and COSMIC atmospheric profiles data to quantify differences among radiosonde types and the effects of imperfect collocation on comparison statistics. In revision for J.Geophys. Res.

***Submitted and under revision this quarter**:*

"Radiosonde Balloon Drift Climatology" by Dian J. Seidel, Bomin Sun, Michael Pettey, Anthony Reale, in revision for J. Geophys. Research.

"Climatological Characteristics of Arctic and Antarctic Surface-Based Inversions" by Yehui Zhang, Dian J. Seidel Jean-Christophe Golaz , and Clara Deser, Robert A. Tomas, submitted to Journal of Climate.