NOAA Air Resources Laboratory
Quarterly Activity Report
FY2014 Quarter 4
(July - September, 2014)

Contents

DISPERSION AND BOUNDARY LAYER

1. READY Tailored Web Interface for National Hurricane Center

A new tailored web interface was created in READY (Real-time Environmental Applications and Display sYstem) after receiving a request from Warren Madden of the National Hurricane Center (NHC). The tailored interface now allows forecasters to create forecast height contour maps for flight planning purposes with minimal input by the user. Warren works with the Chief, Aerial Reconnaissance Coordination, All Hurricanes (CARCAH) unit, a U.S. Air Force unit collocated with the NHC. CARCAH's mission is to coordinate and manage all aircraft reconnaissance into tropical systems. Warren reported that, as part of their quality assurance procedures for aircraft data, his unit and the Air Force's 53rd Weather Recon Squadron (aka Hurricane Hunters) "rely on the ARL Ready website extensively to produce contoured geo-potential height maps over the ocean areas we fly." ARL's READY was initially developed in 1997 to allow ARL researchers access to HYSPLIT and NCEP model forecasts from any location through a user-friendly web interface.
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2. Volcanic Ash Modeling

Alice Crawford and Barbara Stunder worked on several aspects of volcanic ash dispersion modeling to support NOAA forecasts at the Washington, DC, and Anchorage, AK, Volcanic Ash Advisory Centers (VAACs). They coordinated with the U.S. and U.K. VAACs on proposing standards for dispersion model output to facilitate comparison among the VAACs' different models. Alice wrote an internal report summarizing literature search findings in relating eruption column height to mass eruption rate, which needs to be known to produce quantitative volcanic ash output. ARL received volcanic ash satellite analyses of the eruption of Kasatochi, Alaska, 2008, from the NESDIS Center for Satellite Applications and Research (STAR). ARL has reformatted it for use in an inverse modeling system and for model verification.
barbara.stunder@noaa.gov

3. New HYSPLIT Upgrade Delivered to NCEP

A HYSPLIT upgrade package, including the new Comprehensive Test Ban Treaty Organization (CTBTO) back-tracking application, was put into operations at NCEP September 30, 2014. This completes a lengthy process of making final changes following rigorous testing by NCEP and providing documentation to NCEP. The HYSPLIT software was upgraded to revision 560. This includes use of pre-computed random numbers and an option for using a variable Lagrangian time scale. All of the NCEP HYSPLIT applications (wildfire smoke, dust, volcanic ash, radiological, HAZMAT, and CTBTO) are run using a single dispersion executable. The smoke runs now use the 3-D particle configuration within HYSPLIT to better include the new automated Canadian and Mexican fire source locations. This will improve NCEP's smoke forecast guidance in the US when smoke comes from Canada or Mexico. Two new HYSPLIT-formatted meteorology files are available. The first is a half-degree horizontal resolution, native model level, Global Forecast System (GFS) model output, which is the default meteorology for volcanic ash and radiological HYSPLIT runs. The second (new

to NCEP but not new to ARL) is a weekly one-degree, pressure-level, Global Data Assimilation System (GDAS) model output (ARL's GDAS1 archive), which is used for CTBTO runs. These and the existing HYSPLIT-formatted meteorology files are output to an NCEP server (ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/hysplit/prod/) and are transferred to the ARL READY server (http://www.ready.noaa.gov/), both serving the public, and to a NOAA operational server (https://www.hysplit.noaa.gov/) to support NWS Weather Forecast Offices. This upgrade is an example of transferring NOAA's research and development to operations. Much coordination among ARL, NCEP's Environmental Modeling Center and NCEP Central Operations, NWS Office of Science and Technology, and others was needed to make this upgrade package happen. barbara.Stunder@noaa.gov

4. Convective Initiation Project

In support of ARL's contribution to the funding received from the Disaster Relief Appropriations Act of 2013 (Sandy Supplemental), a field campaign was conducted to enhance understanding of triggers of convection in non-synoptic forcing conditions, such as those observed in the Southeastern U.S. Five tower systems were deployed to measure the surface fluxes, as well as to monitor the atmospheric forcing variables and land surface properties. An upper air intensive campaign was also conducted using weather balloons (radiosondes). The radiosondes were released at a field site located on the Tennessee Valley Research and Extension Center (TVREC) operated by Auburn University. The nearly 800 acre TVREC is near Belle Mina, Alabama located just north of the Tennessee River, and just east of Interstate 65. The campaign began the week of July 23 and lasted for several days. Profiles were obtained every two hours between 5:00 am CDT (1000 GMT) and 9:00 pm CDT (0200 GMT next day) during a synoptic period in which convective initiation could be tied to regional surface energy exchange. The series of atmospheric soundings are currently being evaluated and will be coupled with multiple measurements of surface heat flux and associated components from installed flux towers to develop a database for atmospheric forecast model development and evaluation addressing convective initiation.

Data was also collected by ARL's project partner, the University of Tennessee Space Institute (UTSI), using their Piper Navajo aircraft. The aircraft flew over the Belle Mina site at 2000 feet above ground level (AGL) on July 23 and 25, 2014. Another pass was made over the entire site at 7500 feet AGL on July 29, 2014. ed.dumas@noaa.gov B. Baker

A small unmanned aerial system (sUAS) was acquired by ATDD. The sUAS is a DJI S-1000 octocopter that is capable of lifting approximately 10 lbs of payload to an altitude of 400 feet above ground level for approximately 15 minutes on a single battery charge. Payload for the octocopter will include a small downward-looking FLIR Tau 2 infrared camera, a GoPro Hero 3 visible camera, and a GRAW radiosonde package to measure temperature and relative humidity. The mission for the octocopter will be to measure the spatial variability of both the thermal infrared and visible wavelengths of the surface surrounding the flux towers in the portion of the Convective Initiation experiment that is expected to happen near Venus, Florida, in March, 2015. Additionally, profiles of

temperature and humidity will be conducted using the octocopter over the tower sites. ed.dumas@noaa.gov, B. Baker

5. Project Sagebrush

ARL's Field Research Division (FRD) completed its initial draft of the comprehensive data report for Phase 1 of Project Sagebrush (PSB1). The report is undergoing internal review. The final report will provide detailed description of all aspects of the experimental design, instrumentation, measurements, quality control procedures, and the final database for the project. Washington State University (WSU) partners provided key data from their four flux stations, which covered the time period of the FRD tracer experiments, and allowed FRD to proceed with completion of the draft report. A manuscript for journal publication has been drafted that covers some of the key findings of PSB1.

Measurements continued to be collected on the Grid 3 tall tower in collaboration with WSU. Collection will continue until at least late October. Depending on needs and schedules, it is possible that the measurements will continue into next spring. The combination of data from WSU and FRD will provide a very detailed look at the vertical profiles of turbulence over a broad range of conditions. dennis.finn@noaa.gov, Rick Eckman

In preparation for the next field deployment, additional sampler cartridges are being refurbished by replacing the tubing and sealing the sampling bag to the tubing connection. FRD refurbished 278 sampler cartridges, making a total of 840 cartridges available. This allows five complete sampling periods using all available samplers to be completed before cartridges must be re-used. roger.carter@noaa.gov

An abstract entitled "Changes in Horizontal Plume Distributions at Larger Turbulence Intensities" was accepted for oral presentation at the 2015 American Meteorological Society Annual Meeting in Phoenix, Arizona. It describes some unexpected results obtained from the Project Sagebrush tracer study in periods with high turbulence intensities. richard.Eckman@noaa.gov, Dennis Finn, Kirk Clawson

6. Birch Creek Valley Wind Flow Study

The draft manuscript "Diurnal Late Spring and Summertime Wind Patterns on the Snake River Plain and the Influence of Complex Terrain Factors" was submitted for publication in the Journal of Applied Meteorology and Climatology. It is currently in review there. It summarizes results from the first phase of the Birch Creek Valley measurements. Follow up work on a second phase of analysis was started, but FRD is waiting for data from the U.S. Forest Service Fire Sciences Laboratory in order to move forward. dennis.finn@noaa.gov

7. Consequence Assessment for the Nevada National Security Site

The Special Operations and Research Division (SORD) participated in an emergency response exercise as the Consequence Assessment Team for the NNSA Nevada Field Office. The exercise was conducted on the Nevada National Security Site (NNSS). In

this exercise, SORD provided exercise specific weather data and weather forecasts, and generated dispersion products based on the worst case event scenario information provided for the facility involved. The exercise was a security event. A Consequence Assessment model was run for the worst case scenario and group leaders were briefed on the results. This exercise involved the DOE/NNSA/NFO Emergency Response Organization. Walt Schalk participated in the exercise as the Facilitator for the Consequence Assessment Team. walter.w..schalk@noaa.gov, Rick Lantrip, Kip Smith

8. Support for Experiments on the NNSS
Walt Schalk participated in several planning meetings with regard to the non-proliferation experiment, Shock Physics Experiment (SPE) 4-prime. Increased rigor in the planning process and the conduct of the experiments is being implemented. This will result in the addition of specific weather criteria during the preparation and conduct of these experiments. These additions will increase the collaboration between SORD and the experiment team. Technical issues with the experiment have delayed field support of the project. walter.w..schalk@noaa.gov

AIR QUALITY

9. National Air Quality Forecasting Capability
ARL presented information on the merit and necessity to upgrade to the National Air Quality Forecasting Capability (NAQFC) to the Director of the National Center for Environmental Prediction (NCEP) Environmental Modeling Center (EMC). The upgrade includes a distribution of surface particulate matter (PM) concentrations to a select group of local and state air quality forecasters and managers. The EMC Director approved the upgrade and a final 30 days pre-implementation testing was started by NCEP Central Operations. The upgrade showed improved results in all performance metrics when compared to the current operational NAQFC. The upgrade accounted for intermittent PM emissions from wild fire smoke and from wind-blown dust. The upgrade is slated to be a new developmental product for PM and an operational product for ozone around November 9th. This upgrade is an example of transferring NOAA's research and development to operations. pius.lee@noaa.gov

10. Air Quality Forecasting for Quantitative Observing System Assessment Program
ARL began to contribute to the Quantitative Observing System Assessment Program (QOSAP) with air quality applications. The QOSAP is a joint effort across multiple NOAA institutions designed to quantify the effectiveness and utility of current and future observation systems. Dr. Bob Atlas, AOML Director and QOSAP Program Leader, asked ARL to assess scenarios in terms of air quality forecasting capabilities. Funding in FY15 should enable ARL to conduct a high spatial resolution chemical composition model simulation for the troposphere over the conterminous U.S. for a recent summer. pius.lee@noaa.gov

11. Atmospheric Mercury Modeling
The final report on the 3rd year of a Great Lakes Restoration Initiative (GLRI) project "Modeling Atmospheric Mercury Deposition to the Great Lakes: Projected

Consequences of Alternative Future Emissions Scenarios", co-authored by Mark Cohen, Roland Draxler, and Richard Artz, was completed. The HYSPLIT-Hg model was used to simulate the fate and transport of mercury emitted from anthropogenic and natural sources worldwide, and the amount and source attribution of atmospheric deposition to the Great Lakes was estimated. A baseline emissions inventory and three future-scenario inventories were adapted from Lei et al. (Atmos Chem Phys 14: 783-795, 2014) for use in the project. Results from the baseline inventory were evaluated by comparison against ambient concentration and wet deposition measurements in the United States and Canada. Very encouraging agreement was found between the modeling results and measurements. To develop source-attribution estimates, separate simulations for the following emissions inventory subsets were carried out: biomass burning, land surfaces, ocean surfaces, volcanoes, direct anthropogenic emissions, and re-emissions of previously deposited mercury. Additional country-specific simulations were carried out for direct anthropogenic emissions from the U.S., Canada, Mexico, China, Russia, and India, countries estimated to have the highest individual contributions in earlier phases of this work. For Lake Erie, Lake Ontario, and Lake Michigan, it was estimated that direct anthropogenic emissions from the U.S. contributed ~20% of the total deposition for the baseline emissions. For two future scenario inventories with increased emissions, direct U.S. emissions contributed ~40% of the total deposition. For Lake Superior and Lake Huron, it was estimated that the contribution from direct U.S. emissions were ~10-15% in the baseline and ~30% in two higher-emissions future scenarios. mark.cohen@noaa.gov

12. Atmospheric Mercury Measurements

Winston Luke conducted remote manipulations of the Tekran speciation system installed at the Mauna Loa Observatory in order to investigate humidity effects on artifact formation of particulate-bound mercury at the site. Humidification of the sample airflow has been found to substantially reduce the severity of the measurement artifact, which arises from the direct conversion of gaseous elemental mercury (GEM) to particulate bound mercury (PBM) when components in the analytical system become contaminated with unknown material. This artifact can lead to the overestimation of PBM and the underestimation of GEM, thereby over-predicting the concentrations of more reactive forms of mercury and potentially overestimating the impacts of direct and indirect deposition of mercury to sensitive ecosystems. The phenomenon has also been observed at the Grand Bay Atmospheric Mercury Network (AMNet) site in coastal Mississippi. Efforts are underway to assess the magnitude of the artifact formation at other AMNet sites. The data will be analyzed, interpreted and presented at a meeting of the Committee for Environment and Natural Resources Air Quality Research Subcommittee, as well as at the Fall 2014 National Atmospheric Deposition Program Scientific Symposium and the Fall 2014 meeting of the American Geophysical Union. winston.luke@noaa.gov

Winston Luke traveled to Hanoi, Vietnam for an Asia-Pacific Mercury Monitoring Network (APMMN) workshop and a meeting of the APMMN Science Advisory Group. The invitation-only workshop, organized by the Vietnam Environmental Administration, the Taiwan Environmental Protection Administration, U.S.

Environmental Protection Agency, the National Atmospheric Deposition Program, and the National Central University, Taiwan, sought to further advance development of the APMMN and facilitate cooperation among key monitoring stakeholders in the region. Participants shared information on mercury monitoring plans for the region, and partners provided updates on their progress for having an APMMN pilot. Training and demonstrations of the mercury wet deposition sampling operation were provided. Winston provided a talk entitled "Atmospheric Mercury Measurements and Modeling at NOAA's Air Resources Laboratory (ARL)." winston.luke@noaa.gov

CLIMATE

13. Changing Width of Earth's Tropical Belt

The American Geophysical Union made an initial announcement of the July 2015 Chapman Conference on The Width of the Tropics: Climate Variations and Their Impacts. Changes in the width of the tropics have potentially important repercussions for the global hydrologic and carbon cycles and impact human societies and ecosystems. Dian Seidel is co-convening this conference with colleagues from ESRL, Colorado State University, and Columbia University.

An invited feature article titled "The Changing Width of Earth's Tropical Belt" by T. Birner (Colorado State Univ.), S.M. Davis (NOAA/ESRL/CSD), and Dian Seidel was accepted for publication in the December issue of Physics Today. The article, geared toward a general science readership, describes the fundamental physics governing atmospheric circulation patterns that determine the tropical belt and discusses the challenges associated with locating the edges of the belt and determining its changing width. dian.seidel@noaa.gov

14. Fireworks Effects on Air Quality

Dian Seidel and summer intern Abby Birnbaum completed an analysis of the effects of July 4 fireworks on fine particulate air pollution in the U.S. This study is the first comprehensive analysis of fireworks effects on air quality over a large region or based on systematic observations over multiple years. Results have direct applications to the epidemiology of respiratory ailments, air pollution modeling, and national and local air quality regulations. Abby will present findings at the January 2015 AMS Annual Meeting. A manuscript is in progress. dian.seidel@noaa.gov

15. Climate-Weather Research and Forecast Model

Using the Climate-Weather Research and Forecast (CWRF) model, a series of downscaling/nesting experiments were performed and analyzed. Publications are forthcoming concerning improvement of the skills associated with seasonal climate outlook at the regional scale and of the seasonal prediction of U.S. precipitation and temperature by the nested Climate Extension of the Weather Research and Forecasting Model European Centre Hamberg Model (CWRF-ECHAM) system. julian.wang@noaa.gov

16. Soil Moisture Datasets

ARL/HQ is collaborating with European Space Agency's Climate Change Initiative Phase 1 Soil Moisture Project team, NCEP Land Surface development team, NASA land surface modeling and data team, and Texas A&M University's NASMD (The North American Soil Moisture Database) team. Three types of soil moisture datasets have been acquired via satellite remote sensing, in-situ observation, and model simulation. Data quality is being assessed. julian.wang@noaa.gov

17. FOCAL – Alaska Study

ATDD continued its analysis of the data collected during the Flux Observations of Carbon from an Airborne Laboratory (FOCAL) –Alaska study. The study involved, for perhaps the first time, the capability of measuring not only methane, water vapor, and carbon dioxide at a fast enough rate for eddy-covariance flux calculations but also their isotopologues with carbon-13 and deuterium, all from a relatively unobtrusive light-twin airplane. Flights were conducted over the North Slope of Alaska the previous summer (August 2013), collecting samples approximately10 m above ground in order to capture the effect of surface heterogeneity on the concentrations and fluxes of these gases. The results for methane flux are complex and analysis is ongoing. Conclusions so far are:

- Methane flux varied in absolute value by a factor up to 25 with clear sunny days having the strongest upward flux.
- Though all days analyzed had net upward methane flux, downward flux was quite common, especially on cooler days.
- The strongest mean upward flux, about 175 kg / (km^2 d), was found on August 13, a day with a well-developed mixed layer 160 m deep.

A proposal was submitted to the National Science Foundation for continued funding of the FOCAL study. The proposal includes engineering development flights near Wallops Island, Virginia in the summer of 2015, followed by deployment to the North Slope of Alaska in the summers of 2016 and 2017. A new component was added to the proposal to include use of the Weather Research Forecast with Stochastic Time-Inverted Lagrangian Transport (WRF-STILT) model to extend the high resolution spatial methane and carbon dioxide flux data from the Centaur aircraft to larger regional scales. ed.dumas@noaa.gov, ron.dobosy@noaa.gov, Bruce Baker

ARL 4th Quarter Publications

Free, M. and B. Sun. (2014) Trends in U.S. Total Cloud Cover from a Homogeneity-Adjusted Dataset. *Journal of Climate*. 27(13): 4959-4969. doi:10.1175/jcli-d-13-00722.1.

Lei, H. and **J.X.L. Wang** (2014) Observed characteristics of dust storm events over the western United States using meteorological, satellite, and air quality measurements, *Atmospheric Chemistry and Physics*. 14 (15), 7847-7857, doi:10.5194/acp-14-7847-2014.

Wilson, T. B., **J. Kochendorfer**, **T.P. Meyers**, M. Heuer, K. Sloop, and J. Miller (2014).

Leaf litter water content and soil surface CO_2 fluxes in a deciduous forest. *Agricultural and Forest Meteorology*. 192–193, pp 42-50. doi:10.1016/j.agrformet.2014.02.005

Brooks, S.; X. Ren, **M. Cohen**, **W.T. Luke**, P. Kelley, **R. Artz**, A. Hynes, W. Landing, B. Martos (2014). Airborne Vertical Profiling of Mercury Speciation near Tullahoma, TN, USA. *Atmosphere*, 5 (3): 557-574. doi:10.3390/atmos5030557
The paper presents, for the first time, vertical profiles of mercury speciation from aircraft for an annual cycle over a same location in Tennessee. Data obtained from 0 to 6 km altitudes show that gaseous elemental mercury exhibited a relatively constant vertical profile for all seasons. A pronounced seasonality of gaseous oxidized mercury (GOM) was observed throughout the low to middle free troposphere, with the highest GOM concentrations in the summer flights and lowest in the winter flights. Vertical profiles of GOM show the maximum levels at altitudes between 2 and 4km. Limited particulate bound mercury measurements exhibit similar levels to GOM at all altitudes.

Saylor, Rick D., Glenn M. Wolfe, **Tilden P. Meyers**, and Bruce B. Hicks. (2014). A corrected formulation of the Multilayer Model (MLM) for inferring gaseous dry deposition to vegetated surfaces. *Atmospheric Environment* Volume 92, 141–145. http://dx.doi.org/10.1016/j.atmosenv.2014.03.056

Pickering, E. K., and **P. Lee** (2014) Air quality forecasting guides flight plans during DISCOVER-AQ, *Environmental Manager*, September, 2014, 39-43.

Flynn, C. M., E.K. Pickering, J. Szykman, T. Knepp, M. Silverman, R. Long, and **P. Lee** (2014) Can surface air quality be estimated from satellite observations of trace gases? *Environmental Manager*, September, 2014, 28-33.

Duncan, B. N., A. I. Prados, …**Pius Lee**…et al. (2014). Satellite data of atmospheric pollution for U.S. air quality applications: Examples of applications, summary of data end-user resources, answers to FAQs, and common mistakes to avoid. *Atmospheric Environment* 94: 647-662.

Vet, Robert, **Richard S. Artz**, and Silvina Carou (2014). Preface to: A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorus. *Atmospheric Environment* 93: 1-2. doi:10.10.1016/j.atmosenv.2013.11.013.

Vet, Robert, **Richard S. Artz**, Silvina Carou, Mike Shaw, Chul-Un Ro, Wenche Aas, Alex Baker, Van C. Bowersox, Frank Dentener, Corinne Galy-Lacaux, Amy Hou, Jacobus J. Pienaar, Robert Gillett, Cristina M. Forti, Sergey Gromov, Hiroshi Hara, Tamara Khodzher, Natalie M. Mahowald, Slobodan Nickovic, P.S.P. Rao, and Neville W. Reid. (2014). A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorus. *Atmospheric Environment* 93: 3-100. doi:10.1016/j.atmosenv.2013.10.060

Vet, Robert, **Richard S. Artz**, Silvina Carou, Mike Shaw, Chul-Un Ro, Wenche Aas, Alex Baker, Van C. Bowersox, Frank Dentener, Corinne Galy-Lacaux, Amy Hou, Jacobus J. Pienaar, Robert Gillett, Cristina M. Forti, Sergey Gromov, Hiroshi Hara, Tamara Khodzher, Natalie M. Mahowald, Slobodan Nickovic, P.S.P. Rao, and Neville W. Reid. (2014). Addendum to: "A global assessment of precipitation chemistry and deposition of sulfur, nitrogen, sea salt, base cations, organic acids, acidity and pH, and phosphorus" *Atmospheric Environment*. 93: 101-116. doi:10.1016/j.atmosenv.2014.02.017

Conference Presentations & Invited Talks

Dian Seidel participated in the Climate Engineering Conference 2014 in Berlin, hosted by the Potsdam-based Institute for Advanced Sustainability Studies. She presented a talk on "Potential Assessment of Albedo Changes due to Climate Engineering" in a session on Assessment Methodologies for Climate Engineering Technologies, and a poster on "A Bibliometric Analysis of Climate Engineering Research."
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Outreach

LaToya Myles served as a panelist at the 2014 White House Initiative on Historically Black Colleges & Universities Conference in Washington, DC. She was invited to address one of the conference themes, "framing new pathways to science, technology, engineering, and mathematics."