NOAA Air Resources Laboratory

Quarterly Activity Report

FY2017 Quarter 1 (October, November, December 2016)

Contents:

DISPERSION AND BOUNDARY LAYER

1. DOE Ashfall Research Project

Alice Crawford attended the Department of Energy (DOE) Ashfall Research Project planning meeting in Hanford, WA, along with other scientists from the US Geological Survey, Desert Research Institute, and DOE. The main objective of this project is to assess the impact of a potential volcanic eruption of Mount St. Helens on the nuclear waste management facility at Hanford, WA. ARL's role is to develop and test new ash re-suspension algorithms that will be incorporated into the HYSPLIT modeling system. alice.crawford@noaa.gov

2. Updated READY Website

ARL launched an updated READY web site (http://www.ready.noaa.gov) that now includes some new features, such as:

- Access to 3 km High Resolution Rapid Refresh (HRRR) meteorological data forecasts and archives on sigma and pressure surfaces through READY meteorological display programs and the HYSPLIT dispersion model. HRRR forecast animations are also available.
- Access to the 4 km CONUS Nest forecasts on sigma-hybrid pressure surfaces in READY and HYSPLIT
- Short-Range Ensemble Forecast (SREF) dispersion products that can be moved by ARL to an ongoing event location that includes dispersion forecasts for individual members and ensemble statistical plots (HYSPLIT runs using the SREF forecasts will be coming soon)
- Trajectory frequency analysis of HYSPLIT trajectories based on up to 31 day trajectories
- Faster processor and more memory for calculations

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3. ARL Signs Memorandum of Agreement with EPA

In November, 2016 ARL signed a Memorandum of Agreement (MOA) with the U.S. Environmental Protection Agency's Office of Radiation and Indoor Air titled, "Atmospheric modeling of foreign nuclear incidents with radiological consequences in the United States." The MOA establishes a collaborative effort to protect human health and the environment following a major foreign nuclear incident. Global-scale modeling of the atmospheric fate and transport of radioactive materials is required to predict the impact of any release on the U.S. and its territories. ARL will develop, test, and provide specialized HYSPLIT products to support this MOA. In turn, EPA will provide ARL with RadNet (gamma radiation monitoring network) observations. Using these observations, ARL will develop estimates of source location and strength, as well as air concentrations and deposition of radioactive materials using a HYSPLIT-based inverse modeling methodology. ariel.stein@noaa.gov

4. Unmanned Aircraft Systems

ATDD continued to evaluate the iMet-XF instrumentation that goes aboard the Coyote small Unmanned Aircraft Systems (sUAS). The Coyote aircraft that was previously housed at ATDD was returned to Raytheon after it was determined that ATDD personnel could not swap the iMet-XF payloads without additional training. In the meantime, three iMet-XF systems were procured by ATDD and are being tested in the Thunder Scientific temperature / humidity chamber prior to installation in each Coyote. These systems will be used on the three replacement Coyote aircraft for the 2017 hurricane season. Ed Dumas and Mark Heuer are planning to travel to Raytheon in Tucson, AZ, in early February, 2017, to be trained on how to install and remove the iMet-XF payloads. ed.dumas@noaa.gov, Bruce Baker

ATDD received permission to fly the S-1000 and other sUAS at the House Mountain Radio Control model flying field in Corryton, TN. This flying site offers a relatively large, flat homogeneous grass field that will be ideal for testing the sUAS. On December 16, 2016, ATDD measured the variability of surface heat fluxes around a tower using both the S-1000 and the MD4-1000 sUAS. In addition to the sUAS, ATDD installed two surface flux towers to measure heat flux and surface temperature.

A total of seven flights were made, four with the S-1000 and three with the MD4-1000. The S-1000 was used to perform profiles over each tower to measure air temperature and relative humidity, as well as to collect images of surface temperature over each tower at the top of each profile. The MD4-1000 flew horizontal transects between each tower at altitudes of 2m, 10m, 25m, 75m, 125m, 175m, 225m, and 275m. ed.dumas@noaa.gov, Bruce Baker

Figure 1 - Google Earth image of HMRC showing the runway outlined in white and the bounds of the sUAS operating area in red. Blue and red stars show the approximate location of each surface flux tower.

ed.dumas@noaa.gov, Temple Lee, Michael Buban, Bruce Baker

5. Project Sagebrush

The four nighttime atmospheric tracer experiments of Project Sagebrush Phase 2 were conducted between October 13 and October 26. These releases targeted light winds on clear nights shortly before sunrise. Tracer was released for 2.5 hours, but the first half

hour was used to allow the plume to reach all the sampling arcs, so sampling did not take place during this time. For the remaining two hours, the samplers were programed to collect 10-minute samples per bag (12 bags per sampler). Samplers were deployed on three 210^{o} arcs located between 100 and 400 m from the source. A mobile tower at 400 m, a fixed tower at 200 m, and a set of three fixed towers at 100 m provided vertical tracer samples ranging from 10 to 25 m AGL. One fast response tracer analyzer was also deployed on each arc.

A preliminary summary of the meteorology during each of the four tests has been prepared. The analysis of the bag samples has been completed, including the primary quality assurance and control procedures. Predicting the average wind direction under nighttime light wind conditions proved challenging even with the wide 210^{o} sampling arcs. Even high-resolution numerical forecasts have difficulty forecasting wind directions under these conditions. Still, each of the four nighttime experiments had some periods that provided useful tracer data with some much better than others.

The same extensive suite of meteorological instrumentation and measurements that were deployed for the summer daytime experiments were also used for the October nighttime experiments. This was augmented with an additional five sonic anemometers and a ceilometer provided by Washington State University. These sonics were deployed at 3 m AGL across the tracer sampling array to help evaluate the horizontal variability of the turbulence in stable nighttime conditions. Two of the sonics were collocated with an infrared gas analyzer for measurement of water vapor and carbon dioxide fluxes.

Final detailed quality assurance and control procedures are in progress to ensure the most complete and accurate tracer data sets possible. This includes an evaluation of two striking features of the data. One is the surprisingly limited vertical plume rise observed in some instances. The other is the sometimes large differences observed between co-located, duplicate samplers positioned less than a meter apart. richard.eckman@noaa.gov

6. Wind Forecast Improvement Project (WFIP2)

Though most of FRD's instruments used for the WFIP2 have been functioning properly, there have been some problems with the wind profiler and the heater on the sodar at the Prineville site. Shane Beard visited the WFIP2 sites in late December to attend to the instruments.

FRD uploaded quality controlled datasets from the sodars and a conventional meteorological tower to the WFIP2 data repository, as well as associated metadata.

FRD began comparing data from the WFIP2 flux stations with forecasts from NOAA's High Resolution Rapid Refresh (HRRR) model. Additionally, in-house WRF model simulations are being run to further investigate some of the results observed with the HRRR model. Generally, the in-house WRF runs are showing similar biases as the HRRR model in comparison to the WFIP2 observations. The models tend to have a cold bias in soil and surface temperatures. A similar cold bias has also been observed when

comparing soil temperatures from nearby Climate Reference Network stations to the model forecasts. Further investigations are under way to better understand the source of these biases and their linkage to the land-surface parameterizations used in the forecast models. matt.brewer@noaa.gov, Shane Beard, Richard Eckman.

7. London Fog

A tracer dispersion project called London Fog was completed at the Idaho National Laboratory in October. The project focused on testing samplers that were developed at the John Hopkins University for defense applications and used a different tracer technology than samplers employed by FRD. FRD provided daily wind forecasts and forecast discussions to the Johns Hopkins researchers to help in determining the best times to conduct the London Fog tracer releases, but FRD did not actively participate in the releases themselves. jason.rich@noaa.gov, Richard Eckman

8. MARS Methane

Fieldwork on the MARS methane project by a university research group was conducted on the INL property during the first week of October. FRD provided the research group with general logistical and meteorological support during the field study. Data from a network of sonic anemometers that were deployed as part of Project Sagebrush were also provided after completion of their work. dennis.finn@noaa.gov

9. Consequence Assessment for the Nevada National Security Site

James Wood, Rick Lantrip, and Walt Schalk participated in three emergency response functional exercises as the Consequence Assessment Team (CAT) for the NNSA Nevada Field Office. The exercises were conducted on the Nevada National Security Site (NNSS). In the exercises, location weather data and weather forecasts were provided and dispersion products were generated based on the worst case event information provided for the scenarios. The events were two radiological accidents at different facilities and a chemical spill at a facility. These events were conducted with the DOE/NNSA/NFO Emergency Response Organization.
rick.lantrip@noaa.gov, James Wood, Walter Schalk

10. SORD Mesonet

SORD continues to look at ways to improve the SORD/NNSS mesonet. As we approach our first year with this new system, several areas of improvement have been revealed. Mitigation of ice riming of our 3D sonic anemometers and the need for heated precipitation gauges are at the top of the list of improvements. walter.w.schalk@noaa.gov, James Wood, Rick Lantrip

11. Support to DOE/NNSA NNSS Projects and Experiments

Walt Schalk, James Wood, and Rick Lantrip participated in the field support at the Nevada National Security Site (NNSS) for the non-proliferation Source Physics Experiment #6 (SPE-6) conducted in mid-October. Daily weather forecasts and

weather surveillance activities focusing on wind and lightning were provided during the days prior to the experiment as the site was prepared. SORD provided very specific and time sensitive weather forecasts and weather surveillance activities focusing on wind and lightning the day prior to and the day of the experiment. A radiosonde release was a part of this support for this experiment.

Walt Schalk has been working to develop a portable micro-net of weather stations to support experiments on the NNSS such as the SPE. A proof of concept with one station was deployed in support of SPE-6. A test system had been operating at the Desert Rock Weather Observatory at the NNSS for a couple of weeks. The proof of concept station during the SPE-6 experiment was a success and greatly appreciated by the national laboratory scientists. The main challenge was maintaining a wired connection to the station as the local critters were prone to chew on the communications cable (even in one day's time).

Rick Lantrip supported another non-proliferation experiment on the NNSS in December, by releasing a radiosonde down range of the experiment in southern Utah. The radiosonde was released from the Saint George, UT airport in coordination with the local FAA and airport staff. The winds aloft were very strong on that day and took the balloon downrange very quickly. The strong winds combined with the mountainous terrain caused an early termination of communications. A second radiosonde was released and similar results were observed. Data were provided to the national laboratory scientists. Walt Schalk and James Wood provided specific weather forecasts and surveillance for the experiment series. Walter.w.schalk@noaa.gov, James Wood, Rick Lantrip

ATMOSPHERIC CHEMISTRY AND DEPOSITION

12. Atmospheric Mercury Modeling

Mark Cohen carried out extensive testing and numerous simulations with the HYSPLIT-Hg model to estimate the 2011 transport and deposition of mercury to the Great Lakes in conjunction with a Great Lakes Restoration Initiative funded project. Mark also finished specification and incorporation of an extensive set of new watershed receptors into HYSPLIT Hg. The receptors are for a project being carried out in collaboration with the State of Maryland regarding Total Maximum Daily Loads analysis for mercury-impacted waterbodies in Maryland. Simulations of atmospheric mercury transport and deposition to these receptors from sources in the U.S. and the rest of the world have begun.

The paper "Atmospheric Mercury Temporal Trends in the Northeastern United States from 1992 to 2014: Are Measured Concentrations Responding to Decreasing Regional Emissions?" by Zhou, H, C. Zhou, M. M. Lynam, J. T. Dvonch, J. A. Barres, P. K. Hopke, M. D. Cohen, and T. M. Holsen was published online in Environmental Science and Technology Letters. mark.cohen@noaa,gov

Chris Loughner made substantial additional progress on parallelizing the HYSPLIT-Hg model, to further improve consistency between the serial and parallel simulations. Numerous variables had to be converted to double-precision to achieve satisfactory consistency, and the serial and parallel versions now give essentially identical results, even after extended model simulations. Chris also made substantial progress in developing a nested-grid capability with the Eulerian modeling framework of HYSPLIT-Hg. mark.cohen@noaa.gov; Chris Loughner

13. Ammonia Studies

Development of new parameterizations describing the ammonia emission potential of soil and stomatal pathways as a function of nitrogen status is ongoing. Data collected during the 2014 collaborative field study with the University of Illinois at Urbana-Champaign has been used in the development of these parameterizations for the SURFATM-NH3 model. SURFATM-NH3 is a bi-directional model that simulates ammonia exchange between terrestrial ecosystems and the atmosphere. Initial results are promising, with further refinement needed to more accurately estimate ammonia fluxes. latoya.myles@noaa.gov, Lichiheb, Heuer

CLIMATE OBSERVATIONS AND ANALYSES

14. Climate Reference Network (CRN)

ATDD staff visited 20 CRN sites, making16 annual maintenance visits, one installation, and three unscheduled maintenance visits. mark.e.hall@noaa.gov

15. NOAA/INL Mesonet

Eastern Idaho experienced periods of snow, ice, and extreme cold during December that presented challenges in keeping the Mesonet operating. In past years, extreme cold has often been associated with interruptions in Mesonet radio communications due to electrical arcing from power lines near FRD. Equipment replacements on these power lines by the power company appear to have mostly eliminated the radio interference from arcing. FRD is also discussing whether more heating elements need to be installed in the network to keep cup anemometers and vanes from icing during the winter.

FRD is collaborating with DOE-Idaho and INL site contractors to develop rules of engagement for installing non-NOAA equipment at the Mesonet stations. These rules will ensure that anyone installing equipment will be meeting safety guidelines and will not be placing equipment such that it is interfering with the primary meteorological measurements. All equipment will also have to be labeled with contact information. richard.eckman@noaa.gov

ARL 1st Quarter Publications

Brune, W. H., B. C. Baier, J. Thomas, X. Ren, R. C. Cohen, S. E. Pusede, E. Browne, A.H. Goldstein, D. R. Gentner, F. N. Keutsch, J. Thornton, S. Harrold, F. Lopez-Hilfiker, P. O. Wennberg, Ozone Production Chemistry in the Presence of Urban Plumes, Faraday Discuss., 189, 169-189, 2016, doi: 10.1039/c5fd00204d

Chang, C.-Y., E. Faust, X. Hou, P. Lee, H. C. Kim, B. C. Hedquist, and K.-J. Liao (2016). Investigating Ambient Ozone Formation Regimes in Neighboring Cities of Shale Plays in Northeast United States using Photochemical Modeling and Satellite Retrievals, Atmospheric Environment. 142, 152-170 , doi:10.1016/j.atmosenv.2016.06.058

Coopersmith, E. J., M. H. Cosh, J. E. Bell, V. Kelly, M. Hall, M. A. Palecki, and M. Temimi (2016). Deploying temporary networks for upscaling of sparse network stations. International Journal of Applied Earth Observation and Geoinformation, 52, 433-444. doi:10.1016/j.jag.2016.07.013

Finn, D., **B. Reese**, B. Butler, N. Wagenbrenner, **K. L. Clawson**, **J. Rich**, E. Russell, Z. Gao, and H. Liu (2016). Evidence for gap flows in the Birch Creek Valley, Idaho. Journal of the Atmospheric Sciences. 73:12, 4873-4894. doi:10.1175/JAS-D-16-0052.1

Graham, S. L., **John Kochendorfer**, Andrew M.S. McMillan, Maurice J. Duncan, M.S. Srinivasan, and Gladys Hertzog (2016). Effects of agricultural management on measurements, prediction, and partitioning of evapotranspiration in irrigated grasslands. Agricultural Water Management 177: 340-347. http://dx.doi.org/10.1016/j.agwat.2016.08.015

Hicks, B. B., **R. D. Saylor**, and B. D. Baker (**2016**). Dry deposition of particles to canopies—A look back and the road forward, Journal of Geophysical Research Atmospheres, 121, doi:10.1002/2015JD024742

Lei, H., **J. Wang**, D. Q. Tong, and **P. Lee** (2016). Merged dust climatology in Phoenix, Arizona based on satellite and station data. Climate Dynamics, 47(9-10), 2785-2799. doi:10.1007/s00382-016-2997-7

Lyman, S., C. Jones, T. O'Neil, T. Allen, M. Miller, M. S. Gustin, A. M. Pierce, **W. Luke**, X. Ren, P. Kelley (2016), Automated calibration of atmospheric oxidized mercury measurements, Environ. Sci. Technol., 50, 12,921−12,927, doi:10.1021/acs.est.6b04211

Mazzuca, G. M., Ren, X., Loughner, C. P., Estes, M., Crawford, J. H., Pickering, K. E., Weinheimer, A. J., and Dickerson, R. R. (2016). Ozone Production and Its Sensitivity to NOx and VOCs: Results from the DISCOVER-AQ Field Experiment, Houston 2013, Atmospheric Chemistry & Physics, 16, 14463-14474. doi:10.5194/acp-2016-215

Ren, Xinrong, **Winston T. Luke**, Paul Kelley, **Mark D. Cohen**, **Richard Artz**, Mark L. Olson, David Schmeltz, Melissa Puchalski, Daniel L. Goldberg, Allison Ring, Gina M. Mazzuca, Kristin A. Cummings, Lisa Wojdan, Sandra Preaux, and Jeff W. Stehr (2016) Atmospheric

mercury measurements at a suburban site in the Mid-Atlantic United States: Inter-annual, seasonal and diurnal variations and source-receptor relationships. Atmospheric Environment. 146; 141-152. doi:10.1016/j.atmosenv.2016.08.028

Wilson, Timothy B., **C. Bruce Baker**, **Tilden P. Meyers**, **John Kochendorfer**, Mark Hall, Jesse E. Bell, Howard J. Diamond, and Michael A. Palecki, (2016) Site-Specific Soil Properties of the US Climate Reference Network Soil Moisture, Vadose Zone Journal, 15 (11), 10.2136/vzj2016.05.0047

Conferences, Presentations, & Invited Talks

Rick Saylor participated in the 2016 Steering Committee meeting of the Interagency Monitoring of Protected Visual Environments (IMPROVE) network at the Santa Fe National Forest in Santa Fe, New Mexico. IMPROVE is a cooperative measurement effort managed by the Steering Committee. The Steering Committee consists of representatives from the EPA, National Park Service, U.S. Forest Service, Fish and Wildlife Service, the Bureau of Land Management, NOAA, and organizations representing state air quality agencies that monitor, evaluate and assess progress toward national visibility goals on protected federal lands such as National Parks and Wilderness Areas. The IMPROVE Steering Committee meets annually to review network operations and advise on future directions of the program. This year the IMPROVE meeting was co-located with the National Atmospheric Deposition Program (NADP) Annual Meeting in Santa Fe, and Rick Saylor was invited to participate in the NADP Total Deposition subcommittee meeting.