NOAA Air Resources Laboratory
Quarterly Activity Report
FY2016 Quarter 3
(April-May-June, 2016)

Contents

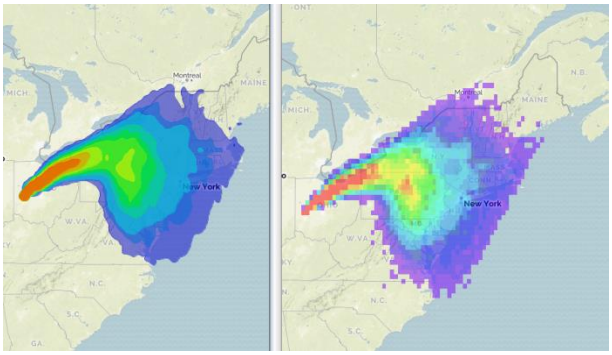
DISPERSION AND BOUNDARY LAYER

1. HYSPLIT Workshop

ARL gave a 3-day HYSPLIT workshop May 17-19, 2016, at NOAA's Center for Weather and Climate Prediction (NCWCP) in College Park, Maryland. The workshop focused on the use of the February 2016 release of the PC model and its Graphical User Interface (GUI) with a focus on the HYSPLIT model verification of the CAPTEX 2 atmospheric tracer release conducted in 1983. Nineteen participants from government agencies, including other parts of NOAA, the Nuclear Regulatory Commission, the Department of Homeland Security, Army, and Air Force, as well as academia and foreign participants from China, Mexico, Croatia and South Korea attended the workshop in person. Over 50 other participants viewed the workshop through video conferencing, from as far away as Brazil, Finland, the Philippines, and India. All of the participants expressed thanks for providing this service so they can learn to run the model and understand its capabilities. glenn.rolph@noaa.gov

2. HYSPLIT Improvement Project

The Field Research Division continued its work on assessing state-of-the-art mapping displays to help guide future HYSPLIT development. A survey was conducted of some of the more popular mapping Application Programming Interfaces. The survey assessed the strengths and weaknesses of each. Software was also developed to explore different contouring approaches as shown in the figure below from the 1983 Cross-Appalachian Tracer Experiment (CAPTEX). The image on the left was developed by taking output from the HYSPLIT cdump file and converting it into gridded data. A contouring routine, using a triangular mesh, was implemented to read the gridded data and output contoured line segments. Additional routines were written to take the line segments and convert them into discrete polygons. A final piece of software was developed to load and smooth the polygons and render them as plume isopleths over a map background. The figure on the right is a first cut at applying a gradient filled color map at each grid cell location. brad.reese@noaa.gov



3. Unmanned Aircraft Systems

Ed Dumas and Bruce Baker attended a meeting in Boulder, CO May 9-13 to discuss the Coyote Small Unmanned Aircraft System (sUAS). The ARL Atmospheric Turbulence and Diffusion Division's (ATDD) role with the Coyote will be to improve the

instrumentation to measure air temperature, relative humidity, pressure, and hopefully 3-component winds in upcoming Coyote flights in 2017 and 2018. ATDD's experience using the Extreme Turbulence probe and the Best Aircraft Turbulence probe will be brought to bear to improve the Coyote instrumentation.

While in Boulder, Ed and Bruce also visited a company called UASUSA, a drone designer and manufacturer. They talked with the President of UASUSA about potentially using their Tempest UAS and/or their Twister sUAS for upcoming measurements. A visit was also made to the sUAS facility at the University of Colorado at Boulder. ed.dumas@noaa.gov, B. Baker

In June, Ed Dumas attended a training class near Montreal, Quebec to learn to fly the Microdrone MD4-1000 quadcopter. Ed demonstrated the ability to successfully fly and land the MD4-1000 in Inertial Navigation System (INS) mode. Ed also learned the capabilities of the flight planning software. ATDD has acquired an MD4-1000 from NOAA's Center for Cooperative Unmanned Technologies to investigate making profile measurements of temperature, relative humidity, and pressure in a similar manner to the DJI S-1000, which ATDD has been flying. The key difference is the flight duration of the MD4-1000 can be as much as 45 minutes, whereas the DJI S-1000 can only fly for a maximum of 15 minutes. ed.dumas@noaa.gov

4. Project Sagebrush

Plans for the tracer sampling arrays for both the daytime (July-August) and nighttime (October) experimental periods of Phase 2 of Project Sagebrush have been finalized. Since these experiments are focusing on dispersion in light winds, The Field Research Division (FRD) will be using 210° wide sampling arcs to optimize the available number of bag samplers. Within each arc, the samplers are spaced 6° apart. The arcs for the daytime releases will be centered north-northeast of the release point. During the nighttime releases the arcs will be centered northeast of the release point. These orientations are based on the most common wind directions observed on a nearby tower. A mobile 28 m high tower from Aluma Tower arrived at FRD in late June. This tower will sample the vertical tracer distribution during the tracer releases using bag samplers placed at intervals up the tower.

All four gas chromatographs have been brought into operational mode and characterized for dynamic range and instrument limit of detection. Cleaning of the sample bags contained in the 800 bag sampler cartridges is nearly complete. That includes checks on the effectiveness of the bag cleaning by gas chromatography analysis in the lab. The proper operation of the 150 available bag samplers was completed previously. Four fast response analyzers are operational and attempts are being made to increase that number.

FRD already has a large number of meteorological instruments available to measure boundary layer structure during the Sagebrush releases. Washington State University will be deploying an additional 6 sonic anemometers as part of the project in early July. During the tracer releases, these sonic anemometers will be deployed in a horizontal

array to measure spatial variability in the turbulence field.

The manuscript "Project Sagebrush: Revisiting the value of the horizontal plume spread parameter σ_y" was accepted for publication in the Journal of Applied Meteorology and Climatology. The manuscript "An investigation into the magnitude and variation in the standard deviation of horizontal wind direction σ_θ" was submitted to the journal Boundary Layer Meteorology. Much of the material included in the manuscript is related to the results of Project Sagebrush. Kirk.Clawson@noaa.gov

5. Wind Forecast Improvement Project (WFIP2)

With half of the WFIP2 field deployment now complete, a great deal of quality data has been collected and most instruments have functioned properly. One issue that has developed at two of the Oregon WFIP2 deployment sites is frequent damage to buried cables by rodents. During recent visits to the sites, the cables were encased in conduit to limit future damage. FRD is also comparing the WFIP2 observations with model forecasts, particularly with a special version of the High Resolution Rapid Refresh (HRRR) model being run for WFIP2 by the Earth System Research Laboratory. Much of the model comparison effort is focusing on the surface energy balance and evaluating the parameterization of air-surface exchange in the HRRR model. These comparisons are still in the early stages. matt.brewer@noaa.gov, Shane Beard, Rick Eckman, Kirk Clawson

6. Consequence Assessment for the Nevada National Security Site

James Wood, Rick Lantrip, and Walt Schalk participated in an emergency response Functional Exercise as the Consequence Assessment Team for the NNSA Nevada Field Office. The exercise was conducted on the Nevada National Security Site. In the exercise, location weather data and weather forecasts were provided and dispersion products were generated based on the worst case event information provided for the scenario. The event was a wild land fire in a contaminated area. This event was conducted with the DOE/NNSA/ NFO Emergency Response Organization. kip.smith@noaa.gov, Rick Lantrip, James Wood, Walt Schalk

7. SORD Mesonet Upgrade

The new system is operational. A few communication bugs had to be worked out, but the system is performing well and providing good quality data. James Wood, Bobby Gates, and Rick Lantrip completed the first 6 month calibration cycle. This was done early to get into a Spring/Fall cycle to avoid the summer heat and the winter snow at the higher elevations. walt.w.schalk@noaa.gov, Kip Smith, James Wood, Phil Abbott, Rick Lantrip, Bobby Gates

8. Support to DOE/NNSA NNSS Projects and Experiments

Walt Schalk, James Wood, and Rick Lantrip were in the field at the Nevada National Security Site (NNSS) providing data and information for the non-proliferation Shock Physics Experiment #5. Daily weather forecasts and weather surveillance activities focusing on wind and lightning were provided during the months prior to the experiment as the site was prepared. Numerous practice runs were supported by providing

experiment location-specific forecasting, as well as wind speed measurements reported every 3 seconds. Two radiosonde balloons were released on the experiment day to support personnel, aviation assets, and to obtain data. The experiment was a success and the 2nd balloon released collected data up to approximately 103,000 feet

James Wood, Rick Lantrip, and Walt Schalk worked to support the Shock Physics Experiment (SPE) series by testing a tethered balloon platform to elevate an experiment instrument package. The platform did not perform as desired. This platform will be re-evaluated and redesigned for the next experiment in the fall. SORD is working with Los Alamos National Lab in tethering a weather balloon to lift an instrument package about 50 meter above the ground. walter.w.schalk@noaa.gov, Kip Smith, James Wood

AIR QUALITY

9. Korean US Air Quality Study (KORUS-AQ)

Xinrong Ren and collaborators at the University of Maryland participated in an air quality field study in China to characterize aerosol and trace gas emissions, transformations and transport over the north China plain, currently one of the most heavily industrialized and polluted regions on Earth. The study was coordinated with the concurrent NASA-sponsored Korean US Air Quality Study (KORUS-AQ). Through partnerships with Beijing Normal University, Peking University, and the Hebei provincial weather service, the team made aircraft observations of major air pollutants. The data collected from aircraft, ground sites, and satellites are being analyzed and will be compared to chemical transport models to understand the factors controlling atmospheric chemistry across urban and rural interfaces and transport to the east. xinrong.ren@noaa.gov

10. US Weather Research Program Proposal Awarded

A NASA-ARL proposal submitted to USWRP 2016-2019 air quality related research solicitation was awarded funding. The proposal is entitled: "Towards the improvement of chemical lateral boundary conditions (CLBC) for the National Air Quality Forecasting Capability (NAQFC)." Daniel Tong and Youhua Tang are Co-PIs and Pius Lee is a collaborator. This work leverages the advanced parametrization in the well tested GEOS-Chem, a Harvard University maintained global model for chemical, physical and transport modification of air pollutants. GEOS-Chem accounts for detailed planetary boundary science (PBL), wind-blown dust, wildfires and entrainment of stratospheric ozone. The NASA Modern-Era Retrospective Analysis for Research Application version 2 (MERRA2) will provide the best re-constructed global meteorology for this project's selected sensitivity case studies. The selected studies are planned to represent all conceivable chemical, seasonal and meteorological scenarios. The temporally-resolved characteristics of the chemical constituents predicted by GOES-Chem provide a basis for improved CLBC for the NAQFC. In addition, outcomes of this three-year study will include improved modeling of the planetary boundary layer processes for fine particulate ($PM_{2.5}$) forecast, and physical- and chemical-processes for long range transport in regional- and meso-scales for better ozone forecast.
daniel.tong@noaa.gov, Pius Lee

11. Atmospheric Mercury Modeling

The following advancements were made in atmospheric mercury modeling:

- Chris Loughner successfully completed the parallelization of the Lagrangian and Eulerian components of the HYSPLIT-Hg model. Previously, the model could only be run using one "CPU" at a time. The parallelized version will make analyses with the model more efficient, and will make it practical to run the model with higher-resolution grids.
- Mark Cohen and Xinrong Ren carried out a back-trajectory analysis of 9 years of mercury measurements collected at ARL's Atmospheric Mercury Network site in Beltsville, MD. In carrying out this analysis, HYSPLIT back-trajectories were run for every hour during 2007-2015, and the geographical distribution of pathways to the site were mapped for high vs. low concentration periods for each type of mercury measured at the site. Put simply, Mark and Xinrong investigated where the air came from when relatively high mercury concentrations were observed at the site, and where the air came from when relatively low concentrations were measured at the site. In this analysis, the HYSPLIT-associated program to analyze the geographical distribution was modified to allow the user to separately account for trajectories above or below the planetary boundary layer at any given time/location. This analysis was carried out for a manuscript in preparation about measurements at the Beltsville site and results will be reported when the paper is published.
- Mark Cohen assembled anthropogenic mercury emissions inventory data for the period 1990-2014 from the following sources: USEPA Toxic Release Inventory; USEPA National Emissions Inventory; Environment Canada National Pollutant Release Inventory; AMAP/UNEP global anthropogenic mercury emissions inventory; and a new global anthropogenic mercury emissions inventory (Zhang et al. (2016), PNAS 113(3), p526-531). These inventories were mapped and time trends of emissions at different distances away from key receptors (e.g., the Great Lakes, and numerous mercury measurement sites) were calculated. Emissions in the U.S. and Canada generally decreased significantly over the 1990-2014 period due to a variety of factors. Throughout the rest of the world, overall emissions showed a small decline from 1990-2000 (driven largely by reductions in Europe) but have increased from 2000-2014 (driven largely by increased emissions from Asia and from worldwide small scale gold mining activities). These inventories will be used to model the time-trends of deposition to the Great Lakes and other receptors, and in addition, the HYSPLIT-Hg model will be evaluated by comparison of measured and modeled time-trends of concentration and deposition at measurement sites.
- Natalie Collina, a student at Princeton University, began a summer internship working with Mark Cohen. Natalie's project involves first attempts to link an ocean mercury model with ARL's atmospheric HYSPLIT-Hg model. The net flux of elemental mercury from the ocean represents a significant fraction (~1/3) of total global mercury emissions. Thus, it is important to accurately characterize the bi-directional flux of mercury between the ocean and atmosphere in the model. It is the desire to have this work lead to a fully coupled ocean-atmosphere (and also land-atmosphere) simulation of global mercury fate and transport. mark.cohen@noaa.gov Christopher Loughner, Xinrong Ren

12. ACCESS Modeling System

Two NOAA Hollings Scholars, Sheridan Green from the University of North Carolina-Chapel Hill and Kathryn Wheeler from the University of Delaware, began their summer internships on May 31. The undergraduate students are working this summer with Rick Saylor and are performing research with the Atmospheric Chemistry and Canopy Exchange Simulation System (ACCESS) modeling system exploring biogenic hydrocarbon chemistry in different forest types and environmental conditions. The ACCESS modeling system is being developed to study various aspects of surface-atmosphere exchange. Results from the research are intended to help advance the representation of surface-atmosphere exchange processes in three-dimensional air quality models, including NOAA's National Air Quality Forecasting Capability. rick.saylor@noaa.gov.

13. Ammonia Flux Data

LaToya Myles and Mark Heuer contributed to the first manuscript developed from data collected during the 2014 study of ammonia exchange in collaboration with the University of Illinois at Urbana-Champaign (UIUC) and funded by the National Science Foundation. The manuscript, *Ammonia Flux Above Fertilized Corn in Central Illinois, USA, Using Relaxed Eddy Accumulation*, describes measurements of ammonia in a managed agricultural ecosystem dominated by rotations of highly fertilized corn and moderately to lightly fertilized soybeans. The lead author is Andrew Nelson from UIUC. latoya.myles@noaa.gov

CLIMATE

14. U.S. Climate Reference Network (CRN)

The NOAA National Center for Environmental Information (NCEI) retrieved 46 data files from the CRN sites through the ATDD server: ftp.atdd.noaa.gov. Data are passed to NCEI by this path when retrieved episodically by ATDD from individual site visits to fill data gaps. Instrument characteristics for each site are maintained in the database ISIS (Integrated Station Information System) on NCEI's server, along with a record of events which affect data quality. New ISIS events are identified from ATDD's field crews and archived data. lynne.satterfield@noaa.gov

CRN staff completed annual maintenance visits to 48 sites. CRN staff also installed a new power system at the Ivotuk site in Alaska. A cold-test chamber for testing components for use in Alaska was purchased earlier this year. This outside cold-test chamber was delivered in June. Final installation of components is in progress and it is expected to be operational within a few weeks. This will allow us to test power system components for extended periods on site. mark.e.hall@noaa.gov

15. FOCAL Data Analysis

A new procedure to analyze the uncertainty in estimates of greenhouse-gas exchange has been developed for the Flux Fragment Method (FFM) used to analyze airborne turbulence data. The analysis has been applied to the 2013 airborne measurements of

the Flux Observation of Carbon from an Airborne Laboratory (FOCAL) project in Alaska. The procedure takes the serial covariance characteristic of all turbulence data into account in a way not previously possible with the FFM. The primary effect of removing the serial covariance is an enhancement of the variance with the result that one could no longer claim a separation of the influence of the sedge-covered landscape from the open water with a confidence of 95%. Instead one must accept 80% with associated consequences to be determined. The most important and valuable consequence, however, is that the unrealistically optimistic 95% is replaced by a more defensible estimate of uncertainty. There is some hope that further refinements of the procedure will sharpen the confidence intervals without sacrificing realism. ron.dobosy@noaa.gov

16. NOAA/INL Mesonet

FRD has been actively testing potential replacements for the VHF radios used to collect data from the weather stations in the NOAA/INL mesonet. The radios being considered provide internet like connectivity over a VHF radio link. FRD has three sets of radios, one purchased and two on loan. For the testing, one radio is set up at the FRD office, one at the Jumpoff Peak repeater site, and one at the mesonet weather station in Roberts, ID. All the radios worked and FRD was able to leave the two sets on loan installed for a few weeks. One radio performed significantly better than the others but all of the radios were less reliable than FRD liked. kirk.clawson@noaa.gov

ARL FY16 Quarter 3 Publications

Barth, M. C., M. M. Bela, A. Fried, P. O. Wennberg, J. D. Crounse, J. M. St. Clair, N. J. Blake, D. R. Blake, C. R. Homeyer, W. H. Brune,… X. Ren …et al. (2016). Convective transport and scavenging of peroxides by thunderstorms observed over the central U.S. during DC3, Journal of Geophysical Research - Atmosphere. 121,4272–4295, doi:10.1002/2015JD024570

Bucher E.H. and **A. F. Stein** (2016) Large Salt Dust Storms Follow a 30-Year Rainfall Cycle in the Mar Chiquita Lake (Córdoba, Argentina). *PLoS ONE* 11(6): e0156672. doi:10.1371/journal.pone.0156672

Buisan S.T., J.I. López-Moreno, M.A. Saz, **J. Kochendorfer** (2016) Impact of weather type variability on winter precipitation, temperature and annual snowpack in the Spanish Pyrenees. *Climate Research* 69:79-92. doi:10.3354/cr01391

Chen, L., Xin-Zhong Liang, David DeWitt, Arthur N. Samel, and **Julian X. L. Wang** (2016). Simulation of seasonal US precipitation and temperature by the nested CWRF-ECHAM system. *Climate Dynamics* 46:3, 879-896. doi:10.1007/s00382-015-2619-9

Eslinger, P. W., Ted W. Bowyer, Pascal Achim, Tianfeng Chai, …Fantine Ngan, …**Ariel F. Stein**…(2016). International challenge to predict the impact of radioxenon releases from medical isotope production on a comprehensive nuclear test ban

treaty sampling station. *Journal of Environmental Radioactivity* 157: 41-51. http://dx.doi.org/10.1016/j.jenvrad.2016.03.001

Finn, D., **K .L. Clawson**, **R. M. Eckman**, H. Liu, E. S. Russell, Z. Gao, and S. Brooks (2016). Project Sagebrush: Revisiting the Value of the Horizontal Plume Spread Parameter σy. *Journal of Applied Meteorology and Climatology* 55(6): 1305-1322. doi: 10.1175/JAMC-D-15-0283.1

Lu, C.-H., A. da Silva, J. Wang, S. Moorthi, M. Chin, P. Colarco, Y. Tang, P.S. Bhattacharjee, S.-P. Chen, H. –Y. Chuang, H.-M. H Juang, J. McQueen, and M. Iredell (2016). The implementation of NEMS GFS Aerosol Component (NGAC) Version 1.0 for global dust forecasting at NOAA/NCEP, *Geoscience Model Development*, 9, 1905-1919, doi:10.5194/gmd-9-1905-2016, 2016.

Nowlan, C. R., ...Paul Kelley, **Winston T. Luke**, Xinrong Ren, and Jassim A. Al-Saadi (2016). Nitrogen dioxide observations from the Geostationary Trace gas and Aerosol Sensor Optimization (GeoTASO) airborne instrument: Retrieval algorithm and measurements during DISCOVER-AQ Texas 2013. *Atmospheric Measurement Techniques* 9(6): 2647-2668. doi:10.5194/amt-9-2647-2016

Sun, X. J., P. X. Wang, and **J. X. L. Wang** (2016). An assessment of the atmospheric centers of action in the northern hemisphere winter. On-line in *Climate Dynamics*: 1-17. doi:10.1007/s00382-016-3126-3.

Conference Presentations & Invited Talks

Ariel Stein presented an invited paper entitled "NOAA's HYSPLIT Atmospheric Transport and Dispersion Modeling System: History, Applications, and New Developments" at the 2016 Guideline to Air Quality Models: The New Path Conference in Chapel Hill, NC. This conference was organized by the Air & Waste Management Association and attracted more than 100 participants. In addition, Dr. Stein participated as a panelist in the Town Hall Meeting: The Future of Regulatory Modeling that was held at the same conference venue. The discussion focused on questions such as: Will other models replace those we currently use? Will the state of the art be crippled by current regulatory constraints? What other model results should we be looking for? Is it time for more significant field experiments?

LaToya Myles (ARL) and Marie Bundy (NOS), co-chairs of the NOAA Ecosystem Research Committee, provided a final report on the Ecosystem Research Agenda to the NOAA Research Council. The report outlined steps the Committee took to integrate NOAA's multi-disciplinary (natural and social science) research capabilities in a strategic manner to improve the understanding of marine and coastal ecosystems in support of NOAA's mission and mandates.

LaToya Myles delivered two oral presentations during the ARL Laboratory Science Review in June 2016 at College Park, MD. The first was a session introduction for the

Lab's Atmospheric Chemistry and Deposition research area, and the second was a science presentation on Atmospheric Deposition, which covered the lab's wet and dry deposition research.

LaToya Myles served as a panelist for OAR and gave a presentation at the 2016 NOAA Scholar Orientation in Silver Spring, Maryland in June.

Outreach & Engagement

Rick Lantrip and Walt Schalk hosted an ARL/SORD – NNSS Weather booth as part of the 65th Anniversary of the Nevada National Security Site celebration held Saturday, May 7th. Demonstrations included the mobile upper-air weather balloon capability, the evolution of weather instruments on the site, vintage pictures, and cloud chart handouts. Many people stopped and listened to the history of the NNSS.

Walt Schalk and Rick Lantrip hosted two tours of about 15 scientists each from the DOE National Laboratories. The tour was part of the Federal Expertise Training program hosted by NNSA. The tour took place at the Desert Rock Weather Observatory at the Nevada National Security Site. A verbal history of the SORD program and support of the testing program was given. SORD's current activities were also presented. The numerous instrumented sites that SORD maintains for NNSS Programs (SODAR, mesonet and lightning detection network) and hosts for a variety of NOAA Programs (Climate Reference Network, SURFRAD, GPS Water Vapor soundings – ESRL) located in the immediate Desert Rock area were discussed. As a finale, a Pilot Balloon (PIBAL) release was demonstrated.

Dr. Kip Smith, SORD Research Meteorologist, retired from Federal service after 10 years on April 30, 2016.

Bobby Gates, SORD Electronics Technician, took a position with the NWS Reconditioning Center in Kansas City, MO on March 19, 2016.