NOAA Air Resources Laboratory
Quarterly Activity Report
FY2016 Quarter 2
(January-February-March, 2016)

Contents

DISPERSION AND BOUNDARY LAYER

1. HYSPLIT/DELFIC model integration

Glenn Rolph and Ariel Stein traveled to the Oak Ridge National Laboratory (ORNL) March 21 to get an update and provide feedback on the integration of HYSPLIT with the Cloud Rise Module of the Defense Land Fallout Interpretive Code (DELFIC) model and the Fallout Planning Tool, headed by Dr. Vincent Jodoin. DELFIC uses a rather simple Gaussian plume model to transport the nuclear material, so HYSPLIT will greatly enhance the downwind transport and dispersion calculations and HYSPLIT will benefit with a better nuclear cloud rise module. After the integration is complete, the new modeling system will be used to rerun the six Nevada nuclear tests modeled in the recent NOAA paper (Rolph, et al., 2014) to see if improvements can be made in the results using the nuclear cloud source term of DELFIC. glenn.rolph@noaa.gov

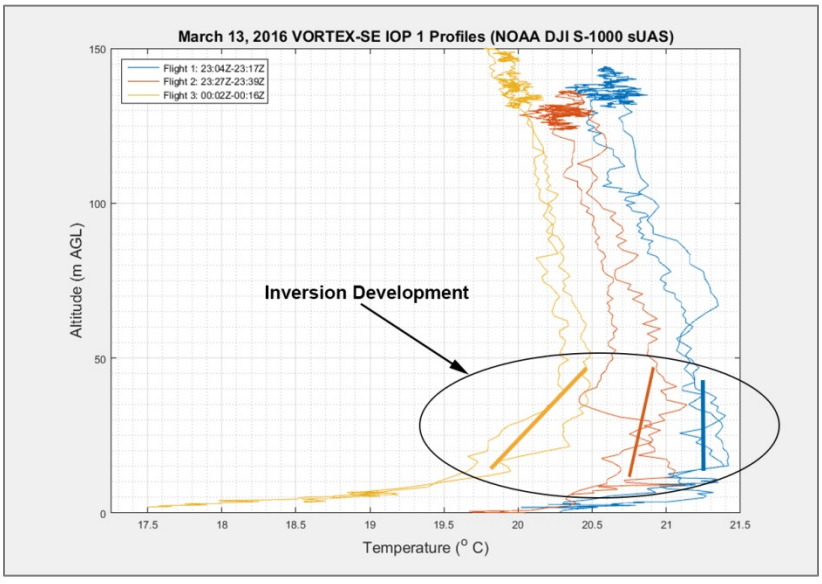
2. Convective Initiation

FRD completed all of the large-eddy simulations that were planned for the Convective Initiation project. These simulations examined the effects of horizontal variations of surface fluxes on convective development. Mike Buban gave a presentation on the simulations at the January 2016 American Meteorological Society Annual Meeting in New Orleans. Manuscripts describing the simulations are in preparation. The work started under this project will likely continue as part of the VORTEX SE project. michael.buban@noaa.gov, ATDD staff, Rick Eckman

3. Unmanned Aircraft System Operations during VORTEX-SE

The Atmospheric Turbulence and Diffusion Division's DJI S-1000 small Unmanned Aircraft System (sUAS) was used to make vertical profile measurements of temperature, relative humidity, and storm damage assessments for the Verification of the Origins of Rotation in Tornadoes Experiment-Southeast (VORTEX-SE) in Huntsville, Alabama. The sUAS flew in two intensive operations periods in March and one assessment period in April.

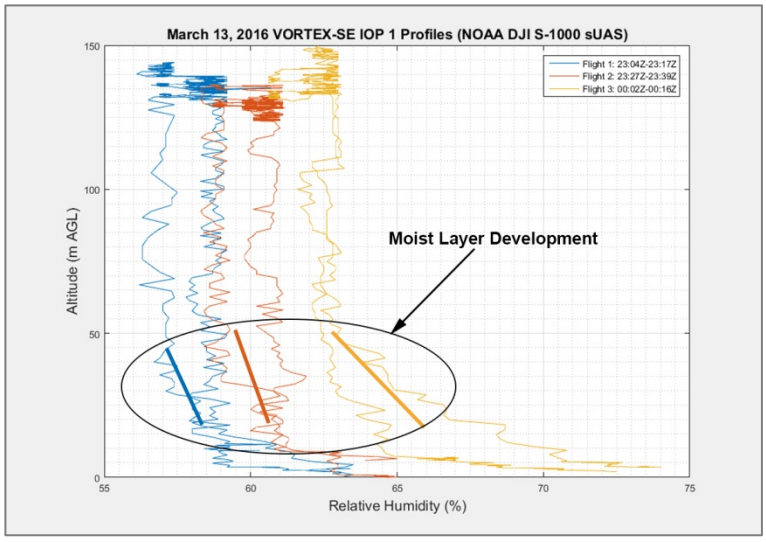
Using findings from test flights at the Knox County Radio Control (KCRC) Society's model flying field in Knoxville, Tennessee, the two temperature sensors that compared most favorably with each other in the ground tests were located on the left and right sides of the sUAS for the profile measurements. These locations correspond to mounting one sensor on each "wing" of the aircraft. This location minimizes the sensors' dependence on attitude changes, particularly pitch, during flight.



Three flights were made on March 13, 2016, at Belle Mina, Alabama in generally fair weather around sunset. Profiles to 120 meters above ground level were made, followed by horizontal transects to map the surface temperature using the forward looking infrared (FLIR) IR camera. An example of the temperature profile data is shown at left.

These flights were made at 23:04 Z, 23:27 Z, and 00:02 Z, respectively. The temperature curves above show a uniform decrease of both surface temperature and air temperature for each flight. The development of an inversion layer can be seen from 15-40 meters AGL between the first curve (blue) and the final curve (yellow). The period of time between these two curves is approximately 1 hour (23:04 Z to 00:16 Z).

The relative humidity for the three flights is shown at right. Note the development of the moist layer in the same region as the temperature inversion shown in the previous graph.



One flight was made during the IOP on March 24, 2016, from the Cullman, Alabama site. This flight was cut short due to rain showers that developed during the profile, causing the sUAS flight to be terminated early. The flight at this site represented the first time the sUAS was operated under the NOAA-FAA memorandum of agreement (MOA) in Class G airspace. The location of the Cullman site allows the maximum ceiling of the copter to be 700 feet AGL.

Finally, the sUAS was flown four times on April 5, 2016, to assess damage from an EF-2 tornado that passed through Priceville, Alabama, on March 31, 2016. An example image obtained from one of the flights is shown below:

In this image, the orange arrows indicate the direction that trees fell during the tornado's passage.

The operation of the sUAS was very successful with a total of 10 flights flown without incident. ed.dumas@noaa.gov, T. Lee, M. Buban, B. Baker

4. Project Sagebrush

FRD has firmed up its plans for Project Sagebrush Phase 2 (PSB2). An initial set of daytime light-wind releases is planned for 25 July through 10 August 2016. Based on observations near the tracer release point, the 1300-1500 MDT time window is the best target for light-wind releases in unstable conditions. The most likely wind direction during the testing window is from about 200°, so the tracer sampling array will be centered on 20° from north. To keep concentrations within instrument limitations, SF_6 release rates of 0.15-0.20 g s^{-1} appear to be a good target for these daytime releases. A second set of nighttime tests is planned for 12-28 October 2016. These will start around 0500 MDT. The wind direction distribution during the night testing period has two modes, both SW and N, so the best sampler orientation for the October period has not yet been settled on. The likely SF_6 release rates for the night tests will be about 10% of those for the afternoon tests.

As part of the early preparations for the PSB2, the air samplers are being checked, repaired, and readied for use in the project. This should be completed in early April. Checking and testing of fast response analyzers and gas chromatographs will begin in April, along with a number of other activities.

Approval was received for funding the acquisition of a mobile trailer/tower system. An RFQ will be issued early in the third quarter. Plans call for using the tower during the upcoming PSB2 field experiments beginning in late July.

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. Additional papers related to this project are pending. richard.eckman@noaa.gov, Kirk Clawson, Dennis Finn, Roger Carter, Jason Rich

5. Wind Forecast Improvement Project (WFIP2)

An ongoing discussion has developed in the WFIP2 community regarding how vertical fluxes should be computed from the project's turbulence measurements. There is a desire to have the various groups collecting data to use a common set of assumptions in computing the fluxes, in particular a common averaging time. Otherwise, it will be more challenging to compare observations from different groups. Part of the discussion has revolved around whether a specific averaging time best matches the assumptions in numerical models such as WRF. Currently, there are many who want to compute fluxes using both 15 and 5 minute averaging times. Some researchers recommend the shorter time for stable conditions. FRD can adapt its own flux data processing to meet the requirements that are settled on. kirk.clawson@noaa.gov, Rick Eckman

6. HYRad

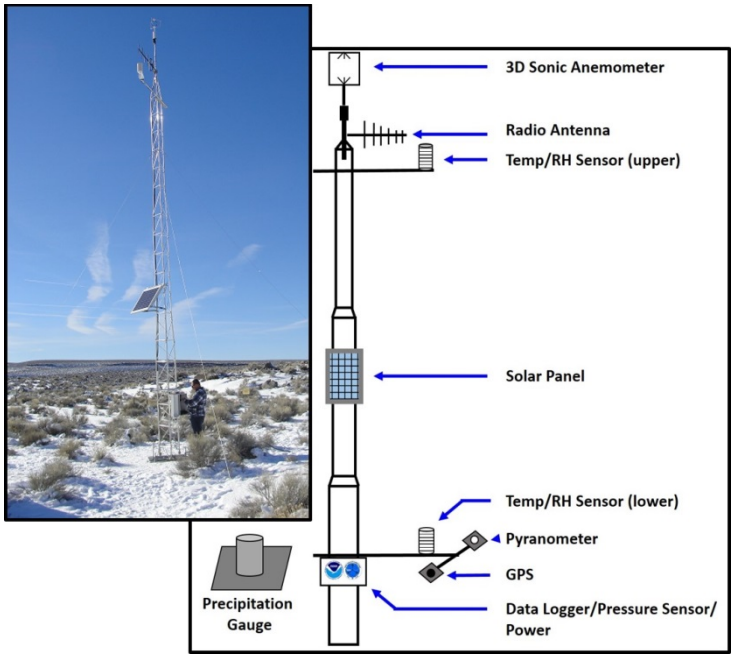
The Idaho National Laboratory Emergency Operations Center's hazardous assessment staff made revisions to several radiological release scenarios that prompted the need for some changes in HYRad (HYSPLIT-Radiological) model. These included the addition of more isotopes in the dose conversion factor table, increasing the number of individual concentrations

and depositions that could be separately plotted, and increasing the maximum duration of a possible release to 96 hours. The changes allowed for the possibility of much longer model run times, especially if the multiple source capability is used. The tradeoffs involved were discussed with the EOC personnel along with possible ways to mitigate this (e.g., use of the proxy capability). dennis.finn@noaa.gov, Brad Reese

7. Consequence Assessment for the Nevada National Security Site

James Wood, Rick Lantrip, Kip Smith, and Walt Schalk participated in an emergency response Functional Exercises and a Full Field Exercise as the Consequence Assessment Team (CAT) for the NNSA Nevada Field Office. These exercises were conducted on the Nevada National Security Site (NNSS). In these exercises, facility specific weather data and weather forecasts were provided and dispersion products were generated based on the worst case event information provided for the different scenarios. The events included both simulated radiological and chemical scenarios. These events were conducted with the DOE/NNSA/NFO Emergency Response Organization. Kip Smith and Walt Schalk were the CAT facilitators for these exercises.

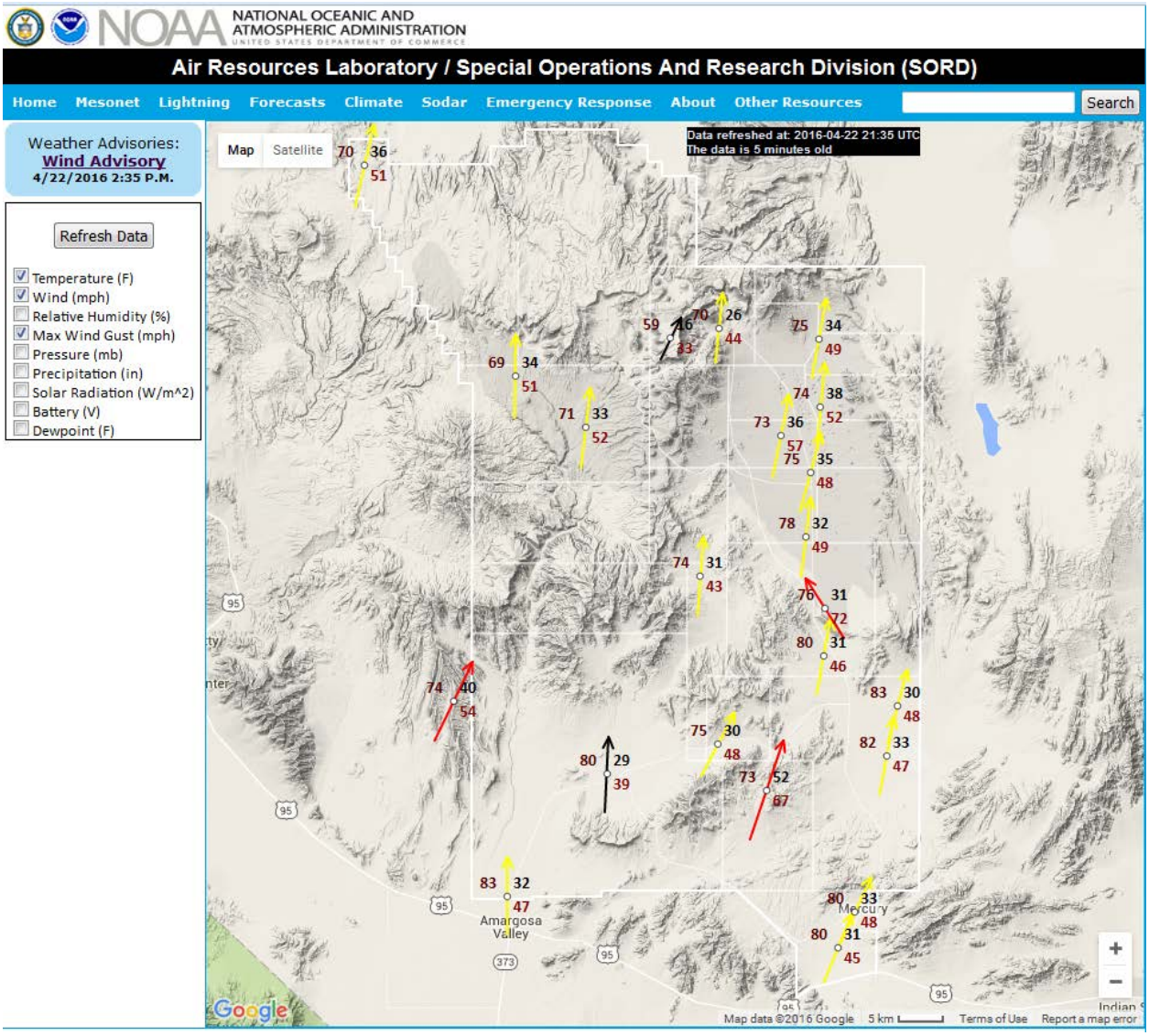
James Wood and Walt Schalk attended a seminar/workshop for the DOE/NNSA Nevada Field Office Emergency Response Organization. The seminar/workshop stepped through the entire process of a response to a hazardous event at the Nevada National Nuclear Site. This event was a part of recurring training required for maintaining consequence assessment qualifications. kip.smith@noaa.gov, Rick Lantrip, James Wood, Walt Schalk



8. SORD Mesonet Upgrade

James Wood, Bobby Gates, and Rick Lantrip completed installation of the new 22 station SORD NNSS Mesonet. Each site consists of a new tower, a 3D sonic anemometer, an upper and lower temperature & relative humidity sensor, total solar radiation sensor, GPS, pressure, rain gage, solar panel/battery/ charging system, and radio communications. See photo and diagram at left.

SORD began using the newly updated mesonet as the operational mesonet for the Nevada National Security Site. All data and products on the SORD website are using these new data. The image below is from the SORD website and shows a 72 mph wind gust in the center right. ***A BIG project with a great effort from the SORD Team, THANKS!*** walter.w.schalk@noaa.gov, Kip Smith, James Wood, Phil Abbott, Rick Lantrip, Bobby Gates



9. Support to DOE/NNSA NNSS Projects and Experiments

SORD continued participation in the Shock Physics Experiment (SPE) series. Walt Schalk attended two status and planning meetings for the next two experiments (#5 and #6). Goals, time lines, contacts, and changes were presented for experiment #5. These experiments are initially planned to occur in the spring and the late summer. The information SORD provides is critical for the safe preparation and execution of the experiment as well as providing important experimental data.

James Wood and Walt Schalk continued work on the project to tether a balloon to act as an elevated platform that will hopefully be used during the next SPE. There is a desire to measure the infrasound signal from an elevated location. We are working with Los Alamos National Lab in tethering a weather balloon to lift an instrument package about 50 meters above the ground. The initial proof of concept was successful. Several areas of improvement were identified and are being addressed. walter.w.schalk@noaa.gov, Kip Smith, James Wood

AIR QUALITY

10. Fluxes of Greenhouse Gases in Maryland

Xinrong Ren participated in the Fluxes of Greenhouse Gases in Maryland (FLAGG-MD) project for the second year to characterize the greenhouse gas (GHG) emissions from the Baltimore/Washington area. The University of Maryland Cessna 402B and Purdue University's Beechcraft Duchess flew over this area to measure GHGs, meteorological variables, as well as other trace gas and aerosol optical properties. The FLAGG-MD project has produced policy-relevant science to provide improved quantification of anthropogenic GHG emissions to the scientific community and to regulatory agencies such as Maryland Department of Environment (MDE) and US EPA through direct analysis of ambient measurements and model simulations. xinrong.ren@noaa.gov

11. Indianapolis Flux Experiment

Xinrong Ren also participated in the Indianapolis Flux Experiment (INFLUX) project to characterize the anthropogenic greenhouse gas (GHG) emissions from Indianapolis. The University Maryland's Cessna research aircraft and Purdue University's Duchess Beechcraft flew together over Indianapolis and measured GHGs, meteorological variables, as well as other trace gas and aerosol optical properties. Fluxes of GHGs were derived from the aircraft observations and will be compared to inverse model simulations. The INFLUX was designed to develop and evaluate methods for the measurement and modeling of greenhouse gas fluxes from urban environments. Determination of greenhouse gas fluxes and boundaries of uncertainty are essential for the evaluation of the effectiveness of mitigation strategies. xinrong.ren@noaa.gov

12. Advanced Atmospheric Chemistry Simulation and Analysis

Rick Saylor has been granted an additional 250,000 CPU hours from the National Institute for Computational Sciences (NICS) at the University of Tennessee- Knoxville for continuation of a project entitled "Advanced Atmospheric Chemistry Simulation and Analysis." NICS is one of the leading high performance computing centers for excellence in the United States and is co-located on the University of Tennessee, Knoxville campus and on the Oak Ridge National Laboratory campus. The long-term goal of the project is to advance the state-of-the-science of three-dimensional air quality models through investigations to improve the parameterization of important chemical and physical atmospheric processes included in these models and improve numerical or computational techniques to allow more realistic simulation of the chemical state and evolution of the atmosphere. Initial work on the project has focused on improving the parameterization of aerosol particle dry deposition algorithms to more realistically represent the removal of particles over forested landscapes. rick.saylor@noaa.gov

13. Ammonia Flux Data

LaToya Myles and Mark Heuer provided ammonia flux data to collaborators at the University of Illinois Urbana-Champaign (UIUC) for use in their DeNitrification-DeComposition model, a computer simulation model of carbon and nitrogen biogeochemistry in agro-ecosystems. UIUC partners will use ATDD's ammonia flux data to determine regional emissions estimates. latoya.myles@noaa.gov

CLIMATE

14. U.S. Climate Reference Network (CRN)
The Atmospheric Turbulence and Diffusion Division (ATDD) personnel traveled to 22 U.S. Climate Reference Network (USCRN) sites for annual maintenance visits. mark.e.hall@noaa.gov

NOAA's National Centers for Environmental Information (NCEI) retrieved 12 data files from the USCRN 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. Characteristics of the instruments 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

15. World Meteorological Organization -SPICE
ATDD staff reanalyzed precipitation data from the Marshall, CO and Finland test beds using standardized QA/QC methods. ATDD developed and applied a 10-fold cross-validation to test transfer functions and determine their uncertainty from measurements that are independent of the data used to create the transfer functions. A manuscript describing the work is in process.

Results from four WMO-SPICE sites (from Spain, Switzerland, Norway, and Canada) are now available for analysis.

For WMO-SPICE the improvement to precipitation transfer functions using the catch ratio between and unshielded gauge and a single Alter shielded gauge were assessed. This approach was conceived at the beginning of WMO-SPICE to help estimate a reference measurement from sites that do not have a large reference-shielded gauge. The results were not conclusive. There was no improvement in the transfer function for rain or mixed precipitation, but there was a small improvement for snow. Further analysis will be performed on this as more WMO-SPICE results become available. john.kochendorfer@noaa.gov

16. NOAA/INL Mesonet
Radio frequency interference continued to be a problem for the NOAA/INL Mesonet telemetry system. FRD worked with Idaho Falls Power and consulted with a number of outside companies on the issue. Power engineers in Boise, Idaho suggested a tool that Idaho Falls Power could use to look for the problem. Idaho Falls Power eventually accepted their suggestion and tracked the problem to a defective lightning arrestor, which was replaced. That resolved the problem. Idaho Falls Power had thought that the lightning arrestors had been replaced a few months earlier and they were ignoring it as a possible interference source. Unfortunately, that misunderstanding cost a lot of time and effort. roger.carter@noaa.gov, and Shane Beard

ARL FY16 Quarter 2 Publications

Anderson, D. C.,…**M. Cohen**…**B. Stunder**…et al. (2016). A pervasive role for biomass burning in tropical high ozone/low water structures. *Nature Communications*. 7. doi:10.1038/ncomms10267

Bodeker, G., S. Bojinski, D. Cimini, R. Dirksen, M. Haeffelin, J. Hannigan, D. Hurst, T. Leblanc,

F. Madonna, M. Maturilli, A. Mikalsen, R. Philipona, T. Reale, **D. Seidel**, D. Tan, P. Thorne, H. Vömel, and J. Wang (2015). Reference upper-air observations for climate: From concept to reality. *Bulletin of the American Meteorological Society*. 97, 123-135. doi:10.1175/BAMS-D-14-00072.1.

Chen, B., **Ariel F. Stein**, NuA.M. Sanchez de la Campa, and J.D. de la Rosa (2016). Modeling and evaluation of urban pollution ria Castell, Yolanda Gonzalez-Castanedo, events of atmospheric heavy metals from a large Cu-smelter. Science of the Total Environment 539: 17-25. doi:10.1016/j.scitotenv.2015.08.117

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

Free, M., Bomin Sun, and Hye Lim Yoo (2016) Comparison between Total Cloud Cover in Four Reanalysis Products and Cloud Measured by Visual Observations at U.S. Weather Stations. *Journal of Climate*, 29: 2015-2021. http://journals.ametsoc.org/doi/10.1175/JCLI-D-15-0637.1

Huang, M., **P. Lee**, R. McNider, J. Crawford, E. Buzay, J. Barrick, Y. Liu, and P. Krishnan (2016), Temporal and spatial variability of daytime land surface temperature in Houston: Comparing DISCOVER-AQ aircraft observations with the WRF model and satellites, *Journal of Geophysical Research- Atmospheres* 121, 185–195, doi:10.1002/2015JD023996.

Kim, H. C., **P. Lee**, L. Judd, L. Pan, and B. Lefer, 2016: OMI NO2 column densities over North American urban cities: the effect of satellite footprint resolution, *Geoscience Model Development*. 9, 1111-1123, doi:10.5194/gmd-9-1111-2016

Lei, H., **Julian X. L. Wang**, Daniel Q. Tong, and **Pius Lee** (2016). Merged dust climatology in Phoenix, Arizona based on satellite and station data. *Climate Dynamics*. On-Line. doi: 10.1007/s00382-016-2997-7.

Li, X., Y. Choi, B. Czader, A. Roy, H. Kim, B. Lefer, and S. Pan (2016). The impact of observation nudging on simulated meteorology and ozone concentrations during DISCOVER-AQ 2013 Texas campaign, *Atmospheric Chemistry & Physics*. 16, 3127-3144. doi:10.5194/acp-16-3127-2016

Liu, S., **Julian X. L. Wang**, Xin-Zhong Liang, and Vernon Morris (2016). A hybrid approach to improving the skills of seasonal climate outlook at the regional scale. *Climate Dynamics* 46, 1, 483-494. doi:10.1007/s00382-015-2594-1

Milford, Celia, R Fernández-Camacho, A.M. Sánchez de la Campa, Sergio Rodríguez, Nuria Castell, Carlos Marrero, J.J. Bustos, J.D. de la Rosa, and **Ariel F. Stein** (2016). Black Carbon aerosol measurements and simulation in two cities in south-west Spain. *Atmospheric Environment* 126: 55-65. doi:10.1016/j.atmosenv.2015.11.026

Nault, B. A.,…Xinrong Ren… (2016). Observational Constraints on the Oxidation of NOx in the Upper Troposphere. *The Journal of Physical Chemistry A* 120(9): 1468-1478. doi:10.1021/acs.jpca.5b07824

Saylor, R. D. and B. B. Hicks (2016). New directions: Time for a new approach to modeling surface-atmosphere exchanges in air quality models? *Atmospheric Environment* 129: 229-233. doi:10.1016/j.atmosenv.2016.01.032
Current state-of-the-art air quality and atmospheric chemistry models treat the emission and dry deposition of most gases and particles as separate model processes, even though evidence from field measurements has accumulated over time that the emission and deposition processes of many chemical constituents are often directly linked. In this article, the authors argue that the time has come to integrate the treatment of these processes in air quality models to provide biological, physical and chemical consistency and improved predictions of trace gases and particles. Specifically, the authors call for the appropriate field measurement and air quality modeling communities to convene a workshop to identify research needs and next steps to begin this essential effort.

Seidel, D. J., J. Li, C. Mears, I. Moradi, J. Nash, W. J. Randel, R. Saunders, D. W. J. Thompson, and C.-Z. Zou (2016): Stratospheric temperature changes during the satellite era, *J. Geophys. Res. Atmos*., 121, doi:10.1002/2015JD024039.

Tang, Y., L. Pan, **P. Lee**, D. Tong, H. C. Kim, J. Wang, and S. Lu. (2016) The Performance and Issues of a Regional Chemical Transport Model During Discover-AQ 2014 Aircraft Measurements Over Colorado. *In Air Pollution Modeling and its Application XXIV* (pp. 635-640, Chapter 103). ISBN:978-3-319-24476-1, Springer International Publishing, 2016.

Zhao, H., D. Q. Tong, **P. Lee**, H. Kim, and H. Lei, 2016: Reconstructing Fire Records from Ground-Based Routine Aerosol Monitoring, *Atmosphere*, 7(3), 43, doi:10.3390/atmos7030043

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?

Presentations were given by Ed Dumas and Ron Dobosy at the 2016 Annual Meeting of the American Meteorological Society (AMS) describing results from the first flights of the Flux Observations of Carbon from an Airborne Laboratory (FOCAL), a study ARL/ATDD conducted in collaboration with Harvard University and Aurora Flight Sciences Inc. The AMS presentations focused on the flights that passed near the measurement tower, which was installed and maintained by ATDD through the summer of 2013.

Outreach & Engagement

LaToya Myles received an Equal Employment Opportunity/Diversity Award at an OAR Diversity Town Hall on February 26, 2016 for her exemplary service with the NOAA Educational

Partnership Program serving as a presenter and student mentor and her numerous outreach activities and presentations for ARL targeting women and minorities.

LaToya Myles attended the NSF Geosciences Opportunities for Leadership in Diversity (GOLD) Ideas Lab, an invitation-only workshop designed to develop collaborative research ideas and proposals to achieve goals of preparing new leaders within the geosciences community who can catalyze progress in broadening participation within their local spheres of influence and, ideally, foster transformative impact at community-wide scales through collective action and scale up of their individual efforts. The Ideas Lab was held in Annapolis, MD, on March 20-24.

LaToya Myles hosted a visit from NOAA Ernest F. Hollings Scholar, Mary Earp. Mary is from the University of Oregon, and she will be working on atmospheric chemistry studies at ATDD starting in June 2016.