# NOAA Air Resources Laboratory

## Quarterly Activity Report

## FY2019 Quarter 1 (October-November-December 2018)

## Contents:

## *DISPERSION AND BOUNDARY LAYER*

### 1. Project Sagebrush

The manuscript “Mechanisms for wind direction changes in the very stable boundary layer,” by **D. Finn**, **R. M. Eckman**, Z. Gao, and H. Liu, was published in final form in the *Journal of Applied Meteorology and Climatology* (November 2018, vol. 57, 2623-2637, https://doi.org/10.1175/JAMC-D-18-0065.1). This paper investigates the rapid changes in wind direction observed under stable conditions during Phase 2 of Project Sagebrush in 2016. (Dennis Finn, richard.eckman@noaa.gov)

The manuscript “Effects of low-level jets on near-surface turbulence and wind direction changes in the stable boundary layer” passed ARL review and was submitted to the *Quarterly Journal of the Royal Meteorological Society* late in the quarter. (Dennis Finn)

### 2. Field Research Division (FRD) Tracer Program

Due to the large global warming potential of sulfur hexafluoride (SF6) gas, FRD has initiated efforts to identify possible alternative tracers. Several years ago FRD developed a method based on three perfluorocarbon tracers, but it has two principal drawbacks. First, it permits oxygen in the sample to reach the heated electron capture detector on the gas chromatograph (GC), resulting in accelerated detector degradation. Second, it uses a mixture of helium and argon as carrier gases. Maintaining a precise ratio of these gases is critical to the method, but difficult to reliably achieve. During this quarter, FRD developed a revised perfluorocarbon method to essentially eliminate oxygen from entering the detector while using nitrogen as the only carrier gas. This new method is still able to detect concentrations in the low parts per trillion (ppt) range, comparable to SF6. Furthermore, the response appeared to be more stable over time.

This preliminary work provides the basis for an improved multiple tracer method, but there are still some qualifying factors to consider. First, while the global warming potentials of the perfluorocarbons are about one-third to one-half that of SF6, they are still large. Second, the altered GC plumbing required for the perfluorocarbons increases the risk of residual tracer from one sample contaminating subsequent samples. Third, one of the perfluorocarbon tracers has a long retention time that significantly increases analysis times.

FRD also began investigating the feasibility of using a new class of refrigerants with low global warming potentials as tracers. Some researchers are presently measuring atmospheric levels of these refrigerants using elaborate and expensive techniques; however, it is unknown how effectively they might be quantified at low concentrations using faster, low-cost approaches such as electron capture detection. These are important considerations for practical application in tracer experiments.

Preliminary work with one of the new refrigerants suggests that it cannot be quantified at the lower concentrations necessary for use as a tracer gas when using FRD's existing tracer measurement capabilities. However, this is not yet conclusive and further efforts will be made to assess these potential alternatives as tracers. (Dennis Finn, roger.carter@noaa.gov)

## 3. Boundary Layer Research

Since 2013, FRD has conducted two major tracer studies, Project Sagebrush Phases 1 and 2, at the tracer facility located within the Idaho National Laboratory (INL). Both meteorological and plume data resulting from these studies have been analyzed and published. Several interesting discoveries have come from these studies, such as how tracer plumes can quickly change directions due to shifting wind direction within a short time span, and how atmospheric stability can affect the change of wind direction. FRD intends to simulate these experimental cases using a WRF-LES (Weather Research and Forecasting Model - Large Eddy Simulation) coupling approach. As the first step, WRF models were run with different setups (domain size, resolution, initial and boundary condition) and their outputs were compared to the observations from FRD's Mesonet. The purpose was to validate the model in terms of its capability to reproduce the atmospheric conditions at the times when tracer studies were conducted. This would pave a way for the follow-on steps of modeling the turbulent fields and trace plumes observed during the tracer studies. (bai.yang@noaa.gov)

## 4. Renewal of Department of Energy (DOE) Partnership

A new five-year agreement between FRD and the DOE Idaho Operations Office started this quarter. This continues a partnership extending back to 1949. (richard.eckman@noaa.gov)

## 5. HYSPLIT Radiological (HYRad) Dispersion System

Changes in the scheme used at DOE's INL for managing the configuration of radiological release scenarios required some minor upgrades to parts of HYRad. The first of these was standardizing the format for the release scenarios submitted to FRD. A script developed for processing these standardized files into HYRad-ready files will expedite updates to the release library with fewer errors. FRD has long provided the ability to build customized scenarios through the HYRad interface. This has proven especially useful for situations where advance knowledge of what will be present in a release is lacking and a pre-configured scenario is unavailable. Recent changes made it necessary to increase the number of isotopes available for inclusion in a customized release. (brad.reese@noaa.gov, Dennis Finn)

## 6. Collaboration on White-nose Syndrome in Bats

Since the fourth quarter of 2018, FRD has been collaborating with biologists in Southeastern Idaho to better understand the spread of White-nose Syndrome in bats. Preliminary research indicates that the syndrome may be related to unusual bat activity during their winter hibernation period, and this cold-season activity appears to be related to weather changes. Several of FRD's meteorological towers are located near caves with bat colonies. During the first quarter, FRD compiled weather observations at three of these towers going back to 2013 so that they can be correlated with acoustic observations of bat activity (each bat species has distinctive echolocation calls). In late October, ARL issued a research highlight related to the bat study. (richard.eckman@noaa.gov)

## 7. Consequence Assessment for the Nevada National Security Site (NNSS)

James Wood, Rick Lantrip, and Walt Schalk participated in an emergency response training exercise on the NNSS as the Consequence Assessment Team (CAT) for the National Nuclear Security Administration (NNSA) Nevada Field Office (NFO). The event consisted of a field exercise that occurred on the NNSS, during which the activities to be conducted were discussed, local weather data and weather forecasts were provided, and dispersion products were generated based on the worst case event information provided for the scenario. In addition, the CAT worked with field measurement teams to help identify/locate the plume. This event, a simulated chemical accident at a NNSS facility, was conducted with the DOE/NNSA/NFO Emergency Response Organization. Dispersion and consequence assessment products were developed for use during exercise play as "ground truth".

Routine training and practice are required to maintain Consequence Assessment qualifications and expertise. Several other emergency response exercises are in the planning stage and dispersion calculations have been generated for these future events. (rick.lantrip@noaa.gov, james.s.wood@noaa.gov, walter.w.schalk@noaa.gov)

## 8. Special Operations & Research Division (SORD) Mesonet

SORD continued researching several areas in an attempt to improve the SORD/NNSS mesonet. Three-dimensional (3-D) sonic anemometer improvements/upgrades, precipitation gauge replacement, gauges that can better record snow, snow depth sensors, and a light detection and ranging (LIDAR) system top of the list of improvements. Wayne Bailey continues to perform routine monthly maintenance and verification checks on the NNSS mesonet, addressing items like sonic anemometers that still have to be reset on occasion.

Walt Schalk, Rick Lantrip, and Caleb Steele provided NNSS Mesonet data to several groups on the site for use in planning experimental activities. James Wood provided monthly precipitation data to the Environmental Monitoring Group.

Lightning Detection System: SORD continued working with our partners to install a new lightning sensor to the north, but getting information is challenging. We continued working to solidify our information technology support and, after this occurs, Vaisala will return to upgrade the detection

data processing software that will improve location accuracy and better delineate between inter-cloud and cloud-to-ground strikes. (walter.w.schalk@noaa.gov, james.s.wood@noaa.gov, rick.lantrip@noaa.gov, wayne.bailey@noaa.gov)

## 9. Support to DOE/NNSA NNSS Projects and Experiments

Walt Schalk participated in several planning meetings in preparation for Phase II of non-proliferation experiments [Source Physics Experiments (SPE) – Phase I and Dry Alluvium Geology (DAG) – Phase II]. Discussions continue with Los Alamos scientists to determine collaborative and support areas, especially in the area of using balloons to elevate instrument platforms. A practice run was conducted with the new mobile upper air system.

James Wood, Rick Lantrip, and Caleb Steele provided specific point forecasts and weather surveillance for the DAG-2 experiment setup. The experiment was conducted on the NNSS in December. Caleb, James, and Rick participated in the daily Plan of the Day meetings where the forecast was provided and questions were answered. Lightning and winds were particular items of interest.

Schalk continues to develop a portable micro-net of weather stations and a portable wind set package to support experiments on the NNSS, such as the SPE/DAG. A micro-net station was set up to support the DAG experiments and has been collecting data for several months. Direct radio communications were set up on a separate frequency with the micro-net station to "stream" data, leading up to and during experiment execution, directly into the main science operations trailer.

Wood, Steele, Lantrip, Schalk, and Wayne Bailey supported a non-proliferation SPE experiment on the NNSS. During the week of the experiment, the SORD team was on location in the field. They provided detailed point forecasts and weather surveillance, and participated in numerous experiment countdowns and practice scenarios. Due to the nature of the experiment, lightning/storm data/information and wind speeds [under 5 meters per second (m/s) desired] were critical to the success of the experiment. A radiosonde balloon was released just after sunrise to help characterize the boundary layer environment and another balloon was released just after the experiment was executed. The second balloon reached 7.25 millibars/98,212 feet. Forecast models were inconsistent leading up to the event; however, the weather was good on experiment day. The experiment was a success and a lot of good information was collected.

Schalk continues to meet with NFO contractor personnel monthly to discuss NNSS efforts to complete the vulnerability screening activity for the mandated Site Sustainability Project – Climate Resiliency. (***walter.w.schalk@noaa.gov***, ***james.s.wood@noaa.gov***, ***rick.lantrip@noaa.gov***)

## 10. Atmospheric Turbulence & Diffusion Division (ATDD) – Small Unmanned Aircraft System (sUAS) Instrument Testing

The BlackSwift Technologies multi-hole probe, re-worked after a test in September 2018, was tested in ATDD's wind tunnel in November 2018. The probe is designed to mount on a sUAS and measure angles of attack and side-slip of airflow with respect to the sUAS. During the recent test,

the probe was fixed at a 0 degree angle of attack and angle of side-slip, while the wind tunnel speed was maintained at a constant 14.7 m/s. Data from this probe will be combined with aircraft attitude and motion data to calculate 3-D turbulent winds with respect to Earth. (*ed.dumas@noaa.gov*, B. Baker)

## 11. **ATDD sUAS Training**

Training for the BlackSwift S2 sUAS was performed October 22-26, 2018 at the BlackSwift facility in Boulder, Colorado. The operational flight training for Ed Dumas, Mark Rogers, and Nicole Chappelle was conducted by BlackSwift personnel and designed so that each of the three could act as pilot-in-command and operate the aircraft's autopilot system. The aircraft will be kept at ATDD and used for making daily profiles of temperature and relative humidity (RH) to altitudes of up to 1 kilometer (km) above ground level (AGL), as well as flux measurements of carbon dioxide and methane. ATDD also acquired another S2 which will be used to make measurements of incoming and reflected solar radiation using visible, near infrared, and multi-spectral instruments.

Training for the Meteomatics Meteodrone sUAS was performed from October 29 to November 2, 2018 at the ATDD facility. Conducted by Meteomatics personnel, the instruction included operational flight training for Dumas, Rogers, and Chappelle so that each could act as pilot-in-command, and guidance for Temple Lee and Michael Buban to act as observers for the sUAS. The Meteomatics Meteodrone will be kept at ATDD and used to make daily profiles of temperature and RH to altitudes of up to 1 km AGL.

Training for the Microdrone MD4-1000 sUAS lidar system was performed from November 5-9, 2018 at the ATDD facility. A Microdrone representative conducted the training, which involved Dumas and Rogers operating the system and Lee and Buban acting as observers for the sUAS. The Microdrone MD4-1000 and its lidar system will be kept at ATDD and used for making measurements of terrain elevation. (ed.dumas@noaa.gov, T. Lee, M. Buban, B. Baker)

## 12. **ATDD – UAS Program Office Work**

A contract was signed to perform a computational fluid dynamics modeling study of the BlackSwift S2 airframe under normal flight conditions to evaluate the amount of flow distortion created by the aircraft at various locations around the airframe. The goal is to determine the best mounting location on the airframe for the BlackSwift Technologies gust probe in order to perform turbulence measurements.

Work also continues with the team from NOAA's UAS Program Office and Aircraft Operations Center (AOC) to create a Federal Aviation Administration (FAA) Certificate of Authorization (COA) application to perform extended visual line-of-sight (EVLOS) operations with the BlackSwift S2. The purpose is to measure vertical profiles of temperature and RH for the National Weather Service (NWS) to an altitude of 1,000 meters (3,280 feet) AGL on a regular basis. NOAA/AOC submitted the COA application to the FAA in August 2018. FAA, in turn, provided feedback regarding an issue with regular air traffic over the test site. Refined procedures will be developed to eliminate the possibility of collision with manned aircraft. (**ed.dumas@noaa.gov**, T. Lee, M. Buban, B. Baker)

## *ATMOSPHERIC CHEMISTRY AND DEPOSITION*

### 13. **Atmospheric Dispersion Modeling System (AERMOD)**

Caleb Steele worked with the latest version of the AERMOD model and the BEEST software package in support of licensing activities for the NNSS. Steele and his SORD colleagues conducted new model installation and verification, created/assembled new meteorological database/files for the NNSS, completed AERMOD modelling, and began reviewing/documenting and the results. (Note: BEEST is not an acronym. It is a software package that provides a user interface for the AERMOD air quality model.)

### 14. **National Air Quality Forecast Capability (NAQFC) Upgrade**

ARL advanced a major upgrade to the NAQFC in emission science and code management on December 18, 2018. Our nation is experiencing unprecedented rapid change in vehicular and energy generation fuel consumption. It is projected that, by 2030, every other vehicle sold in California will be electrically powered. Transitioning to natural gas-fired peak units in electricity generation is also being developed rapidly, primarily due to environmental and economic advantages. These are just two of the many changing sectors of our nation's energy consumption. To assure accurate forecasts, the NWS operational NAQFC must capture and project these changes into real-time emission rates distributed across the country at hourly intervals.

ARL investigated the applicability and impact of the latest National Emission Inventory (NEI) released by the U.S. Environmental Protection Agency (EPA) in 2014, known as NEI2014. This inventory is a listing of the emission strengths of various air pollutants in accordance with their source and content characteristics. ARL identified that the oil and gas industry, energy generation plants, and mobile sources due to vehicular transportation were among the largest changes in comparison to the operational NAQFC based NEI2011, both in terms of ozone and particulate matter precursor species.

Besides the major improvement in emission science, ARL streamlined the NAQFC multiple domain forecast powered by different software systems (continental U.S., Alaska, and Hawaii domains) into a single unified modeling system by synchronizing all software components/versions of the modeling system. This is the first time that all three domains use one unified software package. For more information, please visit https://airquality.weather.gov/. (pius.lee@noaa.gov)

### 15. **HYSPLIT for Chemical-Specific Analyses**

Mark Cohen carried out an analysis investigating if/when chemical-specific HYSPLIT parameters could be used in simulating a suite of 811 chemicals within the NOAA/National Ocean Service/ Office of Response and Restoration's (OR&R) ALOHA® chemicals suite. NOAA uses HYSPLIT to simulate downwind atmospheric concentrations of these chemicals, after emission to the air, in emergency response situations. The results were presented in the report *HYSPLIT Simulation Parameters for ALOHA Chemicals* and summarized in the PowerPoint presentation *HYSPLIT Simulations for ALOHA Chemicals: Possibilities and Suggestions*. A detailed spreadsheet and other associated analyses were also assembled. It is anticipated that this analysis will be

discussed with OR&R to assess how the information might be used in future HYSPLIT-associated emergency response simulations. Physical-chemical properties were assembled for each of the chemicals using available databases. More than 550 month-long HYSPLIT simulations were carried out, in four seasons and with two meteorological datasets, to illustrate the impact of parameter choices and uncertainties on concentrations from one to 250 km downwind. Statistical distributions of hourly average downwind concentrations at each downwind distance were assembled for each simulation to allow a more comprehensive comparison of results. A range of different approaches were suggested, along with the advantages and disadvantages of each. (mark.cohen@noaa.gov)

## 16. **Site Determination for Sulfur Dioxide ($SO_2$) Tracer Studies**

Mark Cohen conducted a screening analysis to identify regions best suited for initial tracer studies of $SO_2$. A series of maps were created for these potential regions, each including the following elements: (a) $SO_2$ monitoring sites, (b) power plant emission sources with $SO_2$ continuous emission monitoring systems (CEMs), with colored symbols scaled to average $SO_2$ emissions intensity, (c) other significant point-source $SO_2$ emission sources based on the EPA's NEI, with colored symbols scaled to average $SO_2$ emissions intensity, and (d) the spatial extent of urbanized areas. Twelve such maps were created based on data for 2014 - the latest year that NEI emissions were available. (mark.cohen@noaa.gov)

## 17. **HYSPLIT Simulations Compared to Actual $SO_2$ Measurements**

Mark Cohen carried out an analysis comparing HYSPLIT simulation results with $SO_2$ measurements in the Omaha, Nebraska, region for the period of June – July 2014. $SO_2$ emissions were simulated for seven power plants with CEMs and the detailed hour-by-hour results were compared against hourly measurements at a single $SO_2$ measurement site near the geographic center of the Omaha urban area. Time series plots were created for the entire period showing the following on the common time axis: measured concentrations of ground level $SO_2$; height of the planetary boundary layer; wind direction measured at the $SO_2$ monitoring site and at relevant power plant locations, as estimated by the Weather Research and Forecasting (WRF) meteorological model results used to drive the HYSPLIT simulation; the wind direction from each relevant power plant that would carry the emitted $SO_2$ directly to the monitoring site; and the modeled ground level $SO_2$ concentration from each relevant power plant at the actual monitoring site as well as locations five degrees on either side of the monitoring site. Detailed examination of the time series data showed that, in some cases, the modeled concentration matched very well with the measured concentration. When there was a discrepancy between the modeled and measured concentrations, likely causes were sometimes revealed by the data, e.g., clear differences between the actual and modeled wind direction that either caused an artificial plume "hit" or "miss" at the monitoring site. The presentation included a list of 11 key lessons learned from this analysis. (mark.cohen@noaa.gov)

## *CLIMATE OBSERVATIONS AND ANALYSES*

### 18. **U.S. Climate Reference Network (USCRN)**

USCRN staff made 23 annual maintenance visits. (mark.e.hall@noaa.gov)

In October, November, and December, the National Centers for Environmental Information (NCEI) retrieved 39 data files from USCRN sites through the 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. Instruments' 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)

### 19. **Local Meteorological Support**

Data reduction for October, November, and December was completed without problems. The monthly data for these three months was entered into WxCoder and submitted. (lynne.satterfield@noaa.gov)

## *ARL 1st Quarter Publications*


Brune, W. H.; Ren, X.; Zhang, L.; Mao, J.; Miller, D.O.; Anderson, B. E.; Blake, D. R.; Cohen, R. C.; Diskin, G. S.; Hall, S. R.; Hanisco, T. F.; Huey, L. G.; Nault, B. A.; Peischl, J., Pollack, I., Ryerson, T. B., Shingler, T., Sorooshian, A., Ullmann, K., Wisthaler, A.; and Wooldridge, P. J. (2018). Atmospheric oxidation in the presence of clouds during the Deep Convective Clouds and Chemistry (DC3) study, *Atmos. Chem. Phys.*, 18, 14493-14510, https://doi.org/10.5194/acp-18-14493-2018

Chai, T.; **Stein, A.**; and Ngan, F. (2018). Weak-constraint inverse modeling using HYSPLIT-4 Lagrangian dispersion model and Cross-Appalachian Tracer Experiment (CAPTEX) observations – effect of including model uncertainties on source term estimation, *Geosci. Model Dev.*, 11, 5135-5148, https://doi.org/10.5194/gmd-11-5135-2018

**Finn, D.**; **Eckman, R.**; Gao, Z.; and Liu, H. (2018). Mechanisms for wind direction changes in the very stable boundary layer. *J. Appl. Meteor. Climatol.*, 57 (11). https://doi.org/10.1175/JAMC-D-18-0065.1

Lee, T. R.; Buban, M.; Dumas, E.; **Baker, C. B**. (2018). On the Use of Rotary-Wing Aircraft to Sample Near-Surface Thermodynamic Fields: Results from Recent Field Campaigns. *Sensors*, 19(1), 10; https://doi.org/10.3390/s19010010

Nelson, Andrew J.; Lichiheb, Nebila; Koloutsou-Vakakis, Sotiria; Rood, Mark J.; Heuer, Mark; **Myles, LaToya**; Joo, Eva; Miller, Jesse; Bernacchi, Carl (2018). Ammonia flux measurements above a corn canopy using relaxed eddy accumulation and a flux gradient system. *Agricultural and Forest Meteorology*, 264, 104-113. https://doi.org/10.1016/j.agrformet.2018.10.003

Nitu, R., Y.-A. Roulet, M. Wolff, M. Earle, A. Reverdin, C. Smith, **J. Kochendorfer**, S. Morin, R. Rasmussen, K. Wong, J. Alastrué, L. Arnold, B. Baker, S. Buisán, J.L. Collado, M. Colli, B. Collins, A. Gaydos, H.-R. Hannula, J. Hoover, P. Joe, A. Kontu, T. Laine, L. Lanza, E. Lanzinger, GW Lee, Y. Lejeune, L. Leppänen, E. Mekis, J.-M. Panel, A. Poikonen, S. Ryu, F. Sabatini, J. Theriault, D. Yang, C.Genthon, F. van den Heuvel, N. Hirasawa, H. Konishi, H. Motoyoshi, S. Nakai, K. Nishimura, A. Senese, and K. Yamashita. Wmo Solid Precipitation Intercomparison Experiment (Spice) (2012 - 2015). WMO, 2018.

Nowlan, C. R.; Liu, X.; Janz, S. J.; Kowalewski, M. G.; Chance, K.; Follette-Cook, M. B.; Fried, A.; González Abad, G.; Herman, J. R.; Judd, L. M.; Kwon, H.-A.; Loughner, C. P.; Pickering, K. E.; Richter, D.; Spinei, E.; Walega, J.; Weibring, P.; and Weinheimer, A. J. (2018). Nitrogen dioxide and formaldehyde measurements from the GEOstationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator over Houston, Texas. *Atmos. Meas. Tech.*, 11, 5941-5964, https://doi.org/10.5194/amt-11-5941-2018

## *Conference Presentations & Invited Talks*

**World Meteorological Organization (WMO) Commission of Basic Systems (CBS) Expert Team on Emergency Response Activities:** Glenn Rolph participated as an invited guest at this meeting in Vienna, Austria, from October 1-5, 2018. The meeting is held every two or three years to coordinate the activities of the nuclear and non-nuclear Regional Specialized Meteorological Centres (RSMCs) under WMO/CBS, in which NOAA (jointly between the Air Resources Laboratory and the National Centers for Environmental Prediction) is designated as RSMC Washington. The RSMCs provide dispersion modeling products to WMO member countries and the International Atomic Energy Agency for real-time major events with releases from nuclear facilities (for example, the Fukushima nuclear power plant), smoke from large grasslands, forest fires and industrial fires, as well as large chemical releases. Glenn made a presentation on the Transfer Coefficient Matrix work being done under this program and the meeting participants were very interested in seeing this capability used by the RSMCs in the future.

**9th International Workshop on Air Quality Forecasting Research (IWAQFR):** Rick Saylor, Barry Baker, Daniel Tong, and Patrick Campbell attended this event, held November 7–9 at NOAA's Earth System Research Laboratory in Boulder, Colorado. IWAQFR meetings bring together scientists from around the world to exchange recent research findings in the area of air quality forecasting research. Saylor co-chaired a session on "Using Observations for Model Evaluation and Improvement." Baker, Tong, and Saylor co-authored a presentation entitled "Recent developments of the FENGSHA dust emission module: Implementation into FV3-Chem and Future Developments" within a suite of talks on "Emissions and Inventories". FENGSHA is a

dust emission model developed by ARL scientists. Its name means “windblown dust” in Mandarin. Campbell presented a poster focused on his research into the impact of global subgrid (i.e., “tiled”) land cover variability parameterizations and their impact on meteorology and air-surface exchange, which are critical inputs to air quality models. The model used was the Model for Prediction Across Scales–Atmosphere (MPAS-A), and was tested on a gradually refining global-to-U.S. mesh of 92-to-25 km. The maps below compare the top two ranked tiled land cover characterizations (top four panels), and their associated land use fractions for each MPAS-A mesh cell (bottom four panels). Note: The top ranked (#1) tile is the dominant land use, which assumes that the most abundant land use tile occupies the entire cell area.

Results indicate that the tiled land cover parameterization has a significant impact on the global energy fluxes and evaporative fraction, which results in reductions (compared to dominant approach) of the mean bias in 2-m temperature and specific humidity in the central and western United States. These results are important because numerical weather prediction models tend to have systematic warm biases, especially in the central U.S. The work is also important to the development of state-of-science weather, climate, and air quality models. *Implications:* Research on these issues can improve weather and air quality forecasting and lead to more accurate weather and air quality warnings to protect human health. (Patrick.C.Campbell@noaa.gov, rick.saylor@noaa.gov)

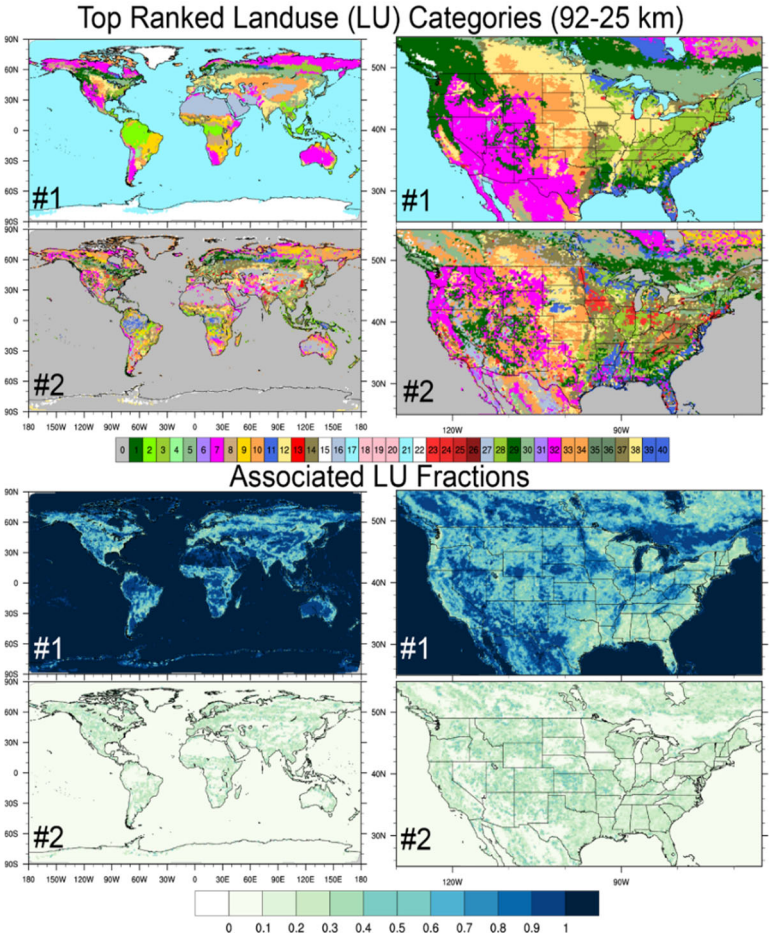


Figure Caption: Spatial plots of the top two ranked, tiled land use categories and their associated landuse fractions for the 20-category National Land Cover Database (NLCD) within the conterminous U.S., and elsewhere the International Geosphere-Biosphere Programme (IGBP)-Modified, 20-category Moderate Resolution Imaging Spectroradiometer (MODIS) satellite database. The IGPB-MODIS (1-20) and NLCD (21 – 40) landuse categories are (lumped for simplification): Forests: 1-5 & 28-30; Grasses, Shrubs, or Savannahs: 6-10 & 31-34 & 37; Lichens/Moss: 35-36; Wetlands: 11 & 39-40; Croplands: 12, 14, & 38; Urban/Developed: 13 & 23-26; Snow and Ice: 15 & 22; Barren/Sparsely Vegetated: 16 & 27; Water: 17 & 21; Unclassified: 18-20; Regions of landuse fraction <0.01: 0 (Filled-grey).

**100th American Geophysical Union (AGU) Fall Meeting:** Patrick Campbell gave an oral presentation at AGU, held December 10-14 in Washington D.C. Campbell’s presentation focused on his research into the impact of global subgrid, as detailed above. Praveena Krishnan presented a paper entitled “Airborne Hyperspectral Imaging to Estimate Vegetation Indices during the Land – Atmosphere Feedback Experiment,” coauthored by T. Lee, M. Buban, E. J. Dumas, T. P. Meyers, B. Baker, and S. Brooks. Dr. Krishnan presented results on the estimation of vegetation indices

using airborne hyperspectral imaging and its comparison with those estimated using airborne multispectral data and tower-based radiation measurements carried out during the Land-Atmosphere Feedback Experiment (LAFE) in August 2017. John Kochendorfer presented "Evapotranspiration measurements using a new fast-response relative humidity probe," coauthored by T. Lee, E.J. Dumas, R. Dobosy, T.P. Meyers, K.T. Paw U, C.B. Baker. (Patrick.C.Campbell@noaa.gov, praveena.krishnan@noaa.gov, john.kochendorfer@noaa.gov)

## *Outreach & Engagement*

James Wood visited a local elementary school and gave a weather talk to the entire third grade class. His presentation consisted of a demonstration of wind, temperature, RH, and pressure instruments, an explanation of the basic science behind weather and the relationship between weather and wildland fire safety, and a question and answer session. (james.s.wood@noaa.gov)

## *Other*

**DOE Meteorological Coordinating Council (DMCC) Activities:** Walt Schalk prepared/finalized the agenda for and ran the bi-monthly conference call, which consisted of a round robin update of program status of those present, a discussion on the path forward with the new U.S. DOE Order and the development of the new Criteria Review and Approach Documents, recent DMCC activities and projects, and site met program discussions. Another topic of interest was an introductory discussion regarding DOE's definition of a "Qualified Meteorologist". Planning is underway for the annual meeting to be held in May 2019 in Knoxville, Tennessee. (walter.w.schalk@noaa.gov)

**ARL/SORD Site Tour:** Walt Schalk and James Wood gave a tour to about 15-20 people in October, with attendees consisting of DOE National Laboratory scientists and Department of Defense representatives. The tour, part of the Federal Expertise Training program hosted by NNSA, took place at NNSS's Desert Rock Weather Observatory. Schalk and Wood presented a verbal history of the SORD program, support of the testing program, and an overview of current activities. The numerous instrumented sites that SORD maintains for NNSS Programs (Sonic Detection And Ranging, mesonet and lightning detection network) and hosts for a variety of NOAA Programs (CRN, SURFace RADiation Network) located in the immediate Desert Rock area were also discussed. As a finale, a pilot balloon release was demonstrated. (walter.w.schalk@noaa.gov, james.s.wood@noaa.gov)

**SORD Website:** Work continues to add improvements, updates, and new capabilities to the website, www.sord.nv.doe.gov. Caleb Steele improved the WRF output display for internal use. (walter.w.schalk@noaa.gov)

**FRD Staff Changes:** FRD's Administrative Officer retired on December 31, 2018. Approval was granted to fill the position and the division is in the initial stages of the hiring process. (richard.eckman@noaa.gov)