SAES-422 Multistate Research Activity Accomplishments Report

Project No. and Title:	NRSP-3, The National Atmospheric Deposition Program – A Long-Term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition
Report Period:	10/1/2016 through 9/30/2017
Date of Report:	December 28, 2017
Meeting Dates:	Fall, Oct 31-Nov 4, 2016 (Santa Fe, NM, FY17); Spring, April 24-27, 2017 (Louisville, KY); Fall, Oct. 30 - Nov. 3, 2017 (San Diego, CA FY18).

Participants

An attendees listing for our Fall Meeting and Science Symposium (FY17), as with all meetings, is available at our meetings page (http://nadp.isws.illinois.edu/conf/).

Meeting Minutes

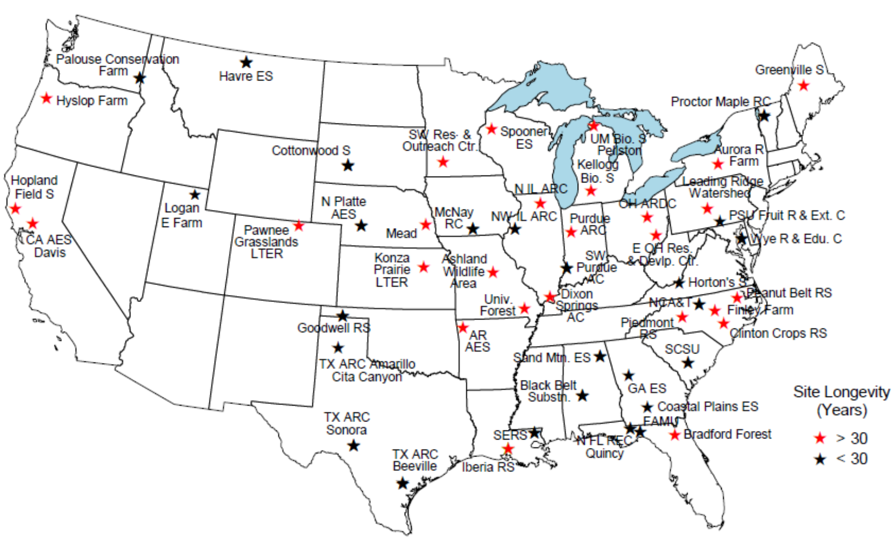
The NADP is comprised of a technical committee (all participants), an executive committee, several scientific committees, and a series of subcommittees focusing on specific areas of the ongoing project, including operations, quality assurance, ecological response and outreach, and data management. All approved meeting minutes from our FY17 Spring and FY2016 and 17 Fall Meetings (and all other meetings) are available on our website (nadp.isws.illinois.edu/committees/minutes.aspx). Posting of committee minutes is controlled by each committee, with some subcommittee minutes delayed for approval.

Accomplishments

The National Research Support Project – No. 3 (NRSP3) provides a framework for cooperation among State Agricultural Experiment Stations (SAES), the U.S. Department of Agriculture-National Institute of Food and Agriculture, and other cooperating governmental and non-governmental organizations that support the National Atmospheric Deposition Program (NADP). The NADP provides quality-assured data and information on the exposure of managed and natural ecosystems and cultural resources to acidic compounds, nutrients, base cations, and mercury in precipitation and through dry deposition of several of these compounds. NADP data support informed decisions on air quality and ecosystem issues related to precipitation chemistry.

Specifically, researchers use NADP data to investigate the impacts of atmospheric deposition on the productivity of managed and natural ecosystems; the chemistry of estuarine, surface, and ground waters; and the biodiversity in forests, shrubs, grasslands, deserts, and alpine vegetation. These research activities address the mission of the NRSPs of "development of … support activities (e.g., collect, assemble, store, and distribute materials, resources and information)… to accomplish high priority research". Researchers also use NADP Mercury networks and data to examine the effect of atmospheric deposition on the mercury content of fish, and to better understand the link between environmental and dietary mercury and human health. This fits with an agriculture research priority of food safety.

The NADP operates three precipitation chemistry networks: the National Trends Network (NTN), the Atmospheric Integrated Research Monitoring Network (AIRMoN), and the Mercury Deposition Network (MDN). This report is specifically for the 48 NTN sites operated at the miscellaneous SAESs, and in part supported by this agreement. But, this report covers all of the accomplishments and impacts from all NADP networks.



State Agricultural Experiment Stations within NADP.

The NTN provides the only long-term nationwide record of basic ion wet deposition in the United States. Sample analysis includes free acidity (H^+ as pH), specific conductance, and concentration and deposition measurements for calcium, magnesium, sodium, potassium, sulfate, nitrate, chloride, bromide, and ammonium. We also measure orthophosphate ions (PO_4^{3-}, the inorganic form), but only for quality assurance as an indicator of sample contamination. At the end of September 2017, 263 NTN stations were collecting one-week precipitation samples in 48 states, Puerto Rico, the Virgin Islands, Canada, and in Argentina, and include the SAES sites shown in the map above. Additionally, there are multiple quality assurance and testing sites located in Illinois, Colorado, and Wisconsin. Complementing the NTN is the 6-site AIRMoN, which are essentially NTN sites, operated on a daily basis (i.e., single precipitation events). Samples are collected to support continued research of atmospheric transport and removal of air pollutants and development of computer simulations of these processes.

The 100-site MDN offers the only long-term and routine measurements of mercury in North American precipitation. Measurements of total mercury concentration and deposition (and optional methyl-mercury) are used to quantify mercury deposition to water bodies, some of which have fish and wildlife mercury consumption advisories. Since 2008, every state and 10 Canadian provinces listed advisories warning people to limit fish consumption due to high mercury levels. Coastal advisories are also in place for Atlantic waters from Maine to Rhode Island, from North Carolina to Florida, for the entire U.S. Gulf Coast, and for coastal Hawaii and Alaska.

The NADP operates two newer gaseous atmospheric chemistry networks: the Atmospheric Mercury Network (AMNet) and the Ammonia Monitoring Network (AMoN). In each case, the network goal is to provide atmospheric concentrations of these particular gases, and then to estimate the rate of dry deposition (without precipitation) of the gas. In many cases, dry deposition of the gas could far exceed the wet deposition of the same compound.

At the end of September 2017, 21 AMNet sites were collecting five-minute estimates of gaseous elemental mercury and two-hourly average concentrations of gaseous oxidized mercury and particulate bound mercury. The AMNet provides the only long-term region-wide record of basic atmospheric mercury concentrations in the United States. The AMoN has 101 operating sites, where two-week averages of atmospheric ammonia gas are collected with passive devices. This low-cost network is designed to provide long-running estimates of ammonia in the atmosphere. These data are particularly important to agriculture, since many sources of ammonia are agricultural. Data from both gaseous networks support continued research of atmospheric transport and removal through dry deposition, and development of computer simulations of these processes.

Within this NRSP, there are three stated goals: 1) management and coordination of the five NADP monitoring networks; 2) site support, chemical analysis, and data validation for network sites directly supported by this agreement; and 3) quality assurance and quality control activities to ensure consistent operation and standard operational procedures. During this annual period, all three of our goals were met.

The major accomplishment of the NADP is the operation of the five monitoring networks. Operation, maintenance, management, quality assurance, and data distribution from these networks is the major outcome of this grant and project. Network specifics are listed below.

The principal output or deliverable from the NADP's five networks is the database of precipitation chemistry and deposition rates, along with atmospheric gaseous concentrations intended for the development of dry deposition fluxes (AMoN, AMNet). The wet deposition database has almost 500,000 observations in it now.

Short-term Outcomes and Outputs.

Samples Collected. NADP's principal objective and accomplishment/outcome is the collection, analysis and quality assurance of samples for precipitation and atmospheric chemistry. Briefly, there were 13,636 precipitation samples collected and analyzed by the NTN (not including QA samples), for all network sites. The analyses included observations of 10 different analyte concentrations and precipitation volume, which allow for calculation of deposition flux for each analyte. In the other networks there were 927 precipitation samples from the AIRMoN, 2,663 gaseous ammonia samples collected by the AMoN, 5,294 total mercury samples collected by the MDN, and approximately 112,500 hourly and two-hourly mercury fraction concentrations collected in the AMNet. All data are available on the NADP website, and were summarized in annual maps and figures.

Major Activity: Our principal output is the collection and analysis of precipitation chemistry and atmospheric chemistry samples. For all of these networks except AMNet, 22,520 samples were collected of the four network types. In AMNet, 112,000 hourly/2-hourly gaseous observations from the AMNet. Specifics are included in the products section of this report.

NADP Database. Our second most important accomplishment/outcome is making data available to all for the support of continued research. Scientists, policymakers, educators, students, and others are encouraged to access data at no charge from the NADP website (nadp.isws.illinois.edu). This website offers online retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, and other data and information about the program. The NTN database is now populated by 450,000 observations of precipitation chemistry for all sites and all years. As of today, 2016 calendar year data are complete and online, and the 2017 data are posted through August, with final QA to be completed in the next few months (final data QA is completed after the full year of data is available).

Internet disbursement of precipitation chemistry and atmospheric data is the primary route of dissemination for the NADP project. Website usage statistics provide evidence that our data are being used. During this reporting period, we recorded 33,027 registered users who accessed our website information and viewed our website 1,269,000 different times/pages ("hits"). Maps and NADP data from the five monitoring networks were downloaded 23,641 times during the 12 months.

We continually collect basic information about our data users, and this year was again very typical; about 40% were from federal and state agencies, 36% from universities, 16% from K-to-12 schools, and 8% from other individuals or organizations. These statistics demonstrate that NADP continues to be relevant to the scientific, policy, and educational communities. NADP data are used by policy makers to make informed decisions on agriculturally important topics, including the impact of atmospheric pollutant on the North American food supply. Data are also used in Science, Technology, Engineering and Mathematics (STEM) curricula on the elementary, secondary, and post-secondary level. All NADP data are available free of charge (nadp.isws.illinois.edu).

Map Summary. The 2016 annual map series of atmospheric concentrations, wet deposition fluxes, and report was developed during Summer 2017 and finalized and printed in September/October 2017. For each summary and calendar year, the NADP produces a series of 23 national maps of wet deposition concentration and flux maps for all of our analytes, and summary figures for each of the gaseous networks. These maps are used widely and are one of the major network products. Individual maps are filed by network, year, and constituent, and can be downloaded in several formats (http://nadp.isws.illinois.edu/data/annualmaps.aspx). Individual maps are compiled into annual Map Summary reports, and the summaries are available for download (nadp.isws.illinois.edu/lib/dataReports.aspx). We printed 2000 copies of the 2016 Annual Summary, and distribution has begun. We printed 2000 copies of the 2015 Map Summary (Sept 2016) and all have been distributed.

Fall Scientific Meeting (FY2016 & 17). At the end of each federal year, a combined business and scientific meeting is held to showcase some of the latest deposition research that occurred during the year. Additionally, during each spring, a 3 day business meeting is also held.

FY17 Fall Scientific Meeting: This meeting was held in Santa Fe, New Mexico between October 31 - November 4, 2016 (beginning of this reporting period). Information about is available here (http://nadp.isws.illinois.edu/conf/2016/). The meeting included 130 attendees, eleven oral sessions, 48 oral presentations, and 27 posters. The meeting was highlighted by a presentation from Dr. Dan Wildcat, Director, Haskell Environmental Research Studies (HERS) Center, Haskell Indian Nations University, and entitled "Understanding the Natural LAW: Land, Air and Water" (http://nadp.isws.illinois.edu/videoLib/symposia.aspx). The meeting included discussions of both wet and dry deposition measurement, and agricultural emissions, etc.

After FY17, and after this project period (Oct. 2017), the Fall Meeting and Symposium was held in San Diego, CA and will appear in next year's report.

Every spring, NADP holds a 3-day business meeting (Technical Committee, subcommittees, Executive Committee). All final committee meeting minutes are available here (nadp.isws.illinois.edu/committees/minutes.aspx). The NADP Spring Business Meeting (FY2017) was held in Louisville, KY, and the Spring 2018 meeting will be held in Milwaukee, WI in April. Attendance in Louisville was about 80 members.

These basic activities fulfilled the project objectives: (1) coordination of these networks; (2) quality assurance to ensure consistency; and (3) analytical, site support, and data validation services for the sites financed directly through this agreement. Again, this report is for the 48 SAES sites, but the network results are equivalent for all sites. Over the year, 48 SAES sites operated, including a relatively new SAES site operating at North Carolina Agricultural and Technology University (NCA&T). It became an active NTN site on Jan 30, 2015. NCA&T is a historically black university and is an 1890 Land-Grant University. This site operation with cooperation of the U.S. Dept. of Energy.

Additional notable outcomes during the project period are as follows:

One major change during this reporting period (August, 2017) for the NADP is the move from a home base of the University of Illinois to the University of Wisconsin's State Laboratory of Hygiene. This move will be for both the Program Office and laboratory services for the NTN, AIRMoN, and AMoN networks. The PO will move effective 2/28/2018. Laboratory services will move sometime in the summer period. Planning for the move is currently ongoing. The transition is proceeding reasonably well at the moment, and will very likely be a relatively smooth transition.

During the last 24 months, EROS subcommittee undertook a rewrite of our traditional "Nitrogen in the Nation's Rain", which is a general sciences booklet aimed at laymen and 6-12th grade science students. The new version, now called "Nitrogen from the Atmosphere" was completed in Aug. 2016, and is available on our website (http://nadp.isws.illinois.edu/lib/brochures/nitrogenAtmos.pdf) and in print from the Program Office. At this fall's NADP meeting, EROS will develop a plan for further distribution, with an emphasis on distribution to science teachers. Two thousand copies were printed for distribution.

The Ecological Research and Outreach Subcommittee (EROS) has also developed a series of science videos, aimed at more general audiences, which cover topics such as acid precipitation, ammonia in the atmosphere, nitrogen cycling in ecosystems, etc. During the 2016 and 2017 year, 10 videos were developed, edited and added to our listing and are available on NADP's website (http://nadp.isws.illinois.edu/videoLib/). This is a new direction for NADP, and many more videos are planned.

During the past year, several other important results have occurred beyond our basic mission and goals.

- Collaboration with USGS on mercury isotopes monitoring (FY16-17), with a goal of determining the ultimate source of mercury (atmospheric deposition, coal combustion, etc.). Measurement are being made at 20 NADP MDN sites for two years (started in early 2017);
- Collaboration with Asia countries, USEPA and EPA-Taiwan on mercury monitoring (FY14-17) across Asia, with NADP providing "know how" for network development

and continuous monitoring; countries include Japan, Taiwan, South Korea, Canada, Vietnam, Australia, Mongolia, Indonesia, Malaysia, Laos, Cambodia, Bangladesh, India, Thailand, Philippines, and Myanmar (http://rsm2.atm.ncu.edu.tw/apmmn/);

- NADP's Total Deposition Committee (TDep) is working with EPA scientists to produce a web-based tool to estimate dry deposition, and with NADP deposition to provide basic maps of total N and S deposition, resulting in a next-generation map series for total deposition, accessible by the research community (http://nadp.isws.illinois.edu/committees/tdep/tdepmaps/). New maps were produced during the year;
- Full integration of PRISM/USDA-NRCS precipitation data into our precipitation deposition mapping routines, and PRISM is supported by the USDA-Natural Resources Conservation Service (http://www.wcc.nrcs.usda.gov/climate/). This important change continues;
- The Critical Loads Atmospheric Deposition Subcommittee, a NADP Science Subcommittee, received approval for five more years of operation; and
- Litterfall Mercury Pilot Network: working with USGS scientists, the NADP is operating a pilot litterfall network for a 6^{th} year (26 sites) to determine the deposition of mercury with forest litterfall. The network is designed to determine the feasibility and easy of network measurement, for the potential adoption by the NADP as a full network.
- Equipment Upgrade: Originating with a Technical Committee decision in 2006, the NADP has converted the overwhelming majority of its older-style mechanical precipitation gages to digital-style precipitation gages. There are only 23 remaining sites, representing < 8% of the network.

During CY2017, 213 journal articles and reports were generated using the NADP data, and are listed in the publication section of this report. This is again evidence that NADP continues to produce data that are both valuable and useful. Reports for Oct.-Dec. 2016 are listed in the CY2016 report (http://nadp.isws.illinois.edu/lib/bibliography.aspx). Additionally, in support of our education and outreach responsibilities, NADP data was used in 29 dissertation and theses (also included in the bibliography).

Continued Quality Assurance Audits. NADP contract laboratories and the Program Office are each reviewed annually in rotation to identify problems, improve performance, and provide external checks to the program. These audit team members are a mix of external and NADP member scientists. The CAL was audited in 2011 and 2014 and 2017; the HAL in 2015 and will be audited in 2018; and the Program Office in 2013, and 2016. The audit report was delivered, and responses and updates to the Program Office are ongoing.

During the project period, several other additional products were developed, including an updated version of the NTN Site Operations Manual, and the Site Systems and Performance Survey QA Project Plan. These can be found here: http://nadp.isws.illinois.edu/lib/manualsSOPs.aspx. In addition, we have new versions of many of our twenty-seven Standard Operation Procedures from individual networks were approved and being used (http://nadp.isws.illinois.edu/committees/minutes.aspx). These will improve the performance of the network in future years.

Impacts

As a National Research Support Project (NRSP-3), our main mission is to support research, and in particular, to provide data for research journal articles and reports. Each calendar year, the NADP compiles a list of research articles, reports and theses/dissertations that used NADP data in some fashion, or compared their results to NADP data. For this project year, we can report over @@@ articles and reports. The journal articles that follow are example journal articles from the project period with a strong connection to agriculture. The annual bibliography of articles and reports can be found here: nadp.isws.illinois.edu/lib/bibliography.aspx.

These example publications, which are more agricultural-related publications, were published during this project period (Oct. 2016-Sept. 2017).

Craft, K. J., 2017. Modeling long-term impacts of alternative subsurface drainage systems and quantifying impacts of cover crops. Doctoral dissertation, Iowa State University.

Dr. Craft (in SAES department, SAES committee members) modeled the impact of alternative drainage systems in agricultural use. She modeled controlled, shallow, and conventional drainage systems, and found significant changes in nitrogen loss with the different systems. Her results showed shallow drainage type was the best at controlling N losses in the Spring, but not for all seasons. Also studied was the impact of delayed rye termination (harvest) prior to soybean planting reduced soil moisture content. Her work was completed in Southern Iowa.

NADP data was used to set the default model chemistry of rainwater in the area (pH= 5.1, NH_4= 0.5 mg-N L^{-1} and NO_3-N=1.3 mg-N L^{-1}).

Elkin, K. R., Veith, T. L., Lu, H., Goslee, S. C., Buda, A. R., Collick, A. S., ... & Bryant, R. B., 2016. Declining Atmospheric Sulfate Deposition in an Agricultural Watershed in Central Pennsylvania, USA. Agricultural & Environmental Letters 1 (Nov): 160039 (November), DOI: 10.2134/ael2016.09.0039.

The authors (including ARS scientists) studied the impact of reduced sulfur/sulfate deposition over the past 40 years to agricultural lands in central Pennsylvania. Atmospheric sulfur/sulfate deposition has decreased by 75% since 1979. With this reduction, many agricultural soils now have sulfate deficiencies. Twenty six percent of fields were found to be below optimum values (10 mg S per Kg soil). They concluded that S as a nutrient will require future monitoring and more sulfur enriched fertilizers will be needed.

The study used weekly sulfate deposition in precipitation (NADP samples) from 1979 through current times from a south central NADP site (PA47). Trends of NADP measurements were used to as a basis for their conclusions.

Fant, Charles, R. Srinivasan, B. Boehlert, L. Rennels, S. C. Chapra, K. M. Strzepek, J. Corona, A. Allen, and J. Martinich, 2017. Climate Change Impacts on US Water Quality Using Two Models: HAWQS and US Basins. Water 9(Feb): 118.

The authors (includes SAES scientists) compared and contrasted two different water quality models; Hydrologic and Water Quality System (HAWQS) and USBasin under future climate scenarios and focusing particularly on water temperature, dissolved oxygen, total nitrogen and phosphorus. The authors concluded that with some differences, the models were generally similar in output, and that both models estimate that water quality will more likely worsen in the East than in the West, and result in future significant financial costs.

The authors used input data from all NADP's NTN sites across the country for input to the WAWQS model, for nitrogen and phosphorus over several years, as input to the landscape portion of the model (i.e. baseline).

Felix, J. D., Elliott, E. M., & Gay, D. A., 2017. Spatial and temporal patterns of nitrogen isotopic composition of ammonia at U.S. ammonia monitoring network sites. Atmospheric Environment 150(Feb): 434–442.

The authors used monthly ammonia samples at a subset of nine Ammonia Monitoring Network (NADP AMoN) sites and analyzed each for nitrogen isotopic composition. The authors used these samples in order to begin to determine the *source* of the ammonia gas. Given that agriculture is such a large source of ammonia, this new technique of source apportionment will be of interest to agriculture. The authors were able to delineate a signal varying between non-agricultural and agricultural regions, delineate between seasonal agricultural emissions and more steady "natural" sources. They also noted a seasonal spring rise in agricultural emissions associated with spring fertilization and gaseous emissions of other types of agricultural operations.

The authors used multiple samples from nine locations within the NADP's Ammonia Monitoring network to determine isotopic nitrogen ratios.

Katz, B. S., Stotler, R. L., Hirmas, D., Ludvigson, G., Smith, J. J., & Whittemore, D. O., 2016. Geochemical recharge estimation and the effects of a declining water table. Vadose Zone Journal 15(Oct), DOI: 10.2136/vzj2016.04.0031.

The authors studied the changing recharge rates of the High Plains Aquifer (in Kansas), a very important agricultural region of the U.S. that is experiencing important groundwater use by agricultural. The authors used the movement of chloride through the surface layers to estimate recharge rates. The authors argue that previous estimated recharge rates based on chloride concentration are in error due to remnant chloride (and other analytes) remaining from previously-pumped water, that recharge has still yet to occur, that recharge rates are much longer than anticipated, and that recharge is much more complicated rather than general regional recharge.

The authors used both rainfall rates and chloride concentrations from several NADP NTN sites in this region of Kansas.

Nelson, Andrew J., S. Koloutsou-Vakakis, M. J. Rood, L. Myles, C. Lehmann, C. Bernacchi, S. Balasubramanian, E. Joo, M. Heuer, M. Vieira-Filho, and J. Lin, 2017. Season-long ammonia flux measurements above fertilized corn in central Illinois, USA, using relaxed eddy accumulation. Agricultural and Forest Meteorology 239(May): 202-212.

The authors (includes ARS scientists) used a relaxed eddy correlation system to measure ammonia deposition and emission from corn in central Illinois during 2014, with and after the addition of nitrogen fertilizer. The authors found large emission fluxes of ammonia primarily during the first 30 days after application, and through the season. They also concluded that this emission during the first 21 days after application was approximately 80% of the total nitrogen loss to the atmosphere during the entire growing season.

The authors used the NADP AMON laboratory and field methods for the measurement of ammonium for their denuders (capture device), laboratory analysis procedures (FIA), passive monitor standard operating procedures, and compared their results to regional AMoN observations from our IL11 site.

Pina, A. J., 2017. A social-ecological approach to managing agricultural ammonia emissions and nitrogen deposition in Rocky Mountain National Park (May). Doctoral dissertation, Colorado State University, https://dspace.library.colostate.edu/handle/10217/181440.

The author was interested in a "social-ecological approach" to decreasing the emissions and impact of agricultural ammonia to the Rocky Mountains National Park. He used meteorological monitoring and passive tracers to show a connection of park ammonia to the agricultural areas through summer time advection ("large-scale winds were responsible for slow and steady transport") rather than simple convection. He then developed an early warning system where farmers could minimize ammonia emissions during times where to-park-transport were occurring to minimize the air quality/environmental impact.

The author used NADP data extensively, from several NADP NTN sites in Colorado (primarily CO19, NPS-Beaver Meadows, and CO98 NPS-Loch Vale), over the long period of record.

Prasad, R., & Hochmuth, G. J., 2016. Environmental nitrogen losses from commercial crop production systems in the Suwannee River Basin of Florida. PloS One 11(Dec): e0167558, DOI: 10.1371/journal.pone.0167558.

The authors (SAES scientists) are working on nitrogen input to the Suwanee River (FL) basin, which is one of the few basins remaining with increasing nitrogen levels, and thought to be from agricultural runoff. Attempting to estimate nitrogen losses into the environment from commercial row and vegetable crops currently using best management practices, the authors constructed N budgets for 3 crops; potato, sweet corn, and silage corn over a four year period. The authors estimate that ~35% of nitrogen applied is lost, and particular from crop residue and from late season application.

The authors used NADP NTN nitrate and ammonium data obtained from the nearby SAES observation point (Branford FL, FL03) to use in their nitrogen input and budget. Atmospheric deposition was determined to be only 5% of the nitrogen in the system.

Raper, Tyson B., A. T. McClure, F. Yin, and B. Brown, 2017. Sulfur and Tennessee Row Crops. https://extension.tennessee.edu/publications/Documents/W435.pdf.

The authors (all SAES scientists, extension) developed this extension education bulletin to emphasis the importance of S and the role it plays within higher plants, describe the common occurrence of limited sulfur, and define options for agricultural professionals. They give a very good introduction to the importance of sulfur to crops, with many examples and pictures. They focused on why this is occurring more often now, which is based upon NADP long-term observations of decreasing sulfate deposition in Tennessee. They provide farmers with yield curves, estimated amounts needed for certain crops, and the cost recovery of the same.

The authors use long-term NADP data for sulfur deposition at a central Tennessee site (TN14) as the explanation of the new need for sulfate-containing fertilizer application. This same observation is made at almost all NADP sites.

<u>Future Work/Directions</u>

NADP is currently in discussions with the Council of State and Territorial Epidemiologists (FY16-17) and affiliated organizations (including NOAA, EPA, CDC, etc.) for a national allergen tracking network of aeroallergens (causing rhinitis {hay fever} and asthma). The CSTE is concerned about the lack of routine and consistent measurements, and this could be an important network for agricultural activities. The NADP formed a short-term science committee (AeroAllergens) to formalize this effort.

The Technical Committee has requested that NADP publish its digital precipitation record (approximately 300 gages) as an independent precipitation database to be used as our other wet and dry deposition databases. This should be added during FY18 and provide additional data with no additional expenditures. This will allow researchers to access the precipitation data as a stand-alone product.

Training: During the next year, we intend to produce online "training classes" that operators can take on their own schedule. These classes will use video footage of the earlier training classes (discussed above), and utilize one-on-one questioning periods with the site liaisons to provide a chance for the operators to ask questions, and for the site liaisons to assure that the operators/students understand what is needed and expected at our NADP sites.

With the transition to UWisc., there will be significant changes in the leadership of the NADP. Some of the employees will migrate to the new Program Office, but many will not. This will certainly result in changes to the management of the program. However, the goal is to make this transition as seamless to the operators and data users as possible. Therefore, new methods for management will be coming in the next few months.

Publications

Includes @@@ publications that used NADP data, resulted from NRSP 3 activities in calendar year 2017 (articles published in 2016 Oct-Dec are listed in the 2016 CY bibliography available online). A publically available online listing of citations using NADP data is accessible at: nadp.isws.illinois.edu/lib/bibliography.aspx.

1. Aas, W., Artz, R. S., Bowersox, V. C., Carmichael, G., Cole, A., Dentener, F., ... & O'Connor, F., 2017. Global Atmosphere Watch Workshop on Measurement-Model Fusion for Global Total Atmospheric Deposition (MMF-GTAD), https://www.wmo.int/pages/prog/arep/gaw/documents/DRAFT_GAW_REPORT_MMF-GTAD_4May2017FinalDraft.pdf.
2. Acharya, B. S., Hao, Y., Ochsner, T. E., & Zou, C. B. ,2017. Woody plant encroachment alters soil hydrological properties and reduces downward flux of water in tallgrass prairie. Plant and Soil 414(1-2): 379-391.
3. Adane, Z. A., 2017. Evaluating the Impacts of Grassland Conversions to Experimental Forest on Groundwater Recharge in the Nebraska Sand Hills. Doctoral Dissertation, University of Nebraska.
4. Aguirre, A. A., Derry, L. A., Mills, T. J., & Anderson, S. P., 2017. Colloidal transport in the Gordon Gulch catchment of the Boulder Creek CZO and its effect on C-Q relationships for silicon. Water Resources Research 53(3): 2368-2383.
5. Akers, P. D., Welker, J. M., & Brook, G. A., 2017. Reassessing the role of temperature in precipitation oxygen isotopes across the eastern and central United States through weekly precipitation-day data. Water Resources Research 53(9): 7644-7661.
6. Alam, M. J., Goodall, J. L., Bowes, B. D., & Girvetz, E. H., 2017. The Impact of Projected Climate Change Scenarios on Nitrogen Yield at a Regional Scale for the Contiguous United States. JAWRA Journal of the American Water Resources Association 53(4): 854-870.
7. Allen, M. F., & Allen, E. B., 2017. Mycorrhizal mediation of soil fertility amidst nitrogen eutrophication and climate change. In Mycorrhizal Mediation of Soil (pp. 213-231).
8. Allen, G., Rector, L., Butcher, T., & Trojanowski, R., 2017. Evaluation of alternative filter media for particulate matter emission testing of residential wood heating devices. Journal of the Air & Waste Management Association 67(10): 1055-1060.
9. Ambrose, J. L., 2017. Improved methods for signal processing in measurements of mercury by Tekran® 2537A and 2537B instruments. Atmospheric Measurement Techniques 10(12): 5063-5073.
10. Anderson, S. M., 2017. Atmospheric Nitrogen Deposition in the Western United States: Sources, Sinks and Changes over Time. Doctoral dissertation, Washington State University.
11. Atkins, J. W., Epstein, H. E., & Welsch, D. L., 2017. Seasonal and inter-annual variability in litter decomposition and nitrogen availability in a mid-Appalachian watershed. Ecosphere 8(9):e01908. 10.1002/ecs2.1908.
12. Badia, A., Jorba, O., Voulgarakis, A., Dabdub, D., García-Pando, C. P., Hilboll, A., ... & Janjic, Z., 2017. Description and evaluation of the Multiscale Online Nonhydrostatic AtmospheRe CHemistry model (NMMB-MONARCH) version 1.0: gas-phase chemistry at global scale. Geoscientific Model Development 10(2): 609.
13. Balasubramanian, Srinidhi, Andrew Nelson, Sotiria Koloutsou-Vakakis, Jie Lin, Mark J. Rood, LaToya Myles, and Carl Bernacchi. 2017. Evaluation of DeNitrification DeComposition model for estimating

ammonia fluxes from chemical fertilizer application. Agricultural and Forest Meteorology 237: 123-134.
14. Baron, J. S., Blett, T., Malm, W. C., Alexander, R. M., & Doremus, H., 2017. Protecting National Parks from Air Pollution Effects: Making Sausage from Science and Policy. Science, Conservation, and National Parks 141.
15. Battaglia Jr, M. A., Douglas, S., & Hennigan, C. J., 2017 Effect of the Urban Heat Island on Aerosol pH. Environmental Science & Technology, 51(22): 13095-13103.
16. Beck, M., 2017. The Effect of Chronic Nutrient Addition from Wastewater on Forest Ecosystems at the Rice Rivers Center. Master's Thesis, Virginia Commonwealth University.
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