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:	10/1/2015 through 9/30/2016
Date of Report:	December 28, 2016
Meeting Dates:	Fall, Oct. 23-27, 2015; Spring, April 25-29, 2016, Oct 31-Nov 4, 2016.

Participants

An attendees listing for our Fall Meeting and Science Symposium (FY16), as with all meetings, is available at our meeting summary page (http://nadp.isws.illinois.edu/conf/2016/roster.pdf).

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 FY2015 Spring and FY2016 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 "environmental stewardship," one of the Agricultural Experiment Station's research challenges (Science Road Map #6). Researchers also use NADP Mercury Deposition Network data to examine the role of atmospheric deposition in affecting the mercury content of fish, and to better understand the link between environmental and dietary mercury and human health. This fits with another research priority of "relationship of food to human health."

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 State Agricultural Experimental Stations (SAES), and in part supported by this agreement. This report focuses on the accomplishments and impacts from this network.

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 2016, 266 NTN stations were collecting one-week precipitation samples in 48 states, Puerto Rico, the Virgin Islands, Canada, and in Argentina. Additionally, there are multiple quality assurance and testing sites. 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 110-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 2016, 24 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 103 operating sites (September 2016), where two-week averages of atmospheric ammonia gas are being 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 (Roadmap Challenge #6). Data from both gaseous networks support continued research of atmospheric transport and removal of air pollutants and development of computer simulations of these processes.

Within this national research support project (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 is now populated by over 450,000 observations.

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 13,679 precipitation samples collected and analyzed by the NTN (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 not included in the SAES subset of sites were 877 precipitation samples from the AIRMoN, 2,577 gaseous ammonia samples collected by the AMoN, 6,100 total mercury samples collected by the MDN, and approximately 1,100,0000 hourly mercury fraction concentrations. QA samples are run at the individual sites and not part of these sample counts. This results in approximately 60,000 hourly/2-hourly concentrations released for 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, over 20,053 samples were collected of the four network types, along with approximately 62,000 hourly/2-hourly gaseous observations from the AMNet and AMoN. 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 over 450,000 observations of precipitation chemistry. As of today, 2015 calendar year data are complete and online, and the 2016 data through August 2016 is online with final QA to be completed in 2017.

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 have recorded 32,791 registered users who accessed our website information and viewed our website 1,275,841 different times/pages ("hits"). Data from the NADP's five monitoring networks was downloaded 26,922 times during the 12 months, and the annual maps/figures (our principal result) 24,167 times, which is about our typical number.

We continually collect basic information about our 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 both the scientific 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 2015 annual map series of atmospheric concentrations, wet deposition fluxes, and report was developed during Summer 2016 and finalized and printed in September/October 2016. 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 (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 3,000 copies of the 2014 Annual Summary, and almost all have been distributed. We printed 2000 2015 Map Summaries and about 80% have been distributed, and the remaining will be distributed over the next 12 months.

Fall Scientific Meeting (FY2015 & 16). 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.

FY16 Fall Scientific Meeting: In October 2015, the NADP combined its fall scientific symposium with the every-5 year global 9th International Conference on Acid

Deposition ("Acid Rain 2015"). This meeting was held in Rochester NY, and was planned and supported by the NADP (http://acidrain2015.org/). There were 350 global scientists (~30 countries) and policy professionals in attendance, with 7 keynote addresses, 106 oral presentations and 200 posters over 5 days. Keynote videos and presentation files are available for review at the meeting website (http://acidrain2015.org/). This meeting was very successful and valuable to the global scientists in attendance.

FY16 Spring Business Meeting: The Spring 2015 meeting (Technical Committee, subcommittees, Executive Committee) was held in Madison, WI on April 26-28, 2016. All final committee meeting minutes are available here (nadp.isws.illinois.edu/committees/minutes.aspx). This meeting is always focused on network operation and results, updates on outreach efforts, and future directions of the NADP.

FY17 Fall Scientific Meeting: This meeting was held in Santa Fe, New Mexico between October 31 - November 4, 2016 (after this reporting period, and will be discussed fully in next year's report. Information about this meeting is being assembled now and will be located here (http://nadp.isws.illinois.edu/conf/2016/). Attendance was above average (140).

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 Universities. This site operation is in cooperation with the U.S. Department of Energy. However, during the year, we lost the SAES supported site at Shabbona Illinois (IL18) due to the SAES being permanently closed for cost saving actions by the University of Illinois.

Additional notable outcomes during the project period are as follows:

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

EROS has also planned a series of science videos, aimed at more general audiences, which will cover topics that NADP works in, such as acid precipitation, ammonia in the atmosphere, nitrogen cycling in ecosystems, etc. The first videos are in production now, and should be available shortly through the NADP website.

The Critical Loads Atmospheric Deposition subcommittee published a 2015 map summary of their U.S. critical loads map series (Oct. 15), a first for NADP. The map series focuses on nitrogen and sulfur critical loads. The CLAD Map Summary is available from the NADP Program Office, or downloaded from the NADP website (http://nadp.isws.illinois.edu/committees/clad/db/NCLDMapSummary_2015.pdf). The CLAD subcommittee was also approved as a science committee for another 5 years.

Litterfall Mercury Pilot Network: working with USGS scientists, the NADP is operating a pilot litterfall network (26 sites in Fall 2016) to determine the deposition of mercury with forest litterfall. This is its 5th year of operation. In autumn, when leaf fall occurs, mercury on the outsides and insides of the leaves is deposited to the ground. Measurements show this deposition is a large and significant addition of mercury to the ecosystem surface. The network is designed to determine the feasibility and easy of network measurement, for the potential adoption by the NADP as a full network.

Methyl mercury wet deposition data from the period of 2002 through 2013 was released in Fall 2015, and current data is now available following normal schedules (nadp.isws.illinois.edu/mdn/methyl/). This marks the release of new data from the MDN. Methyl mercury is the organic form of mercury deposition, an added observation of mercury deposition from the MDN.

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. A plan was developed between December 2015 and March 2016 to purchase and install the remaining digital gages. The purchase is underway, and the installation should be completed by Summer, 2017.

During CY2016, 247 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.

In support of our education and outreach responsibilities, one new text used NADP information during 2016: (1) Visconti, G., 2016. Fundamentals of Physics and Chemistry of the Atmosphere. Chapter 20, Springer. Additionally, eleven dissertations (6) and theses (5) used NADP data, and are noted in the publications listing. There was also one senior honors thesis.

The NADP continues its formal effort to estimate dry deposition, partnering with Environment Canada, towards an estimation of total deposition (wet plus dry) of mercury. Formal acceptance of this method is expected to occur at this Fall's Executive Session (Oct., 2016). This will constitute a new and major data product, if approved.

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; the HAL in 2012 and 2015; and the Program Office in 2010, 2013, and 2016. The audit report has been delivered, will be discussed at the 2016 Fall meeting, and a written response is pending from the Program Office.

Another improvement to the database and quality assurance is to digitize all of the individual paper field records (back to 1978, most importantly precipitation data) and make them available to researchers. This was completed this year, with ongoing digitization of new paper field records.

Collaboration with USGS on isotopes of Mercury. Briefly, by measuring isotopes of mercury, scientists think that they can determine the ultimate source type of the mercury (atmospheric deposition, coal combustion, etc.). Therefore, in support of this science, we are working with several USGS scientists to send out samples to about 20

NADP MDN sites to measure atmospheric isotopes of mercury at MDN and AMNet sites for one year. Sampling started about 2 months ago. Results will be forthcoming.

Collaboration with Asians Countries on monitoring for mercury: including USEPA and EPA-Taiwan, and miscellaneous other countries. NADP is helping multiple countries develop a mercury wet deposition and potentially an atmospheric concentration network across Asia. NADP is providing "know how" for network development and continuous monitoring in support of the basic mercury science and the Minamata Convention on Mercury. Countries involved include environmental ministries of Japan, Taiwan, South Korea, Canada (supporting countries), and Vietnam, Australia, Mongolia, Indonesia, Malaysia, Laos, Cambodia, Bangladesh, India, Thailand, Philippines, and Myanmar (monitoring countries). For more information, see the APMMN website (http://rsm2.atm.ncu.edu.tw/apmmn/).

US EPA with dry deposition estimates for N and S: One of the NADP science committees (Total Deposition Science Subcommittee, TDEP) is working with several EPA scientists to estimate dry deposition, and with NADP deposition to provide basic maps of total N and S deposition. The collaboration is a large mapping and modeling effort, resulting in a next-generation map series for total deposition. The modeling/mapping particulars can be found at the NADP website, and are downloadable for the research community (http://nadp.isws.illinois.edu/committees/tdep/tdepmaps/).

PRISM/USDA-NRCS precipitation data: The NADP uses precipitation data to determine the flux of compounds in precipitation (i.e. wet deposition). Including this year (FY16), the NADP uses its own measurements along with the PRISM precipitation database to make its national scale maps. PRISM (Parameter-elevation Relationships on Independent Slopes Model) is a modeling effort for improved precipitation prediction based on observational data, supported by the USDA-Natural Resources Conservation Service. See http://www.wcc.nrcs.usda.gov/climate/ for more information.

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 200 articles and reports. The 2015/2016 journal articles that follow are example journal articles with a strong connection to agriculture. The annual bibliography of articles and reports can be found here: nadp.isws.illinois.edu/lib/bibliography.aspx.

Alshawaf, M., Douglas, E., & Ricciardi, K. 2016. Estimating Nitrogen Load Resulting from Biofuel Mandates. International Journal of Environmental Research and Public Health 13(5): 478, DOI: 10.3390/ijerph13050478.

This study was designed to determine if additional nitrogen gas emissions are present and/or important with increased use of corn and soybeans to manufacture biofuels in support of federal regulations. One primary output from the study was an estimate of increases of nitrate flux to the northern Gulf of Mexico region, and that using corn to meet future mandates will increase nitrate flux, but will require less agricultural land.

In this study, the authors used data from 186 different NADP sites over 1990-2005 as SPARROW model input for nitrogen deposition, in part to determine a longterm deposition value, and as input to the SPARROW model to estimate future scenarios.

Brooker, A. P., 2016. Soil fertility status in Ohio and Indiana and the association between soil fertility and soybean grain yield in Ohio. Master's Thesis, The Ohio State University.

Brooker ran 624 experiments over four years in Ohio and Indiana to assess the soil fertility conditions in each state, and to determine the impact of soil fertility on soybean grain yield in his Master's Thesis (Horticulture and Crop Science). He concluded that Ohio soybean grain yield was reduced by of 7 and 4 bu/acre, which were associated with Phosphorus and Potassium levels below state-established soil critical levels.

Brooker used NADP national maps over time to partially explain the trends in acid conditions of the soils for his site and experiment area (decreasing acidity).

David, M. B., Mitchell, C. A., Gentry, L. E., & Salemme, R. K., 2016. Chloride sources and losses in two tile-drained agricultural watersheds. Journal of Environmental Quality 45(1): 341-348.

David et al (includes SAES scientists) investigated the chlorine balance between agricultural systems and two rivers in Illinois over roughly 20 years. Chloride inputs to watersheds are most often from atmospheric deposition, road salt, or agricultural fertilizer. Particular to this section of IL, fertilizer is added as potassium chloride, the largest source of Cl to these sites. Agricultural chloride was determined to be the largest flux to the rivers, and that river concentrations respond relatively quickly to these inputs (2-6 years).

The authors used locally measured NADP precipitation chemistry (IL11, Bondville) to determine the longterm concentration and flux of chloride in precipitation for their chloride balance.

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 1:160039, 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 required.

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

Kennedy, C. D., Kleinman, P. J., & DeMoranville, C. J., 2016. Spatial scale and field management affect patterns of phosphorus loss in cranberry floodwaters. Journal of Environmental Quality 45(1): 285-293.

The authors (including ARS scientists) were trying to determine the amount of phosphorus loss from cranberry agricultural areas under flooding conditions, and therefore the addition of phosphorus to these non-agricultural surface waters. The authors determined that high P export (4 kg P per acre) occurred with flooding conditions in organic rich cranberry bogs, but that more mineral soils would produce significantly less P flux.

The study used NADP chloride data in precipitation (site MA01) as a tracer for the dilution of precipitation, and the precipitation phosphorus addition to the individual farms and study areas.

Simmonds, M. B., Li, C., Lee, J., Six, J., Kessel, C., & Linquist, B. A., 2015. Modeling methane and nitrous oxide emissions from direct-seeded rice systems. Journal of Geophysical Research: Biogeosciences, 120(October), 2011-2035.

The study was designed to model methane and nitrous oxide emissions from rice fields with different management practices in place. Different combinations of observation times were used for model calibration and validation. Growing season emissions were reasonably well modelled, but fallow season emissions were poorly replicated. Management practices were poorly replicated. The model was determined to be very sensitive to root to total plant biomass ratio.

The authors used NADP's NTN deposition data for ammonium and nitrate from CA88 (UC Davis, SAES site) for a depositional information for their modeling effort.

Zheng, J., & Doskey, P. V. Simulated rainfall on agricultural soil reveals enzymatic regulation of short-term nitrous oxide profiles in soil gas and emissions from the surface. Biogeochemistry 128:327–338, DOI 10.1007/s10533-016-0210-z.

The authors of this study investigated the role of enzymatic regulation on the accumulation of N_2O during a transition from oxygen rich conditions to anoxic conditions during/after rainfall events. Anoxic conditions were induced by a simulated rainfall in the field. The authors conclude that the activity of N_2O reductase in a corn field played a crucial role in regulating N_2O emissions. The dynamics of N_2O mixing ratios in soil gas and surface emissions were in excellent agreement with simulations using a one-dimensional, diffusion–reaction equation of the denitrification enzyme kinetics.

The authors used the rainfall chemistry of a local NTN site (IL11 Bondville, SAES site) to develop chemically accurate synthetic precipitation based on long term measurements of NADP.

Zhu, L., Henze, D., Bash, J., Jeong, G. R., Cady-Pereira, K., Shephard, M., Luo, M., Paulot, F., & Capps, S., 2015. Global evaluation of ammonia bidirectional exchange and livestock diurnal variation schemes. Atmospheric Chemistry & Physics, 15 (November), 12823-12843, www.atmos-chem-phys.net/15/12823/2015/, DOI:10.5194/acp-15-12823-2015.

In this study, the authors upgraded the GEOS-Chem atmospheric ammonia model, particularly with bi-directional atmospheric deposition and emission from the agricultural livestock and some fertilizer applications. Additions of these bi-directional emission sources improve the model comparison to atmospheric concentration primarily in the Southeast U.S. These sources increased model gross emissions by ~7%, and increases atmospheric lifetime of ammonia. The authors also conclude that these agricultural emission sources are still underrepresented.

The authors used the NADP AMoN ammonia concentrations from 2007-2010 as ammonia concentration input and model evaluation/quality assurance.

Other Impacts

In conjunction with the Ecological Response and Outreach Subcommittee (EROS), and the hiring of a part time Outreach Coordinator, the NADP continues both a quarterly NADP newsletter (November 1, 2014 was the first issue), and a presence on social media through Facebook and Twitter. Newsletter distribution continues, with the current newsletter being the 10th of the series. The Twitter feed is designed to build an audience (again of nonprofessionals), but also educators and other interested parties to alert them to new products, updates from NADP, and new educational products as they become available. Both the newsletter and the Twitter feed will increase the information dissemination and the community of interest size beyond just researchers and scientists.

During the past year, the NADP developed an SAES Impact Statement with the SAES Western Region. The NADP Impact Statement was printed and is available at NADP by request, or is downloadable here http://nadp.isws.illinois.edu/newissues/NRSP_3ImpactStatement.pdf, and at the Western SAES Directors website http://www.waaesd.org/multistate-program/multistate-projects-impact-statement-archive in the future.

Future Work/Directions

Council of State and Territorial Epidemiologists (CSTE): Currently in discussions with the CSTE and affiliated organizations (including NOAA, EPA, CDC, etc.) on the monitoring effort for a national allergen tracking network for monitoring of aeroallergens (causing allergic rhinitis {hay fever} and asthma). The CSTE is concerned about the lack of routine and consistent measurement, and began discussing with NADP the possibility of this type of network and using NADP's considerable experience in this area. Discussions are ongoing, and the full participation of NADP is still unclear. But a collaborative network (and new) network is a possibility.

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 FY17 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.

Additional Hires: During FY16, the NADP Program Office will hire two more people, including a Site Liaison (direct interface with sites) and an Assistant Coordinator (help with network management due to growth). These two additions have been approved by the NADP Executive Committee, and should improve our service to NADP members.

Publications

Includes 247 publications that used NADP data, resulted from NRSP 3 activities in calendar year 2016 (articles published in 2015 Oct-Dec are not listed). A publically available online listing of citations using NADP data is accessible at: nadp.isws.illinois.edu/lib/bibliography.aspx.

1. Abbaspour, A., Tanyu, B. F., & Cetin, B. 2016. Impact of aging on leaching characteristics of recycled concrete aggregate. Environmental Science and Pollution Research 23(20): 20835-20852.
2. Acharya, B. S., Hao, Y., Ochsner, T. E., & Zou, C. B., 2016. Woody plant encroachment alters soil hydrological properties and reduces downward flux of water in tallgrass prairie. Plant and Soil, DOI 10.1007/s11104-016-3138-0.
3. Adelman, Z., Shankar, U., Yang, D., & Morris, R. Western Air Quality Modeling Study Photochemical Grid Model Draft Model Performance Evaluation Simulation 2011 Base Version B (Base11b), vibe.cira.colostate.edu.
4. Allen, E. B., Egerton-Warburton, L. M., Hilbig, B. E., & Valliere, J. M., 2016. Interactions of arbuscular mycorrhizal fungi, critical loads of nitrogen deposition, and shifts from native to invasive species in a southern California shrubland. Botany 94: 425–433, dx.doi.org/10.1139/cjb-2015-0266.
5. Alshawaf, M., Douglas, E., & Ricciardi, K. 2016. Estimating Nitrogen Load Resulting from Biofuel Mandates. International Journal of Environmental Research and Public Health 13(5): 478, DOI: 10.3390/ijerph13050478.
6. Anderson, L., Berkelhammer, M., & Mast, M. A. 2016. Isotopes in North American Rocky Mountain Snowpack 1993–2014. Quaternary Science Reviews 131: 262-273.
7. Andronache, C., 2016. Dependence of Daily Aerosol Wet Deposition on Precipitation at Appalachian Mountains Site in the United States. Aerosol and Air Quality Research 16(3): 665-673, DOI: 10.4209/aaqr.2015.05.0322
8. Angot, H., Dastoor, A., Simone, F. D., Gårdfeldt, K., Gencarelli, C. N., Hedgecock, I. M., ... & Pfaffhuber, K. A., 2016. Chemical cycling and deposition of atmospheric mercury in Polar Regions: review of recent measurements and comparison with models. Atmospheric Chemistry and Physics 16(16): 10735-10763.
9. Ashton, I. W., Symstad, A. J., Davis, C. J., & Swanson, D. J., 2016. Preserving prairies: understanding temporal and spatial patterns of invasive annual bromes in the Northern Great Plains. Ecosphere 7(8) Article e01438.
10. Badia, A., Jorba, O., Voulgarakis, A., Dabdub, D., Pérez, C., Hilboll, A., ... & Janjic, Z., 2016. Gas-phase chemistry in the online multiscale NMMB/BSC Chemical Transport Model: Description and evaluation at global scale. Geoscientific Model Development Discuss., DOI: 10.5194/gmd-2016-141.
11. Baldigo, B. P., Roy, K. M., & Driscoll, C. T., 2016. Response of fish assemblages to declining acidic deposition in Adirondack Mountain lakes, 1984–2012. Atmospheric Environment 146: 223-235.

12. Battye, W. H., Bray, C. D., Aneja, V. P., Tong, D., Lee, P., & Tang, Y., 2016. Evaluating ammonia (NH 3) predictions in the NOAA National Air Quality Forecast Capability (NAQFC) using in situ aircraft, ground-level, and satellite measurements from the DISCOVER-AQ Colorado campaign. Atmospheric Environment 140: 342-351.

13. Berryman, E., Ryan, M. G., Bradford, J. B., Hawbaker, T. J., & Birdsey, R., 2016. Total belowground carbon flux in subalpine forests is related to leaf area index, soil nitrogen, and tree height. Ecosphere 7(8): 01418.

14. Boot, C. M., Hall, E. K., Denef, K., & Baron, J. S., 2016. Long-term reactive nitrogen loading alters soil carbon and microbial community properties in a subalpine forest ecosystem. Soil Biology and Biochemistry 92: 211-220.

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