

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

Period Covered: 10-2010 through 9-2011

Date of Report: January 4, 2012

Meeting Dates: October 25–28, 2011

Participants

A list of meeting participants from our Fall Meeting and Scientific Symposium can be downloaded from our website (<http://nadp.isws.illinois.edu/committees/minutes.aspx>).

Meeting Minutes

All meeting minutes from our 2011 Spring Meeting (Business Meeting) and our 2010 Fall Meeting and Scientific Symposium are available on our website (<http://nadp.isws.illinois.edu/committees/minutes.aspx>).

Accomplishments

The NRSP-3 provides a framework for cooperation among State Agricultural Experiment Stations (SAES), the U.S. Department of Agriculture, and other governmental and nongovernmental 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 these same compounds. NADP data support informed decisions on air quality 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 Experiment Station Section’s research challenges. 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). At the end of September, 2011, 250 NTN stations were collecting one-week precipitation samples in 48 states, Puerto Rico, the Virgin Islands, and Quebec Province, Canada. The NTN provides the only long-term nationwide record of basic ion wet deposition in the United States. Complementing the NTN is the 7-site AIRMoN and the 106-site MDN. Data from daily precipitation samples collected at AIRMoN sites support continued research of atmospheric transport and removal of air pollutants and development of computer simulations of these processes. The MDN offers the only long-term and routine measurements of mercury in North American precipitation. These data are used to quantify mercury deposition to water bodies that have fish and wildlife consumption advisories due to this toxic chemical. In 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), which is NADP's newest network. In each case, the network goal is to provide atmospheric concentrations of 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 2011, 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 mercury concentrations in the United States.

The AMoN has 52 sites as of September 2011, 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. This gas and data are particularly important to agriculture since many sources of ammonia are agricultural in nature. Data from both gaseous networks support continued research of atmospheric transport and removal of air pollutants and development of computer simulations of these processes.

Short-term Outcomes and Outputs.

Samples Collected. NADP's principal objective and accomplishment/outcome is the collection and analysis of samples for precipitation chemistry. Briefly, the NADP processed a total of 13,058 weekly precipitation samples from the NTN. These include 12,814 samples and 244 quality assurance samples. The chemical analyses include observations of 10 different analyte concentrations and precipitation volume, which allow for calculation of deposition flux for each analyte. These same data are collected daily (i.e., every day with measurable precipitation) from the AIRMoN network. For the year, AIRMoN collected and processed 1,163 precipitation samples, including 113 QA samples. The MDN collected and processed 5,762 weekly mercury-in-precipitation samples during the year, including 131 quality assurance samples. The AMoN collected and quality assured 1,408 ammonia samples during the year. The AMNet collected, quality assured, and produced 39,000 hourly and two-hourly averages.

NADP Data. 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 (<http://nadp.isws.illinois.edu>). This site 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. As of today, 2010 calendar year data are complete and online, with data through June of 2011 available online. Website usage statistics provide evidence that our data are being used. During FY2011, website usage continued to grow. There are now more than 39,000 registered users with over 356,000 independent user sessions. There were almost 27,000 data downloads from the site. The site received more than 1.505 million webpage "hits," and our data maps were viewed approximately 124,000 times. Information about users is collected, and the user types include about 33 percent from federal and state agencies, 33 percent from universities, 20 percent from K-to-12 schools, and 14 percent from other organizations. The NADP website has registered users from more than 150 countries across the globe. These statistics demonstrate that NADP continues to be relevant to both the scientific and educational communities, and to attract new users.

Map Summary. During FY11, annual maps of atmospheric pollutants, concentrations, and depositions were developed for 2010 calendar year measurements. These maps are used widely for a number of reasons, and constitute one of the major products of the network. Individual maps are filed by network, year, and constituent (see examples at <http://nadp.isws.illinois.edu/data/annualiso.aspx>). Individual maps are compiled into annual Map Summary reports (<http://nadp.isws.illinois.edu/lib/dataReports.aspx>). We also completed the distribution of 2,000 printed 2009 Map Summaries, and printed and

began distributing 2,000 of the 2010 Map Summaries in September. Currently, the 2010 maps data are finalized, and the 2010 Map Summary is available for all to download.

Scientific Meeting (Fall 2010). At the end of each federal year, a scientific meeting is held that showcases some of the latest deposition research that occurred during the year. During FY10 (Lake Tahoe, California, Oct. 19-21, 2010), the meeting focused on "Networking the Networks," with a goal of bringing networks together so that collaboration and efficiencies could be generated. The meeting attracted 152 registered participants with three keynote speakers, six speaking sessions, and one poster session. Sessions included "Soil Networks" with direct agriculture topics, and other sessions detailing biological, atmospheric, and hydrologic monitoring networks and systems. All presentations, posters, and meeting proceedings are available on the NADP website (<http://nadp.isws.illinois.edu/conf/2010/>).

Scientific Meeting (Fall 2011, FY12). The next scientific meeting was held on October 25 to 28, 2011 in Providence, Rhode Island. It was entitled "NADP at the Nexus: Cross System Connections." All meeting information, participants, presentations, and other details are available online. See <http://nadp.isws.illinois.edu/conf/2011/> for more information and details.

These basic activities fulfilled the project objectives: (1) coordination of three networks; (2) quality assurance to ensure consistency; and (3) analytical, site support, and data validation services for the sites supported directly through this agreement.

Network Operation Notes. The NADP continues to convert our precipitation gages to an all-digital network, originating with a Technical Committee decision in 2006 (<http://nadp.isws.illinois.edu/newissues/newgages/newequip.aspx>). Currently, the network is well on its way to completing this goal. During the summer, our largest site supporter (USGS, with 70+ sites) purchased and installed (most sites) new digital raingages for its sites, along with new precipitation collectors. With these summer additions, the networks have an approximately 80% digital precipitation record.

Further, an independent committee conducted an external review of the management practices of the Program Office (management team) during the summer of 2010. Reports of the review were provided at the Fall Meeting 2010, with a formal response and questions provided to the Executive Committee meeting (Pensacola, May 2011). During the Summer (FY11), the Central Analytical Laboratory (chemistry for NTN and AIRMoN networks) was reviewed and reports are forthcoming.

Other Notes. In November 2004, the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service issued the first report of *Phakopsora pachyrhizi*, commonly known as Asian Soybean Rust (ASR), in the continental U.S. ASR is an obligate fungal parasite that can cause significant losses in soybean and other leguminous crops. From infected plants, ASR spreads through the aerial release and dispersal of spores. These airborne spores can be scavenged in and below clouds and deposited by rain on uninfected host plants hundreds of kilometers from an existing infection. During the 2010 growing season, NADP again partnered with the USDA Cereal Disease Laboratory (CDL) to look for ASR spores in NTN samples (5th year). With partial support from the Agricultural Research Service, weekly samples from 80 eastern U.S. NTN sites were selected and are undergoing study. Additionally, a new wheat rust investigation, also with CDL, began in November 2009. This investigation occurred at 44 Southern U.S. sites and weekly precipitation samples for several strains of winter wheat rust. Results should be available soon. An investigation occurred during the summer with an intern to locate soybean fields with remote sensing, and further to locate soybean rust with any accuracy. A journal article is pending.

The presence of ammonia gas in the atmosphere and its association with agricultural operations has become a very important topic of discussion, and NADP is continuing with an ammonia monitoring network across the central part of the U.S. and Canada. This network was recently accepted as a full network within the NADP system, with a stated goal to develop, deploy, and operate a cost-efficient *passive* sampling network for basic ammonia gas concentrations. The network includes a quality assurance program to document the accuracy of passive samplers. Following NADP methods, the resulting quality-assured concentrations are now routinely being reported (see <http://nadp.isws.illinois.edu/nh3net/>). This network has numerous implications for agriculture, including directly addressing Challenge Area #2 in The Science Roadmap for Agriculture.

The NADP, with support from USGS, worked on its ability to capture the analyte bromine in its NTN samples. Bromide is released into the environment via natural and anthropogenic processes, including agricultural fumigants and flame-retardants. Methyl bromide is classified as an ozone-depleting substance, and its use is strictly regulated and monitored by the U.S. EPA. During FY11, regular collection and reporting of this analyte was initiated, and is now a regularly reported analyte in NTN and AIRMoN networks.

Scientists at the U.S. Environmental Protection Agency supported research at the NADP's Central Analytical Laboratory to determine whether organic nitrogen deposition can be measured reliably and accurately in weekly NTN samples.

Preliminary results from these tests indicate a seasonal trend in organic nitrogen concentrations. Furthermore, these concentrations may account for as much as one-third of total nitrogen deposition. A pending journal article is currently at the submission stage and further action by NADP is forthcoming.

The NRSP-3 continues to enhance our website to better serve our members and data users. Additionally, a new database technician was hired specifically to increase our ability to handle increasing levels of data (new networks, digital precipitation data).

During the 2011 calendar year, 172 journal articles and reports were generated using the NADP data in some form. These are listed in the Publications section. This is again evidence that NADP is producing data that are both valuable and useful.

Milestones

1. As of the beginning of FY11, approximately 400,000 observations of precipitation chemistry are archived by the NADP (NTN and AIRMoN). More importantly, all of these remain available in our database, and are comparable over the years for research.
2. At the NADP Fall 2010 Meeting and Scientific Symposium, the technical sub-committees voted to approve the Ammonia Monitoring Network (AMoN) as an official NADP network. This is the fifth network of the NADP in our 33-year history. This network has operated as an NADP special study since 2008. The focus of AMoN is the measurement of atmospheric ammonia concentrations across North America. These data will be used to model dry deposition of mercury to the environment. AMoN has grown tremendously in the past year, in part due to the importance of the sampling information, and in part due to the low cost and simple approach taken by the network (passive sampling). Currently, AMoN has 52 sites. More information about AMoN can be found at <http://nadp.sws.uiuc.edu/amon/>. Data are currently being reported and are available for this network.

Impacts

As a National Research Support Project, the NADP's most important impacts are the research reports and journal articles that are produced using our data and products. From January through December 2011, we identified 172 journal articles and reports that used NADP data or maps specifically in their research, modeling applications, or for comparison. These articles are included in our online database of NADP-supported publications.

Here, 16 articles which are of particular interest to the agricultural community are briefly summarized.

- 1) Aitkenhead-Peterson et al. studied the use of "green roof" technology popular in the Southwest to reduce runoff in water-limited areas. Specifically the authors investigated the chemical gain and loss relative to the input growth medium used in supporting the rooftop growth media. NADP information (N) in precipitation was used as added N input to their observations.
- 2) Chen and Dick developed an outreach document for the Ohio State University Extension to guide usage of flue-gas-derived gypsum as a calcium and sulfur additive for agricultural application. NADP data were used to show decreasing addition of sulfate to soils by wet deposition.
- 3) Dietze and Moorcroft studied tree mortality to determine what forcings were important across the eastern two-thirds of the U.S. The authors conclude that the two most important factors are forest stand characteristics and air pollution. NADP information for nitrate, ammonium, sulfate, and acid ions was used extensively to define air pollutant inputs to these systems.
- 4) Faulkner et al. investigated the changes in animal waste water after treatment using silage bunker impoundment areas. The authors were looking at ammonium, nitrogen, chloride, and phosphorus removal efficiencies, which were quite high in some cases. Chemical input to the bunkers from precipitation was defined using NADP nitrate, ammonium, and chloride information for the New York area.
- 5) Fortner et al. (including one USDA ARS scientist) investigated the influence of human agricultural practices on silicate weathering. They found that dissolved silica yields are sensitive to nitrogen fertilizer applications, etc. NADP data were used to correct stream flow chemistry from chemical additions by wet deposition.
- 6) Greenquist et al. investigated the addition of distillery grains as supplemental feed and/or forage substitution for yearling cows, where increases in N uptake were

noted. NADP data were used in a nitrogen balance for pasture grasses normally used as forage and other feeding statistical treatments.

- 7) Isard et al. (including one USDA ARS scientist) used the NADP/NTN network and precipitation samples to investigate the weekly presence of soybean rust spores (*Phakopsora pachyrhizi*) in North American precipitation. With the genetic determination of spore presence, an incursion model was developed that was based on observations from 80 NADP sites in the eastern and mid-western U.S.
- 8) Ketterings et al. compared several new soil sulfur testing methods under different application rates, given the increasing need for agricultural sulfur application with the (NADP) noted reduction in sulfate from wet deposition. NADP information was used as baseline information for the experimentation and justification for the new tools.
- 9) Peters (a USDA ARS scientist) provided a chapter discussing ecological consequences of globalization, discussing many different subtopics. NADP data (N) were used to make long-term wet deposition maps of nitrogen within her discussion of large-scale ecological forcing.
- 10) Rossignol et al. investigated the changes in phytoplankton response in coastal North Carolina with the operation of a new large chicken egg production facility. The authors found doubling of wet deposition of nitrogen and phosphorus close to the facility, and the potential for increased wet deposition to surrounding waters. NADP data were used for baseline ammonia measurements, and NADP sampling methods were used for the study.
- 11) Sarkar et al. studied water quality and nitrogen loss from switchgrass agricultural systems. Significant nitrogen loss was noted in early crops but the losses decreased significantly with crop maturity. NADP nitrogen deposition was used as input to surface waters of nitrogen, providing an important input to the system.
- 12) Singer et al. (including one USDA scientist) investigated the effect of nitrogen loading on cover crops (soybean, winter wheat), focusing on tile drain nitrogen loading, and concluding that cover crops reduce nitrogen loss through tiles in these situations. NADP information provided baseline N input to the systems in precipitation.
- 13) Stackpoole et al. investigated the relationship of nitrogen input from non-fertilizer sources to characterize the contribution of several nitrogen sources to cranberry cultivation. NADP information was used as wet deposition input to surface water and the investigated subplots.

- 14) Szilagyi et al. estimated annual groundwater recharge in the Nebraska Sand Hills using a theoretical model. NADP data were used in a novel way, by using chloride in precipitation deposition as a tracer for flow into the aquifer. These results were used to check the accuracy of other recharge estimates.
- 15) Talhelm et al. studied the increasing wet deposition of nitrogen's impact (NADP-derived trends) upon the biogeochemistry of northern Great Lakes area forests, attributing increases in available N in forests to increases in wet deposition and other N cycle changes. NADP data were used to document reduction in sulfur and increases in nitrogen deposition at all study sites.
- 16) Tsai (2011) (advisor, NRSP-3 participant) investigated soil genesis on a long-term basis in Maine and Illinois, specifically to detect if reduction in acid precipitation is evident in the chemical makeup of the soil. NADP provided baseline information on acid inputs to soils over multiple years.

Publications

Include 172 publications used NADP data or resulted from NRSP-3 activities in 2011 . A publically available online database that lists citations using NADP data is accessible at: <http://nadp.isws.illinois.edu/lib/bibsearch.asp>.

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