

## SAES-422 Multistate Research Activity Accomplishments Report

Project No. and Title: NRSP-3, The National Atmospheric Deposition Program  
(NADP) – A Long-term Monitoring Program in Support of  
Research on the Effects of Atmospheric Chemical Deposition

Period Covered: 10-2008 through 9-2009

Date of Report: December 14, 2009

Meeting Dates: October 6–8, 2009

Participants: [http://nadp.isws.illinois.edu/committees/minutes/fall2009/  
2009participantList.pdf](http://nadp.isws.illinois.edu/committees/minutes/fall2009/2009participantList.pdf)

Meeting Minutes: <http://nadp.isws.illinois.edu/committees/minutes.aspx>

### Participants

(attached)

### Meeting Minutes

(attached)

### Accomplishments

The NRSP-3 provides a framework for cooperation among State Agricultural Experiment Stations (SAES) and 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. 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; on the chemistry of estuarine, surface, and ground waters; and on 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, which fits another priority, “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 November 2009, 252 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 are the 7-site AIRMoN and the 115-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.

**Outputs.** Our principal objective and accomplishment for this project is the collection and analysis of samples for precipitation chemistry. Briefly, the NADP processed a total of 13,094 samples from the NTN, 1,077 samples from the 7-site AIRMoN (plus 541 QA samples in support of both networks), and 6009 samples from the MDN (plus 1800 QA samples). To date, nearly 400,000 observations of precipitation chemistry are archived by the NADP.

**NADP Data.** Scientists, policymakers, educators, students, and others are encouraged to access data at no charge from the NADP Web site (<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. During FY2009, Web site usage continued to grow. There are now more than 38,560 registered users with 355,000 user sessions. There were 25,500 data downloads from the site. The site received more than 1.50 million Web page “hits,” and 25,571 downloads of color concentration and deposition maps. User type remains about 33% from federal and state agencies, 33% from universities, 20% from K-to-12 schools, and 14% from other organizations. The NADP Web site has registered users from more than 150 countries. These statistics demonstrate that NADP continues to be relevant to the scientific and educational communities, and to attract new users.

**Map Summary.** During FY09, annual maps of atmospheric pollutants, concentrations, and depositions were developed for 2008 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 <http://nadp.isws.illinois.edu/data/annualiso.aspx>). Individual maps are compiled into annual reports along with map animation sequences (<http://nadp.isws.illinois.edu/data/animaps.aspx>). We also distributed approximately 1,800 printed FY08 map summaries (with 2007 maps), which are also available at our web site.

**Scientific Meeting (Fall 2009).** At the end of each Federal year, a scientific meeting is held that showcases some of the latest deposition research that is ongoing during the year. This year (Saratoga Springs, NY, Oct 6-8), the meeting focused on “Bridging Air and Ecosystems.” We had more than 40 speakers (two keynotes) organized into 7 sessions, which included, “Are Ecosystems Responding to Emission Reductions?” and “Agricultural Emissions and Ecosystem Effects.” All presentations, posters, and meeting proceedings are available on the NADP Web site (<http://nadp.isws.illinois.edu/meetings/fall2009/post/>).

Refinement of the quality-assurance documentation occurred during the year. Updated versions of the following were produced and approved prior to the fall 2009 meeting: 1) Quality Management Plan; 2) Quality Assurance Plan; 3) Guidelines for NADP Laboratory Quality Assurance Reports; 4) Guidelines for NADP Laboratory Reviews; 5) Guidelines for NADP Quality Management System Review; 6) NADP Site Information Worksheet; 7) NADP Site Selection and Installation Manual; and 8) Guide for New NADP Initiatives. These documents should improve the network, data, and site operations, and are freely available (<http://nadp.sws.uiuc.edu/lib/qaPlans.aspx>).

**Emerging Issues.** 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 2009 growing season, NADP again partnered with the USDA Cereal Disease Laboratory (CDL) to look for ASR spores in NTN samples (5<sup>th</sup> 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 initiative will investigate 44 Southern U.S. sites and weekly precipitation samples for several strains of winter wheat rusts. Results should be available for the FY10 report.

The presence of ammonia gas in the atmosphere and its association with agricultural operations has become a very important air quality topic. The NADP is continuing with a monitoring network for ammonia gas across the Midwest. The goal is to develop, deploy, and operate a cost-efficient *passive* sampling network for basic ammonia gas concentrations. These two-week integrated values will be used to quantify the spatial and temporal differences in atmospheric ammonia concentrations and estimate dry deposition of ammonia nitrogen. The network includes an appropriate quality-assurance program to document the accuracy of passive samplers. Following NADP methods, the resulting quality-assured concentrations will be reported and made available for use by all data users. Currently, 21 sites have been operating during the 2009 federal year, with plans for at least another year of operation. More information can be found at <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 (Update 2006), and directly measuring an important agricultural gas in agricultural areas of the U.S.

Along with the soybean rust and ammonia, we are partnering with several other researchers to use NADP samples (past and present) to investigate for the presence of new and different compounds in precipitation, including:

- Perchlorate compounds, Texas Tech. University;
- Oxygen isotope variation to predict past temperatures, Un. of Southern CA;
- Perfluoro compounds, Environment Canada;
- Fluoride concentrations, Un. of Texas; and
- Base cation dilution and isotope hydrograph separation, Un. of Maine.

The NADP has run a small pilot network during 2009 to measure total nitrogen deposition, with a major goal of defining the organic nitrogen component in precipitation. Currently proof-of-concept samples are being collected in rural Illinois to determine collection efficiency, sample stability, and rough estimates of organic nitrogen flux. This may become another component of wet deposition data that NADP can provide to its agriculture and ecological scientists since total nitrogen deposition is important in many situations.

***Supporting Informed Decisions on Air Quality Issues.*** In its most recent report, *United States - Canada Air Quality Agreement, Progress Report 2008* (<http://www.epa.gov/airmarkt/progsregs/usca/index.htm>), the binational Air Quality

Committee used NADP data liberally to evaluate progress under the agreement's Acid Rain Annex. Since signing the agreement in 1991, U.S. and Canadian governments have acted to reduce acidic precipitation by requiring sulfur dioxide and nitrogen oxide emission reductions. With major reductions in both sulfate and nitrate deposition highlighted with NADP data, the report acknowledges the importance of our measurements for policy determinations. NADP's data and maps are used extensively to show that wet deposition of acid is declining, and that the bilateral agreement regiments are being met.

The U.S. Environmental Protection Agency's Science Advisory Board has drafted *Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options* (<http://yosemite.epa.gov/sab/>). This report uses NADP measurements to support many advisory conclusions about nitrogen addition to the environment.

Although NADP/MDN data are used to evaluate the relationship between mercury emissions and wet deposition, there are no comparable airborne or dry deposition mercury measurements. Other estimates suggest that mercury dry deposition levels may be three times that of wet deposition in some areas. Recognizing the need for routine, regionally representative measurements, the NADP Executive Committee endorsed a new network for the measurement of atmospheric elemental, reactive gaseous, and particle-bound mercury. This network has a goal to support modelers' needs for data, so that atmospheric mercury process can be understood and that atmospheric deposition of mercury estimated. A Web presence of this new network (since October 2009, <http://nadp.isws.illinois.edu/amn/>) is being developed and more information will be forthcoming.

**Plans for 2010.** The NRSP-3 will continue to support researchers and educators by providing up-to-date, quality-assured data and information on nutrients, acidic compounds, base cations, and mercury in precipitation. A rework of the network Web site is now mostly complete (currently 85%), is operating, and will be completed during 2010. The redesigned site will be better organized and feature ready-access to maps and tabular and graphical data summaries. The new site will allow for more content more easily, for the users to access more data in better ways, and for the network to expand "science outreach" efforts in an affordable way to reach many new users, particularly K-12 and college students.

The NADP continues to convert to an all-digital precipitation gage network. This change was begun during 2008 and will continue through 2010. All older raingages are being replaced with digital models. More than 170 of our 300 sites (55% of 3 networks)

have converted to the new digital standard gages, and most sites should be converted by the end of 2010. This improvement will provide both enhanced precipitation data for users for many years to come.

### 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 to September 2009, we identified 58 publications from refereed journals 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. Brief summaries of several articles are given as specific examples of the research supported by the NRSP-3.

1. Following from our ASR work, Barnes et al. discussed the early years of NADP sampling, showing that 2006 was a year of heavy deposition for ASR. The paper also discusses how the genetic techniques for the identification of the disease were furthered and are now available for future research.
2. Burns et al. investigated the isotopic signatures of nitrogen in streams by including NADP precipitation signatures and different land-use isotopic signatures in precipitation runoff. The authors note specific isotopic differences among urban, forest, and agriculture land uses.
3. Cohen et al. mapped the soil/sediment concentration of total mercury across the Everglades, and concluded that large-scale deposition of mercury controls sediment concentrations and not soil type, and that even with emission decreases in Florida, sediment concentrations are still increasing.
4. Goddard et al. studied the carbon sequestration ability of wet deposited calcium, and concluded that these calcite complexes could sequester carbon much longer than in some organic forms, and that these are likely important in the Mollisol and Alfisol soil orders.
5. Atmospheric nitrogen deposition is an important source to the nitrogen load of rivers feeding the Chesapeake Bay (Goodale et al.). Much of this nitrate is sequestered, but seasonal retention patterns were found which suggests that some nitrogen is more likely to move into the Bay.

6. A study of factors affecting soil nitrification rates in the Northeast U.S. (Ross et al.) used deposition rates and many other factors to develop a mathematical model to predict nitrification rates in different watersheds. Important predictors, along with deposition, include conifer dominance and the presence of large red spruce trees.
7. Sjostrom and Welker present evidence that the source of precipitation at continental sites (NADP sites) could have an important influence over the isotopic ratios of certain compounds (e.g.,  $O_2$ ). This influence seems particularly true at higher latitude sites, and in non-summer seasons. This method could provide information on precipitation sources.
8. Sobota et al. used wet and dry estimates of nitrogen deposition (NADP, Clean Air Status and Trends Network) to examine the factors leading to nitrogen export from 23 California watersheds to rivers and streams. Manure and fertilizer application was indicated to be an important nitrogen source even with little agricultural application in the watersheds.
9. Werdin-Pfisterer et al. examined the composition, concentration, and seasonal patterns of soil amino acids in several areas of Alaska. The widespread similarity of acid composition suggests a broad source of the acids, or at least similar processes involved in their reactions.
10. Aleksic et al. evaluated long-term acidity trends in fog and cloud water samples in upstate New York. The results clearly showed that fog/cloud water samples are significantly more acidic than precipitation on average, and this is typically true for all ions. Further, seasonal fog/cloud concentrations are highly correlated with seasonal precipitation concentrations, but this is not necessarily the case on a short-term basis.

## Publications

Approximately 58 publications used NADP data or resulted from NRSP-3 activities in 2009 (January to August). 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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- Chen, Y., and Lin, L-S. 2009. Responses of streams in central Appalachian Mountain region to reduced acidic deposition—Comparisons with other regions in North America and Europe. *Science of the Total Environment* 407:2285–2295.
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- Cohen, M.J., Lamsa, S., Osborne, T.Z., Bonzongo, J.C.J., Newman, S., and Reddy, K.R. 2009. Soil total mercury concentrations across the Greater Everglades. *Soil Science Society of America Journal* 73:675–685, doi:10.2136/sssaj2008.0126.
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