

## SAES-422 Multistate Research Activity Accomplishments Report

**Project Number:** NRSP-3  
**Project Title:** The National Atmospheric Deposition Program (NADP) – A Long-term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition  
**Period Covered:** 1-2006 to 12-2006  
**Date of Report:** December 22, 2006  
**Meeting Dates:** October 24 - 26, 2006  
**Participants:** URL: <http://nadp.sws.uiuc.edu/meetings/fall06/techComm2006Fall.pdf>  
**Meeting Minutes:** URL: <http://nadp.sws.uiuc.edu/meetings/fall06/techComm2006Fall.pdf>

### 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), which 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.

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 the “environment, natural resources, and landscape stewardship,” one of the Experiment Station Section’s top five National Research Priorities. Researchers also use NADP Mercury Deposition Network (MDN) data to examine the role of atmospheric deposition in affecting the mercury content of fish, and better understand the link between environmental and dietary mercury and human health, which fits another National Research 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 December 2006, 253 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 wet deposition in the United States. Complementing the NTN are the 7-site AIRMoN and the 97-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 regional measurements of mercury in North American precipitation, and MDN data are used to quantify mercury deposition to water bodies that have fish and wildlife consumption advisories due to this toxic chemical. In 2006, 48 states and 10 Canadian provinces listed advisories warning people to limit fish consumption due to high mercury levels. Advisories also were issued for Atlantic Coastal waters from Maine to Rhode Island and North Carolina to Florida, for the entire U.S. Gulf Coast, and for Hawaii.

[NADP Web Site](#). Scientists, policy-makers, educators, students, and others are encouraged to

access data at no charge from the NADP web site. This site offers on-line 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. In 2006, web site usage continued to grow. There are now more than 31,000 registered users, 33 percent at universities, 28 percent at government agencies, and 19 percent in elementary and secondary schools. Through 8 December, there were 21,327 data downloads from the site, an increase of 15 percent from 2005. The site received more than 1.3 million hits, and the number of color concentration and deposition maps viewed in 2006 rose by nearly 22 percent, topping 113,000.

**Emerging Issues.** In November 2004 the USDA-Animal and Plant Health Inspection Service issued the first report of *Phakopsora pachyrhizi*, commonly known as Asian Soybean Rust (ASR), in the continental United States. ASR is an obligate fungal parasite that can result in 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 2006 growing season, NADP partnered with the USDA Cereal Disease Laboratory (CDL) to look for ASR spores in NTN samples. With partial support from the Agricultural Research Service, the weekly samples from 110 eastern-U.S. NTN sites were filtered in entirety. Filters were desiccated, sealed in petri dishes, and sent to the CDL, where they were assayed for an ASR-specific DNA sequence using nested real-time PCR. From mid-May through August, the CDL reported 271 filters positive for ASR, some in areas where ASR was later reported on soybean or kudzu. These data are being examined to study spore dispersal and the spread of ASR.

**Educational/Extension Activities.** Highlights of 2006 activities: (1) The NADP Executive Committee adopted the International Center for First-Year Undergraduate Chemistry Education (ICUC) as an institutional participant and partnered with ICUC to translate the NADP brochure *Nitrogen in the Nation's Rain* (<http://nadp.sws.uiuc.edu/lib/brochures/nbrochespanol.pdf>) into Spanish. The *ICUC Quarterly* featured the NADP in its June 2006 edition. (2) The Upper Midwest Aerospace Consortium at the University of North Dakota produced a video entitled "Acid Rain" that uses an NADP pH map to show the distribution of acidic precipitation. This video is an episode in the public TV series *Our Changing Planet*, designed to promote education and understanding of planet Earth. The series airs on 29 stations and is taped for delayed broadcast on 14 others. (3) NADP Program Office staff participated in the University of Illinois Extension Service program, Environmental Stewardship Days, designed to engage elementary school students in hands-on learning activities in the environmental sciences. Approximately 250 4<sup>th</sup> through 6<sup>th</sup> grade students participated in a learning activity about water quality by measuring the pH of lake water, drinking water, and rain samples from NADP sites across the country.

**Supporting informed decisions on air quality issues.** In its most recent report, *United States - Canada Air Quality Agreement, Progress Report 2006*, the binational Air Quality Committee used NADP data 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 emissions reductions. Between 1991 and 2004, Canadian and U.S. sulfur dioxide emissions decreased by about 33 percent. Over this 14-year period, NADP NTN and AIRMoN data showed roughly proportionate reductions of sulfate deposition. The number of states receiving 20 kilograms per hectare per year or more of sulfate deposition dropped from twelve to one. A ~20-percent reduction of U.S. nitrogen oxide emissions similarly was accompanied by halving the area receiving nitrate deposition of 15-20 kilograms per

hectare per year. A recent analysis estimates that these reductions greatly exceed the costs of emissions controls. The report acknowledges that “without substantial atmospheric deposition monitoring networks, it would be impossible to accurately track and confirm that air quality improvements are taking place.”

**Publications.** There were more than 100 publications, using NADP data or resulting from NRSP-3 activities in 2006. An on-line database that lists citations using NADP data is accessible at <http://nadp.sws.uiuc.edu/lib/bibsearch.asp>.

### **Plans for 2006/2007**

**-Serving science and education.** 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. Experience has demonstrated the value of making NADP data available on-line. An updated homepage and web site schema will be implemented in 2007. The re-designed site will be better organized, making additions and changes less cumbersome. It will feature ready access to maps and tabular and graphical data summaries. The Program Office will continue to develop data products that target user needs. Program Office staff members will continue to work with the author of a chapter on acid rain to appear in the next edition of the general chemistry textbook, *Chemistry in Context*, published by the American Chemical Society in cooperation with McGraw-Hill. In another cooperative effort, a staff member will work with a native-Spanish speaking member of International Center for First-Year Undergraduate Chemistry Education, to translate part or all of the *Inside Rain* curriculum into Spanish.

**- Supporting informed decisions on air quality issues.** In 2005, the U.S. EPA promulgated the Clean Air Interstate Rule, which seeks to lower fine particle and tropospheric ozone levels by reducing SO<sub>2</sub> and NO<sub>x</sub> emissions in 28 eastern states. Recent evidence suggests that gaseous ammonia also has an important and increasing role in fine particle formation. NADP/NTN and AIRMoN measure aqueous ammonium, and the Clean Air Status and Trends Network (CASTNet) measures particulate ammonium. Gaseous ammonia has not been measured routinely. NADP is planning an initiative to add passive ammonia samplers at co-located NTN and CASTNet sites, beginning in mid-2007. One-week samples, matching the NTN sampling schedule, would be collected at 25-40 sites. Also in 2005, the EPA promulgated the Clean Air Mercury Rule, which requires electric utilities to reduce mercury emissions beginning in 2010. While NADP/MDN data are used to evaluate the relationship between mercury emissions and wet deposition, there are no comparable airborne mercury measurements; yet, estimates suggest mercury dry deposition may be three times wet deposition in some areas. Recognizing the need for routine, regionally representative measurements to evaluate these estimates and examine the spatial distribution and temporal trends of airborne mercury, the NADP Executive Committee endorsed a limited study for measuring airborne elemental, reactive gaseous, and particle-bound mercury in 2007.

**- Responding to emerging issues.** Plans are underway to continue collaborations with USDA-CDL scientists to assay filters from NTN samples for fungal spores. The CDL will apply real-time qPCR to look for DNA sequences specific to various rust pathogens. During the winter of 2006/07, filters from 24 Gulf Coast states (and Georgia) and 7 Mississippi River Valley states as far north as southern Illinois will be tested for Asian Soybean Rust and possibly wheat stem (*Puccinia graminis*) and stripe (*Puccinia striiformis*) rusts. With the onset of the 2007 growing season, plans are to expand this effort, once again, to approximately 100 eastern-U.S. sites, focusing on ASR.

## Impacts:

1. During the 2005 growing season, Asian Soybean Rust (ASR) spores were found in midwestern NTN rain samples by applying nested polymerase-chain-reactions to amplify an ASR-specific DNA sequence to the point where it could be detected. Back-trajectory analyses showed that the likely source of these spores was southern Texas, Louisiana, and parts of eastern Mexico.
2. The first detailed survey of North American precipitation for perfluorocarboxylates (PFCAs) was performed using samples from four NADP/AIRMoN sites. PFCAs are long-lived man-made compounds that have been found in lakes, oceans, and soils, in fish, birds, and mammals, and now in eastern U.S. precipitation at levels from 1 nanog/L to 1 microg/L.
3. Using data from the Lewes NADP/AIRMoN site, Delaware scientists determined that atmospheric deposition accounts for 17 to 31 percent of the nitrogen entering nearby Rehoboth Bay in the summer, when the Bay experiences problems related to nutrient over-enrichment.
4. A Bayesian statistical model applied to data from the NTN site at the Clinton Crops Research Station in east-central North Carolina yielded a significant positive ammonium trend of 13.5 percent per year or a near doubling of ammonium concentrations between 1990 and 2003; while over the same period, sulfate decreased by nearly 31 percent.
5. Data from three south Florida MDN sites indicate that total mercury in rain has been level to increasing since 1998, ending the declines recorded in the early 1990s when emissions controls had begun reducing mercury emitted by municipal and medical waste incinerators by 90 percent.
6. NADP/MDN data were used in developing a Lagrangian model to assess the contributions of in-state, out-of-state, and out-of-country sources of mercury deposited in Maryland.
7. Researchers were able to trace sulfate decreases in precipitation at six New York NTN sites with similar decreases in lakes and streams in the Catskill and Adirondack Mountains, leading them to conclude that streams are recovering from decades of sulfate deposition; no similar link between precipitation and surface waters was evident for nitrate or base cations.
8. A 20-year record of nitrogen (N) deposition at the high-elevation, subalpine, Loch Vale NTN site in the Colorado Rockies was used to develop a model that relates N emissions to N deposition. Using N emissions estimates for the 1950s and 60s, the model calculated N deposition to be ~1.5 kg/ha for 1950-1964, when there was a switch in diatom assemblages at this site toward greater N tolerance. A flux of 1.5 kg N/ha is posited as the critical load at which Loch Vale diatoms are affected by atmospheric N deposition.
9. Environmental scientists at Texas Tech University analyzed aliquots of NTN samples for perchlorate in order to evaluate the importance of natural sources of this strong oxidizer. Concentrations of 5 to 105 ng/L with a mean of 15 ng/L were reported, placing rainfall third behind Chilean nitrate fertilizer and solid rocket propellant as a perchlorate source. Perchlorate inhibits thyroid uptake of iodide, which can interfere with neonatal development.
10. The accuracy of the Community Multi-scale Air Quality (CMAQ) model to simulate ammonium deposition for 8-week winter and summer periods was evaluated against ammonium deposition at 35 upper Midwest NTN sites. Simulations for the winter were more accurate than the summer, though the accuracy of both simulations was limited by the model's skill at estimating the precipitation field and by the uncertainties in ammonia emissions.

## **Publications:**

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