

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
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Participants: URL: <http://nadp.sws.uiuc.edu/meetings/fall04/techComm2004Fall.pdf>
Meeting Minutes: URL: <http://nadp.sws.uiuc.edu/meetings/fall04/techComm2004Fall.pdf>

Accomplishments:

The NRSP-3 provides a framework for cooperation among State Agricultural Experiment Stations (SAES) and governmental and nongovernmental organizations to 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 and are used by scientists, policy-makers, educators, and the public. 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 2004, 261 NTN stations were collecting one-week precipitation samples in 49 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 8-site AIRMoN and the 87-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 2004, 44 states and 8 Canadian provinces listed advisories warning people to limit fish consumption due to high mercury levels. Advisories also were issued for coastal Hawaii, Maine, Massachusetts, and Rhode Island, and for the Atlantic Coast from the Virginia-North Carolina border to the southern tip of Florida, and for the entire U.S. Gulf Coast.

NADP Internet Site. NADP data are available at no charge via the Internet, which enables on-line retrieval of individual data points, seasonal and annual averages, trend plots, concentration and deposition maps, reports, manuals, and other data and information (<http://nadp.sws.uiuc.edu>). Internet site usage continued to increase. In 2004 the site received 75,477 unique visitors, up more than 40 percent from 2003. Registered data users more than doubled in the last 12 months and user sessions rose by nearly 90 percent. About 39 percent of NADP Web site usage is for educational purposes, and the balance is for research.

Educational/Extension Activities. In April, NADP staff members partnered with the American Chemical Society (ACS) to develop an earth day activity, entitled “Testing the pH of Rain Water,” for elementary school students. Students were instructed in assembling a simple rain collector from household materials and in measuring rainwater pH with materials from the ACS. Students were directed from the ACS Web site to the NADP Web site (<http://nadp.sws.uiuc.edu/earthday/>), where they could post their pH measurements, compare their measurements with data from nearby NTN sites, and print a personal certificate of completion. Compared with the 2003 ACS earth day activity, participation in this activity tripled, prompting the ACS Committee on Community Activities to award the NADP a “Salute to Excellence” for commitment to education.

Supporting informed decisions on air quality issues. In its most recent report, *United States - Canada Air Quality Agreement, Progress Report 2004*, the bilateral Air Quality Committee, established under the United States-Canada Air Quality Agreement, used NADP data to evaluate progress under the Acid Rain Annex of the agreement. Since signing the agreement in 1991, U.S. and Canadian governments have taken significant actions to reduce acidic precipitation by requiring substantial reductions in sulfur dioxide emissions. The goal is to reduce the deposition of sulfate, the primary acidifying agent in precipitation. Canadian and U.S. sulfur dioxide emissions decreased by about 27 percent and 32 percent, respectively, since 1990. NADP NTN and AIRMoN data confirmed that these reductions were essentially matched by decreases in sulfate deposition. In both countries, reductions in nitrogen oxide emissions were much smaller, averaging 10 - 20 percent. Nitrate at NTN sites decreased in eleven northeastern states but remained unchanged or increasing elsewhere.

NTN data are being used in the Forest Health Monitoring Program (FHMP) to map inorganic nitrogen and sulfur deposition in U.S. ecoregions, as an indicator of forest exposure to air pollutants. The FHMP is a multi-agency program (<http://fhm.fs.fed.us/>) that was initiated in 1991 by the U.S. Department of Agriculture Forest Service to determine the status, changes, and trends of forest health indicators in forested ecosystems. Recent research has focused on nutrient uptake, retention, and cycling in forests and the effect of atmospheric deposition on these processes. Acidic deposition has been implicated as a factor in the loss of base cations from forest soils in the northeastern and southeastern United States and in calcium losses from red spruce needles, making this species more susceptible to damage from disease, frost, and drought.

The recent National Academy of Sciences (NAS) report on *Air Quality Management in the United States* describes the three NADP wet deposition networks (NTN, AIRMoN, and MDN), along with the Clean Air Status and Trends Network (CASTNet) for assessing dry deposition, as “the most comprehensive atmospheric deposition monitoring networks” in the United States today, and

describes “monitoring networks as an essential part of any air quality management system.” The report summarizes some of the applications of NTN and CASTNet data to measure the progress and assess the benefits of existing air quality management programs. These monitoring networks provide data for estimating exposure of sensitive ecosystems to air pollutants, developing information on pollutant source-transport-transformation-removal processes and how these change in space and time, and evaluating compliance with air quality standards. The NAS report also identifies the emerging interest in bioaerosols (bacteria, fungi, viruses, and allergens), which the NADP is uniquely suited to address with its nationwide network of sites. The NADP could play an important role in a surveillance system for the detection and spread of pathogens, whether domestic or foreign in origin.

Publications

There were more than 100 publications, using NADP data or resulting from NRSP-3 activities in 2003. An on-line database that lists citations using NADP data is accessible at <http://nadp.sws.uiuc.edu/lib/bibsearch.asp>.

Plans for 2005/2006

-Serving science and education. The NRSP-3 seeks to continue to support the needs of 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 the Internet in making NADP data available to scientists, educators, students, and policy-makers. New on-line data presentations will be developed, including isopleth map animations that track annual concentration and deposition changes of cations and anions not now included in the current map animation series.

- Supporting informed decisions on air quality issues. Scientists and policy-makers have a keen interest in the atmospheric deposition of nutrients and the role of nutrient deposition in affecting unmanaged forests, shrublands, and grasslands and in affecting surface water quality, especially in the estuarine waters of the Atlantic and Gulf Coasts. The NADP Central Analytical Laboratory is measuring total nitrogen and total phosphorus in precipitation samples to explore the feasibility of adding these analytes to the current measurement set.

- Responding to emerging issues. The NADP Program Office recently collaborated with scientists at the U.S. Department of Agriculture Cereal Disease Laboratory (CDL) to look for wheat stem rust (*Puccinia graminis*) spores in NTN samples. Filters containing insoluble matter from NTN samples collected at selected Midwestern sites from May to November 2004 were sent to the CDL, where plant pathologists applied polymerase chain reaction (PCR) methods to search for the spores. PCR methods are very sensitive and specific and the search frequently uncovered wheat stem rust spores on the filters. Wheat stem rust is one of many plant pathogens that are spread by wind-borne spores. In 2005/2006, this work will focus on detection of Asian soybean rust (*Phakopsora pachyrhizi*) spores. Asian soybean rust was first reported in the southern U.S. in November 2004. Atmospheric transport and deposition are key to the spread of this damaging pathogen. With nearly 250 sites across the country, the NADP/NTN could be a key part of a surveillance system for the detection and spread of Asian soybean rust and other plant pathogens.

Impacts:

1. Applying a Seasonal Kendall Trend test to precipitation-weighted concentrations from 1985 to 2002, University of Illinois scientists reported sulfate decreases at 96 percent ($p \leq 0.1$ at 88 percent) of NTN sites and ammonium increases at 89 percent ($p \leq 0.1$ at 65 percent) of NTN sites, signaling a shift to a more ammonia-rich chemical climate in much of the U.S.
2. Pennsylvania State University researchers combined NTN chemical concentrations and NOAA daily precipitation measurements with topographic variables (slope, elevation, and aspect) to compute high-resolution chemical deposition maps for the eastern United States.
3. Using precipitation and dryfall data from the NTN site at Argonne National Laboratory, Illinois State Water Survey scientists found a strong relationship ($R^2 = 75\%$) between sodium deposition, which exceeded 1 kilogram per hectare during winter months (November- April), and the amount of de-icing salt applied to highways within 20 kilometers of the site.
4. Maine Ag. Exp. Station Contribution #2625 summarized a long-term study of a control watershed receiving acidic deposition under NTN-monitored ambient conditions and an experimental watershed receiving ammonium sulfate additions: the behavior of sulfate, nitrate, base cations, aluminum, iron, and phosphorus in surface water in the control watershed is mimicking the experimental watershed but at lower magnitude and delayed in time.
5. USGS investigators studied field site and Central Analytical Laboratory (CAL) pH measurements from 1987 through 1999 and found that when samples were sent to the CAL in the collection buckets (1987-93), field measurements were 0.10 pH units lower in the median than CAL measurements and when samples were transferred to bottles then sent to the CAL (1994-99), field measurements were only 0.04 units below CAL measurements.
6. Authors from 7 universities, a state agency, two federal agencies, and a non-governmental organization used NTN and surface water chemistry data in a feature article which concludes that emissions reductions under the 1990 Clean Air Act Amendments have lowered acidic deposition and acidity of many lakes and streams in the northern and eastern United States.
7. A U.S. Geological Survey scientist, reviewing our understanding of atmospheric N deposition effects in the Colorado and Wyoming Rockies, concluded that nitrate concentrations in surface waters had risen in response to increased N deposition (measured by the NTN) but that other effects were difficult to distinguish from natural variability and climate effects.
8. An NRSP-3 researcher along with colleagues at the University of Maine and USGS used MDN and soil chemistry data to examine mercury cycling in adjacent Acadia National Park watersheds and found that accumulation of total and methyl mercury in soils and in watershed biota depends on soil pH, vegetation, and land use and cover changes.
9. A team of investigators using MDN data to evaluate HYSPLIT, a model that computes the transport and deposition of mercury using emissions and chemical transformation rates, reported that coal combustion was the largest contributor of atmospheric mercury deposition to the Great Lakes, though incineration and metallurgy were also significant contributors.
10. Two Illinois State Water Survey scientists calculated that at the current atmospheric mercury deposition rate, measured at MDN sites around the country, 2000 years would be required to accumulate the amount of mercury in the top 20 cm of most U.S. soils, leading them to conclude that atmospheric deposition is generally not a significant source of mercury in soils.
11. Investigators are exploring whether nitrogen and oxygen isotopic concentrations in the nitrate molecules of archived AIRMoN samples can be used to apportion the sources of nitrate in precipitation to vehicular exhaust, power plant emissions, soils, or other sources.

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