

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: 1-2005 to 12-2005
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Participants: URL: <http://nadp.sws.uiuc.edu/meetings/fall05/techComm2005Fall.pdf>
Meeting Minutes: URL: <http://nadp.sws.uiuc.edu/meetings/fall05/techComm2005Fall.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 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 2005, 254 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 8-site AIRMoN and the 88-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 2005, 45 states and 8 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 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. In 2005, Internet site usage continued to increase. The site received 89,667 unique users, up nearly 19 percent from 2004. Users retrieved 18,564 data files, an increase of more than 35 percent. The number of MDN data files retrieved from the site more than quadrupled, reflecting the growing interest in mercury deposition.

Educational/Extension Activities. In 2005, NADP chemists continued to collaborate with the American Chemical Society (ACS) in using “acid rain” as a contemporary issue that engages students in real-world learning experiences. This effort focused on measuring rain pH in 4th to 8th grade science classes. The NADP assembled “Chemistry of Rain” packets that included a brochure describing rain chemistry and NADP measurements, pH-measurement strips, a plastic rain gauge, and other materials provided by the ACS. More than 1000 packets were distributed at 14 separate events involving elementary and middle school science teachers. These activities were a follow-on to the very successful 2004 earth day activities in which students recorded their rain pH measurements on the NADP Web site (<http://nadp.sws.uiuc.edu/earthday/>).

In 2005, NADP staff prepared a new informational brochure describing environmental mercury and the MDN as a tool for understanding the link between atmospheric mercury sources and mercury in lakes, streams, and estuaries (<http://nadp.sws.uiuc.edu/lib/brochures/mdn.pdf>).

Supporting informed decisions on air quality issues. In its 2005 report to Congress, the National Acid Precipitation Assessment Program (NAPAP) cited the NADP as a “primary air quality and atmospheric deposition monitoring program providing scientists and policymakers with robust data on the fate, transport, and deposition of air pollutants and on trends in acidic deposition and air quality in the United States.” In this integrated assessment, NTN concentration and deposition data were used to describe the current state of atmospheric deposition in the U.S. Trends in NADP sulfate and nitrate data were especially effective in demonstrating the impacts of recent sulfur and nitrogen oxide emissions reductions and evaluating the efficacy of acid deposition controls (Title IV) under the 1990 Clean Air Act Amendments (1990-CAAA). The emission-to-deposition relationship, based on NADP data, was used to project deposition estimates for emission levels expected in 2010. The report emphasized the growing importance of nitrogen deposition, especially in eastern U.S. estuaries and high-elevation Rocky Mountain ecosystems.

Summarizing 10 years of progress under the 1990-CAAA, the U.S. Environmental Protection Agency (EPA) reported that NADP/NTN data showed decreases in inorganic nitrogen concentrations and deposition in the Mid-Atlantic and Northeast regions of the country. These results paralleled decreases in ambient gaseous and particulate nitrate concentrations in this area, which were partly attributed to recent power plant reductions of nitrogen oxide emissions. Northeastern U.S. power plants were targeted for reducing nitrogen oxide emissions in order to lower ozone levels in northeastern areas failing to meet ambient ozone air quality standards.

The U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service included NADP NTN in its plans (http://www.aphis.usda.gov/ppq/ep/soybean_rust/coordfram041405.pdf) for monitoring Asian soybean rust (*Phakopsora pachyrhizi*) during the 2005 growing season. In

November 2004, the USDA issued a first-ever report of Asian soybean rust, or SBR, in the continental United States. SBR, a fungal pathogen that reduces soybean yields, spreads by way of airborne spores that can be carried 100s of kilometers before being deposited in precipitation. Filters from NTN rain samples were collected, dried, sealed, and sent to the USDA Cereal Disease Laboratory (USDA-CDL), where microbiologists applied a very sensitive technique for identifying SBR-specific DNA sequences. Applying this technique enabled detection of as few as 10 spores on a filter. For this study, eastern U.S. NTN sites were selected. Positive evidence of SBR was found on 85 filter samples from mid May through late August, 2005. A manuscript describing selected results has been accepted-with-revisions to the journal *Plant Disease*. The complete set of results is available for verifying models designed to estimate spore transport and deposition.

Publications

There were more than 100 publications, using NADP data or resulting from NRSP-3 activities in 2005. 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 seeks to 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 to scientists, educators, students, and policy-makers. The Program Office will continue to develop data products that target user needs and requests. Program Office staff members also are working with the authors of a chapter on acid rain that will appear in a general chemistry textbook being published by the American Chemical Society in cooperation with McGraw-Hill Companies. Similar cooperative efforts are underway with the International Center for First-Year Undergraduate Chemistry Education (<http://icuc.chem.uiuc.edu/icucwebsite>), with plans to translate the popular NADP brochure, *Nitrogen in the Nation's Rain* into Spanish.

- Supporting informed decisions on air quality issues. In 2005 the U.S. EPA promulgated the Clean Air Mercury Rule, requiring U.S. electric utilities to reduce mercury emissions in two phases beginning in 2010. While NADP/MDN data can be used to evaluate the effect of these reductions on mercury in precipitation, there are no large-scale networks for measuring airborne mercury; yet, estimates suggest mercury dry deposition may be as much as three times wet deposition in some areas. Routine, regionally representative measurements are needed to evaluate these estimates and examine the spatial distribution and temporal trends of airborne mercury. Recognizing this need, the Executive Committee tasked the mercury dry deposition working group with preparing a plan for adding these measurements in 2006-07. The Technical Committee will decide whether or not to accept this initiative and add these new measurements to the NADP.

- Responding to emerging issues. Plans are underway for the NADP Program Office to collaborate with scientists at the USDA-CDL to look for SBR spores in NTN samples. Filters from NTN samples collected at selected eastern U.S. sites from May to November 2006 will be sent to the CDL, where polymerase chain reaction methods will be used to detect SBR spores. With approximately 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 significant ($p \leq 0.10$) nitrate decreases of 16-34 percent at NTN sites in northeastern states from Virginia, West Virginia, and eastern Ohio to Massachusetts and New Hampshire.
2. Summarizing the Society of Environmental Toxicology and Chemistry's strategy for monitoring mercury in air, surface water, sediment, aquatic biota, and wildlife, a team of scientists from academia, government, and nonprofit organizations recommended that the MDN be the principal means of measuring and documenting mercury deposition in the U.S.
3. National Park Service and USDA Forest Service scientists proposed combining NTN wet deposition measurements and dry deposition estimates to evaluate critical loads, which are deposition amounts below which national park and forest resources would be protected from acidification, nitrogen saturation, and deposition-induced changes in biotic communities.
4. A team of 15 scientists looking for improvements resulting from emissions control programs, reported that except for streams and ponds in the Blue Ridge Mountains of Virginia, sulfate concentrations in eastern North American surface waters decreased significantly since 1990, though the decreases were less than those observed in NTN precipitation samples.
5. Using oxygen isotope measurements of samples from 17 NTN and 2 AIRMoN sites, university researchers modeled the relationship of $^{18}\text{O}/^{16}\text{O}$ to latitude and elevation and computed a U.S. map of $^{18}\text{O}/^{16}\text{O}$ in precipitation, which exhibits important differences from the map of $^{18}\text{O}/^{16}\text{O}$ in river water, especially in the mid-western and western United States.
6. Netherlands scientists used NTN nitrogen deposition data in examining nitrogen export to the oceans, which their model projects will increase by 10 percent from North American rivers due to increasing surface water inputs of nitrogen associated with urbanization, increasing food production, and atmospheric deposition.
7. University of South Florida researchers used ammonium data from the AIRMoN site in Tampa Bay, Florida, to verify their model of below-cloud scavenging of ammonia gas during thunderstorms, which shows that 35 to 60 percent of the ammonium in rainfall is deposited in the first 20 percent of precipitation.
8. Four private consultants and two Brookhaven National Laboratory scientists examined the relationship of U.S. mercury emissions to mercury deposition and methyl-mercury levels in fish and found a positive, but not statistically significant, relationship between mercury deposition, measured by the MDN, and statewide mean mercury concentrations in fish tissue.
9. Investigators studying atmospheric nitrogen inputs to forests at the University of Michigan Biological Station NTN site found it necessary to freeze samples to arrest changes in nitrogen speciation and found that organic nitrogen averaged 15 percent of total nitrogen deposition, the balance coming from ammonium (33 percent) and nitrate (52 percent).
10. A University of Nebraska professor reported seasonal ^2H and ^{18}O concentrations in 1994-98 archival samples from the Pawnee National Grasslands NTN site in order to provide data for studying the relationships of precipitation to groundwater recharge, ground and surface water interactions, and water uptake by prairie vegetation.

Publications:

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