USGS-National Trends Network site KY35 Clark State Fish Hatchery, Rowan County, Kentucky. Photograph provided by National Atmospheric Deposition Program, 2016.

Exploring Atmospheric Deposition Chemistry Data Across the United States

The National Atmospheric Deposition Program

The National Atmospheric Deposition Program (NADP) collects atmospheric data to monitor air pollution effects on the quality of United States water supplies and ecosystems. The NADP requires consistent data collection at fixed locations and is governed by a committee with participation by many Federal and State agencies, universities, Tribes, and private companies. NADP conducts a spring business meeting where the Network Operations, Education and Outreach, and multiple science subcommittees adjourn to discuss all aspects of NADP. Similar to the spring meeting, a fall meeting occurs with the addition of a two-day scientific symposium where scientists present their research using NADP data.

U.S. Geological Survey Role in the National Atmospheric Deposition Program

The U.S. Geological Survey (USGS) has participated in the NADP for more than 45 years and is the largest Federal funding agency among NADP cooperators. The USGS supports 69 sites within the National Trends Network (NTN; fig. 1). The USGS leads the NADP Budget Advisory Committee and is a standing member of the NADP Executive Committee. Participation in these groups ensures that the scientific data needs of the USGS are upheld and that Federal funding is allocated to research in the most effective way possible. The USGS maintains and coordinates field operations for its NADP sites and operates

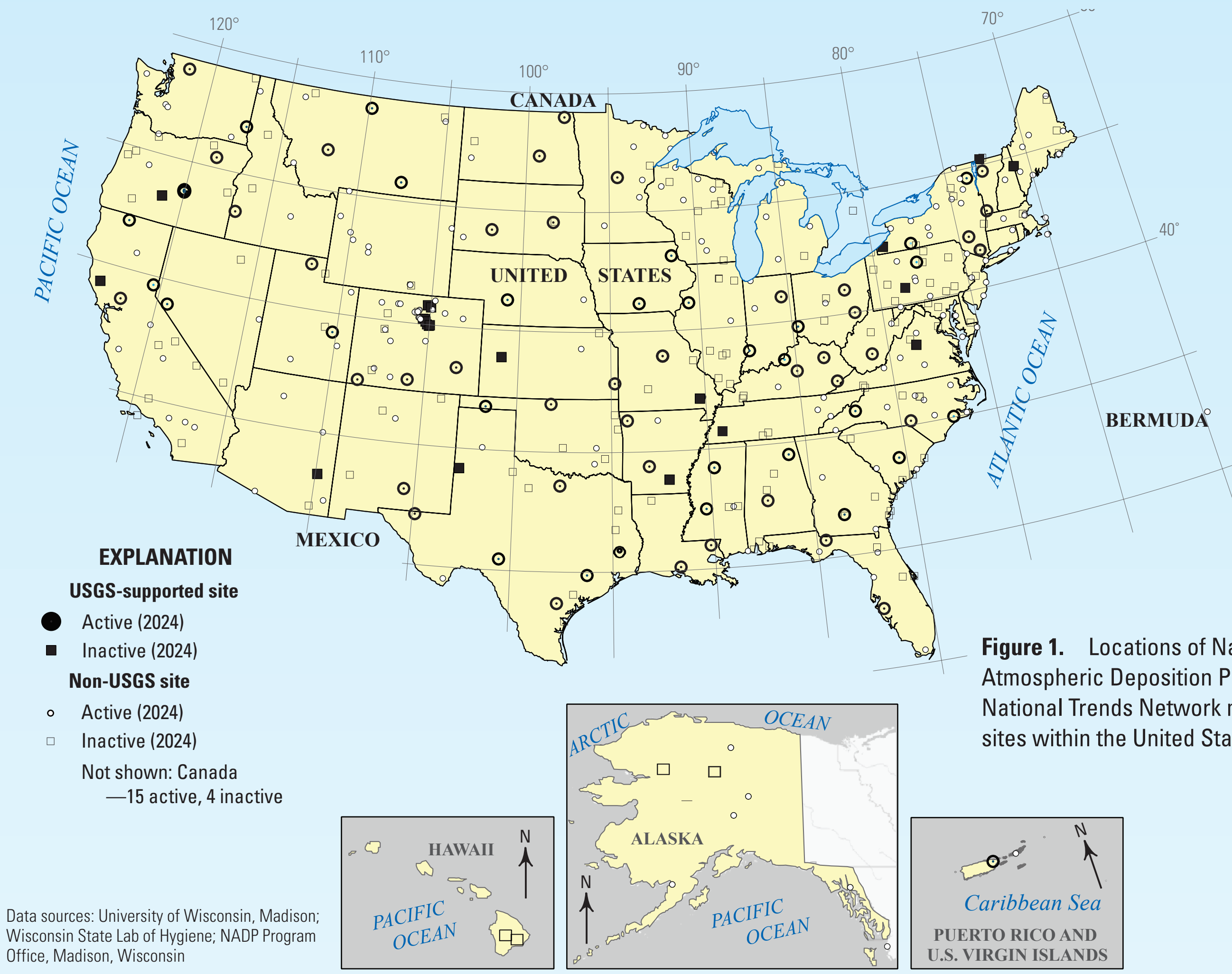

Figure 1. Locations of National Atmospheric Deposition Program National Trends Network monitoring sites within the United States in 2024.

the external Precipitation Chemistry Quality Assurance (PCQA) project to ensure data integrity for the NTN and the Mercury Deposition Network (MDN). The PCQA includes (1) a field audit program to evaluate sample contamination and stability, (2) an interlaboratory-comparison program to evaluate analytical laboratory performance, and (3) a colocated sampler program to estimate overall variability of NTN wet-deposition (chemicals that are deposited from the atmosphere during rain or snowfall) measurements. The MDN-related programs of the PCQA include the System Blank program to evaluate sample contamination and stability, and an interlaboratory-comparison program.

The National Atmospheric Deposition Program-National Trends Network Operations

NTN sites are predominantly located away from urban areas and point sources of pollution. Each site includes at least a precipitation chemistry collector and a rain gauge (fig. 2). The automated collector ensures that the sample is exposed only during precipitation (wet-only sampling).

Site operators follow standard operational procedures to ensure NTN data comparability and representativeness. They collect samples weekly on Tuesday morning, using only

Figure 2. USGS-National Atmospheric Deposition Program site MN23 Camp Ripley, Minnesota, showing MDN and NTN monitoring equipment. Photograph by Ben Torrison, USGS 2024.

containers cleaned at the NADP Analytical Laboratory (NAL) at the Wisconsin State Laboratory of Hygiene. Scientists weigh the collection bucket to determine sample volume and transfer the sample from the collection bucket (fig. 4) to a shipping bottle. All samples are sent to the NAL for analysis, data entry, verification, and screening.

The NAL measures free acidity (H^+ as pH), conductance, calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), sulfate (SO_4^{2-}), nitrate (NO^-), chloride (Cl^-), and ammonium (NH_4^+). The NAL also measures orthophosphate, but only for quality assurance (to detect sample contamination). The NAL reviews field and laboratory data for completeness and accuracy, and flags samples that may have been mishandled, compromised by precipitation collector failures, or grossly contaminated. The NAL delivers all data and information to NADP, which applies a final set of checks and resolves any remaining discrepancies. Data are then made available on the NADP website.

Tracking the Quality of Atmospheric Science

In 1978, the NADP evolved from the National Acid Precipitation Assessment Program to monitor the effects of acid rain on crops. Over the past four decades, NADP data have illustrated how hydrogen ion (acid rain), sulfate, and nitrate deposition amounts have declined, while deposition of ammonium has increased (fig. 3).

Expanding Atmospheric Science

The NADP NTN provides the foundation for four other NADP networks: MDN, Atmospheric Mercury Network (AMNet), Ammonia Monitoring Network (AMoN), and Mercury Litterfall Network (MLN). In 2023, the NADP also approved a transition network (unofficial research network) to monitor PFAS in precipitation.

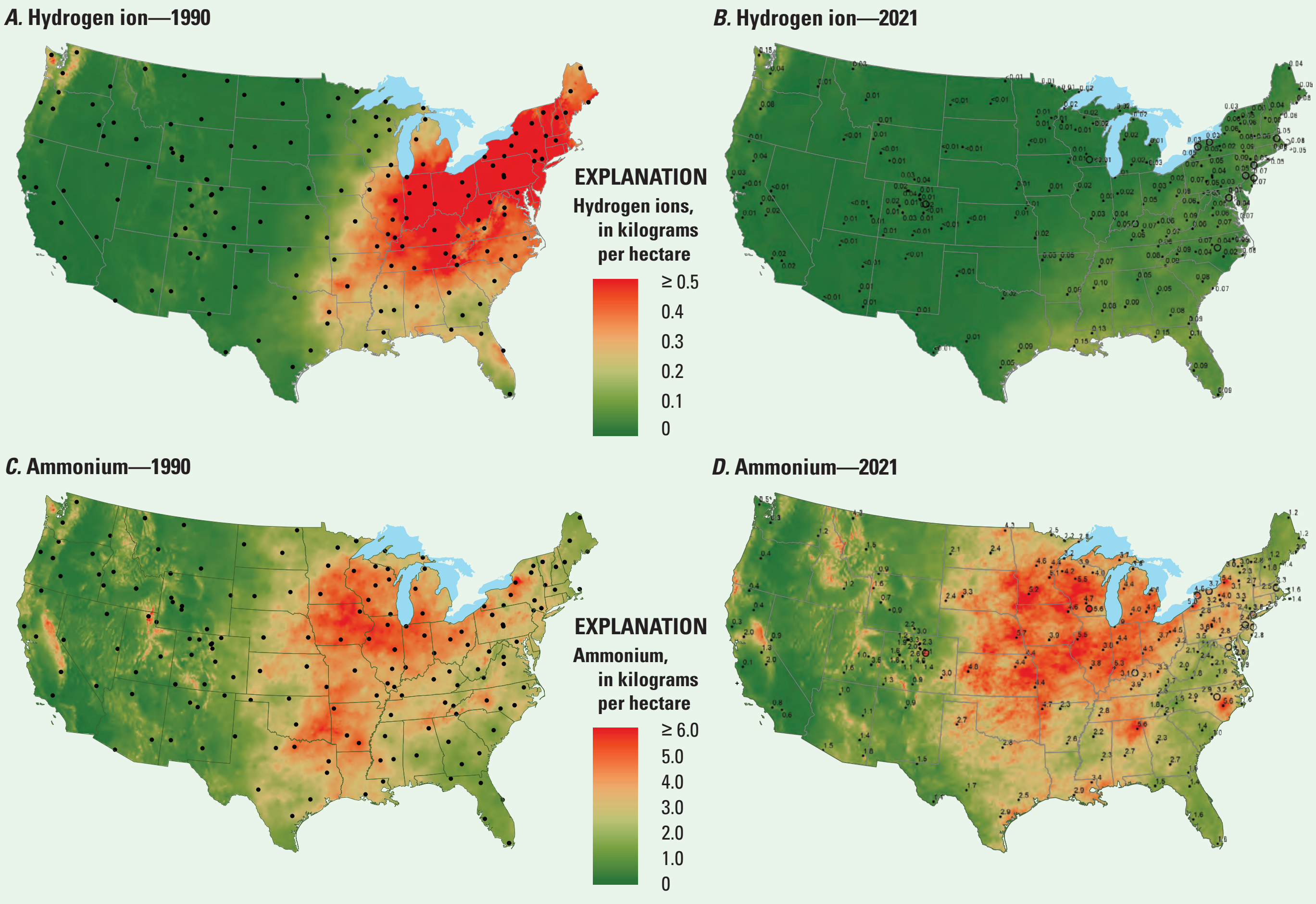

Figure 3. Estimated hydrogen ion (from pH) and ammonium deposition in United States precipitation, 1990 and 2021 (National Atmospheric Deposition Program, A, C 1990 and B, D 2021. Kg/ha, kilograms per hectare. ≥ symbol indicates greater than.

The USGS supports an MDN site in Puerto Rico and one MLN site in Tennessee. The USGS also supports the PFAS transition network through research support at site NY06 and through reviewing planning documents. The USGS continues to enhance precipitation monitoring and data acquisition for its NADP sites by utilizing telemetry to provide real-time assessments of conditions. New technologies for measuring wet and dry deposition of total reactive nitrogen, total phosphorous, and airborne components such as microplastics and pollen are being explored.

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Figure 5. A U.S. Geological Survey site (NY06) for measuring per- and polyfluoroalkyl substances (PFAS) deposition under the forest canopy at Bronx Botanical Gardens, New York. Photograph by Ashley Smith, USGS 2024.

Figure 4. National Trends Network N-CON Systems Company, Inc., systems collector. Photograph provided by National Atmospheric Deposition Program, 2021.

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For information about the research in this report, contact the National Atmospheric Deposition Program Coordinator at waternetworks@usgs.gov

https://www.usgs.gov/mission-areas/water-resources/science/national-atmospheric-deposition-program-nadp

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