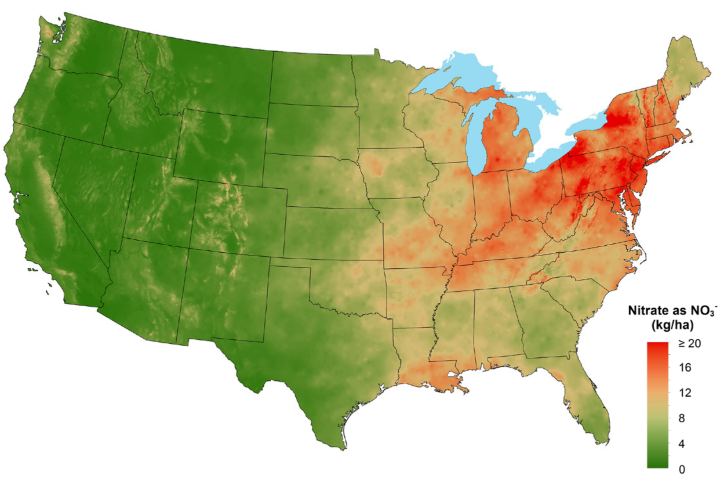
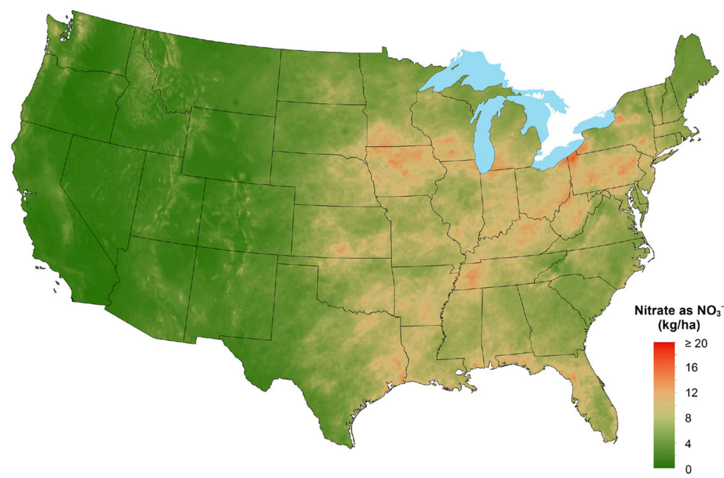
National Atmospheric Deposition Program

2018 Annual Summary

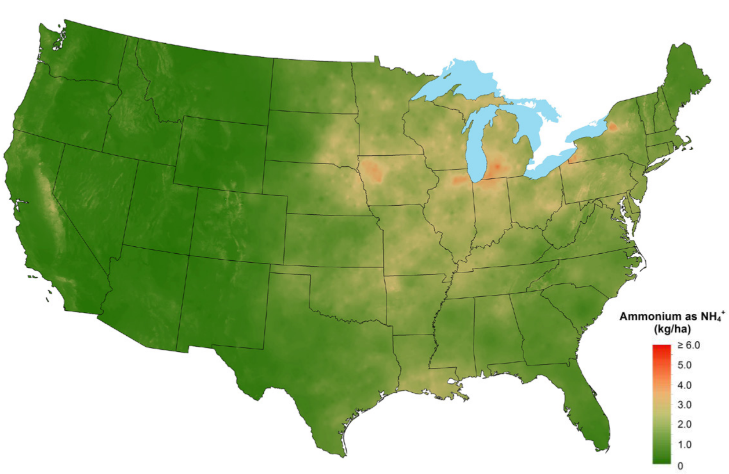
The Changing Landscape of Nitrogen Deposition



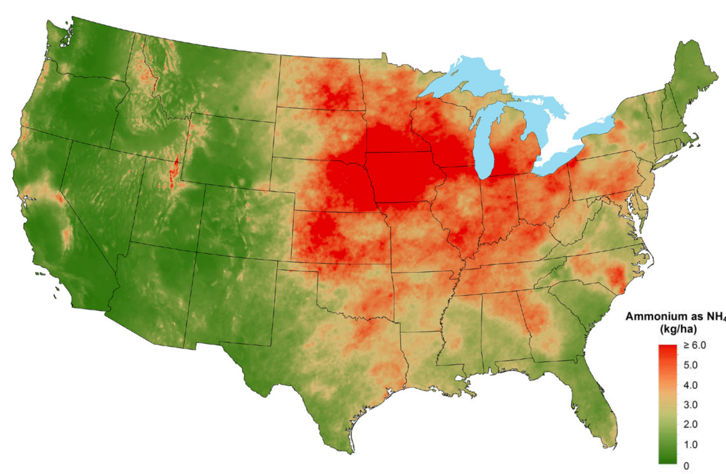
1988 Nitrate Deposition



2018 Nitrate Deposition



1988 Ammonium Deposition



2018 Ammonium Deposition

On the cover: The NADP annual summary maps show the drastic spatial and temporal changes that have occurred in nitrogen wet deposition over the past 30 years. NOx emission control strategies have greatly reduced nitrate deposition, especially in the Ohio Valley and Northeast. On the other hand, ammonium deposition throughout much of the country, but particularly in the Midwest, has increased over recent decades.

When referencing maps or information in this report, please use the citation: National Atmospheric Deposition Program, 2019. National Atmospheric Deposition Program 2018 Annual Summary. Wisconsin State Laboratory of Hygiene, University of Wisconsin-Madison, WI.

Contents

2018 Highlights

The National Atmospheric Deposition Program (NADP) provides high-quality, robust measurements that support informed decisions about environmental and public health issues as they relate to atmospheric deposition chemistry, and advance our understanding of atmospheric processing through the measurement of ammonia, mercury, and emerging species of concern. NADP data is relevant to scientists, educators, policymakers, and the public. All data is available without charge on the NADP website (http://nadp.slh.wisc.edu). Products available on this site in addition to the primary data include seasonal and annual averages, time series trend plots, maps of concentration and deposition, and a noteworthy collection of procedures, policy documents, and collaborative reports.

The NADP is composed of five networks, including the National Trends Network (NTN), the Atmospheric Integrated Research Monitoring Network (AIRMoN; discontinued September 2019), the Mercury Deposition Network (MDN), the Atmospheric Mercury Network (AMNet), and the Ammonia Monitoring Network (AMoN). The table below summarizes the number of measurements from each network in 2018.

Summary of 2018 Network Measurements

Network	Measurements	Period	No. of sites
NTN	12,993	weekly	262
MDN	4,705	weekly	98
AIRMoN	649	daily	5
AMNet	67,435	hourly/ 2-hourly	18
AMoN	2,596	two week	104

Highlights:

- The successful transition of the Program Office (PO) and Central Analytical Laboratory (CAL) from the University of Illinois Urbana-Champaign to the University of Wisconsin-Madison Wisconsin State Laboratory of Hygiene (WSLH) began in late 2017, and was completed in June 2018. The transition included transferring PO and Network Equipment Depot (NED) records, supplies, and equipment from Champaign, IL, to Madison, WI, restructuring the CAL supplies and sample shipping, completing a laboratory inter-comparison evaluation, and adapting a new subscriber funding model.
- NADP data were used in 208 publications through data support and PO and CAL outreach. These publications included:

    √ 14 Doctoral Dissertations

    √ 4 agency reports

    √ 1 article in the journal *Science*

- The Mercury Litterfall Initiative with U.S. Geological Survey (USGS) scientists completed its sixth year of operation. Progress toward making the initiative a formal NADP Network continues. Starting in 2019, the operation of the initiative will be transferred to the PO and Hg Analytical Laboratory (HAL) at the WSLH.
- The Total Deposition Science Subcommittee (TDEP) continued its work with U.S. Environmental Protection Agency (USEPA) scientists to estimate dry deposition of nitrogen, sulfur, and other analytes. TDEP efforts in 2018 focused on synthesizing a large body of previous work culminating in an early 2019 publication of science needs for continued development of total nitrogen deposition budgets in the United States. The report details the state of the science of reactive nitrogen deposition budgets in the U.S., and identifies the research needed to improve deposition budgets in support of refinements to critical loads and secondary National Ambient Air Quality Standards.
- The NADP collaborated with Utah State University to monitor dry deposition of nutrients as part of a pilot study. This study continues to expand, and will generate valuable dry deposition data. A manuscript that highlights these efforts is currently under review for publication.

- The NADP continued to work with the Council of State and Territorial Epidemiologists (CSTE) on establishing a possible monitoring network for airborne allergen tracking. Airborne allergens are important, as they contribute to allergic rhinitis (i.e., hay fever) and asthma. Other participants in this work include the National Oceanic and Atmospheric Administration (NOAA), USEPA, and the Centers for Disease Control and Prevention. The NADP Aeroallergen Monitoring Science Committee (AMSC) has developed language for proposal development to enhance the science committee's impact in the future.
- The NADP continued efforts with the National Park Service, USGS, USEPA, Colorado Department of Public Health and Environment, Colorado State University, and the Longmont and Boulder Valley Conservation Districts to address the effects and trends of nitrogen deposition and the related air quality issues at Rocky Mountain National Park (RMNP). The Rocky Mountain National Park Initiative works to address nitrogen deposition concerns, and the 2017 data generated from this collaboration was used to develop the Rocky Mountain National Park Initiative: 2017 Nitrogen Deposition Milestone Report published in the summer of 2019.
- Through extensive review with the NADP Quality Assurance Advisory Group (QAAG) the NADP CAL documented that the web-published bromide data from January 2012 through June 2018 has known or suspected bias caused by the presence of oxalate in the precipitation. Motions to remove this data from the NADP website and discontinue bromide as an official NADP analyte (due to >80% non-detects) were presented to the NADP Executive Committee and approved on May 17, 2019.
- In November 2018, the NADP Executive Committee passed a motion to move the Hg Analytical Laboratory (HAL) from its longtime home at Eurofins Frontier Global Sciences, Inc., in Bothell, Washington, to the WSLH. This transition was completed in June 2019. The transition could not have been successfully completed without the hard work of WSLH personnel, the QAAG, and the dedicated staff at Eurofins.
- Mark Nilles, Coordinator for the NADP and NPS-Water Quality Partnership Observing Systems Division, U.S. Geological Survey retired in 2018. Mark was a dedicated, long-term advocate for the NADP. Thank you Mark for your long service, and best of luck into the future.
- The NADP has established a charitable foundation allowing supporters to contribute to its operation. The NADP Foundation is administered by the University of Wisconsin Foundation and can be accessed at the following link: http://nadp.slh.wisc.edu/nadp/Foundation.aspx

Service Awards:

The NADP recognizes the extraordinary services that individuals have contributed towards the advancement of the program and the understanding of deposition chemistry and its impacts. Award nominations for exceptional contributions to NADP are forwarded to the Executive Committee for approval.

Awards are commonly given to NADP members who are retiring or leaving the NADP after many years of service to the organization. The *Ellis B. Cowling Lifetime Achievement Award* is presented for dedicated service to the NADP as a significant part of one's career. The *Van Bowersox Meritorious Service Award* is presented for significant, lasting contributions to NADP networks, science committees, and scientific discovery. Recent awardees include:

- **Rick Artz** - *Van Bowersox Meritorious Service Award 2017*
- **Gary Lear** - *Ellis Cowling Lifetime Achievement Award 2017*
- **Marty Risch** - *Van Bowersox Meritorious Service Award 2018*
- **Mark Nilles** - *Ellis Cowling Lifetime Achievement Award 2018*

NADP Background

The NADP was established in 1977 under State Agricultural Experiment Station (SAES) leadership to address the problem of atmospheric deposition, and its effects on agricultural crops, forests, rangelands, surface waters, and other natural and cultural resources. The NADP's primary charge was to provide data on the temporal trends and geographic distribution of the atmospheric deposition of acids, nutrients, and base cations by precipitation. In 1978, sites in the NADP precipitation chemistry network first began collecting weekly, wet-only deposition samples. Chemical analysis was performed at the Illinois State Water Survey's Central Analytical Laboratory, located at the University of Illinois at Urbana-Champaign and the Program Coordinator was housed at Colorado State University.

Initially, the NADP was organized as SAES North Central Regional Project NC-141, which all four SAES regions further endorsed in 1982 as Interregional Project IR-7. A decade later, IR-7 was reclassified as the National Research Support Project No. 3 (NRSP- 3), which it remains to this day. The last renewal was in Federal Year 2017, and will be renewed in 2019 through UW-Madison Research and Sponsored Programs. NRSP projects are multistate activities that support research on topics of concern to more than one state or region of the country. Multistate projects involve the SAES in partnership with the USDA National Institute of Food and Agriculture (NIFA) and other universities, institutions, and agencies. In October 1981, the federally-supported National Acid Precipitation Assessment Program (NAPAP) was established to increase our understanding of the causes and effects of acidic precipitation. This program sought to establish a long-term precipitation chemistry network of sampling sites away from point source influences. Building on its experience in organizing and operating a national-scale network, the NADP agreed to coordinate operation of NAPAP's National Trends Network. Later, to benefit from identical siting criteria, operating procedures, and a shared analytical laboratory, NADP and NTN merged with the designation NADP/NTN. This merger brought substantial new federal agency participation into the program. Many NADP/NTN sites were supported by the USGS, NAPAP's lead federal agency for deposition monitoring.

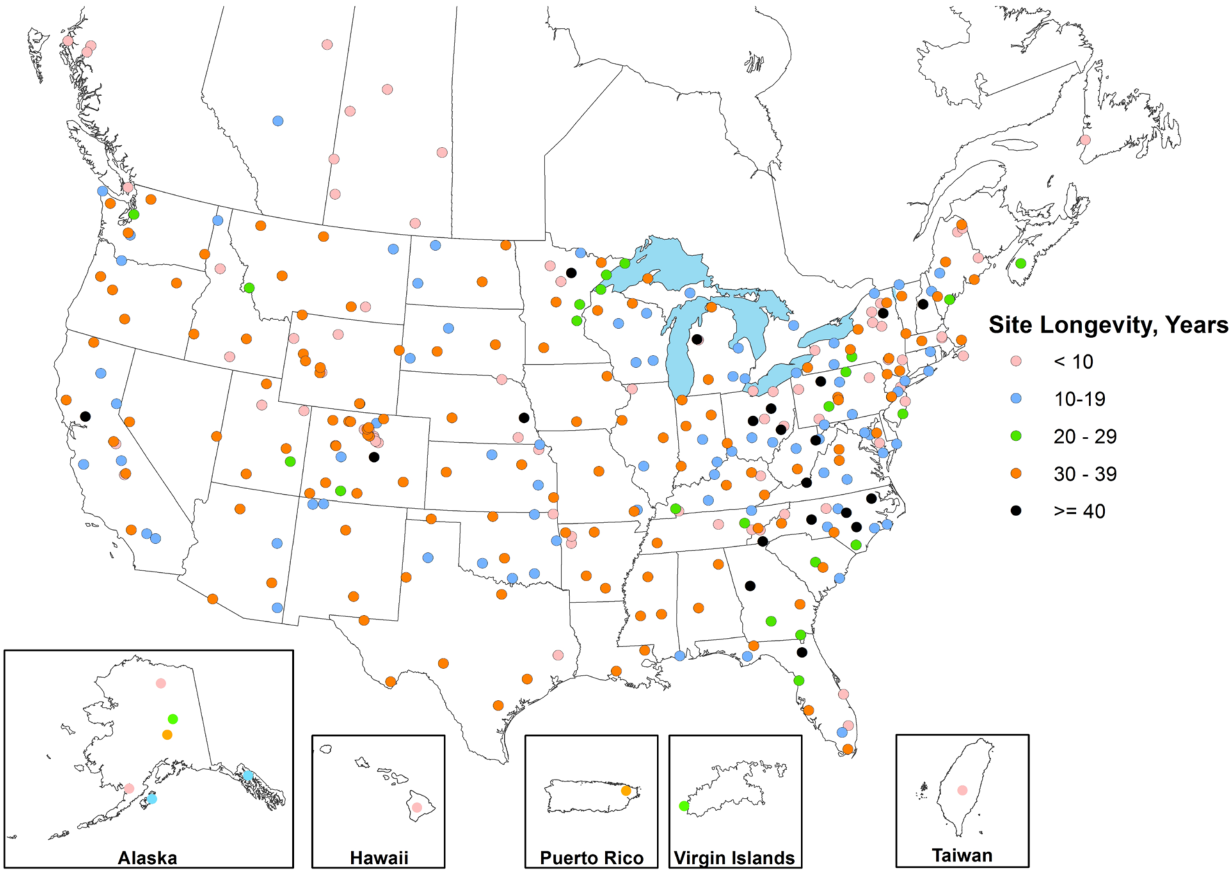
In October 1992, the AIRMoN was formed from the Multistate Atmospheric Power Production Pollution Study (MAP3S), which was operated by the Department of Energy and NOAA. MAP3S measured wet deposition and estimated dry deposition (later discontinued) for the same analytes. AIRMoN sites collect samples daily when precipitation occurs, and are analyzed for the same analytes as NTN samples.

In January 1996, the NADP established the MDN, the third network in the organization. The MDN was formed to provide data on the wet deposition of mercury to surface waters, forested watersheds, and other receptors. MDN samples, like NTN samples, are weekly collections.

In October 2009, AMNet joined the NADP as its fourth network. AMNet measures the concentration of atmospheric mercury at high-time resolution using on-site, real-time, analyzers.

In October 2010, AMoN joined the NADP. Atmospheric ammonia concentrations are measured every two weeks using passive samplers. The AMoN furthers the understanding of wet and dry deposition and ammonia partitioning in the atmosphere, allowing better assessment of ecosystem impacts and secondary air pollution formation.

Beginning in late 2017 and completed in mid-2018, the NADP PO and CAL moved from the University of Illinois at Urbana-Champaign to the University of Wisconsin–Madison, and in June 2019 the HAL moved to the University of Wisconsin–Madison. NADP networks continue to support the NADP mission of high data quality, outreach, and scientific improvement.



Global distribution and longevity of NADP sites.

About the Maps

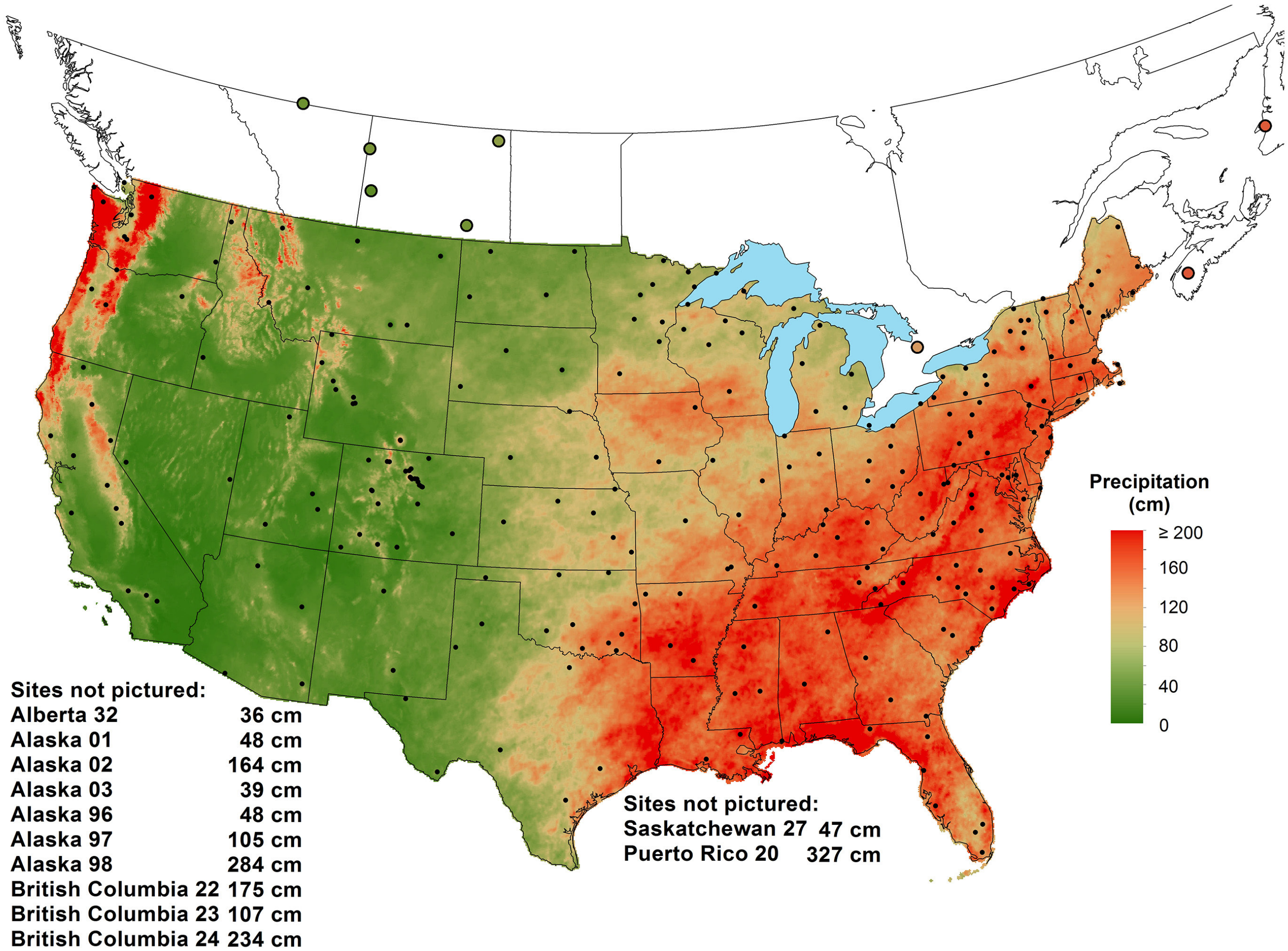
This map series is a principal product of the NADP. It summarizes the results of network operation for the most recent complete calendar year in graphic form. Additional maps, related geographic information, and reviewed analytical results are available on the NADP website.

To be included in a map product, site data must meet strict data completeness criteria (refer to the NADP website for details). Black dots mark site locations that met NADP completeness criteria in 2018. Open circles designate urban sites, defined as having at least 400 people per square kilometer (km^2) within a 15-km radius of the site. Sites (e.g., Canadian sites) that are too far removed from other observations to extend the contour surface are represented as color-filled circles.

The map contour surface represents a gridded interpolation. Grid points within 500 km of each site are used in computations. Urban sites do not contribute to the contour surface. Colors represent interpolated values of concentration, deposition, or precipitation. The precipitation surface is a modified version of the U.S. precipitation grid developed by the PRISM Climate Group ("Parameter-elevation Regressions on Independent Slopes Model," http:// prism.oregonstate.edu, data downloaded September 2019). These annual precipitation estimates incorporate point data, a digital elevation model, and expert knowledge of complex climatic extremes to produce continuous grid estimates.

NADP precipitation observations are used to supplement the PRISM precipitation grids through an inverse distance weighting within a 20 km radius of each NADP site (see the NADP website for specific information). The resulting precipitation map is used to generate the deposition maps.

The precipitation figure on the next page has a continuous gradient of color from dark green (0 cm of precipitation) to yellow to dark red (greater than 200 cm of precipitation). Concentration and deposition maps follow this same format, with specified units on each map. All maps back to 1985 follow this schema and are available in multiple formats from the NADP website (http://nadp.slh.wisc.edu).



Total annual precipitation for 2018, using precipitation measurements from the NADP and PRISM (in cm).

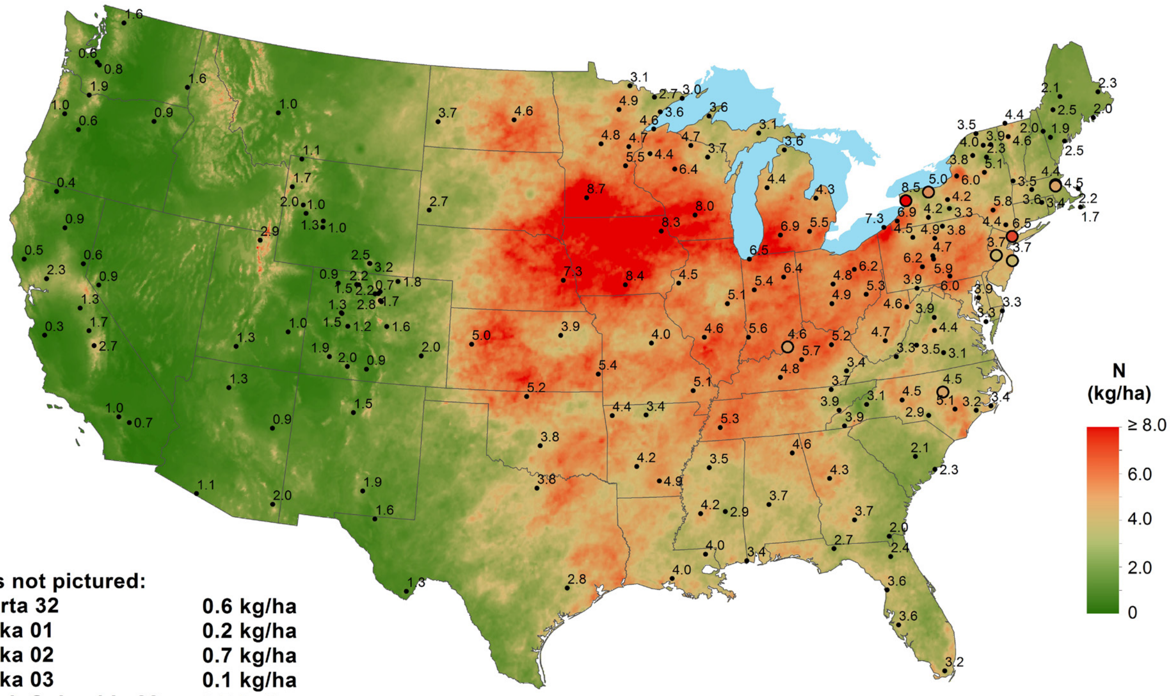
National Trends Network (NTN)

The NTN is the largest North American network that provides a long-term record of precipitation chemistry. Most sites are located away from urban areas and point sources of pollution, although urban sites do participate. Each site has a precipitation collector and rain gage. The automated collector ensures that sampling only occurs during precipitation events. Site operators follow standard operating procedures to help ensure NTN data comparability and representativeness across the network. Weekly samples are collected each Tuesday morning, using containers provided by the CAL. All samples are sent to the CAL for analysis of free acidity (H^+ as pH), specific conductance, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), sulfate (SO_4), nitrate (NO_3), chloride (Cl), and ammonium (NH_4) ions. The CAL quantifies orthophosphate for quality assurance purposes as an indicator of potential field contamination. The CAL reviews field and laboratory data for accuracy and completeness and flags samples that were mishandled, compromised by equipment failure, or grossly contaminated. Data from the NTN are available on the NADP website (http://nadp.slh.wisc.edu/ntn/).

NTN Maps

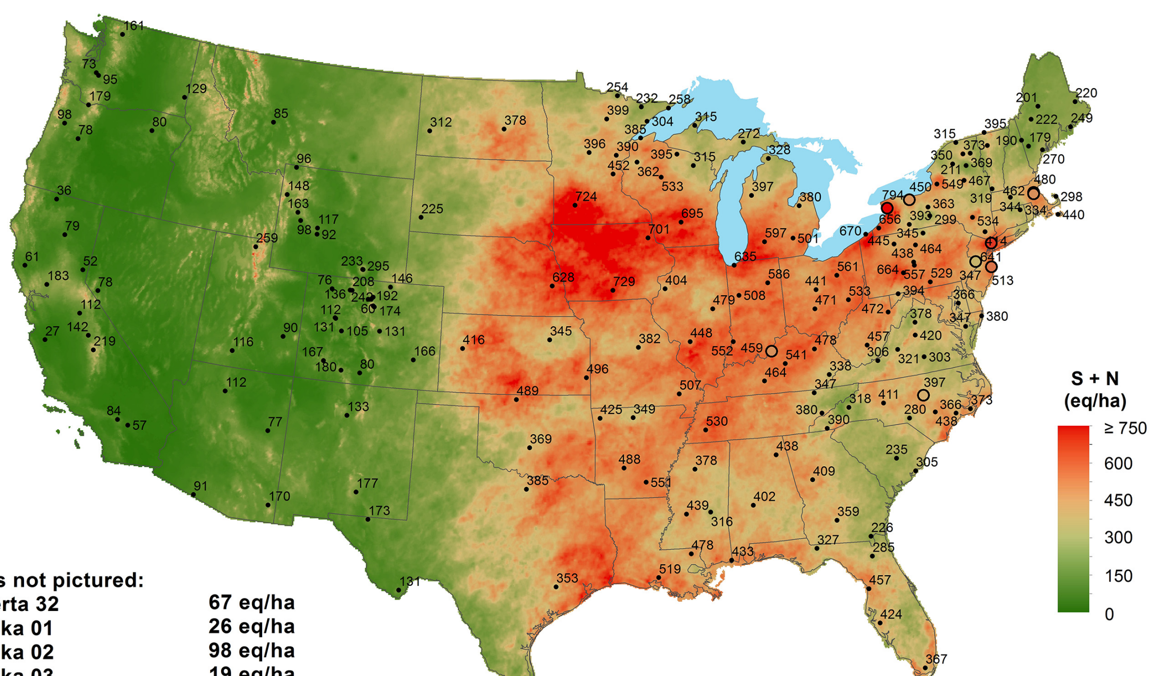
The maps on pages 11 through 19 show precipitation-weighted mean concentration and annual wet deposition for select acid anions, nutrients, and base cations. Substantial spatial heterogeneity across the nation is apparent for all measured species. In 2018, 211 of the 262 active sites met NADP completeness criteria. Concentration and deposition maps are included for SO_4, NO_3, NH_4, pH, Ca, Mg, Cl, and Na. Maps of K are not included in this report, but are available from the NADP website. Br data is no longer reported by NADP.

Annual maps for wet deposition of inorganic nitrogen (i.e., NO_3 + NH_4) and nitrogen + sulfur (N + S) are also included. N + S (i.e., NO_3 + NH_4 + SO_4) deposition is mapped as hydrogen ion equivalents per hectare (eq/ha).



Sites not pictured:

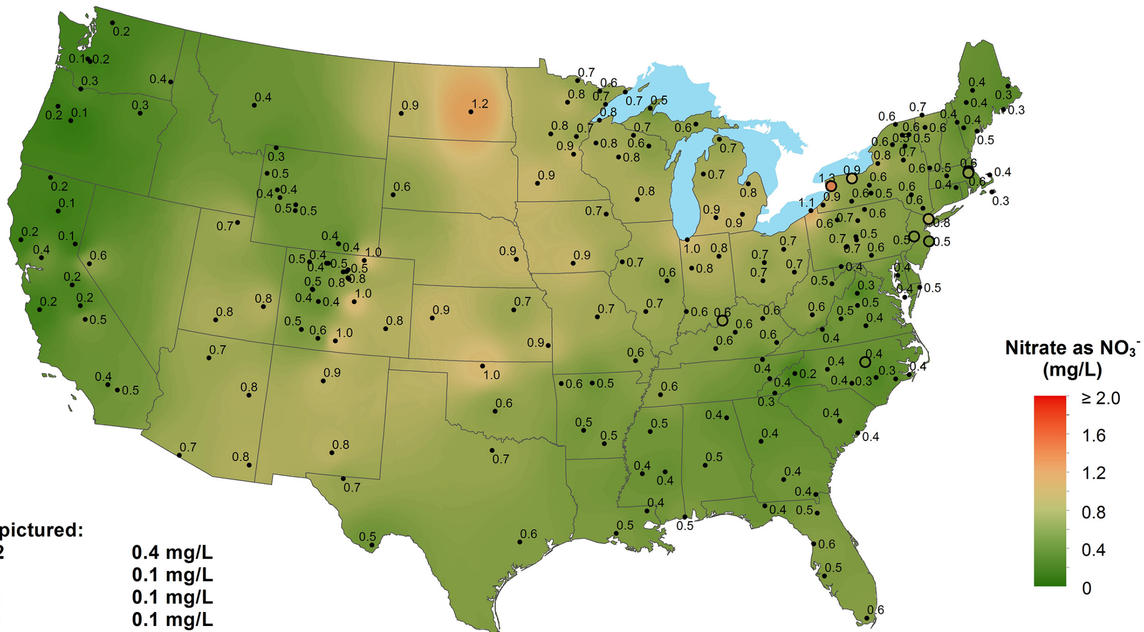
Alberta 32	**0.6 kg/ha**
Alaska 01	**0.2 kg/ha**
Alaska 02	**0.7 kg/ha**
Alaska 03	**0.1 kg/ha**
British Columbia 22	**0.7 kg/ha**
British Columbia 24	**0.8 kg/ha**
Puerto Rico 20	**2.4 kg/ha**
Saskatchewan 21	**2.6 kg/ha**



Sites not pictured:

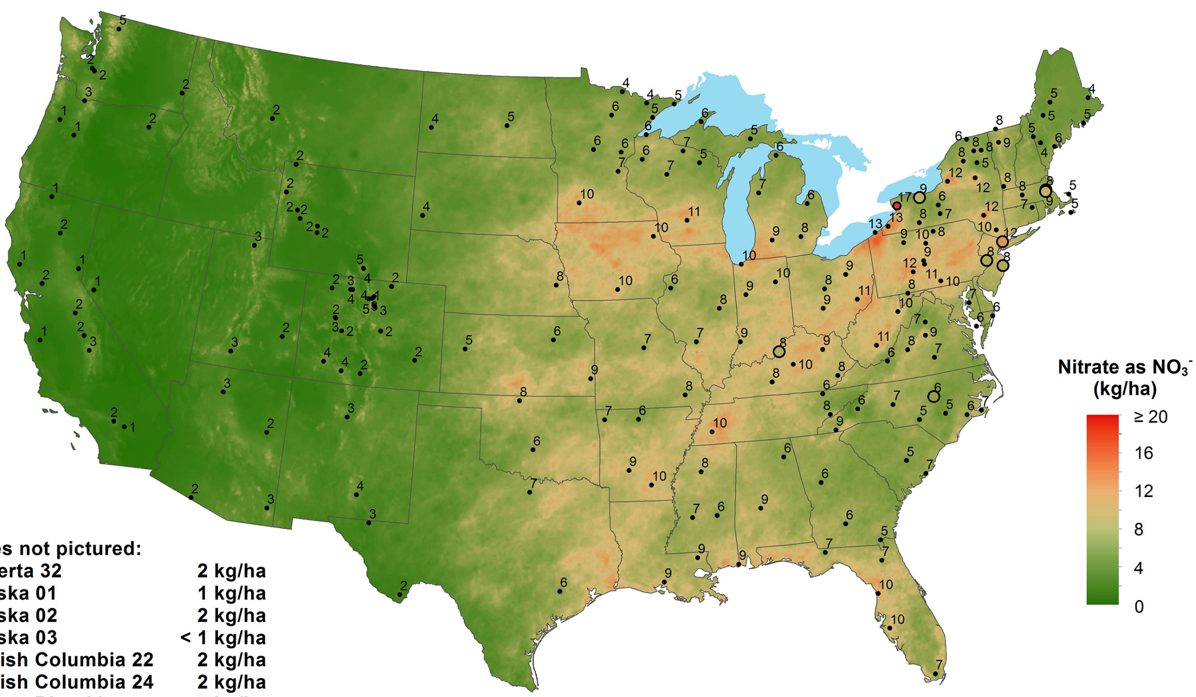
Alberta 32	**67 eq/ha**
Alaska 01	**26 eq/ha**
Alaska 02	**98 eq/ha**
Alaska 03	**19 eq/ha**
British Columbia 22	**520 eq/ha**
British Columbia 24	**154 eq/ha**
Puerto Rico 20	**668 eq/ha**
Saskatchewan 21	**213 kg/ha**
Saskatchewan 31	**174 kg/ha**

Inorganic nitrogen wet deposition from nitrate and ammonium (top) and nitrogen plus sulfur wet deposition from nitrate, ammonium, and sulfate (bottom), 2018.



Sites not pictured:

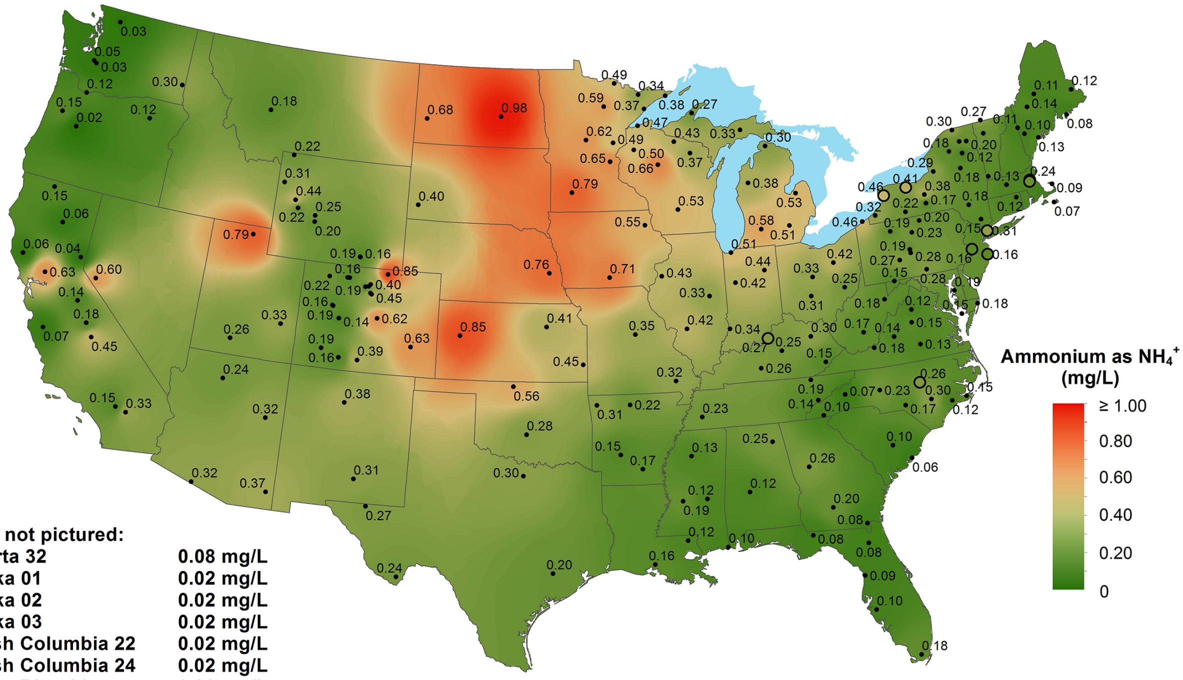
Alberta 32	**0.4 mg/L**
Alaska 01	**0.1 mg/L**
Alaska 02	**0.1 mg/L**
Alaska 03	**0.1 mg/L**
British Columbia 22	**0.1 mg/L**
British Columbia 24	**0.1 mg/L**
Puerto Rico 20	**0.2 mg/L**
Saskatchewan 21	**0.6 mg/L**
Saskatchewan 31	**0.9 mg/L**



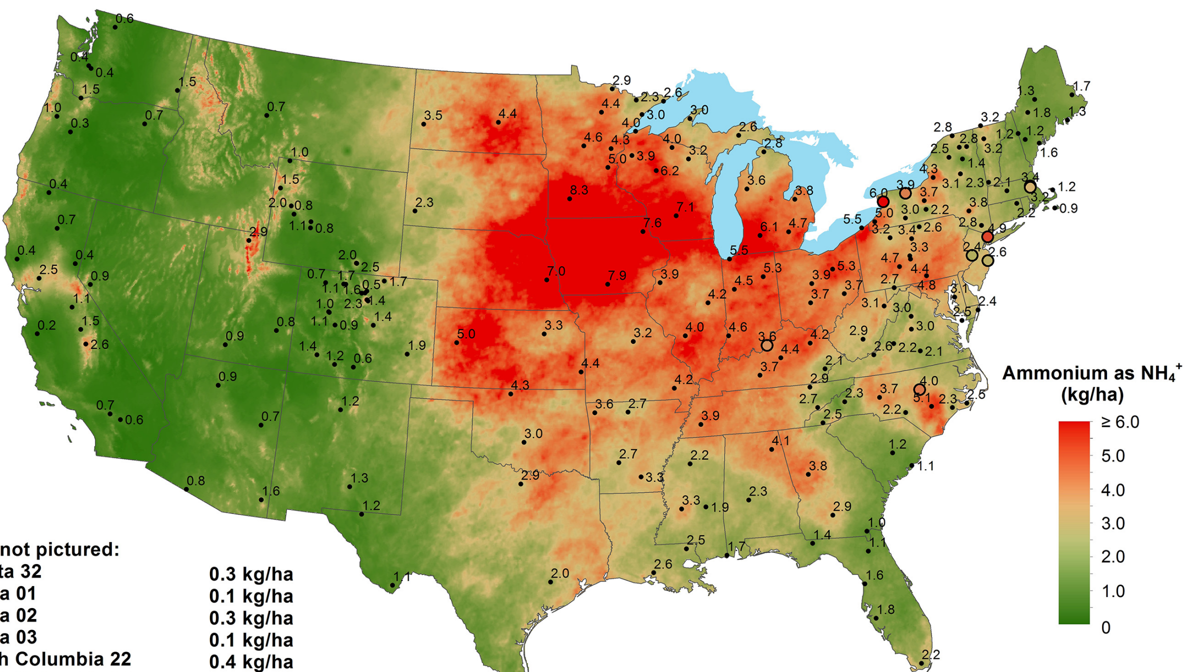
Sites not pictured:

Alberta 32	**2 kg/ha**
Alaska 01	**1 kg/ha**
Alaska 02	**2 kg/ha**
Alaska 03	**< 1 kg/ha**
British Columbia 22	**2 kg/ha**
British Columbia 24	**2 kg/ha**
Puerto Rico 20	**7 kg/ha**
Saskatchewan 21	**3 kg/ha**
Saskatchewan 31	**3 kg/ha**

Nitrate ion concentration (top) and wet deposition (bottom), 2018.

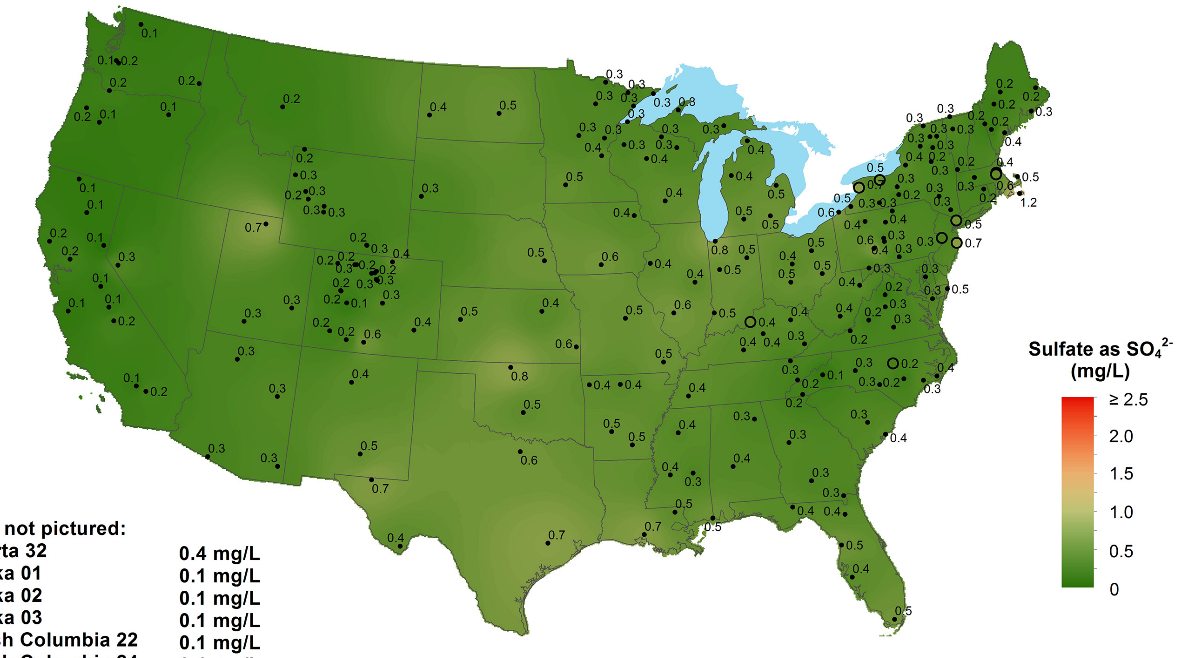


Sites not pictured:	
Alberta 32	0.08 mg/L
Alaska 01	0.02 mg/L
Alaska 02	0.02 mg/L
Alaska 03	0.02 mg/L
British Columbia 22	0.02 mg/L
British Columbia 24	0.02 mg/L
Puerto Rico 20	0.03 mg/L
Saskatchewan 21	0.39 mg/L
Saskatchewan 31	0.56 mg/L



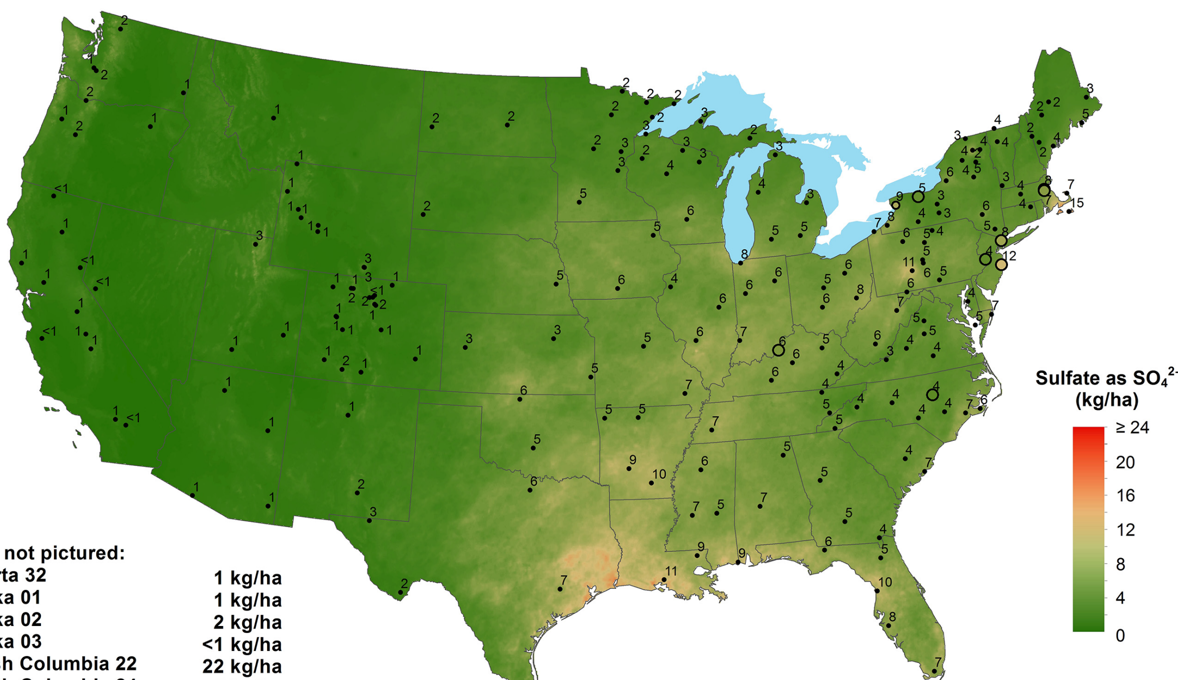
Sites not pictured:	
Alberta 32	0.3 kg/ha
Alaska 01	0.1 kg/ha
Alaska 02	0.3 kg/ha
Alaska 03	0.1 kg/ha
British Columbia 22	0.4 kg/ha
British Columbia 24	0.4 kg/ha
Puerto Rico 20	1.1 kg/ha
Saskatchewan 21	2.3 kg/ha
Saskatchewan 31	1.8 kg/ha

Ammonium ion concentration (top) and wet deposition (bottom), 2018.



Sites not pictured:

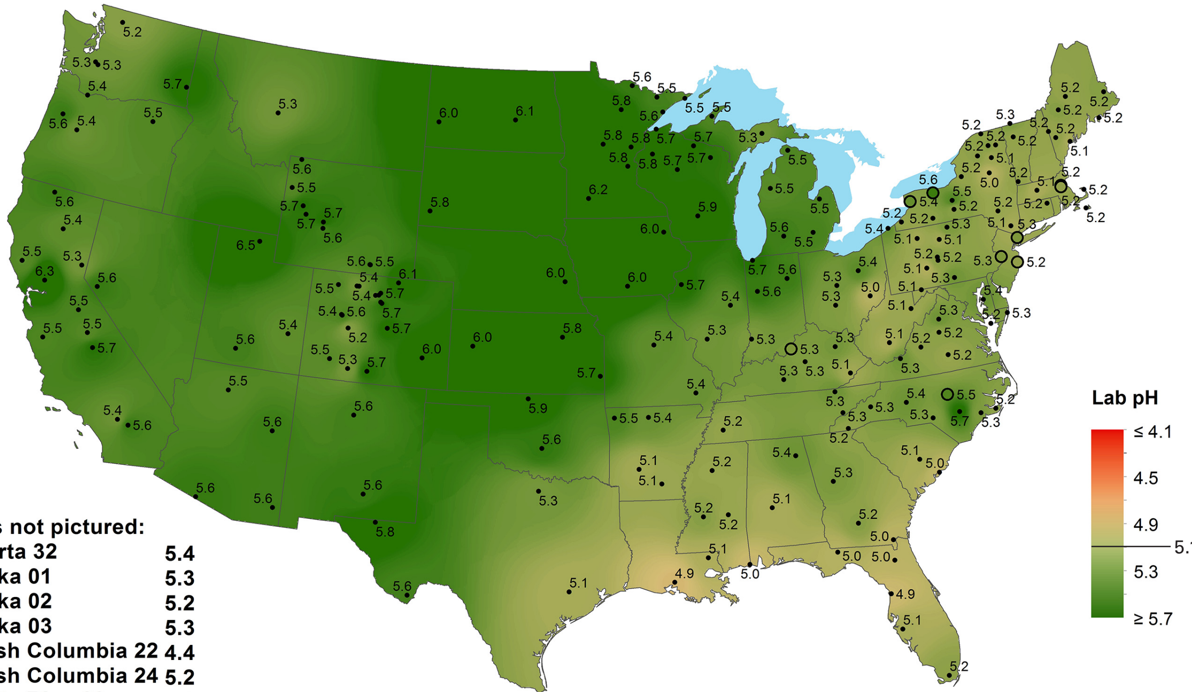
Alberta 32	0.4 mg/L
Alaska 01	0.1 mg/L
Alaska 02	0.1 mg/L
Alaska 03	0.1 mg/L
British Columbia 22	0.1 mg/L
British Columbia 24	0.1 mg/L
Puerto Rico 20	0.2 mg/L
Saskatchewan 21	0.6 mg/L
Saskatchewan 31	0.9 mg/L



Sites not pictured:

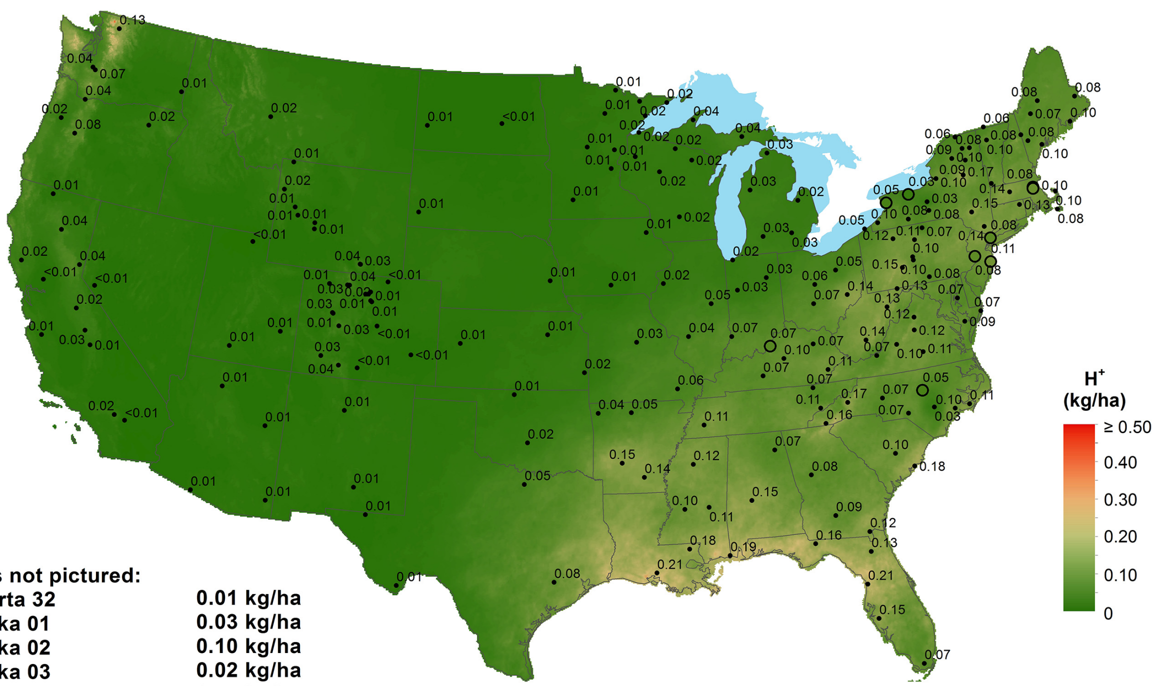
Alberta 32	1 kg/ha
Alaska 01	1 kg/ha
Alaska 02	2 kg/ha
Alaska 03	<1 kg/ha
British Columbia 22	22 kg/ha
British Columbia 24	5 kg/ha
Puerto Rico 20	24 kg/ha
Saskatchewan 21	2 kg/ha
Saskatchewan 31	1 kg/ha

Sulfate ion concentration (top) and wet deposition (bottom), 2018.



Sites not pictured:

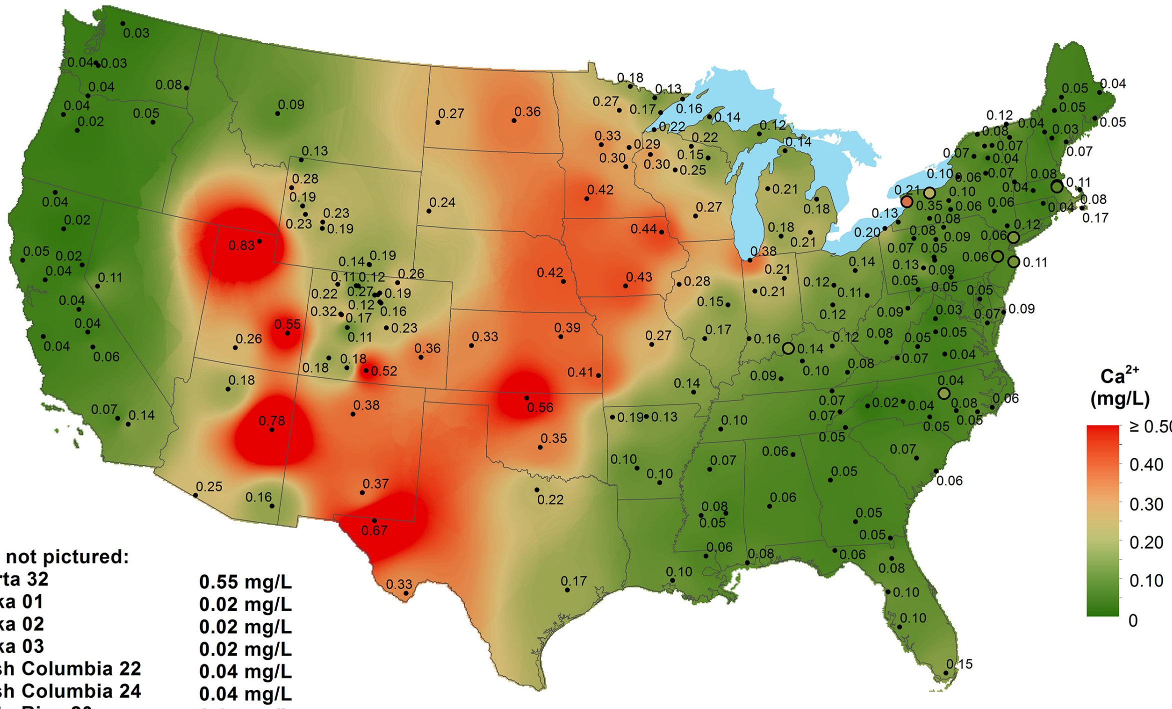
Alberta 32	5.4
Alaska 01	5.3
Alaska 02	5.2
Alaska 03	5.3
British Columbia 22	4.4
British Columbia 24	5.2
Puerto Rico 20	5.3
Saskatchewan 21	5.7
Saskatchewan 31	5.6



Sites not pictured:

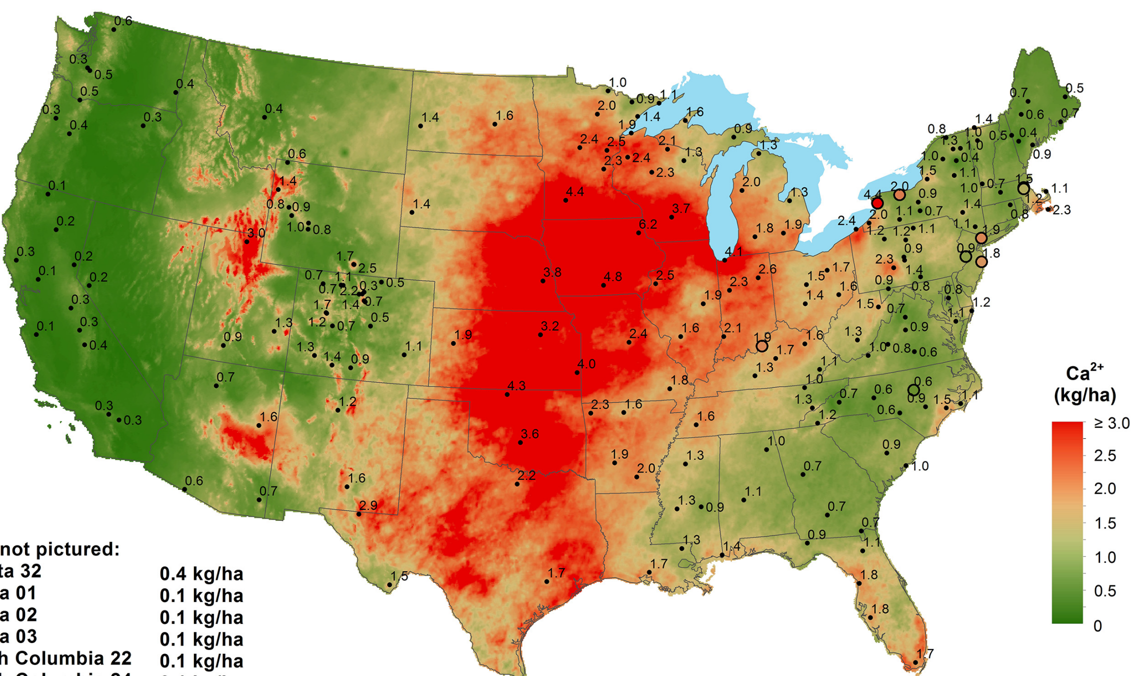
Alberta 32	0.01 kg/ha
Alaska 01	0.03 kg/ha
Alaska 02	0.10 kg/ha
Alaska 03	0.02 kg/ha
British Columbia 22	0.74 kg/ha
British Columbia 24	0.14 kg/ha
Puerto Rico 20	0.17 kg/ha
Saskatchewan 21	0.01 kg/ha
Saskatchewan 31	0.01 kg/ha

Hydrogen ion concentration as pH (top) and wet deposition (bottom), 2018. Typically, a precipitation pH of less than 5.1 is considered acidic.



Sites not pictured:

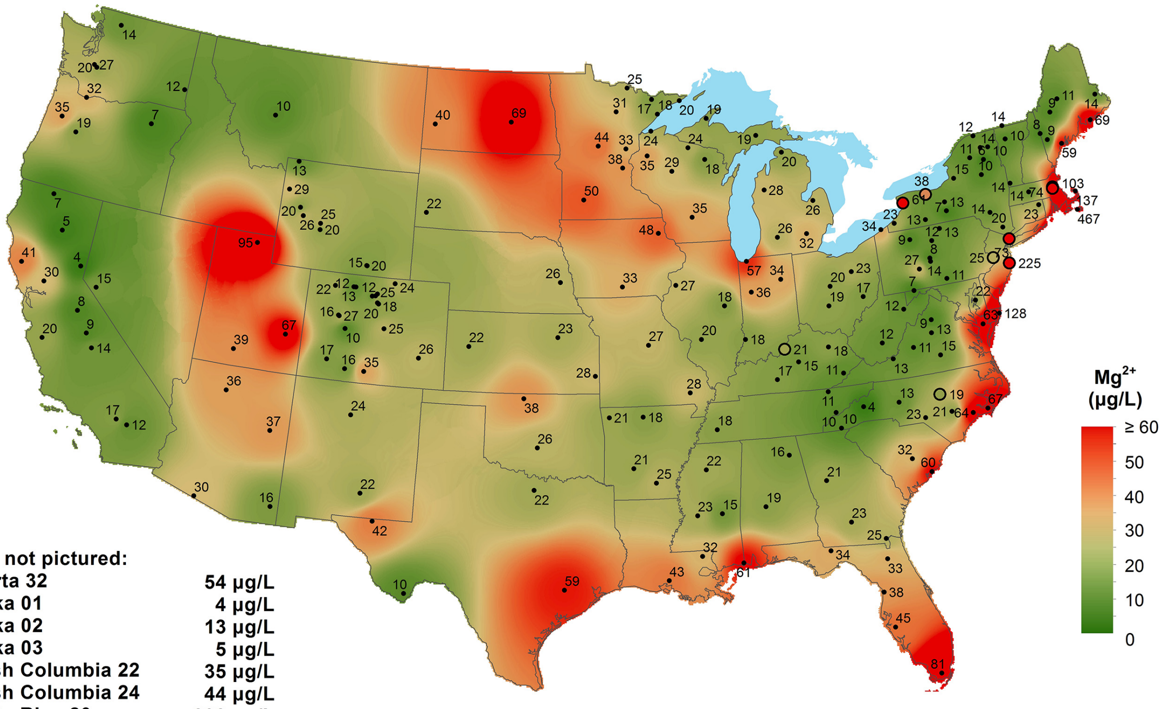
Alberta 32	0.55 mg/L
Alaska 01	0.02 mg/L
Alaska 02	0.02 mg/L
Alaska 03	0.02 mg/L
British Columbia 22	0.04 mg/L
British Columbia 24	0.04 mg/L
Puerto Rico 20	0.15 mg/L
Saskatchewan 21	0.18 mg/L
Saskatchewan 31	0.21 mg/L



Sites not pictured:

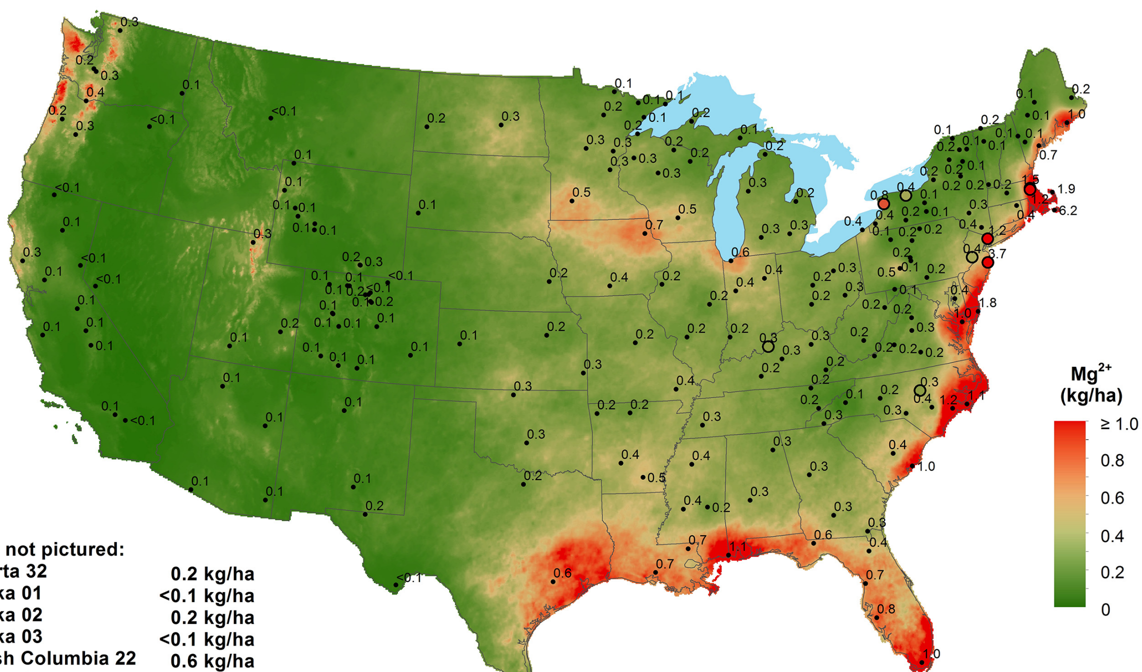
Alberta 32	0.4 kg/ha
Alaska 01	0.1 kg/ha
Alaska 02	0.1 kg/ha
Alaska 03	0.1 kg/ha
British Columbia 22	0.1 kg/ha
British Columbia 24	0.1 kg/ha
Puerto Rico 20	0.2 kg/ha
Saskatchewan 21	0.6 kg/ha
Saskatchewan 31	0.9 kg/ha

Calcium ion concentration (top) and wet deposition (bottom), 2018.



Sites not pictured:

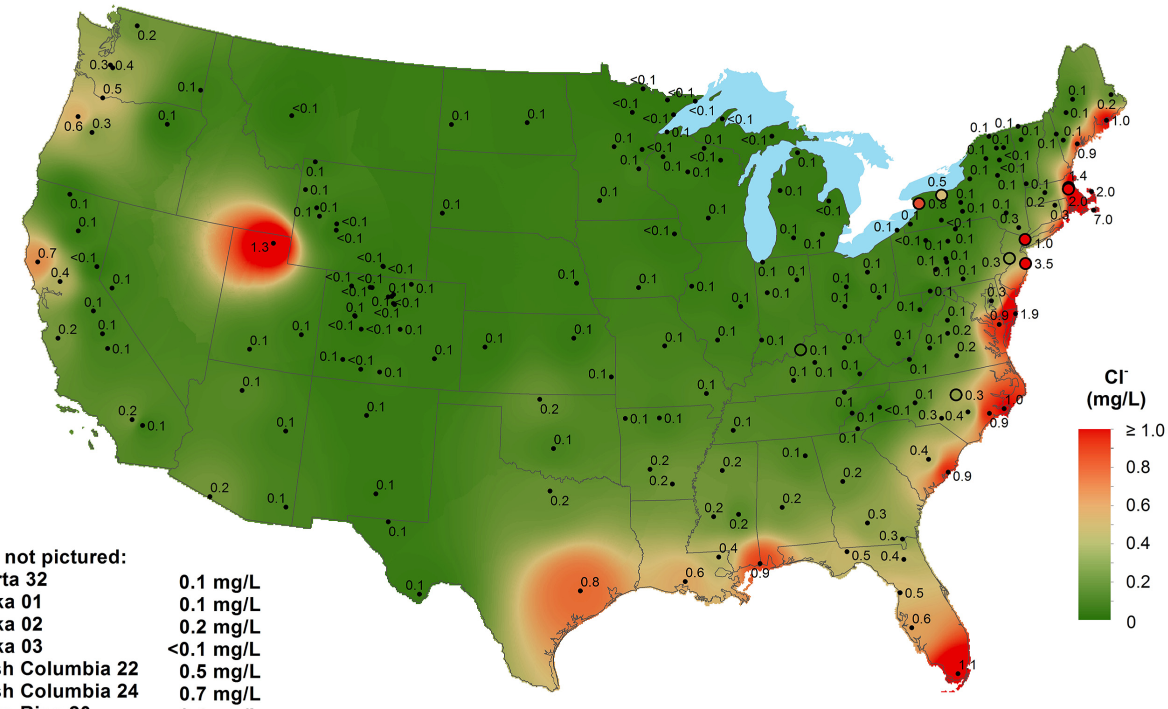
Alberta 32	54 µg/L
Alaska 01	4 µg/L
Alaska 02	13 µg/L
Alaska 03	5 µg/L
British Columbia 22	35 µg/L
British Columbia 24	44 µg/L
Puerto Rico 20	232 µg/L
Saskatchewan 21	43 µg/L
Saskatchewan 31	53 µg/L



Sites not pictured:

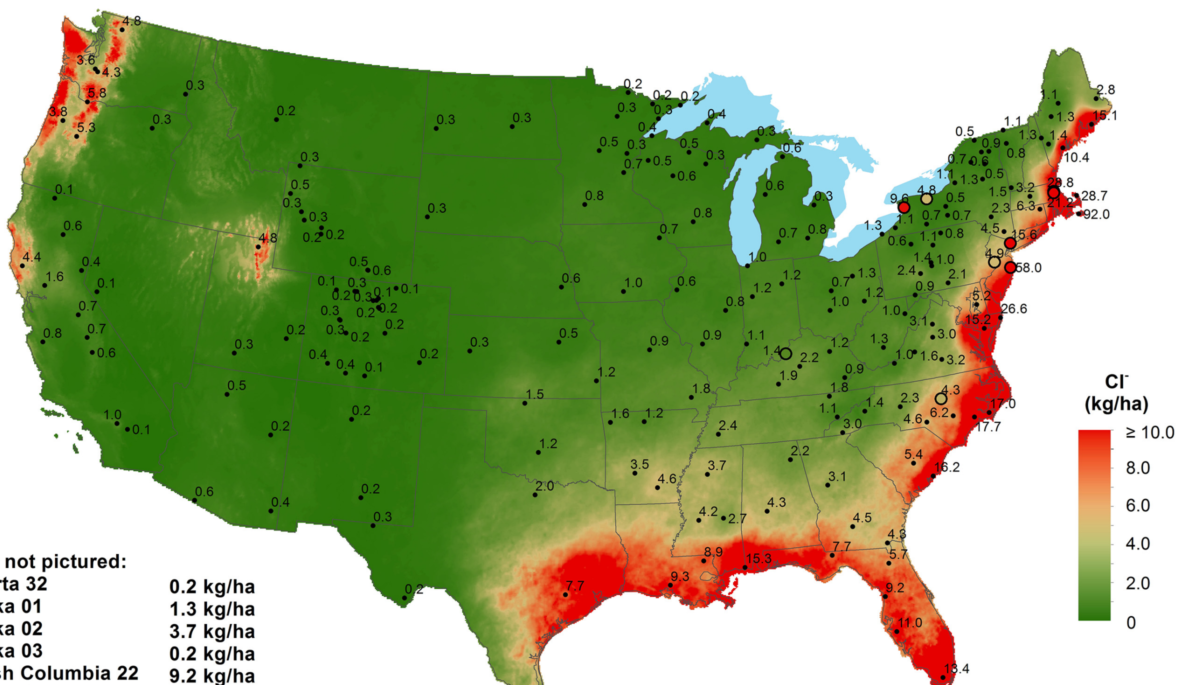
Alberta 32	0.2 kg/ha
Alaska 01	<0.1 kg/ha
Alaska 02	0.2 kg/ha
Alaska 03	<0.1 kg/ha
British Columbia 22	0.6 kg/ha
British Columbia 24	1.0 kg/ha
Puerto Rico 20	7.6 kg/ha
Saskatchewan 21	0.3 kg/ha
Saskatchewan 31	0.2 kg/ha

Magnesium ion concentration (top) and wet deposition (bottom), 2018.



Sites not pictured:

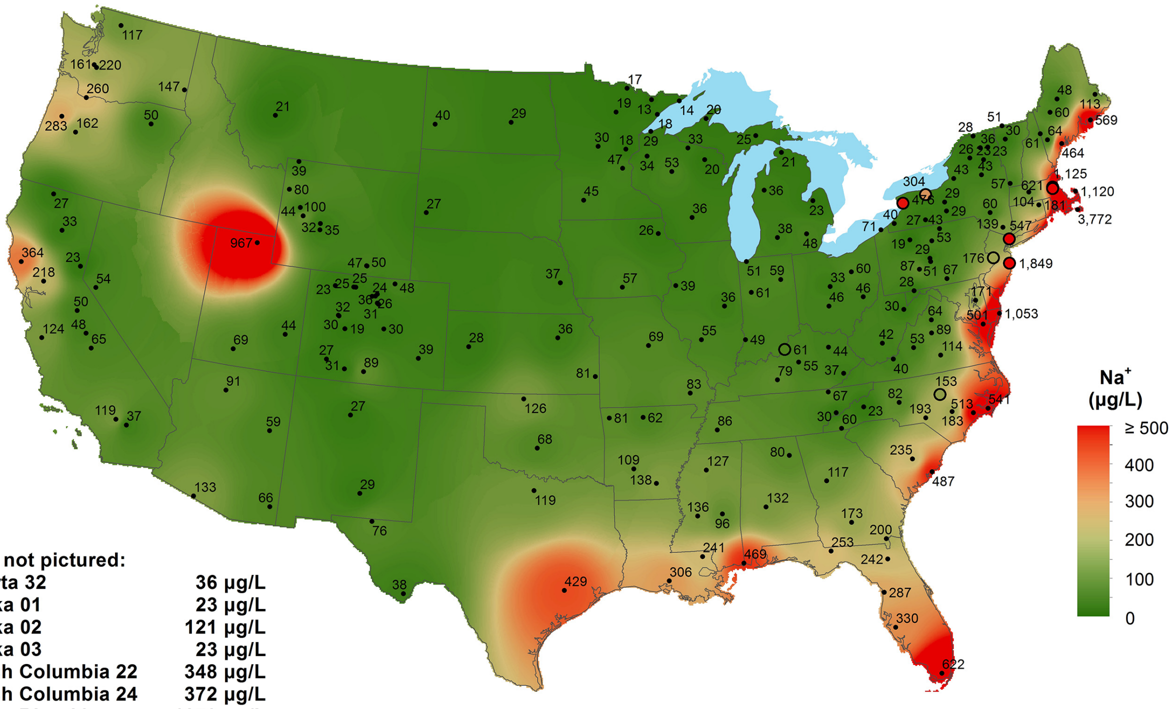
Alberta 32	0.1 mg/L
Alaska 01	0.1 mg/L
Alaska 02	0.2 mg/L
Alaska 03	<0.1 mg/L
British Columbia 22	0.5 mg/L
British Columbia 24	0.7 mg/L
Puerto Rico 20	3.4 mg/L
Saskatchewan 21	<0.1 mg/L
Saskatchewan 31	<0.1 mg/L



Sites not pictured:

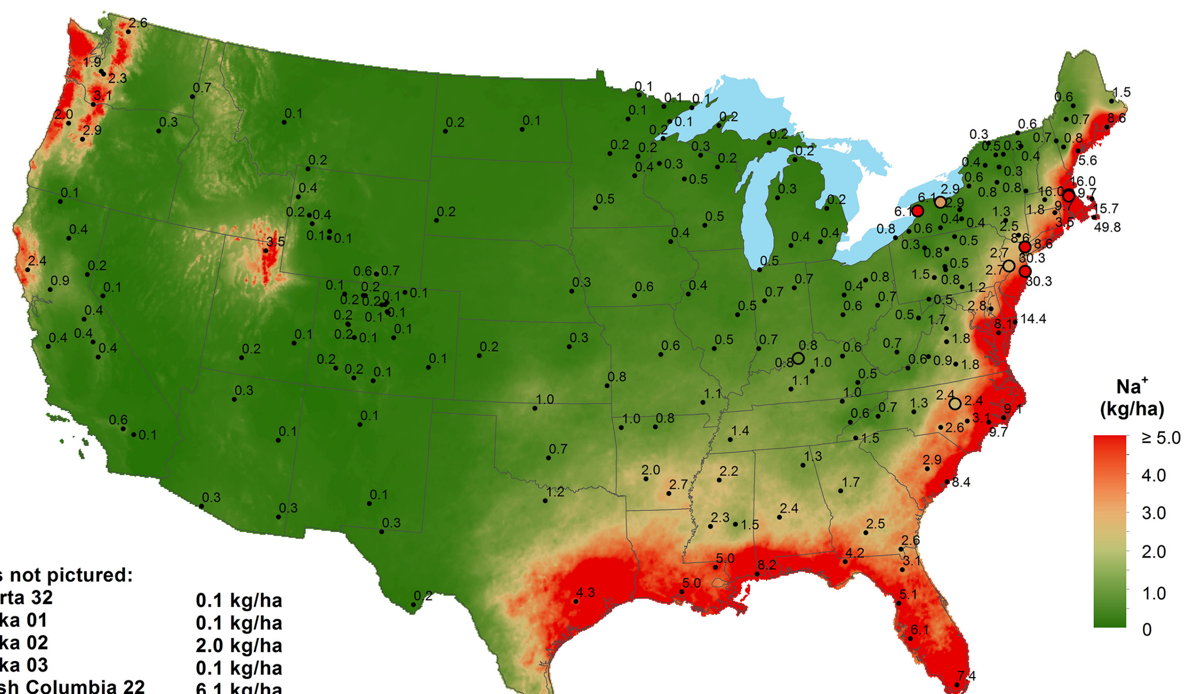
Alberta 32	0.2 kg/ha
Alaska 01	1.3 kg/ha
Alaska 02	3.7 kg/ha
Alaska 03	0.2 kg/ha
British Columbia 22	9.2 kg/ha
British Columbia 24	16.2 kg/ha
Puerto Rico 20	112.4 kg/ha
Saskatchewan 21	0.2 kg/ha
Saskatchewan 31	0.1 kg/ha

Chloride ion concentration (top) and wet deposition (bottom), 2018.



Sites not pictured:

Alberta 32	36 µg/L
Alaska 01	23 µg/L
Alaska 02	121 µg/L
Alaska 03	23 µg/L
British Columbia 22	348 µg/L
British Columbia 24	372 µg/L
Puerto Rico 20	1879 µg/L
Saskatchewan 21	11 µg/L
Saskatchewan 31	18 µg/L

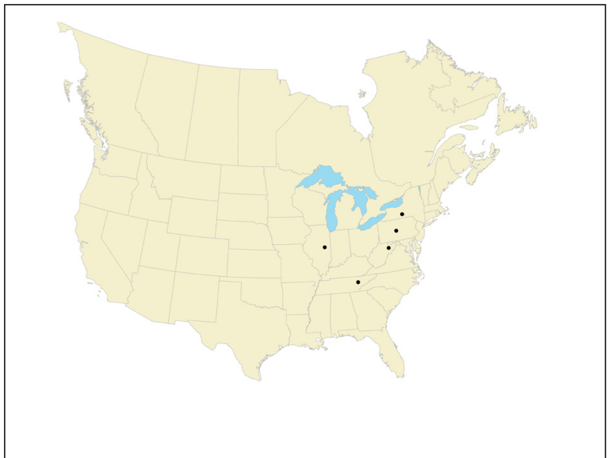


Sites not pictured:

Alberta 32	0.1 kg/ha
Alaska 01	0.1 kg/ha
Alaska 02	2.0 kg/ha
Alaska 03	0.1 kg/ha
British Columbia 22	6.1 kg/ha
British Columbia 24	8.7 kg/ha
Puerto Rico 20	61.5 kg/ha
Saskatchewan 21	0.1 kg/ha
Saskatchewan 31	0.1 kg/ha

Sodium ion concentration (top) and wet deposition (bottom), 2018.

Atmospheric Integrated Research Monitoring Network (AIRMoN)



Sites Active in 2018

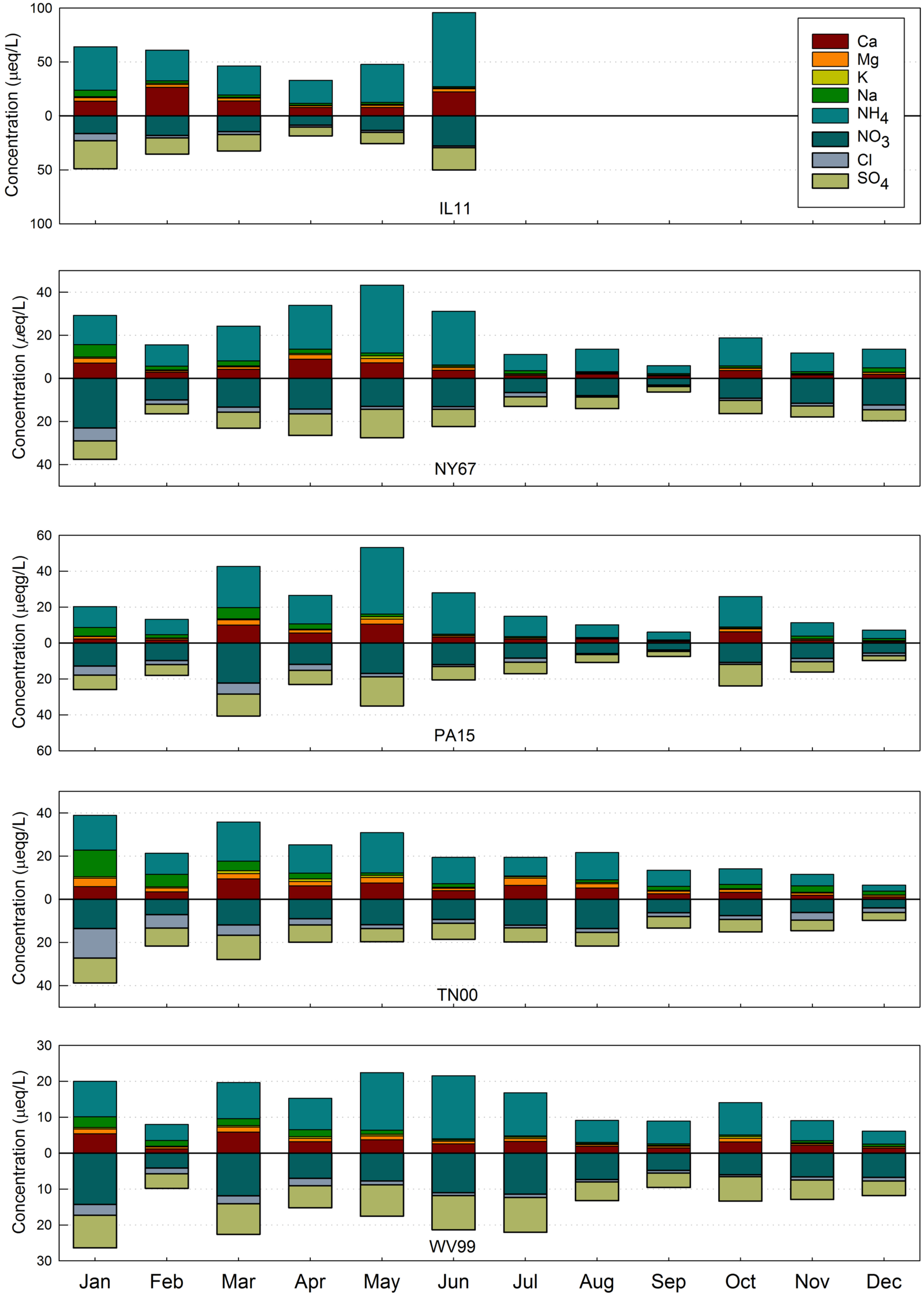
AIRMoN samples are collected daily within 24 hours of the start of precipitation, often providing data for individual storm events. Event-based data facilitate studies of atmospheric processes, give insight to wet deposition data quality sensitivity, and support the development and testing of atmospheric models such as the NOAA/HYSPLIT fate and transport model and Community Multiscale Air Quality (CMAQ) Modeling System.

AIRMoN sites are equipped with the same wet-only deposition collector used at NTN sites. All AIRMoN sites operate digital rain gages to report total precipitation. Each site also has a standard stick-type precipitation gage as a backup.

Samples are refrigerated after collection and are shipped in chilled, insulated containers to the CAL for analysis. Samples remain refrigerated until they are analyzed. Refrigeration helps retard potential chemical changes. Chemical analyses and data screening procedures for AIRMoN and NTN are similar. Data from the AIRMoN are available on the NADP website (http://nadp.slh.wisc.edu/airmon/).

The AIRMoN network offers a unique set of data, with a significant increase in temporal resolution compared to the NTN. The following figure shows the monthly weighted average of major ionic species for active AIRMoN sites, indicating the seasonal trends at IL11, NY67, PA15, TN00, and WV99. Stacked bar plots show the concentration, in units of microequivalents per liter, of major cations in the positive direction, while major anion concentrations are shown in the opposite direction.

The AIRMoN was discontinued in September 2019.



Time series of 2018 monthly weighted average cation and anion concentrations (µeq/L) at the AIRMoN sites.

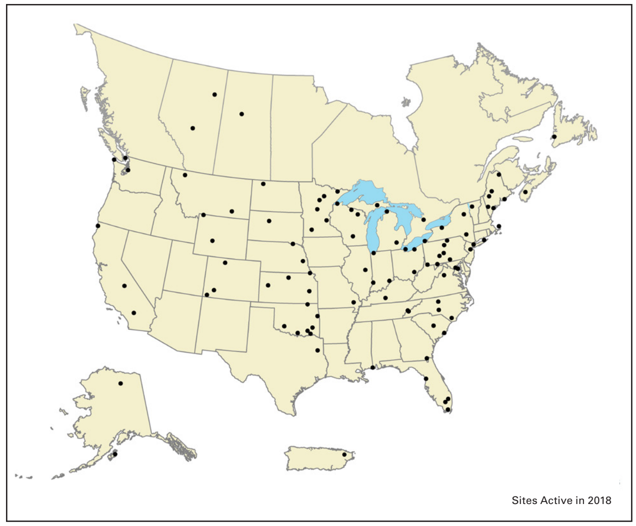
Mercury Deposition Network (MDN)

The MDN is the only network providing a long-term record for the concentration of mercury (Hg) in precipitation in North America. MDN sites follow standard procedures and use approved precipitation collectors and rain gages. The automated collector is similar to the NTN collector, but it is modified to preserve mercury. Site operators collect samples every Tuesday morning. Chemical analysis of the MDN samples was performed by the Mercury Analytical Laboratory (HAL) at Eurofins Frontier Global Sciences, Inc., Bothell, Washington, through June 2019; after this date the HAL is located at the WSLH in Madison, Wisconsin.

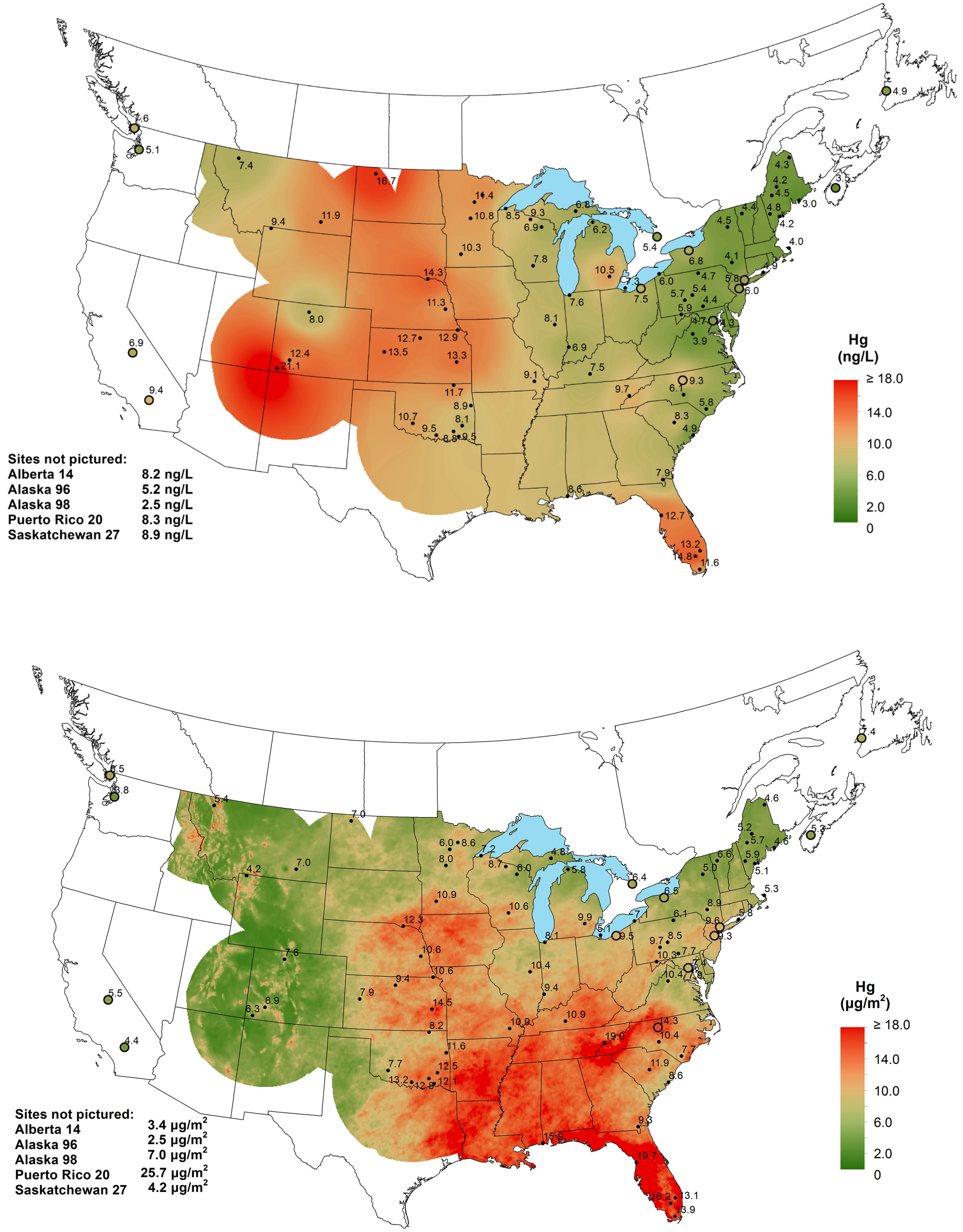
All MDN samples are analyzed for total mercury concentration. The HAL reviews field and laboratory data for accuracy and completeness, and identifies samples that were mishandled, compromised by equipment failure, or grossly contaminated. Data from the MDN is available on the NADP website (http://nadp.slh.wisc.edu/mdn/). Subsamples of MDN precipitation were analyzed for methyl mercury (MeHg) at 11 NADP sites. Details about sample collection and analysis are available on the NADP website.

MDN Maps and Graphs

The maps on page 23 show spatial variability in the precipitation-weighted mean concentration and wet deposition of total mercury across the United States.



Only sites meeting NADP completeness criteria are included. In 2018, 84 of 98 active sites met these criteria. Large variations in both HgT concentrations and wet-deposition are observed across the nation.

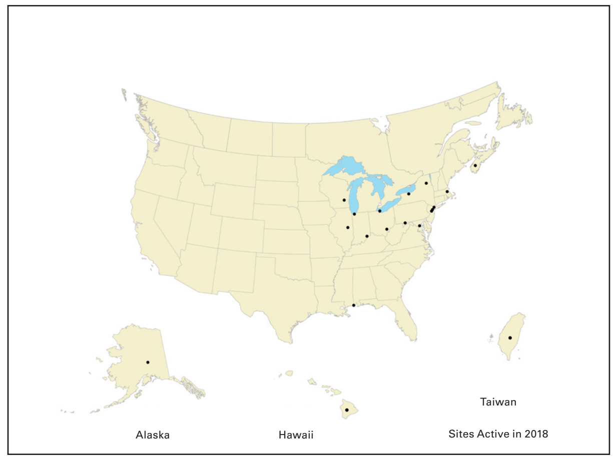


Total mercury concentration (top) and wet deposition (bottom), 2018.

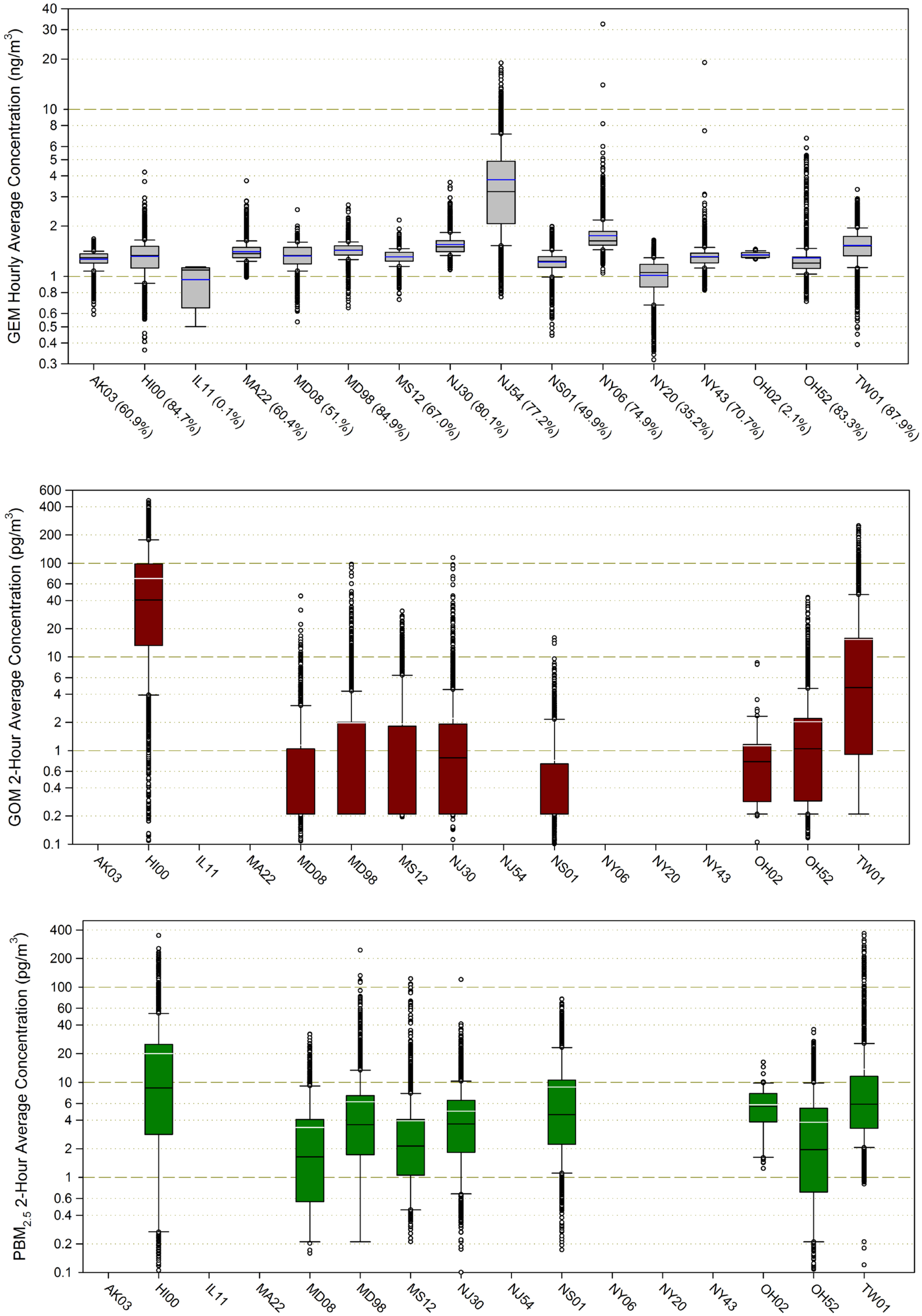
Atmospheric Mercury Network (AMNet)

AMNet sites measure ambient atmospheric mercury using automated, continuous measurement systems in order to understand the impact of atmospheric mercury on deposition. Quality-assured measurements are made using NADP standardized methods.

AMNet measurements are made continuously (five minute and two-hour averages). Data is qualified and averaged to one-hour (gaseous elemental mercury, GEM) and two-hour values (gaseous oxidized mercury, GOM, and particulate bound mercury, $PBM_{2.5}$). As of December 2018, there were 18 AMNet sites. Data from the AMNet are available on the NADP website (http://nadp.slh.wisc.edu/amnet/).



The figures on page 25 show the distribution of atmospheric mercury concentrations for each site, meeting completeness criteria in 2018. The top figure shows the distribution of GEM (shaded grey area), for all sites reporting data. The total annual data completeness (as a percentage) for each site is reported after the site ID in parenthesis. Sites with over 75% data completeness meet criteria for estimating annual averages. GEM is reported in nanograms per cubic meter (ng/m^3). The middle figure shows the distribution of two-hour atmospheric concentrations of GOM (red shaded area) and the bottom figure shows $PBM_{2.5}$ (green shaded area) in picograms per cubic meter (pg/m^3); concentrations are plotted logarithmically, and with different scale ranges, to highlight the range of measured values for each site. GOM and $PBM_{2.5}$ values reported as zero were assigned a value of one-half the instrument detection limit (set to 0.21 pg/m^3) for the production of the logarithmic plots.



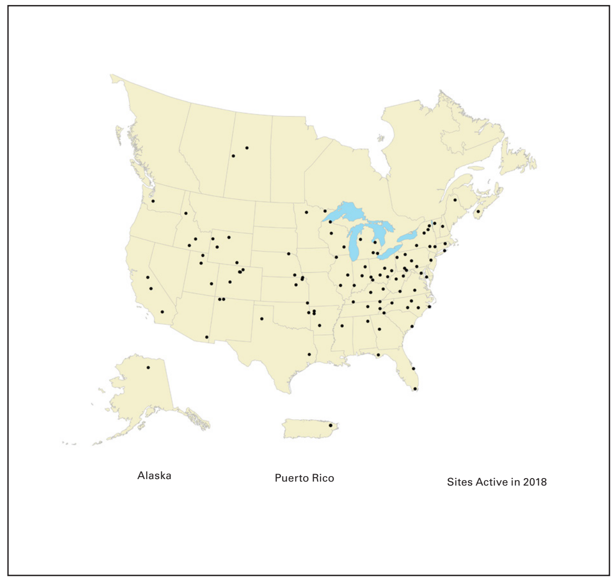
Hourly GEM concentration in ng/m³ for each AMNet site (top) and 2-hour GOM and $PBM_{2.5}$ concentrations in pg/m³ for each AMNet site (middle and bottom) in 2018. For each data set, the mean value is indicated as a blue (GEM) or white line (GOM and $PBM_{2.5}$) and the median is indicated as a black bar. Sites with no GOM and $PBM_{2.5}$ data shown did not monitor for speciated mercury. The percent data completeness for the site is reported in parenthesis next to the site ID in the GEM plot. GOM and $PBM_{2.5}$ values reported as zero were assigned a value of one-half the instrument detection limit (set to 0.21 pg/m³) for the production of the logarithmic plots.

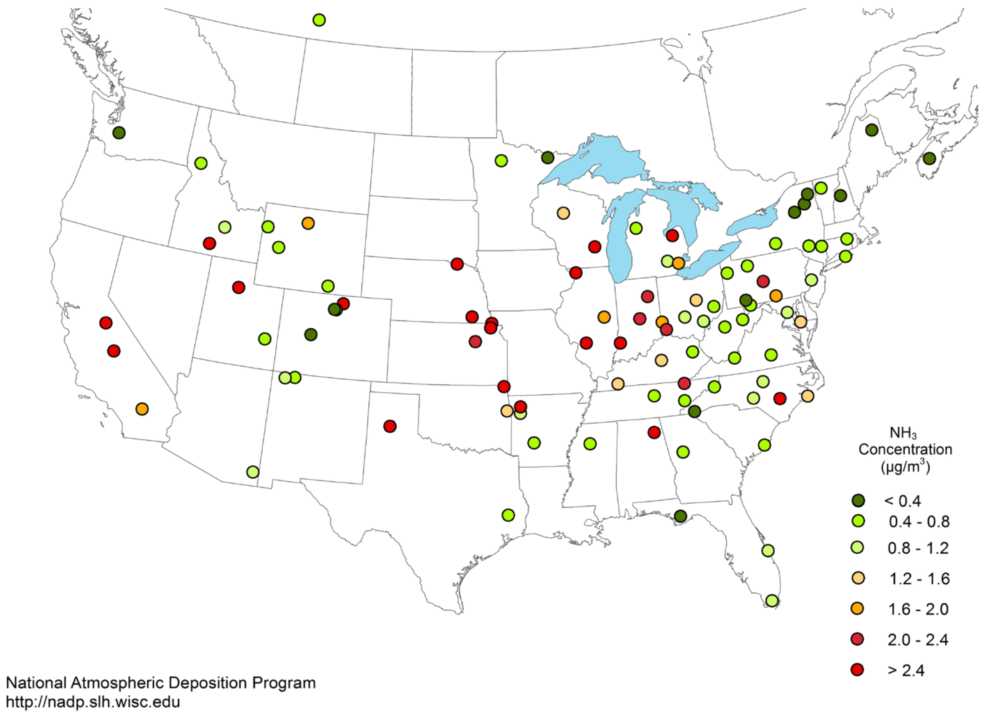
Ammonia Monitoring Network (AMoN)

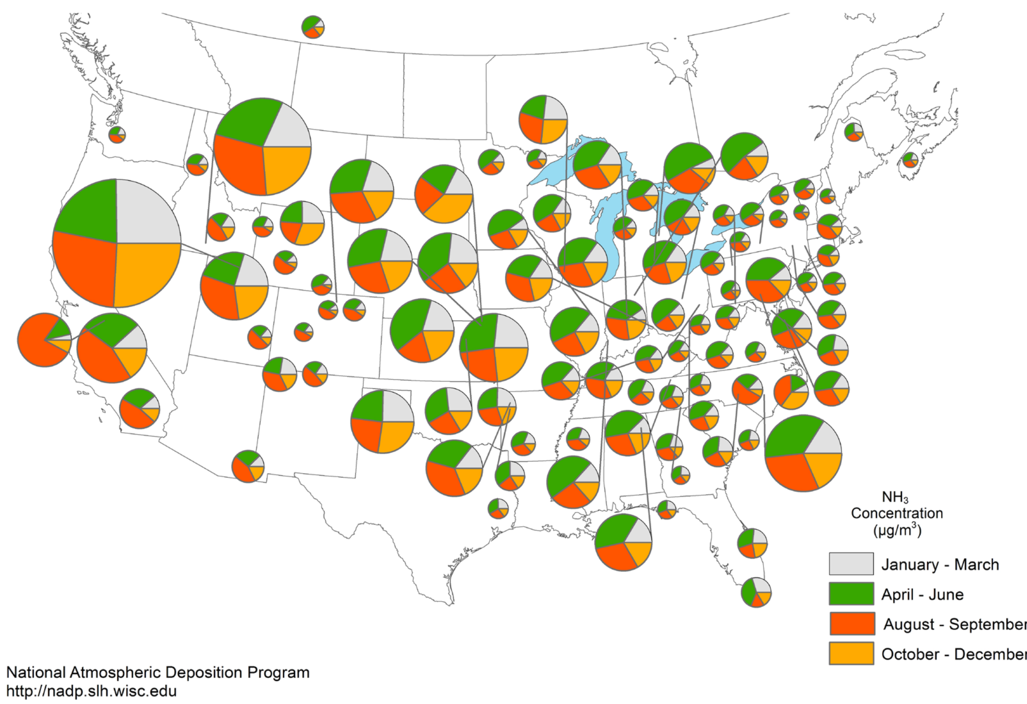
The AMoN measures atmospheric concentrations of ammonia (NH_3) gas. The network uses a passive diffusion-type sampler that provides cost-effective, accurate and time-integrated measurements. Sampling occurs over a two-week period and all sites collect additional quality assurance samples on a rotating basis. This data is used to assess long-term NH_3 trends and changes in atmospheric chemistry, and to provide information for model development and verification.

As of December 2018, there were 104 AMoN sites. Data from the AMoN are available on the NADP website (http://nadp.slh.wisc.edu/amon/).

The figures on page 27 show the distribution and seasonality of gaseous ammonia concentrations for each site meeting completeness criteria. In 2018, 100 of 104 active sites met these criteria. In the top figure, circles represent annual average concentrations in micrograms per cubic meter (μg/m³) at each site. In the bottom figure, the relative concentration for each site is shown for each calendar quarter. The size of the wedge is the relative percentage for the quarter. The area of the pie chart is proportional to the annual average for the site.







Average ammonia concentrations as measured by AMoN (top), and quarterly relative percentage (Q1 = January, February, March, etc.) for each AMoN site (bottom), 2018. Size of the symbol in the bottom plot is relative to the annual concentration.

National Atmospheric Deposition Program

The NADP is the National Research Support Project-3: A Long-Term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition. More than 250 sponsors support the NADP, including private companies and other non-governmental organizations, universities, local and state government agencies, State Agricultural Experiment Stations, national laboratories, Native American organizations, Canadian government agencies, the U.S. Geological Survey, the U.S. Environmental Protection Agency, the National Park Service, National Oceanic and Atmospheric Administration, the U.S. Fish & Wildlife Service, the Bureau of Land Management, the U.S. Department of Agriculture - Forest Service, and the U.S. Department of Agriculture - National Institute of Food and Agriculture under agreement no. 2018-39133-28690. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the program sponsors or the University of Wisconsin-Madison.

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All NADP data and information, including color contour maps in this publication, are available free of charge from the NADP website: http://nadp.slh.wisc.edu. Alternatively, contact: NADP Program Office, Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53706, Tel: (608) 263-9162, E-mail: nadp@slh.wisc.edu.

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