

Total Sulfur Deposition (kg/ha)

Wet

Dry

Size scaled to deposition



NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
A Cooperative Research Support Program of the
State Agricultural Experiment Stations (NRSP-3)
Federal and State Agencies
and Private Research Organizations

What Is NADP?

In 2001, scientists, students, educators, and others interested in the National Atmospheric Deposition Program (NADP) logged nearly 110,000 sessions on the NADP Internet site (see the back cover for the address). Users accessed on-line concentration and deposition maps more than 88,000 times and retrieved nearly 19,000 data files. Records show that about 60 percent of users study atmospheric deposition or its effects on aquatic and terrestrial ecosystems and cultural resources and 40 percent use NADP data for educational purposes.

The NADP is in its third decade of recording high-quality precipitation chemistry data. This cooperative effort is supported by federal, state, local and tribal government agencies, State Agricultural Experiment Stations, universities, and nongovernmental organizations. The length and quality of the data record are due to the continued commitment of NADP sponsors and participating scientists.

Why does NADP keep such diligent vigil over precipitation? The answer lies in the need to monitor how human activities and the forces of nature affect air and precipitation quality, i.e., the health of the atmosphere. This information will equip citizens and policy-makers to make more responsible decisions on how to preserve and improve air quality and manage agricultural, forest, aquatic, cultural, and energy resources.

NADP Past and Present

In 1977, U.S. State Agricultural Experiment Stations (SAES) organized a project, later titled NADP, to measure atmospheric deposition and study its effects on the environment. Sites in the NADP precipitation chemistry network first began collecting samples in 1978. The goal was to provide data on the amounts, temporal trends, and geographic distributions of acids, nutrients, and base cations in precipitation. Initially organized as a regional project, the network grew and expanded its coverage to the entire country and today is SAES National Research Support Project - 3. The

National Acid Precipitation Assessment Program, established in 1981 to improve understanding of the causes and effects of acidic precipitation, provided support for much of the network growth. Today the network has more than 230 sites and is called the National Trends Network (NTN).

In the 1990s, NADP expanded to include two additional networks. The Atmospheric Integrated Research Monitoring Network (AIRMoN) joined NADP in October 1992. In 2001, there were ten AIRMoN sites collecting samples within 24 hours of the start of precipitation. While AIRMoN measures the same chemicals as NTN, sampling is daily rather than weekly. These higher resolution samples enhance researchers' ability to evaluate how emissions affect precipitation chemistry using computer models that simulate atmospheric transport and removal of pollutants on a storm-by-storm basis. This network also evaluates new sample collection and preservation methods.

The Mercury Deposition Network (MDN), joined NADP in 1996. All samples from the 63 MDN sites, including ten in Canada, are analyzed for total mercury, and some for the more toxic methyl mercury. Forty-three states have advisories warning people to limit consumption of fish and wildlife from certain water bodies because of mercury contamination. Researchers can use MDN data to evaluate the role of mercury deposition as a source of mercury in these water bodies.

[About the cover: Scaled pie charts depict the 2001 total sulfur deposition in kilograms per hectare (kg/ha) at 51 Clean Air Status and Trends Network sites (CASTNet). Wet deposition data (blue) are from NTN sulfate measurements. Dry deposition data (red) are from CASTNet sulfur dioxide and sulfate measurements. Total sulfur deposition is indicated in or next to each chart. Dry deposition was calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. Only sites meeting completeness criteria for both networks appear on the map. For information on NTN, see <http://nadp.sws.uiuc.edu>. For CASTNet information, see <http://www.epa.gov/castnet/>.]

This Report

NTN Data

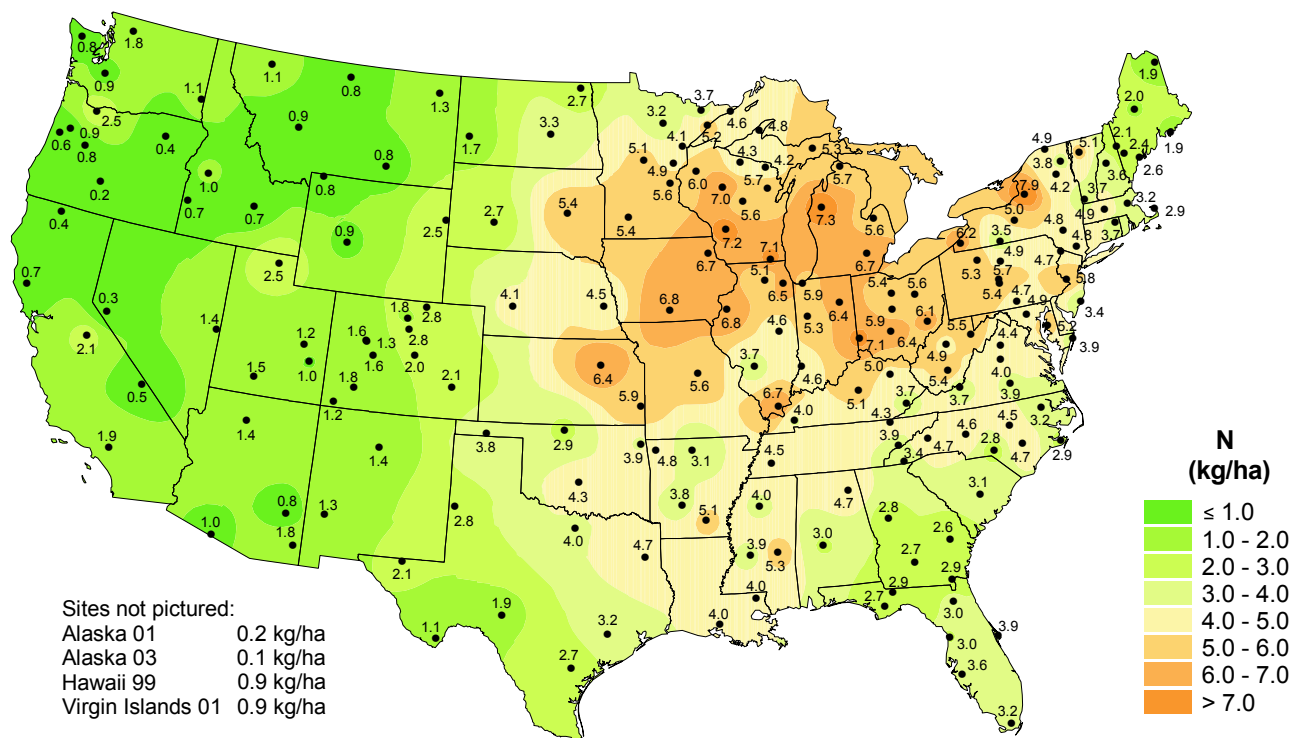
The NTN maps portray spatial variability in the concentration and wet deposition of selected acids, nutrients, and base cations on regional and national scales. Only sites meeting prescribed data completeness criteria are included. In 2001, 193 sites met these criteria. Black dots mark site locations. Annual concentration or deposition values appear next to each site. The concentrations are precipitation-weighted averages. (For an explanation of the data completeness criteria or how the precipitation-weighted averages or deposition fluxes were calculated, see the NADP Internet site.)

Color contours on the NTN maps were created by using site values to compute an array of regularly spaced grid-point values across the nation. Sites within 500 kilometers of each grid point were used in computations. Color contours were drawn on this array of grid-point values. Contours represent the classes of concentrations or

depositions indicated in the legend. (For a more complete description of the algorithm used to compute grid-point values, see the NADP Internet site.)

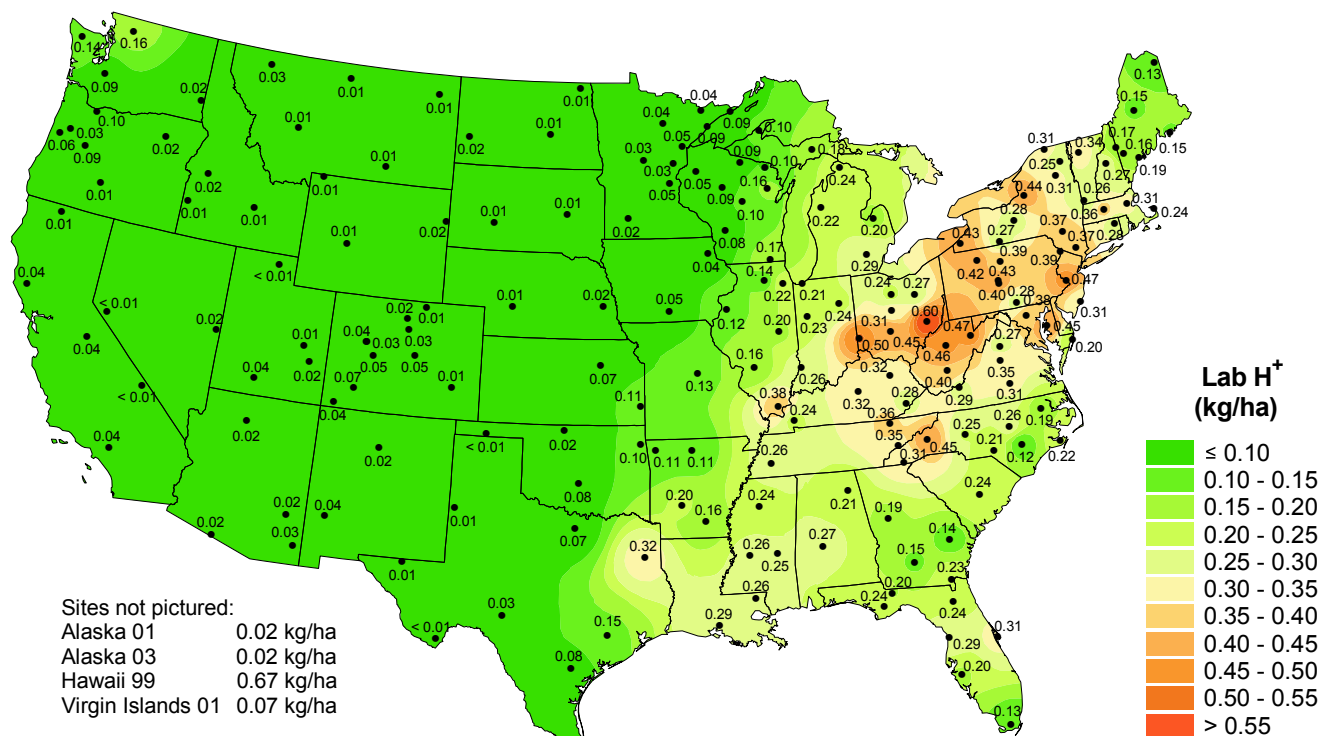
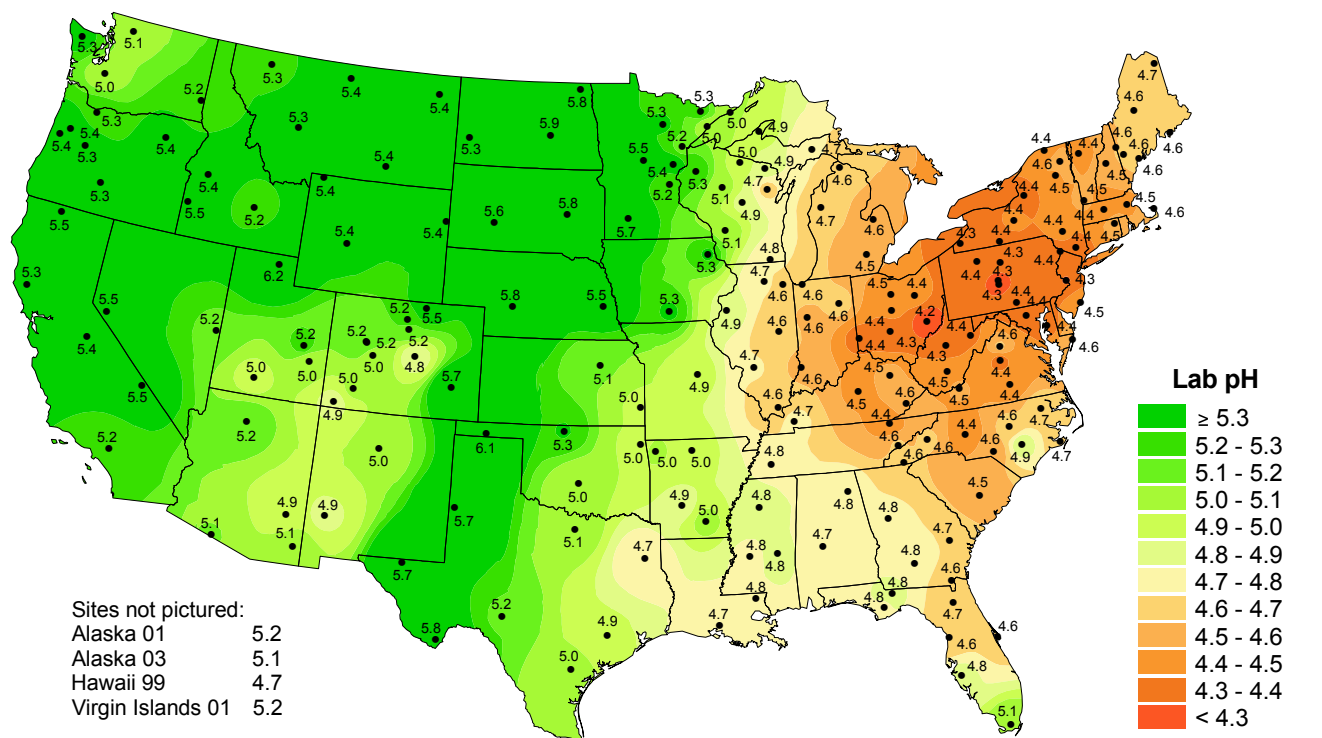
In addition to the map of inorganic nitrogen wet deposition, below, concentration and deposition maps show laboratory pH (H^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), and chloride (Cl^-). Also shown is a map of total precipitation. Maps of potassium (K^+), field pH, and field H^+ deposition are not included but are available from the NADP Internet site.

Explanation of NTN Color Contours: Refer to the figure below, which has eight inorganic nitrogen deposition classes or contours. The light green contour in the middle represents 3.0 - 4.0 kilograms per hectare (kg/ha). Nitrogen deposition values in the area covered by this contour are greater than 3.0 kg/ha and less than or equal to 4.0 kg/ha.



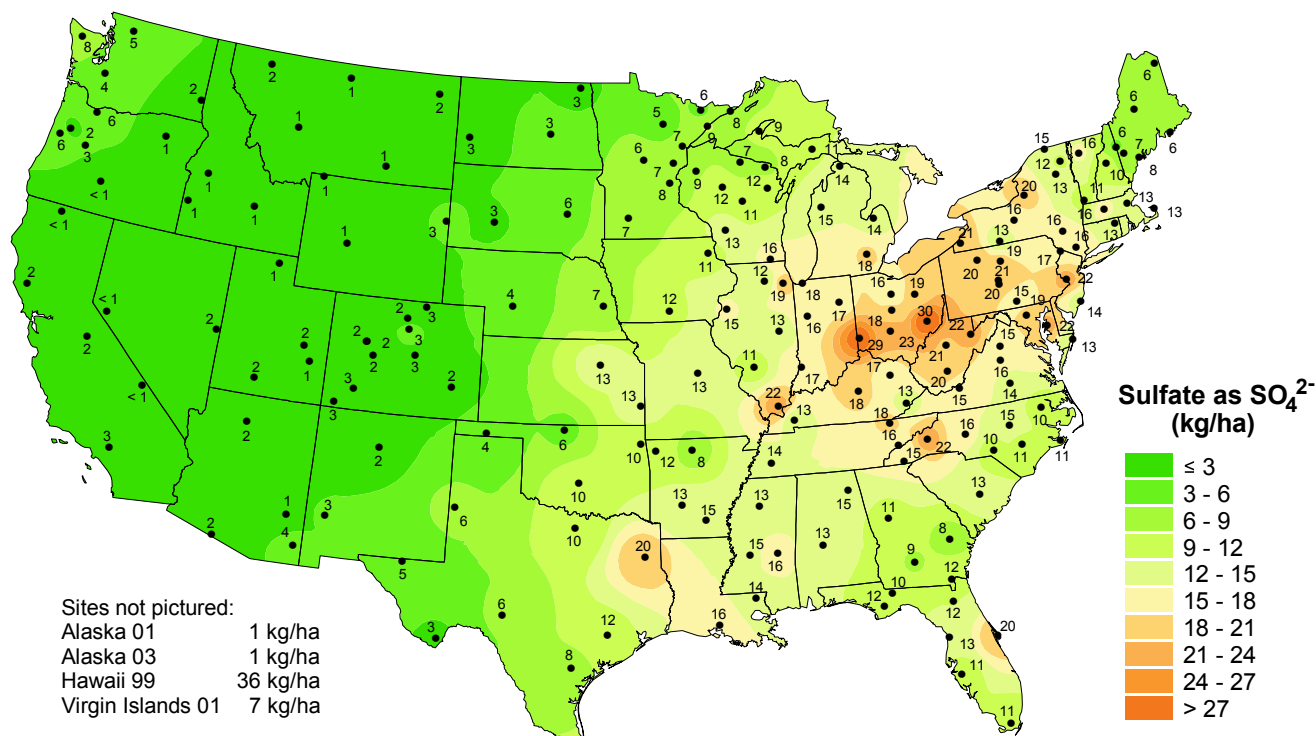
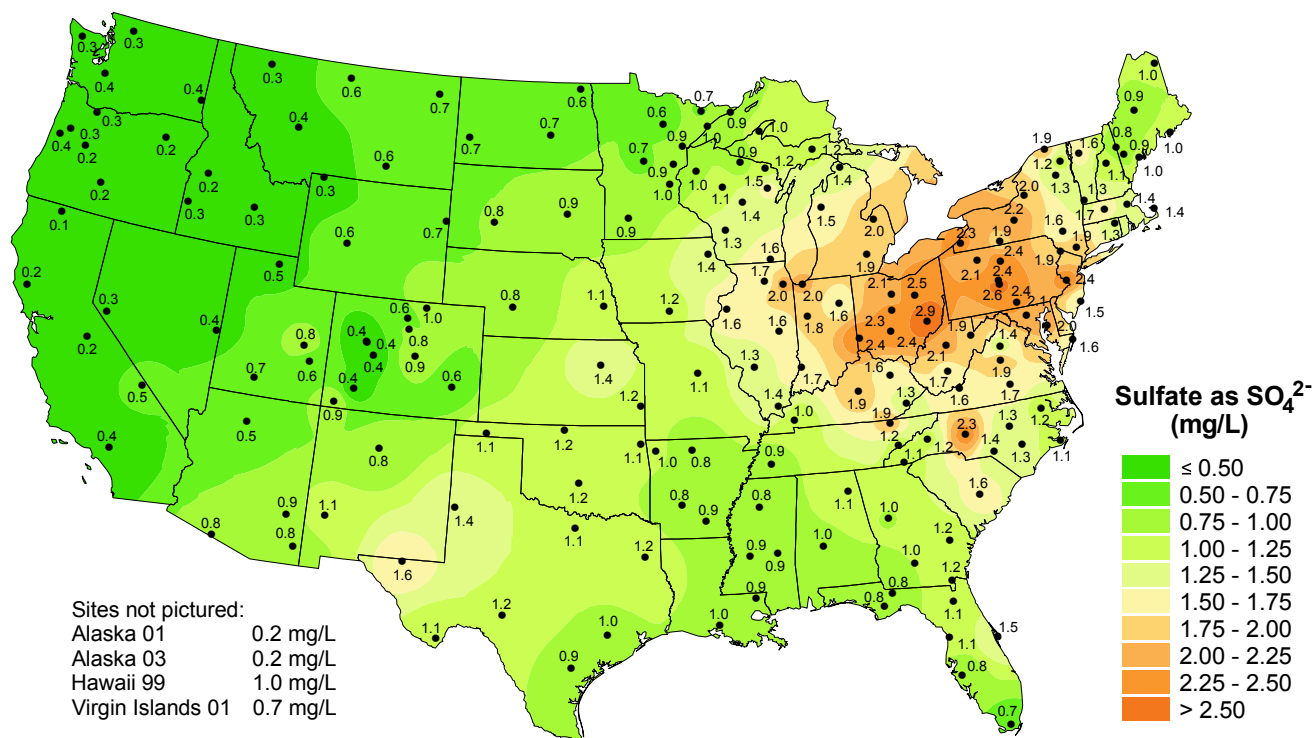
National Atmospheric Deposition Program/National Trends Network

Inorganic nitrogen wet deposition from nitrate and ammonium, 2001.



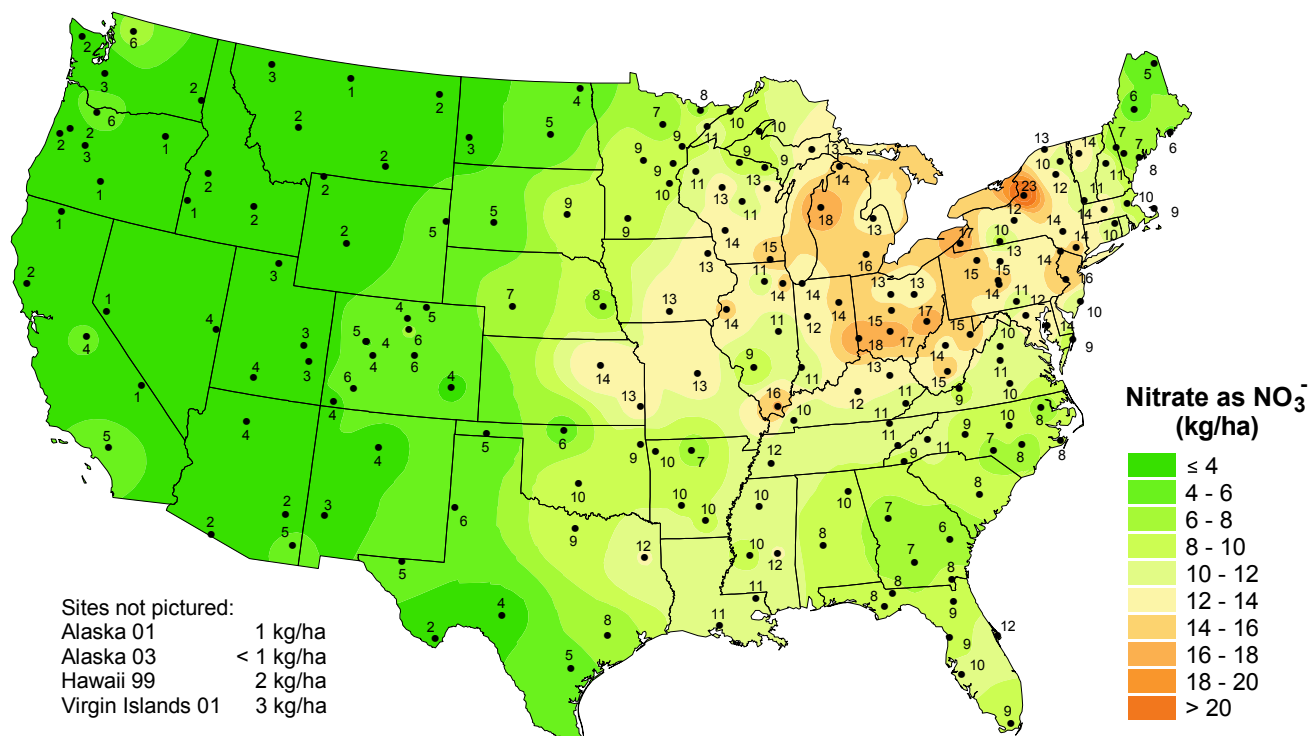
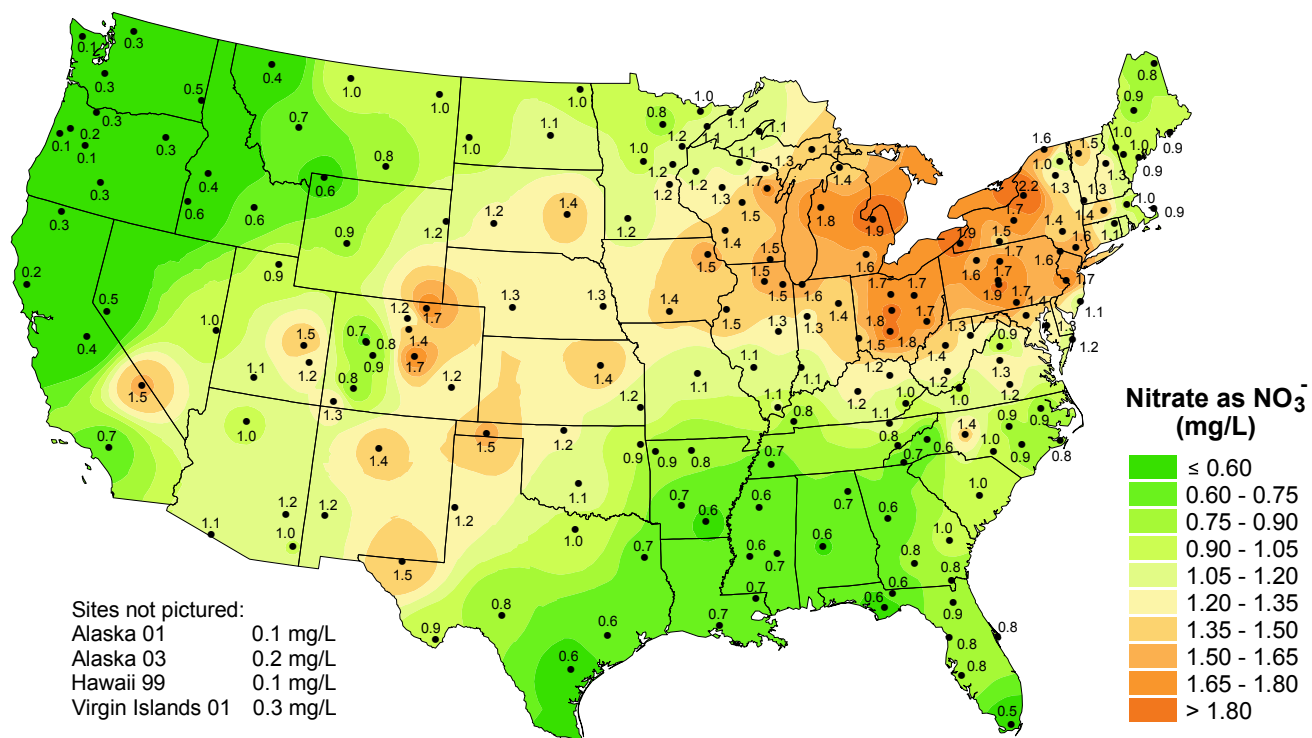
National Atmospheric Deposition Program/National Trends Network

Hydrogen ion concentration as pH (top) and wet deposition (bottom) from measurements made at the Central Analytical Laboratory, 2001.



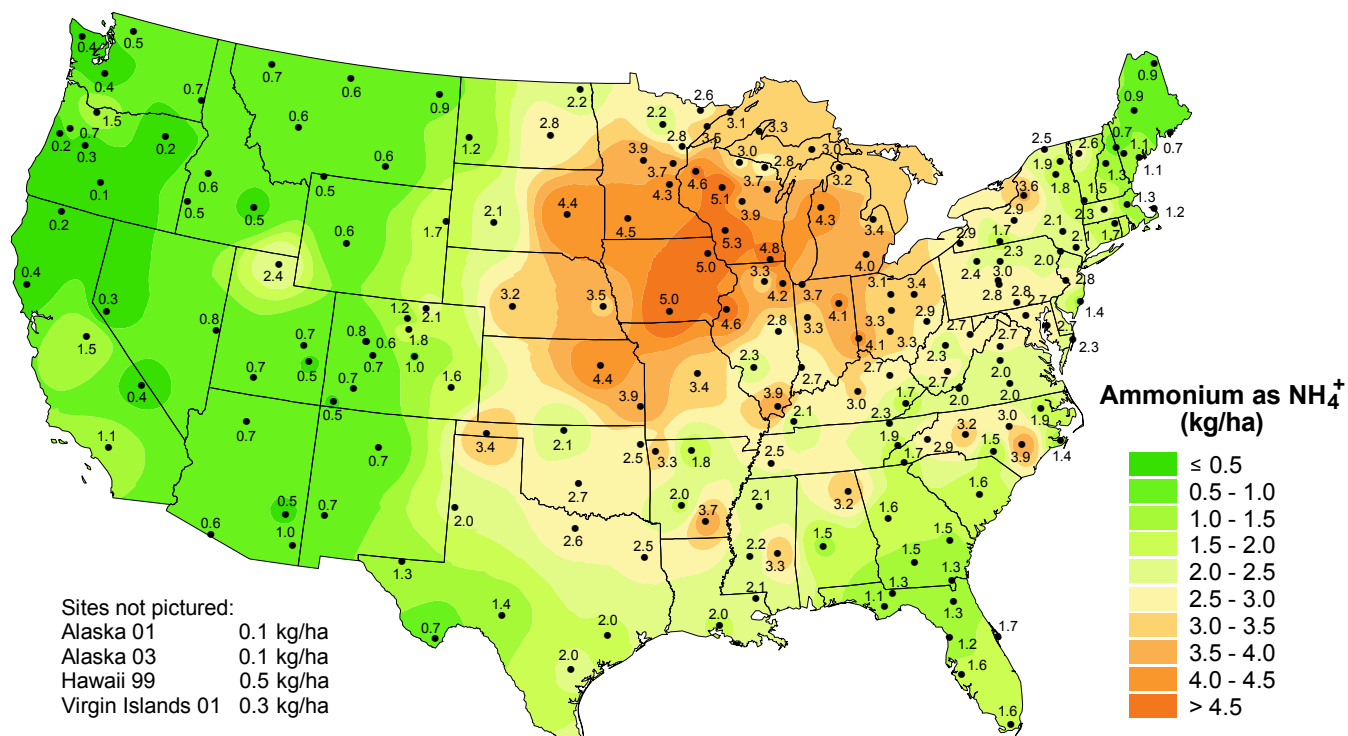
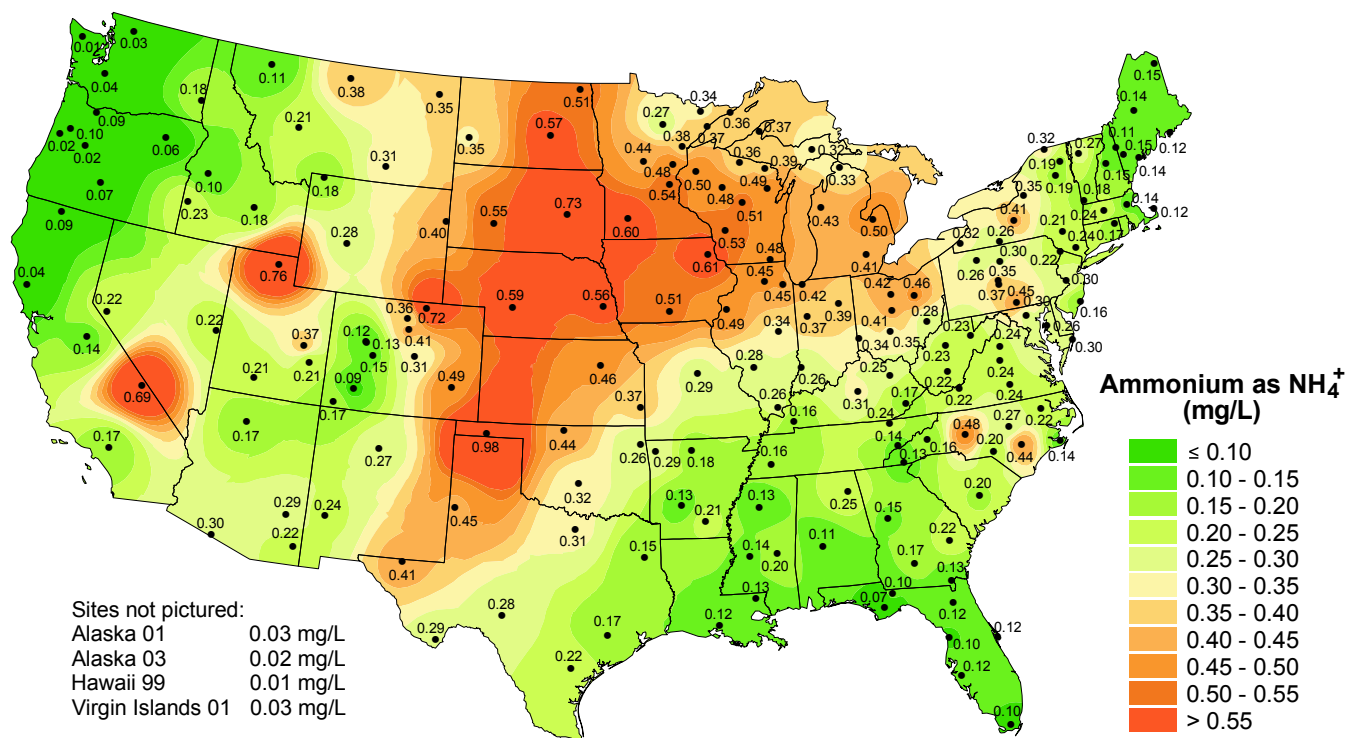
National Atmospheric Deposition Program/National Trends Network

Sulfate ion concentration (top) and wet deposition (bottom), 2001.



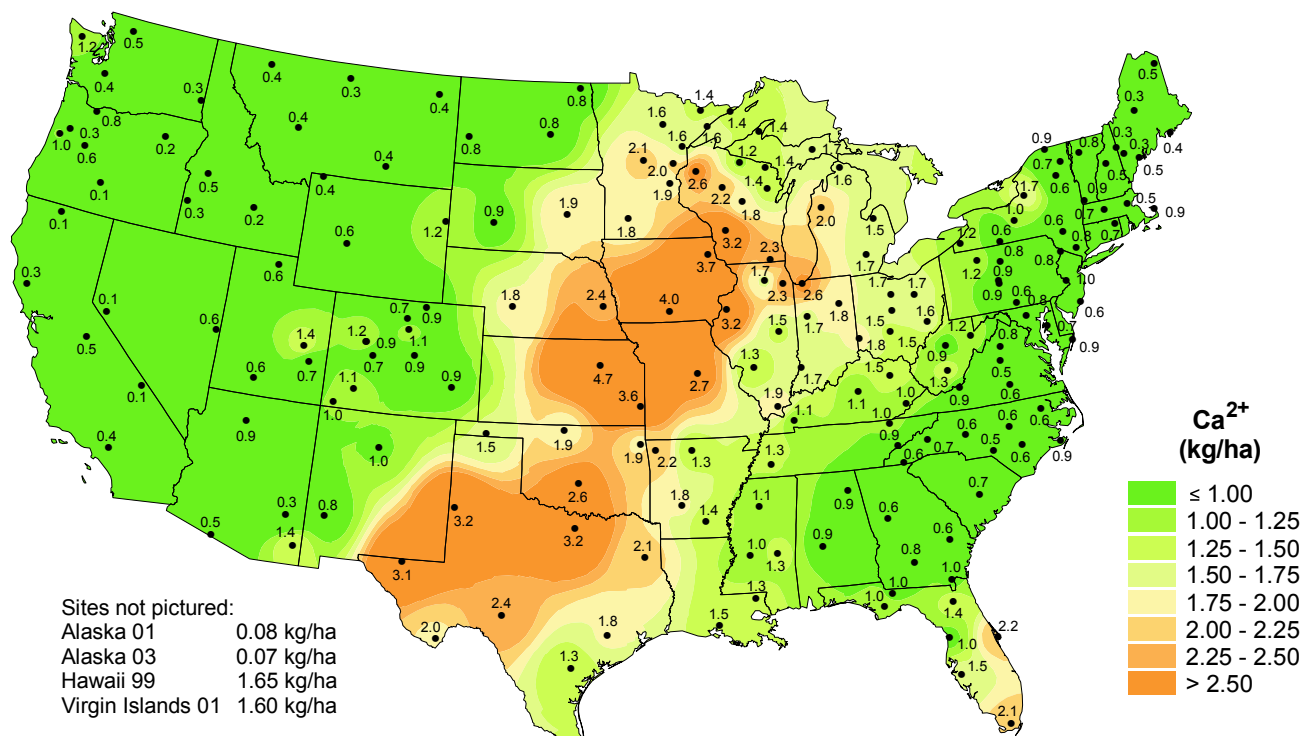
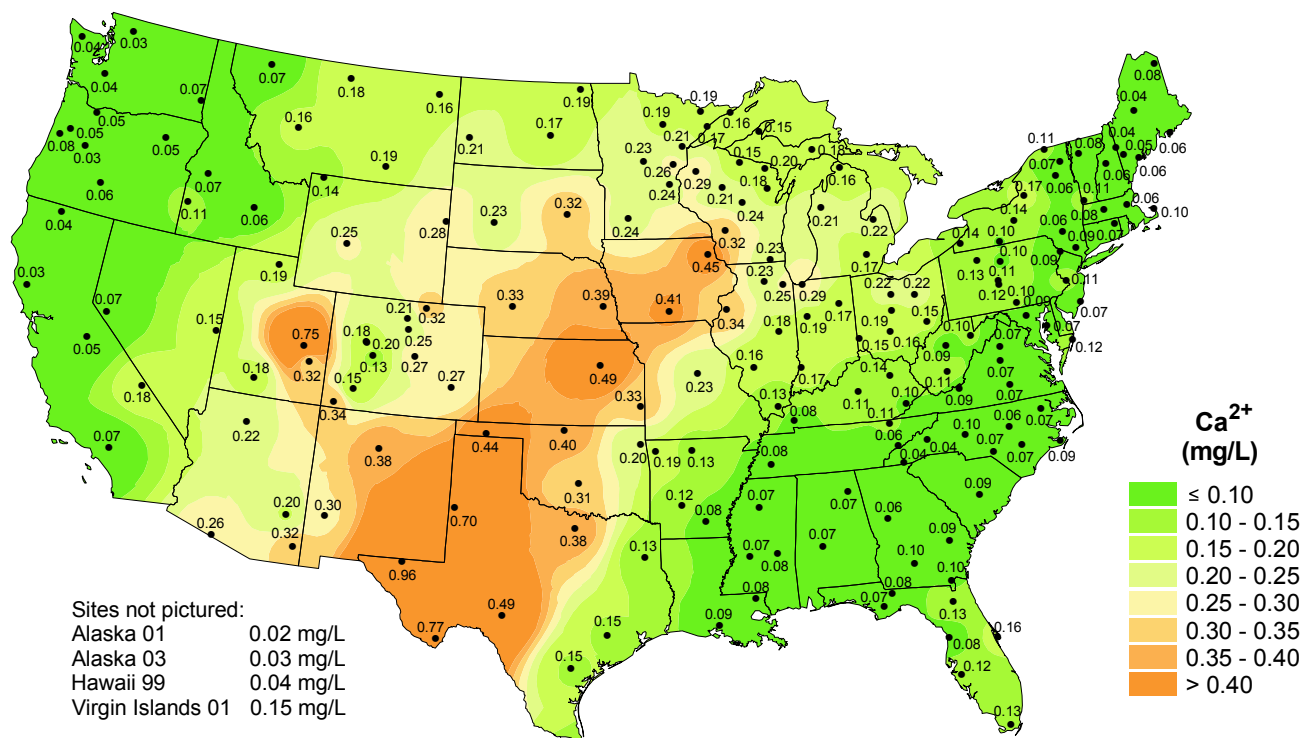
National Atmospheric Deposition Program/National Trends Network

Nitrate ion concentration (top) and wet deposition (bottom), 2001.



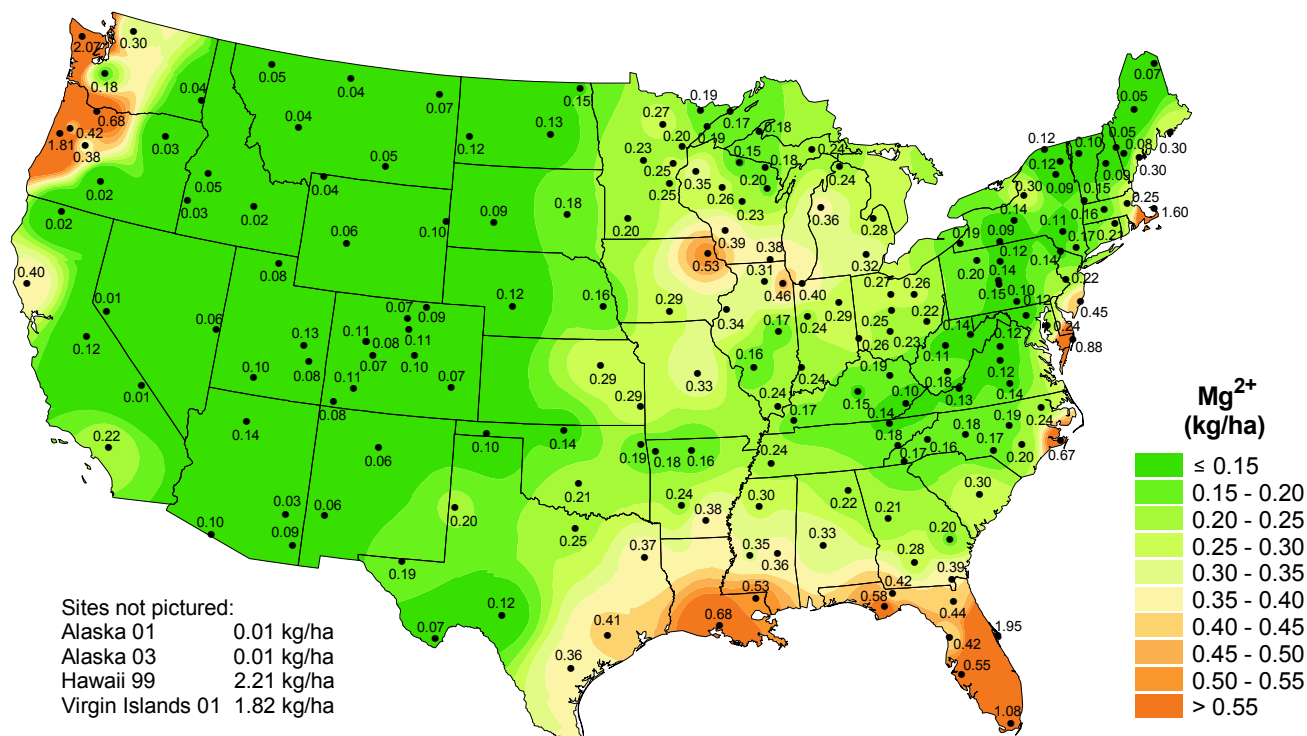
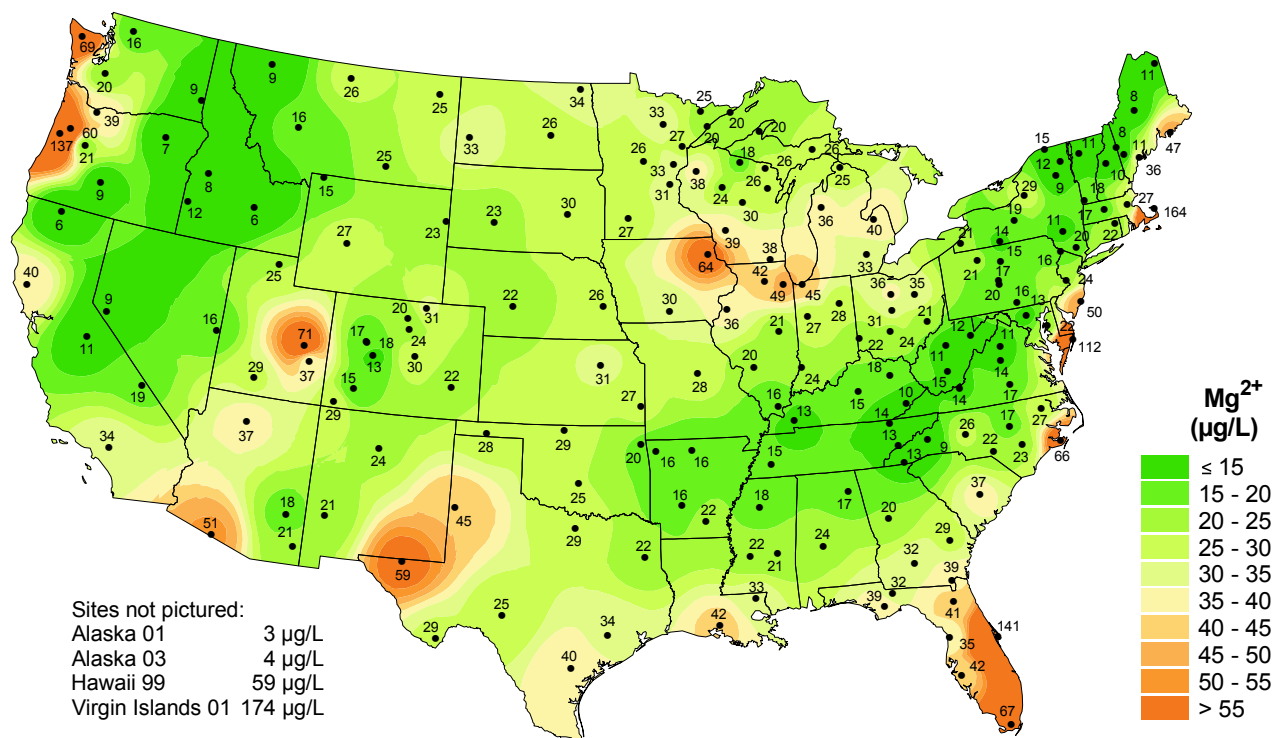
National Atmospheric Deposition Program/National Trends Network

Ammonium ion concentration (top) and wet deposition (bottom), 2001.



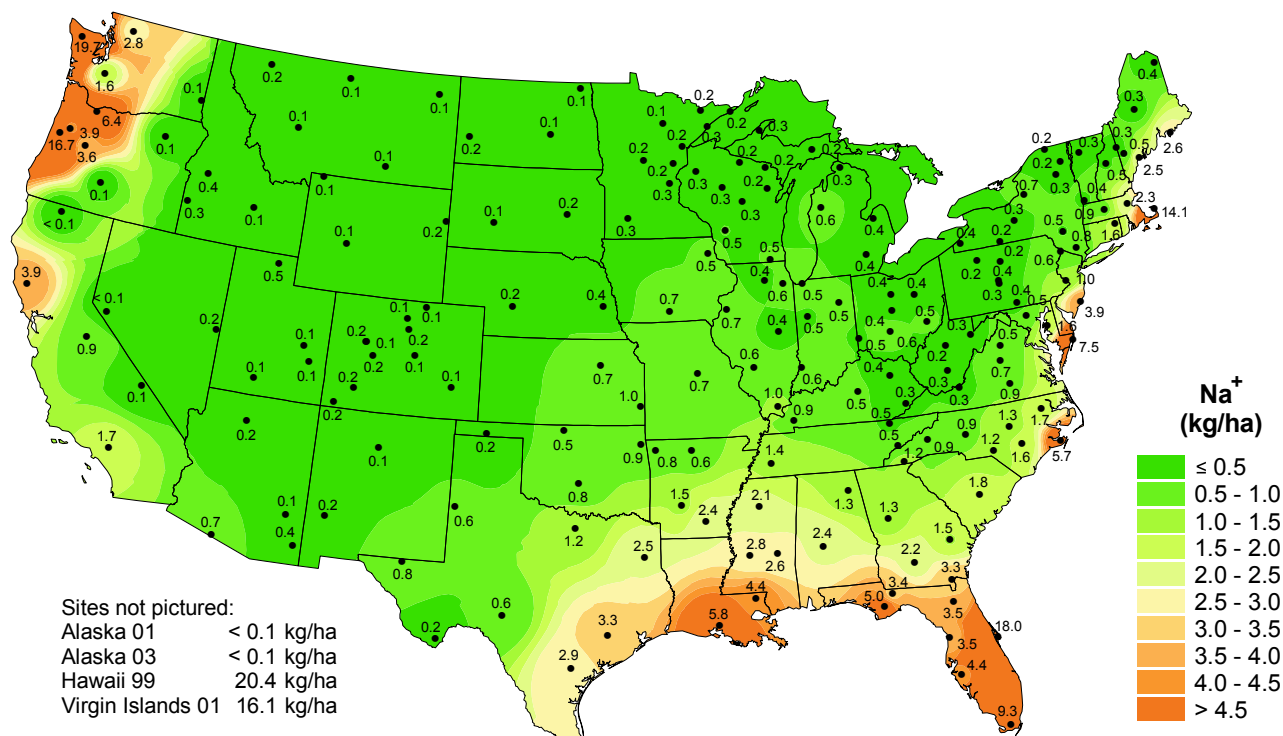
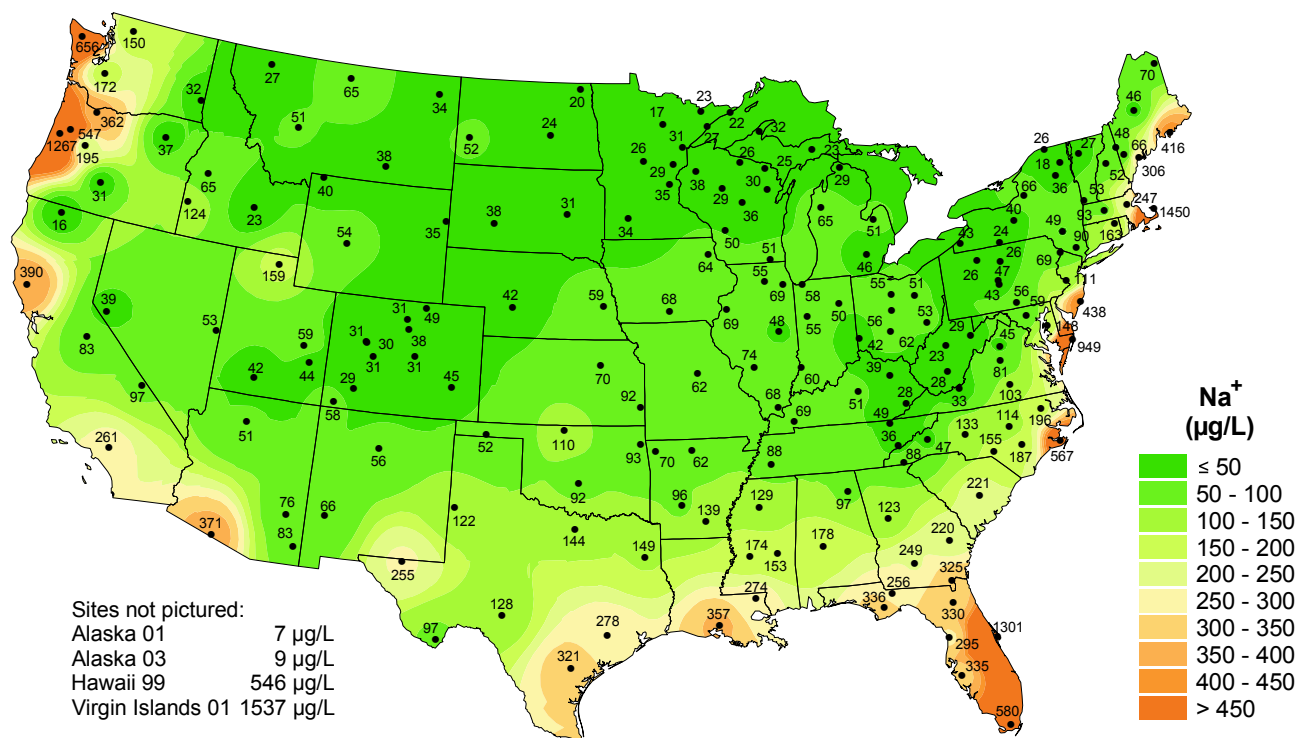
National Atmospheric Deposition Program/National Trends Network

Calcium ion concentration (top) and wet deposition (bottom), 2001.



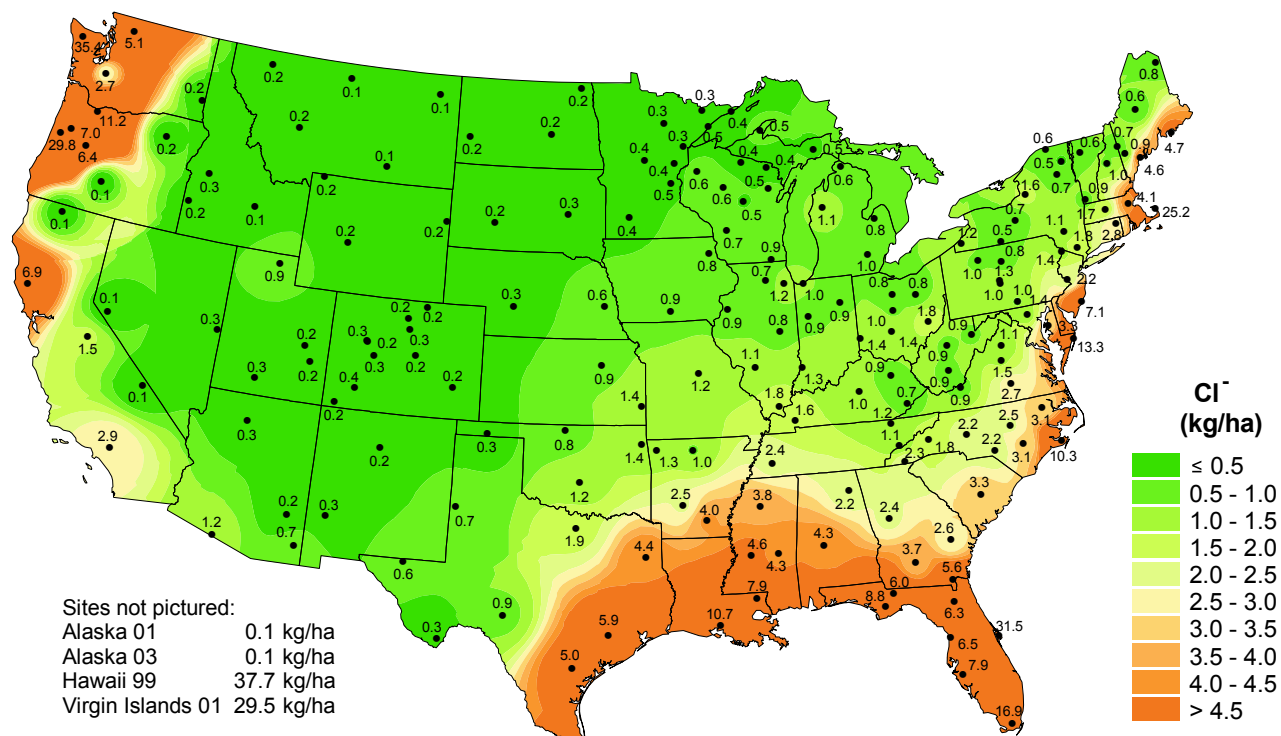
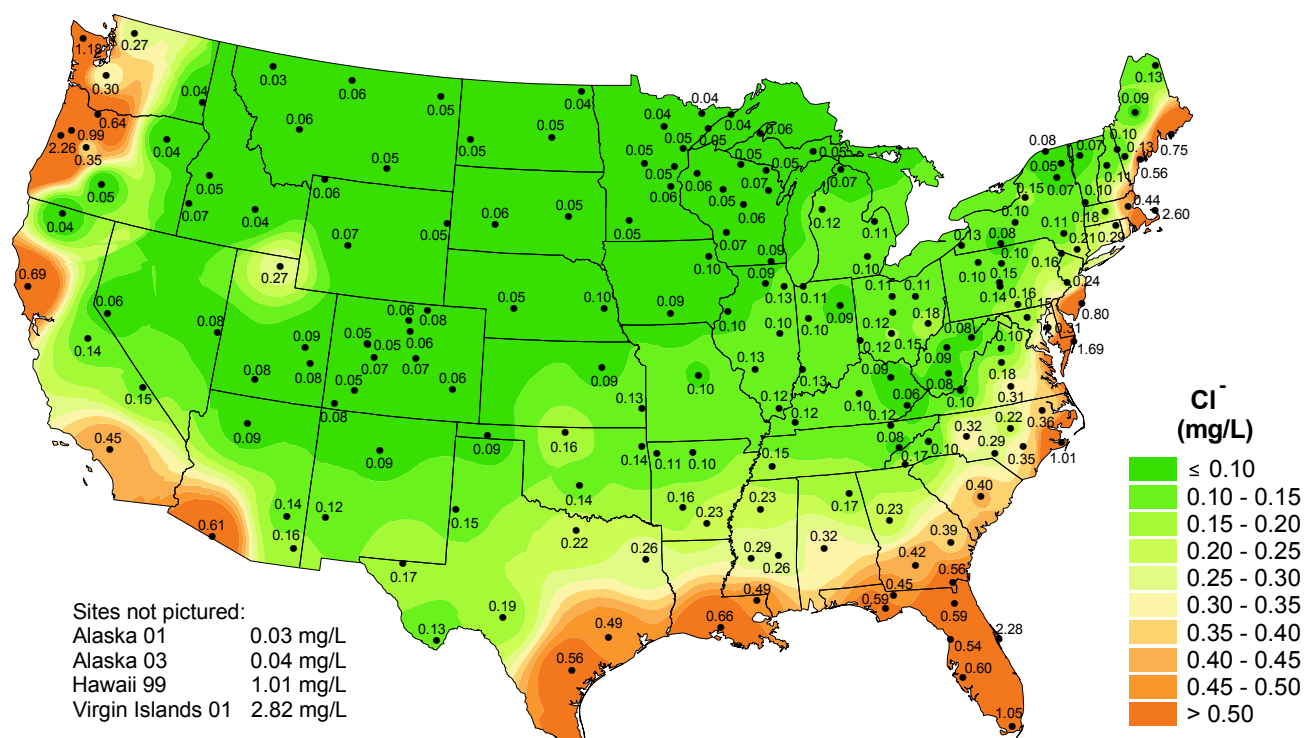
National Atmospheric Deposition Program/National Trends Network

Magnesium ion concentration (top) and wet deposition (bottom), 2001.



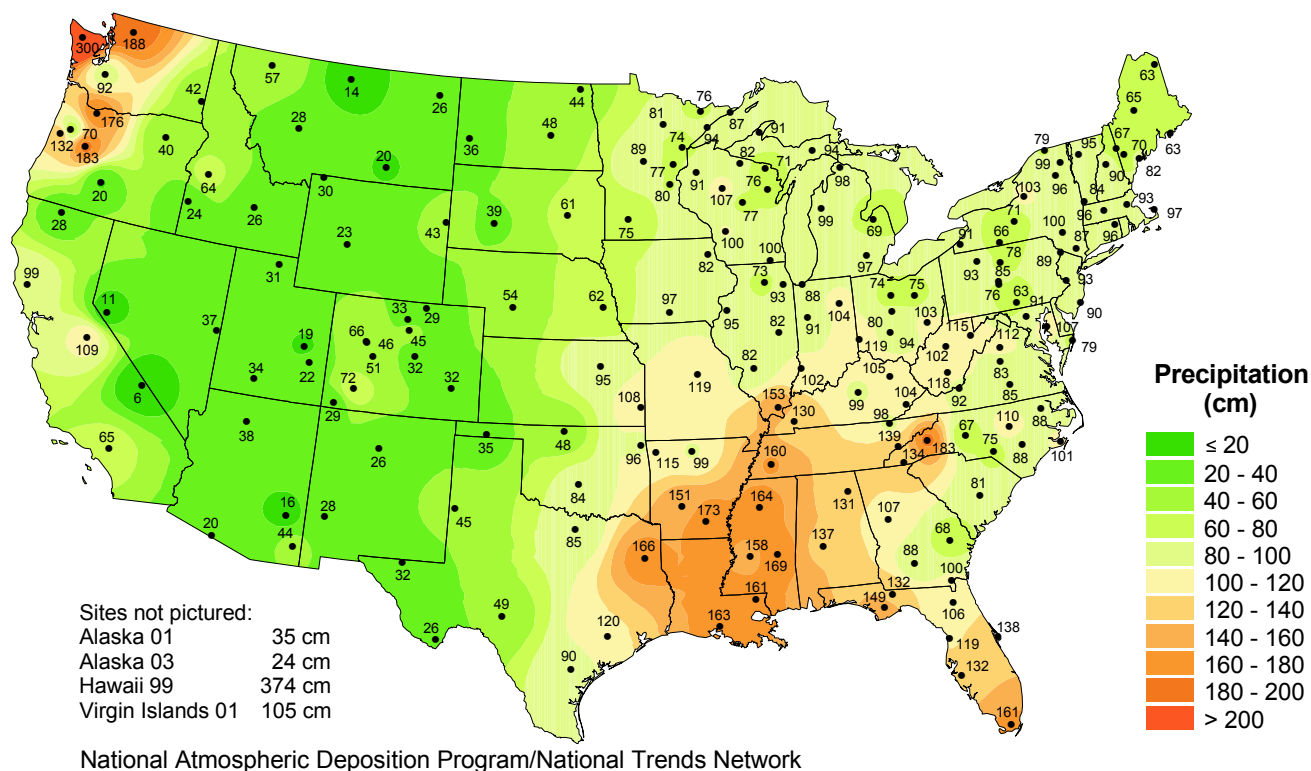
National Atmospheric Deposition Program/National Trends Network

Sodium ion concentration (top) and wet deposition (bottom), 2001.



National Atmospheric Deposition Program/National Trends Network

Chloride ion concentration (top) and wet deposition (bottom), 2001.

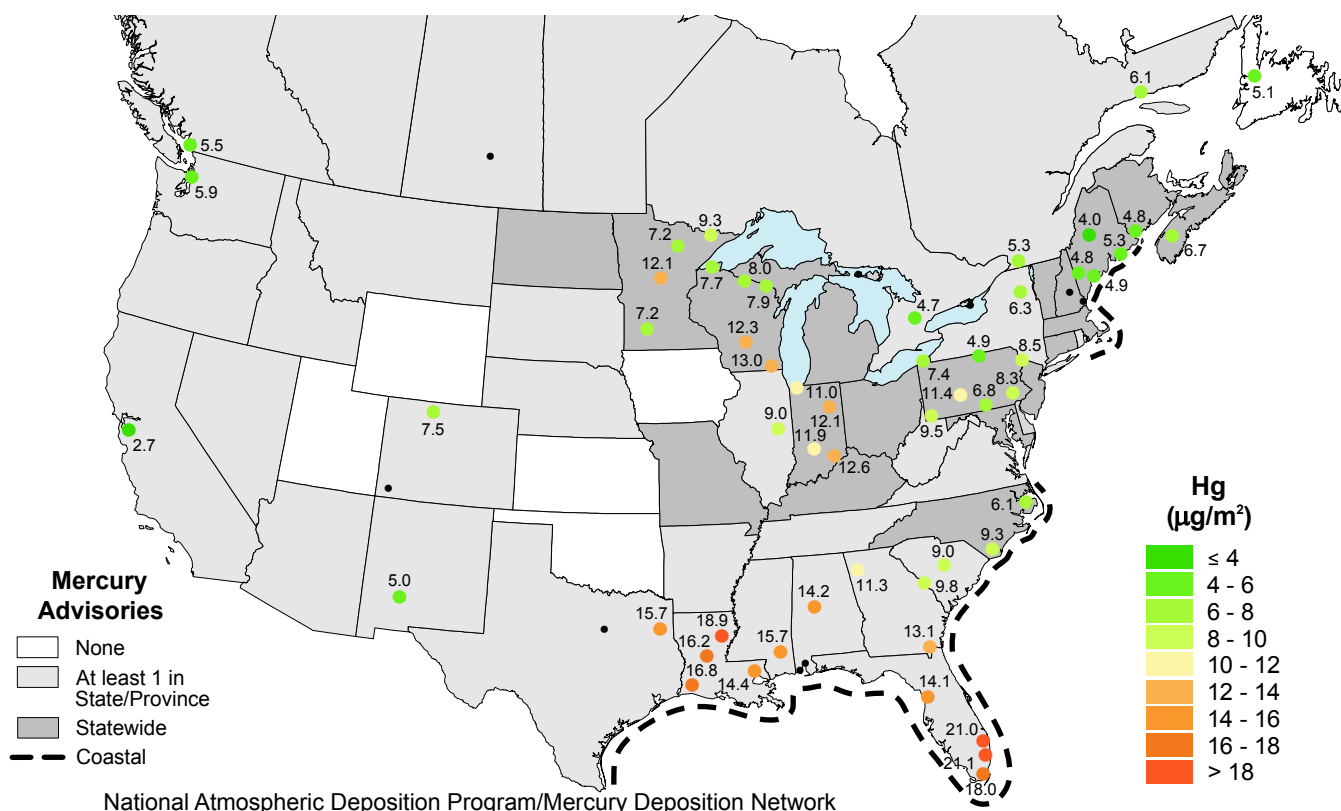
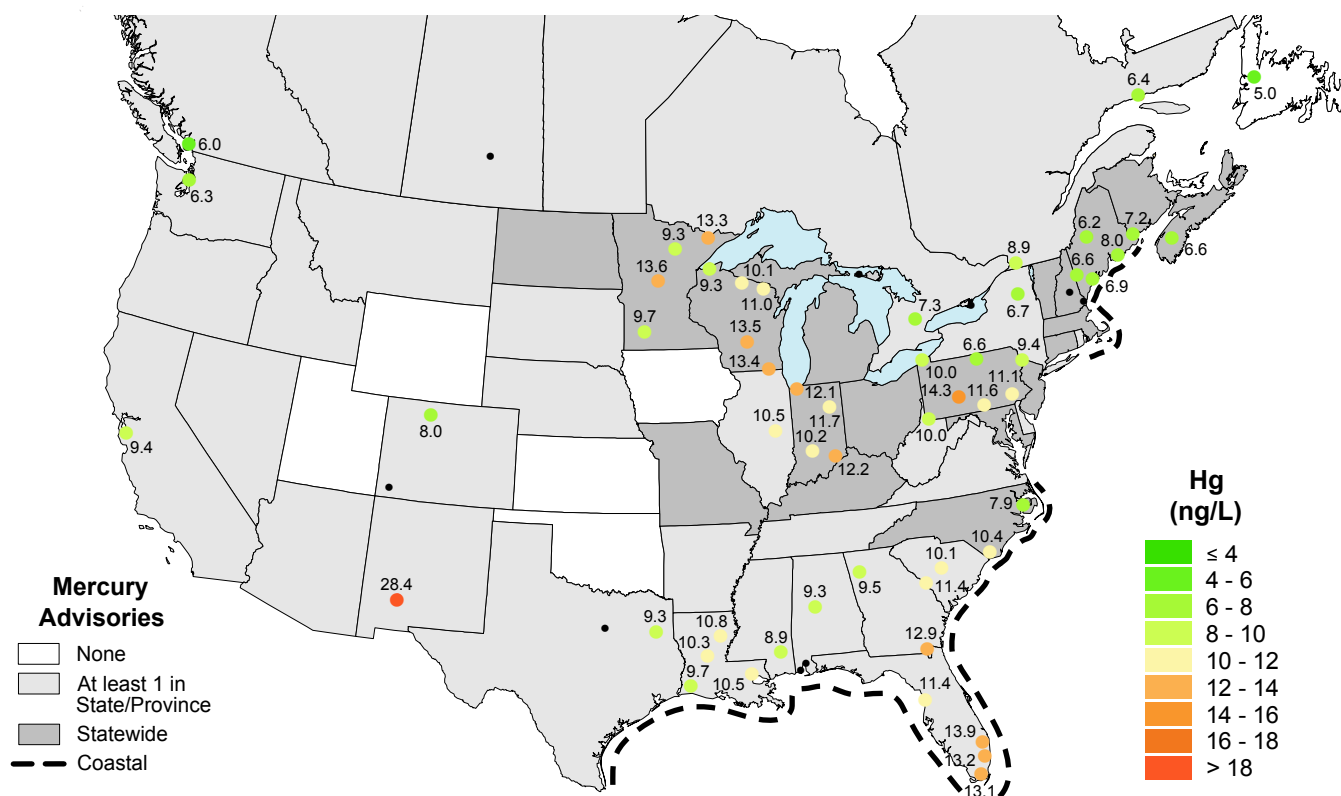


Total precipitation, 2001.

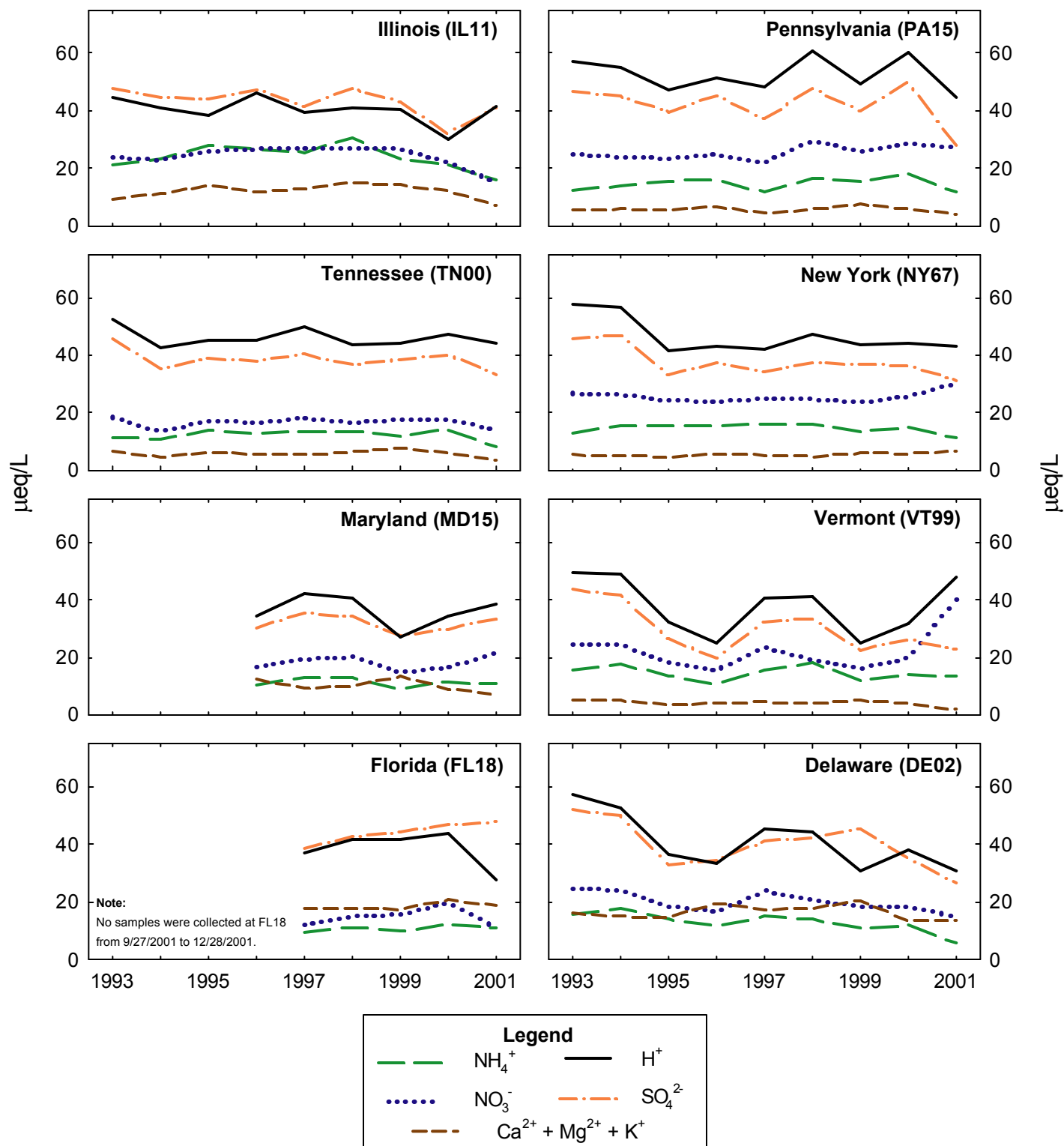
MDN Data

The MDN maps on page 13 show the average precipitation-weighted concentrations (nanograms/liter) and annual wet depositions (micrograms/square meter) of total mercury in precipitation. Colored dots mark MDN sites meeting prescribed data completeness criteria. In 2001, 54 sites met these criteria. The colors represent the concentration or deposition classes indicated in the legend. Concentration and deposition values are printed next to the colored dots. Black dots mark MDN sites that were active in 2001 but did not meet all completeness criteria. (For an explanation of the data completeness criteria and how precipitation-weighted averages or depositions were calculated, see the NADP Internet site.)

Mercury concentrations and wet depositions are plotted on maps of southern Canada and the contiguous United States showing areas with current fish or wildlife consumption advisories. These advisories warn that high concentrations of mercury have been found or are suspected in fish or wildlife from certain water bodies in these areas, and that consumption of these fish or wildlife may pose health risks. Mercury in fish and wildlife can come from many natural processes, including precipitation. The connection between mercury deposition and mercury in fish or wildlife is under study. For more information about mercury advisories, see the U.S. Environmental Protection Agency Internet site at www.epa.gov/ost/fish.



Total mercury concentration (top) and wet deposition (bottom), 2001.
Mercury advisories are for fish and wildlife consumption, not deposition.



National Atmospheric Deposition Program
 Atmospheric Integrated Research Monitoring Network
 annual precipitation-weighted-average ion concentrations, 1993-2001.

AIRMoN Data

Line graphs on page 14 show AIRMoN concentrations over time. The time series graphs depict nine years (1993-2001) of data for six sites. Graphs for the Maryland (MD15) and Florida (FL18) sites begin in 1996 and 1997, respectively, when these sites completed their first full year of operation.

The graphs show annual precipitation-weighted-average concentrations of hydrogen ion (H^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), and base cations. Base cations are defined here as the sum of calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^+). All concentrations are plotted in units of microequivalents/liter, which facilitates comparisons of how these chemicals relate to one another over the nine-year period.

NTN Operations

The NTN is the only network providing a long-term record of precipitation chemistry across the United States. Sites are predominantly located away from urban areas and point sources of pollution. Each site is equipped with a precipitation chemistry collector and gage. The collector is automated to ensure that the sample is exposed only during precipitation, i.e., wet-only sampling.

Samples are collected weekly on Tuesday morning. The site operator transfers the sample from the collection bucket to a shipping bottle and sends it to the Central Analytical Laboratory (CAL) at the Illinois State Water Survey for analysis and data entry and validation. In addition, all sample containers are cleaned at the CAL, which has served as the sole analytical laboratory since the program began. The CAL measures sample volume, conductivity, and the following concentrations: Ca^{2+} , Mg^{2+} , K^+ , Na^+ , NH_4^+ , NO_3^- , Cl^- , SO_4^{2-} , H^+ (pH), and orthophosphate (PO_4^{3-}).

Field and laboratory data are reviewed at the CAL for completeness and accuracy. Data also are screened to identify or flag samples for which the quality is compromised: samples other than wet-only deposition or samples that were mishandled or grossly contaminated. The CAL then delivers

all data and information to the NADP Program Office. One final set of checks is applied, and discrepancies are resolved on a case-by-case basis. At that point the data are made available on the NADP Internet site.

AIRMoN Operations

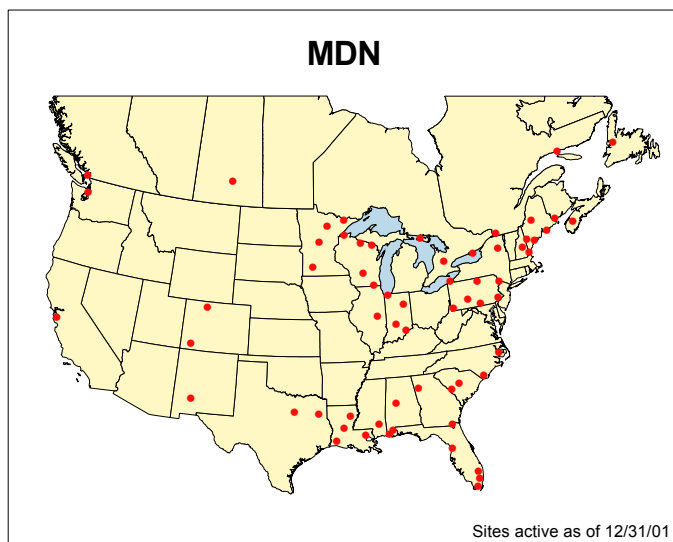
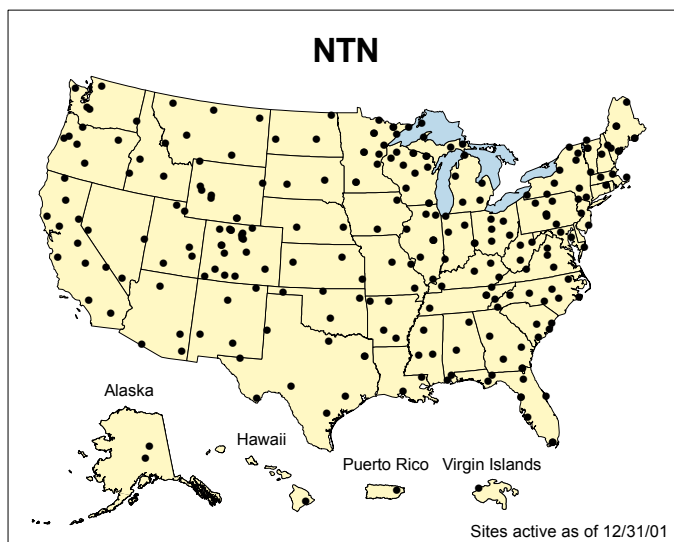
All AIRMoN sites generally follow the same procedures as NTN sites, except that operators collect samples daily within 24 hours of the start of precipitation. To retard chemical changes, samples are refrigerated after collection and until analysis at the CAL. Sites also are equipped with a National Weather Service standard precipitation gage. The CAL performs the same analyses and similar data validation procedures as for NTN. The NADP Program Office makes the data available on the NADP Internet site.

MDN Operations

All MDN sites collect samples using a precipitation chemistry collector especially modified to preserve mercury and equipped with ultraclean glassware. Precipitation is measured with a recording gage. All samples are analyzed for total mercury (Hg) at Frontier Geosciences, Inc., in Seattle, Washington. Data are reviewed and validated by the NADP Program Office before they are made available on the NADP Internet site.

Recent Uses of NADP Data

- Nearly 20 percent of the 63 papers presented at *N2001: The Second International Nitrogen Conference* in October 2001, used NADP data or were presented in NADP sessions.
- In its report, *Clean Coastal Waters, Understanding and Reducing the Effects of Nutrient Pollution*, a National Academy of Sciences Committee used NADP data to evaluate the role of atmospheric nitrogen deposition as a cause of excess nutrient levels in estuarine systems.



Note:

When referencing maps or information in this report, please use the citation: National Atmospheric Deposition Program. 2002. *National Atmospheric Deposition Program 2001 Annual Summary*. NADP Data Report 2002-01. Illinois State Water Survey, Champaign, IL.



The NADP is National Research Support Project - 3: A Long-Term Monitoring Program in Support of Research on the Effects of Atmospheric Chemical Deposition. More than 240 sponsors support the NADP, including private companies and other nongovernmental organizations, universities, local and state government agencies, State Agricultural Experiment Stations, national laboratories, Native American organizations, Canadian government agencies, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the Tennessee Valley Authority, the U.S. Geological Survey, the National Park Service, 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 - Cooperative State Research, Education, and Extension Service (under agreement no. 98-COOP-1-5925). Any findings or conclusions in this publication do not necessarily reflect the views of the U.S. Department of Agriculture or other sponsors.

The NADP Program Office is located at the Illinois State Water Survey, an affiliated agency of the University of Illinois and a Division of the Illinois Department of Natural Resources.

All NADP data and information, including color contour maps in this publication, are available from the NADP Internet site:

<http://nadp.sws.uiuc.edu>

For further information, special data requests, or to obtain copies of this publication, contact the NADP Program Office, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820.

e-mail: nadp@sws.uiuc.edu