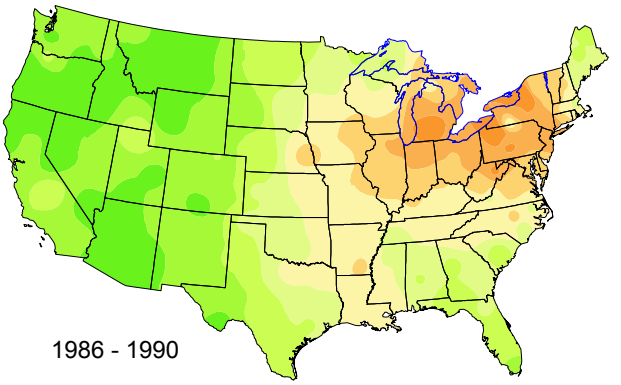
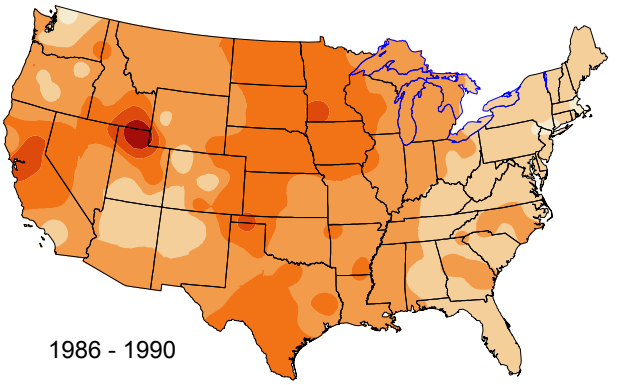
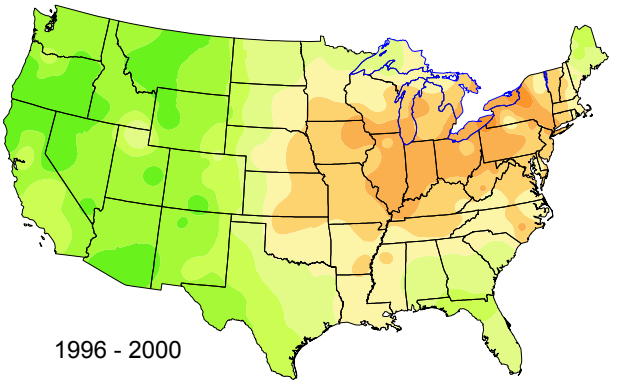
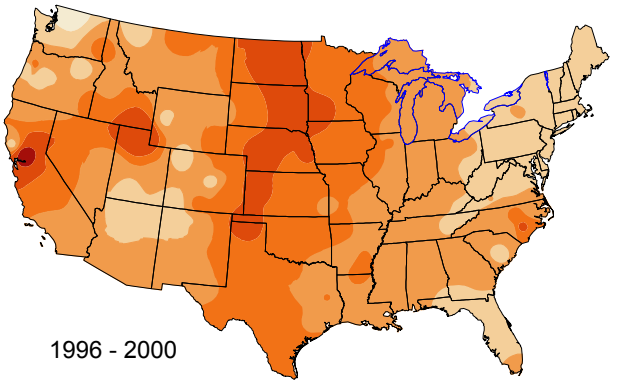
# National Atmospheric Deposition Program
# 2000 Annual Summary

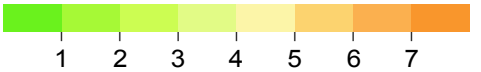


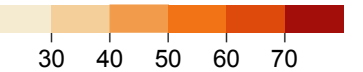




Inorganic Nitrogen Wet Deposition
from Nitrate and Ammonium (kg/ha)




Percent of Inorganic Nitrogen
Wet Deposition from Ammonium




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 2000, scientists, students, educators, and others interested in the National Atmospheric Deposition Program (NADP) logged more than 100,000 sessions on the NADP Internet site (see the back cover for the address). They viewed more than 145,000 maps of chemical deposition from precipitation and retrieved nearly 17,000 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.

NADP is now in its third decade of recording high-quality precipitation chemistry data. This cooperative effort is supported by government agencies at the national, state, and local levels, State Agricultural Experiment Stations, universities, and private organizations. Peer review scientists have said that NADP "is perhaps the most significant, long-term, continuous, and comprehensive sampling and analysis program to be undertaken in the environmental sciences." Certainly, 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 our precipitation? The answer lies in our need to monitor how human activities and the forces of nature affect air and precipitation quality, i.e., the health of the atmosphere. The information we gain will equip us to make more responsible decisions about how to preserve and improve our air quality and how to manage our 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 weekly samples for chemical analysis 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 U.S. 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 there are more than 220 sites in NADP's nationwide precipitation chemistry network, now 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 2000, there were ten AIRMoN sites collecting samples within 24 hours of the start of precipitation. AIRMoN measures the same chemicals as NTN, but 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. AIRMoN also evaluates new sample collection and preservation methods.

The Mercury Deposition Network (MDN), joined NADP in 1996. All samples from the 52 MDN sites are analyzed for total mercury, and some are analyzed for the more toxic methyl mercury. Forty-two states have advisories warning people to limit their consumption of fish and wildlife from certain water bodies because of mercury contamination. MDN data enable researchers to determine seasonal and annual fluxes of mercury in precipitation falling on lakes, wetlands, streams, forested watersheds, and other sensitive ecosystems.

[**About the cover:** Pictured are the average annual wet deposition of nitrogen from nitrate and ammonium and the percent of nitrogen wet deposition from ammonium for two periods: 1986-1990 and 1996-2000.]

## This Report

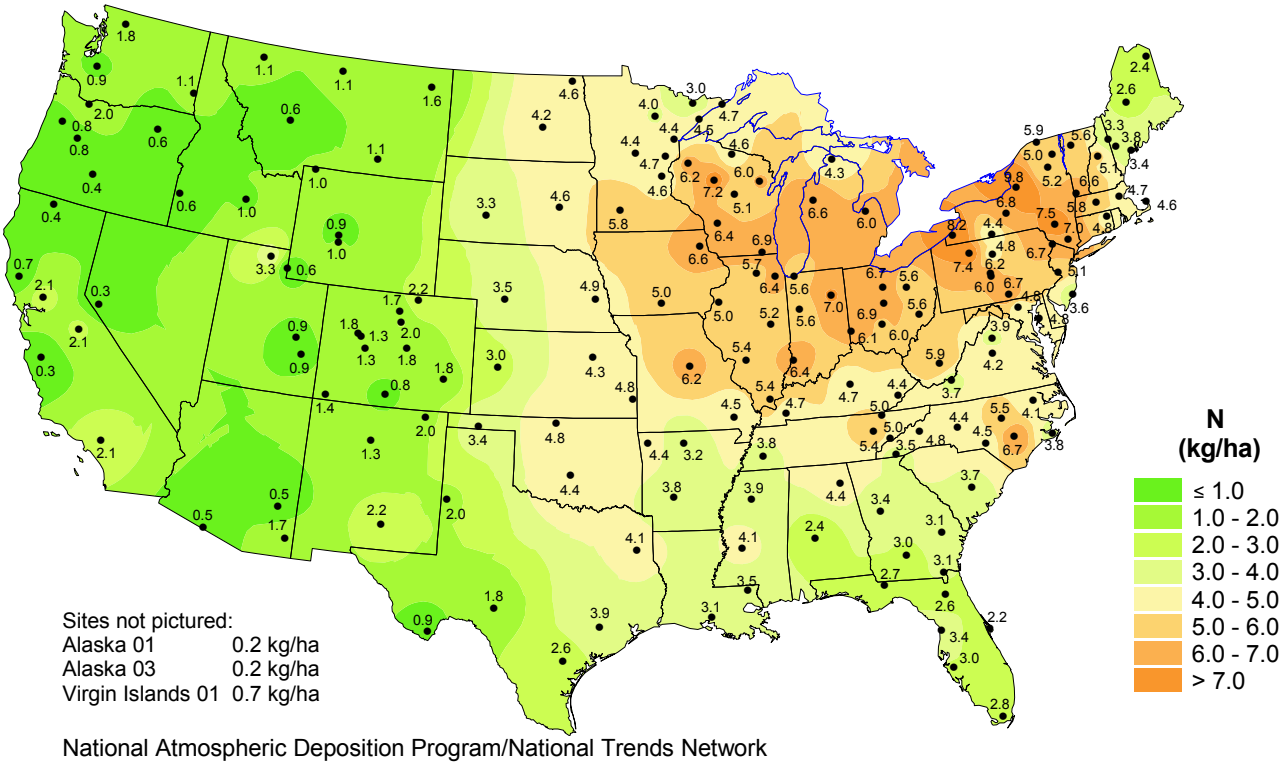
### NTN Data

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 2000, 175 sites met these criteria. Black dots mark site locations. Annual concentration or deposition values are printed 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.)

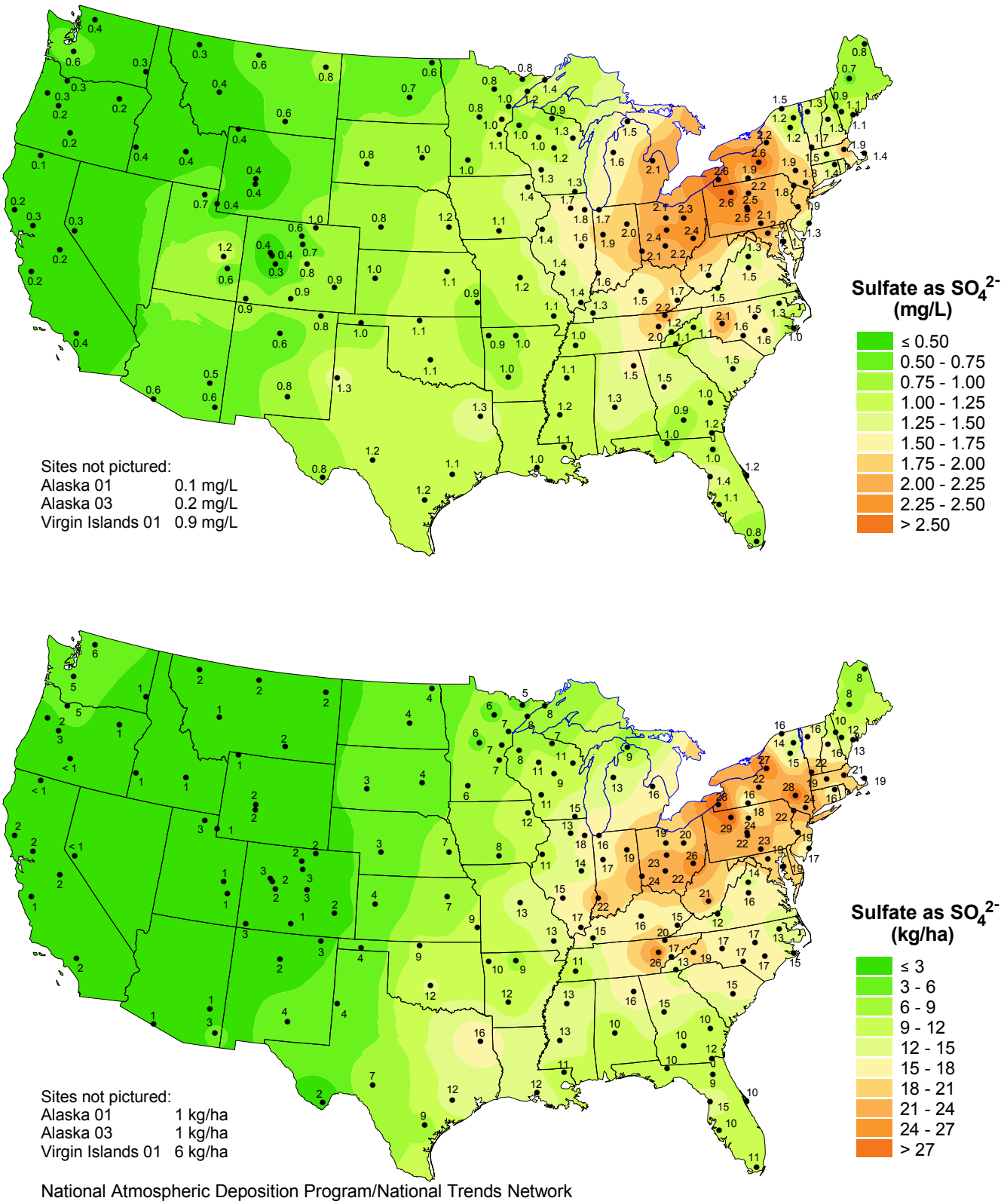
Color contours on the NTN maps were created by using site values to compute an array of regularly spaced grid-point values covering the country. Sites within 500 kilometers of each grid point were used in computations. Color contours were drawn on this array of grid-point values. Each contour represents the class 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.

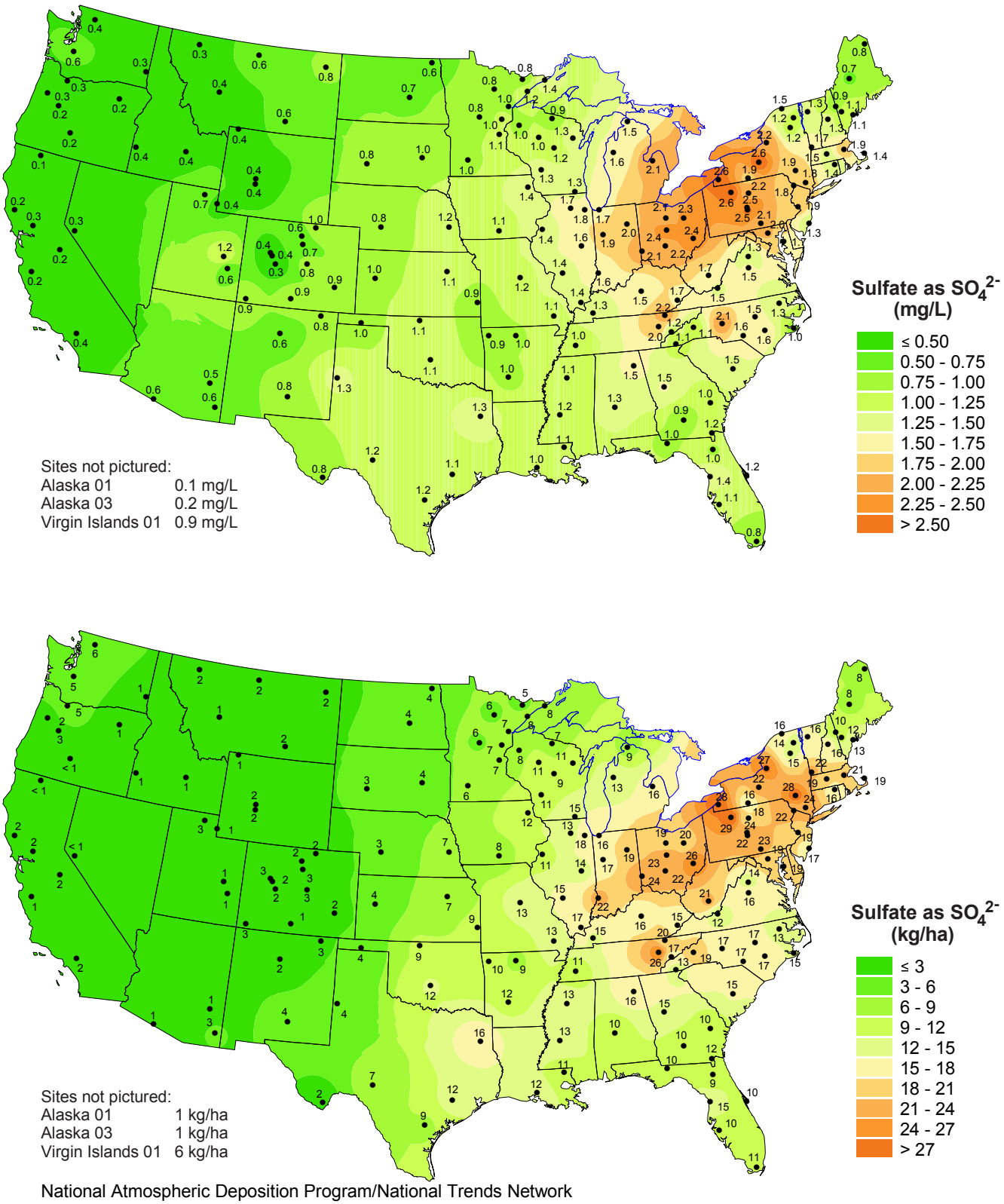
**Explanation of NTN Color Contours:** Refer to the figure below, which has eight inorganic nitrogen deposition classes or contours. The light green contour in the middle represents 3.0 - 4.0 kilograms per hectare (kg/ha). Nitrogen deposition values in the area covered by this contour are greater than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



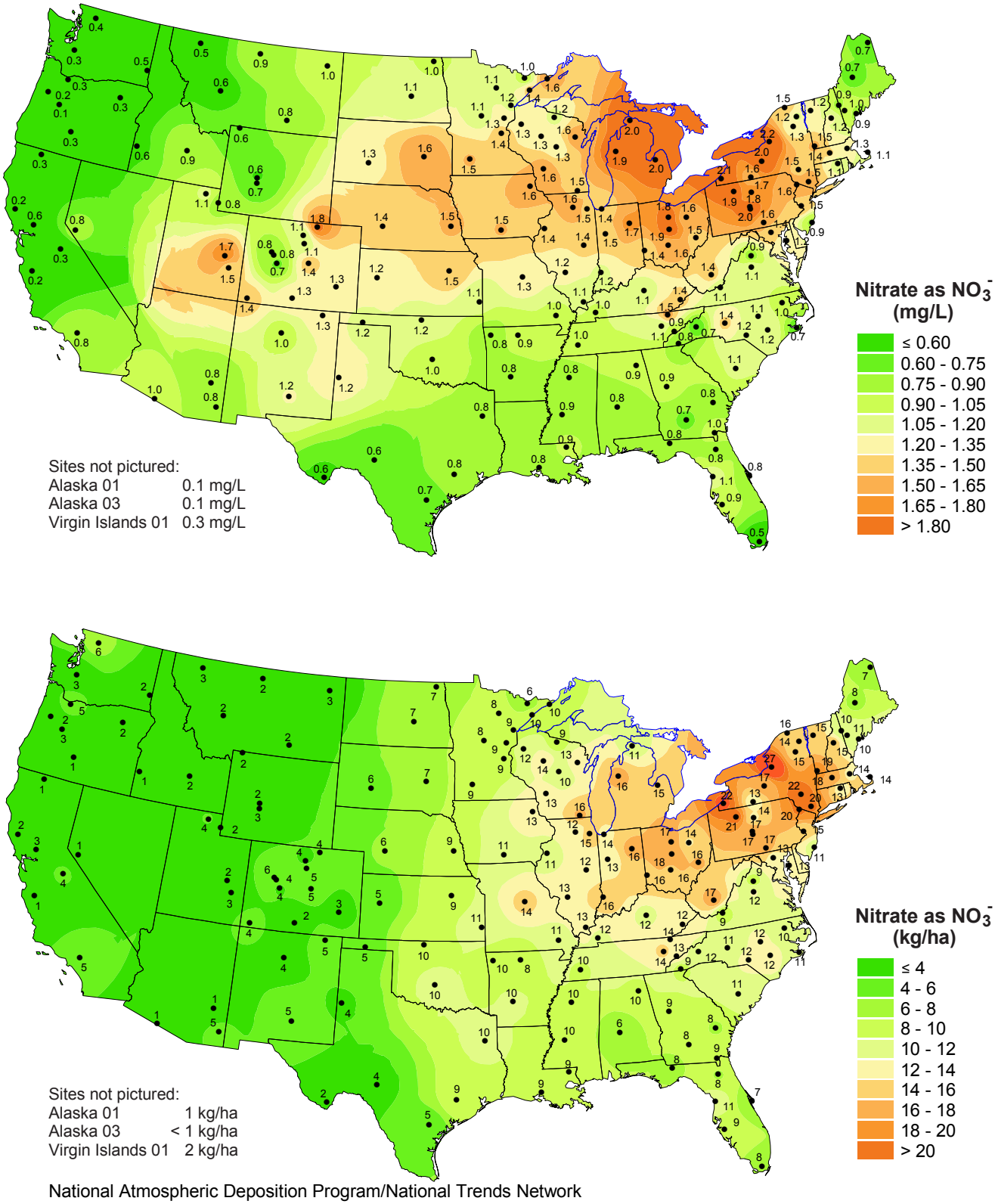

Inorganic nitrogen wet deposition from nitrate and ammonium, 2000



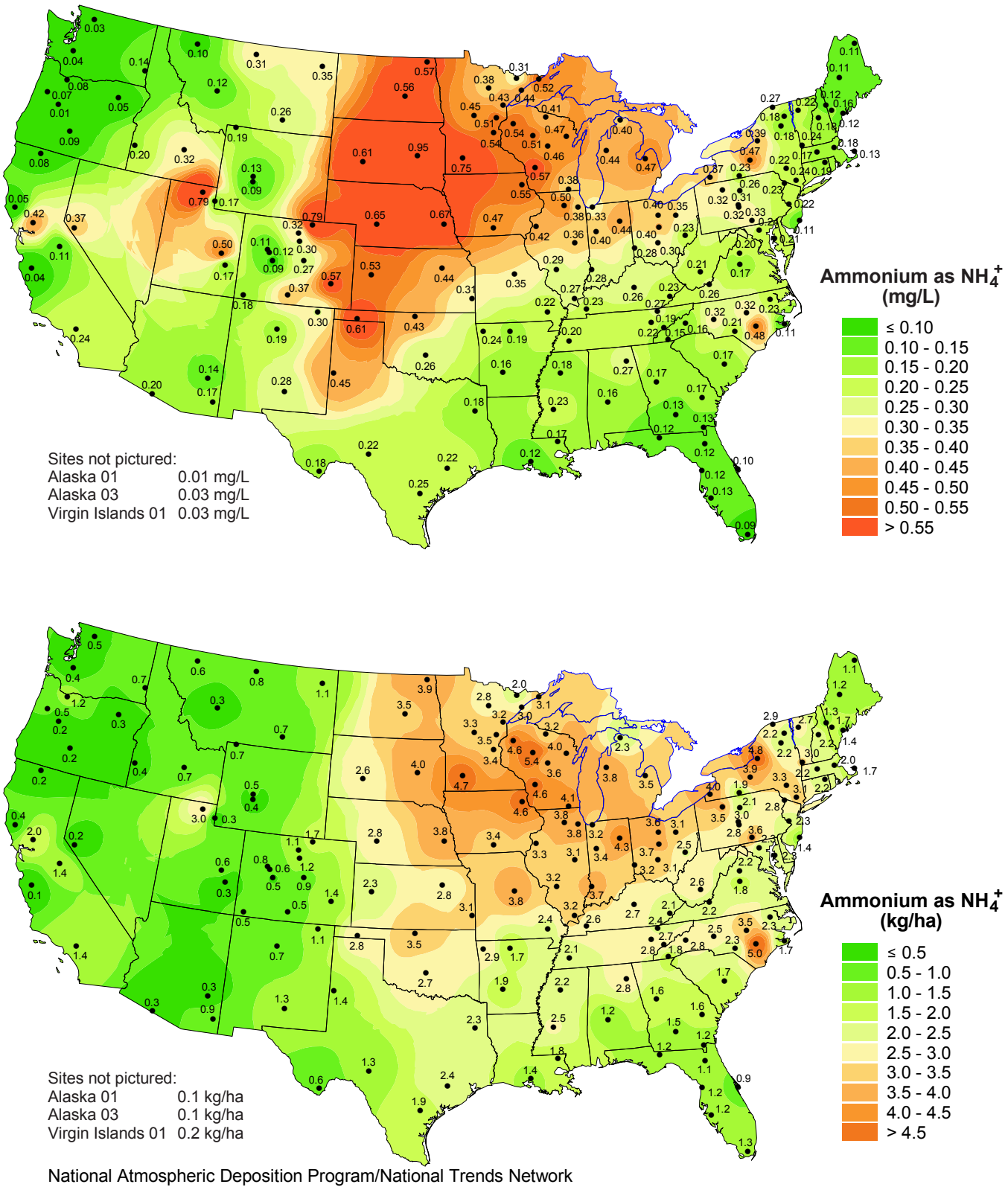

Sulfate ion concentration (top) and wet deposition (bottom), 2000.



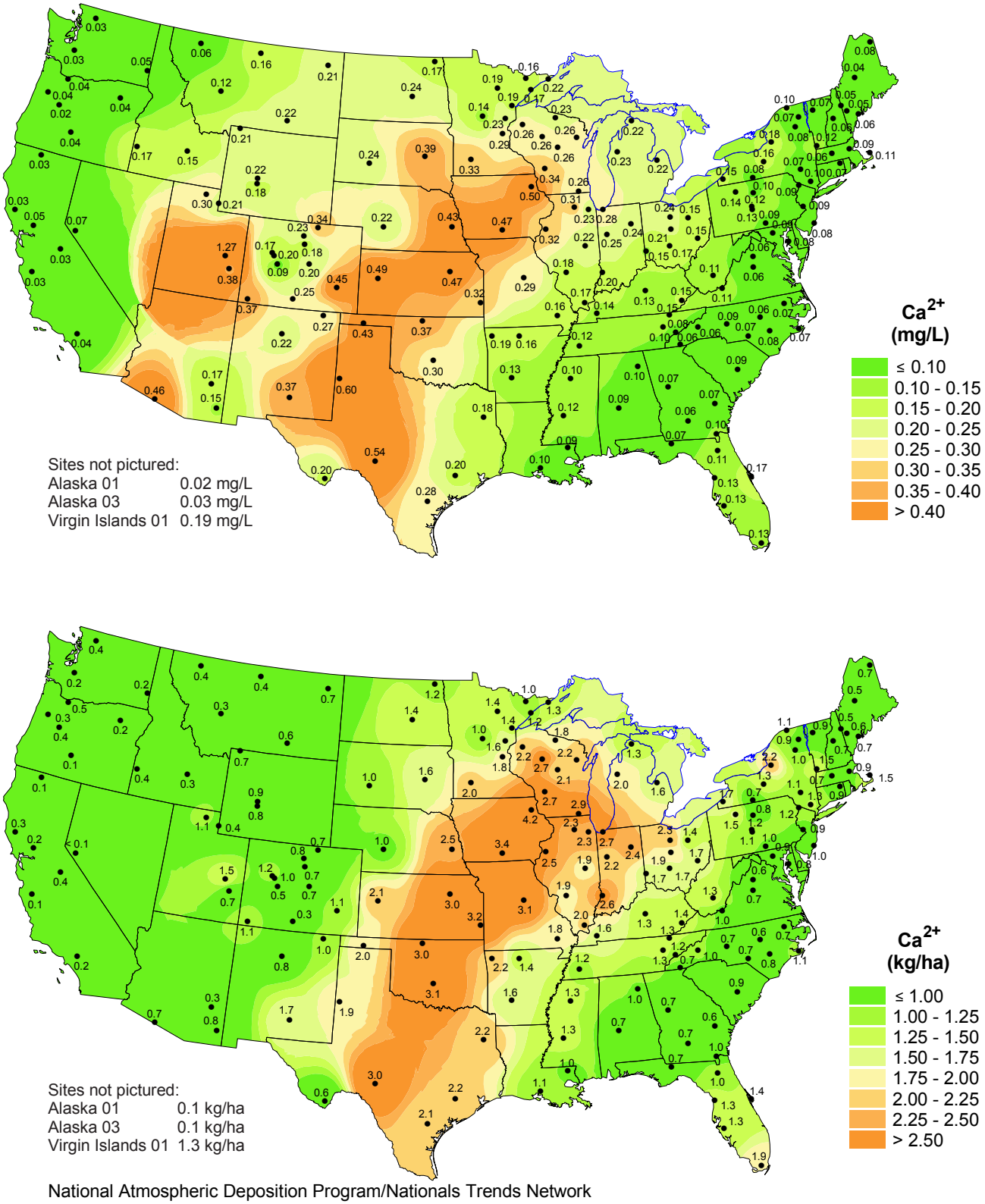

Sulfate ion concentration (top) and wet deposition (bottom), 2000.



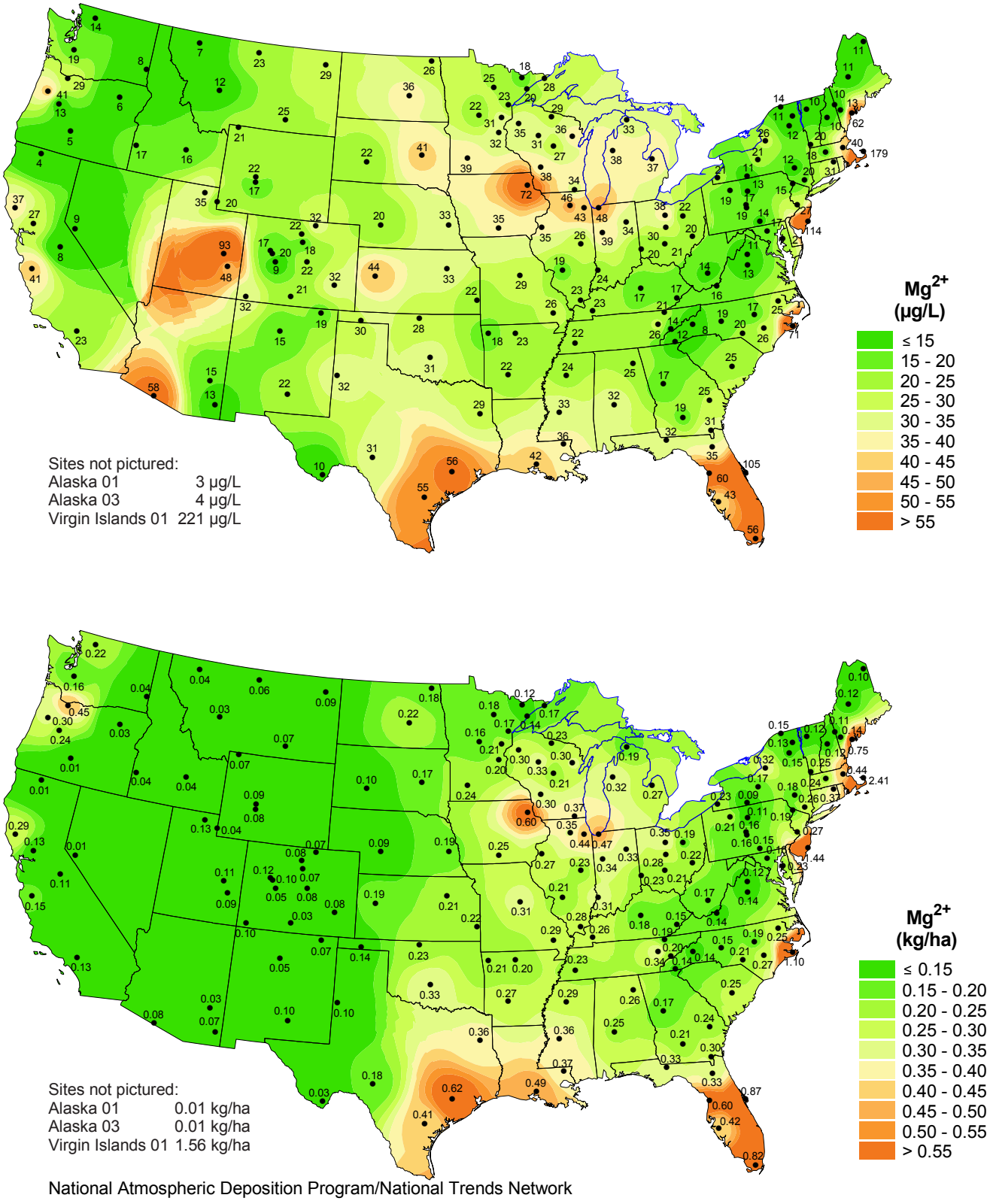

Nitrate ion concentration (top) and wet deposition (bottom), 2000.



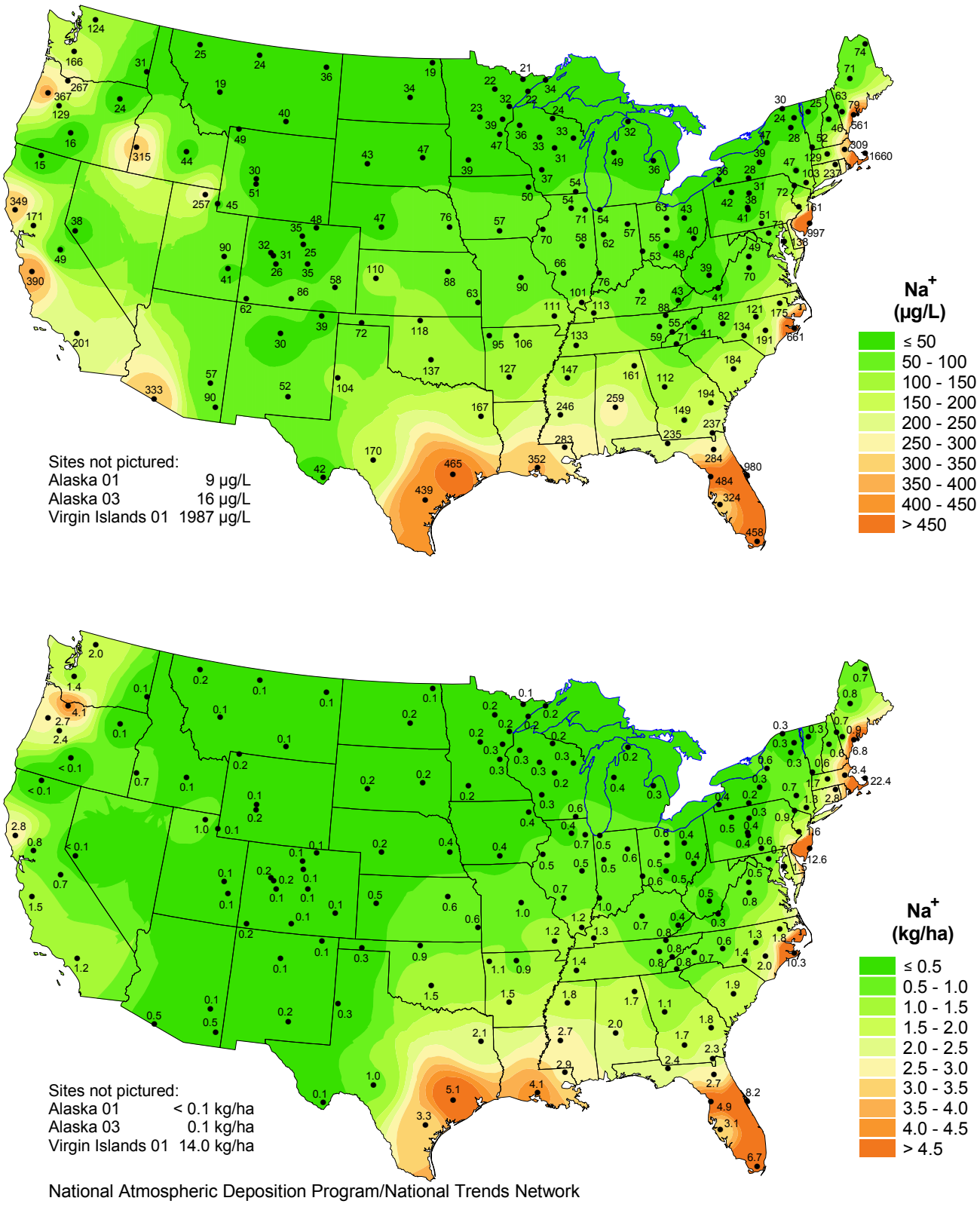

Ammonium ion concentration (top) and wet deposition (bottom), 2000.



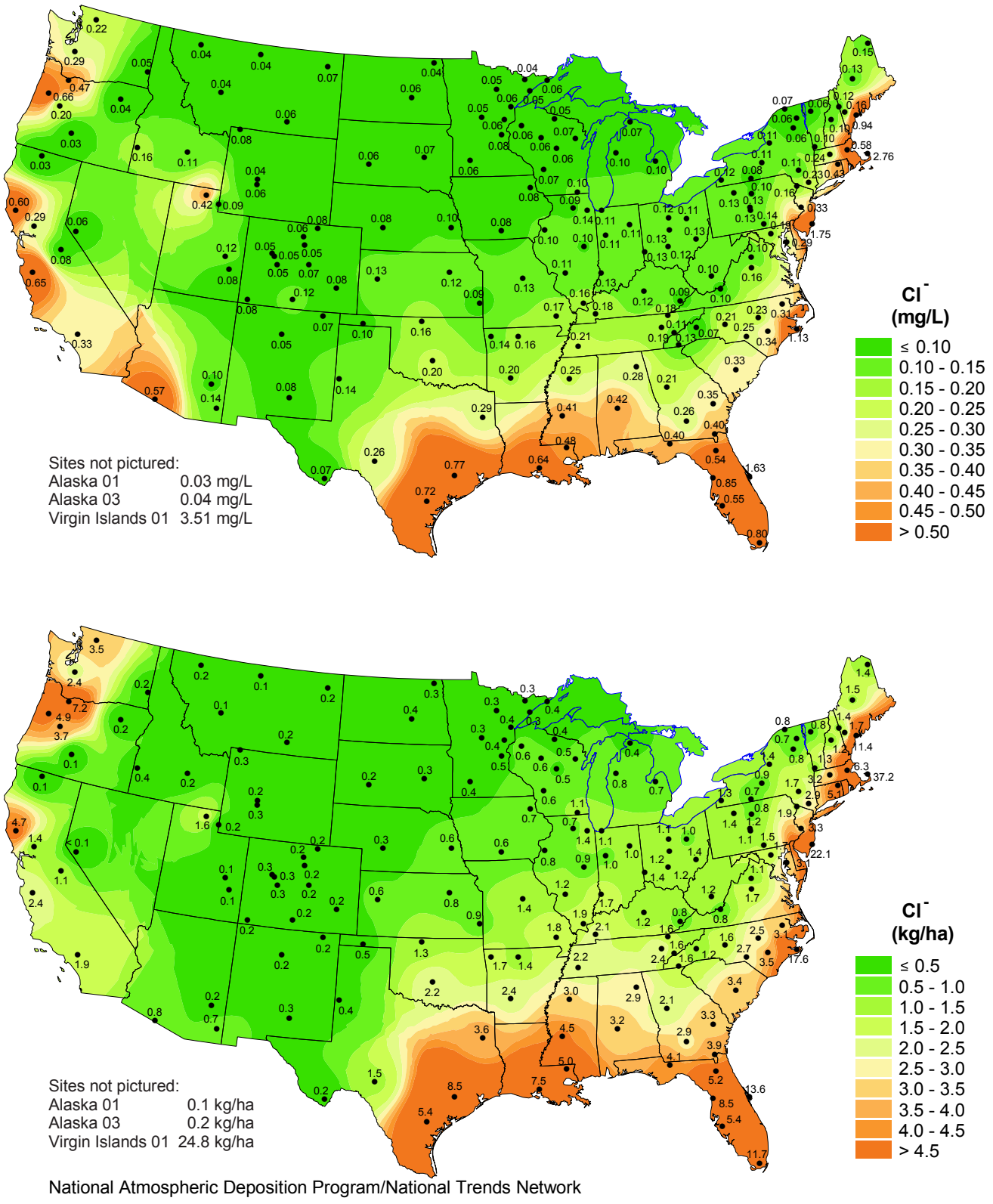

Calcium ion concentration (top) and wet deposition (bottom), 2000.



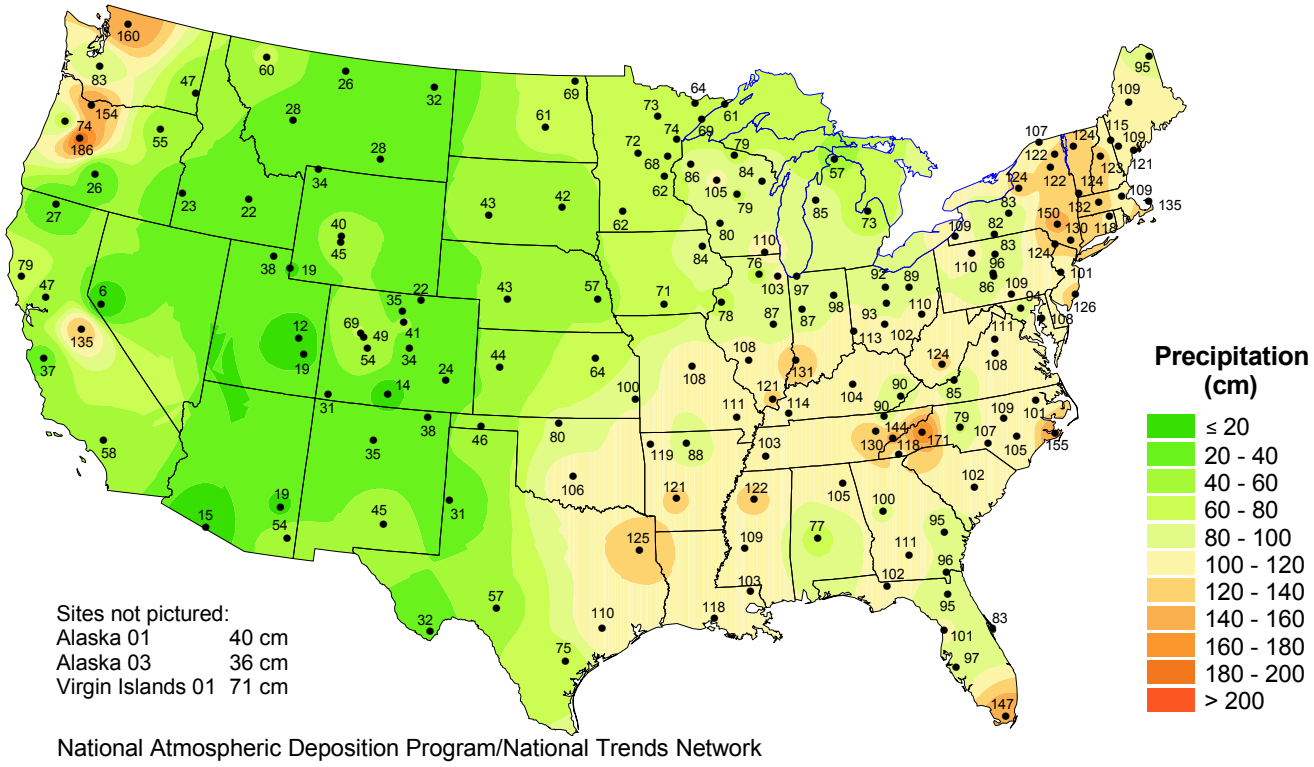

Magnesium ion concentration (top) and wet deposition (bottom), 2000.




Sodium ion concentration (top) and wet deposition (bottom), 2000.




Chloride ion concentration (top) and wet deposition (bottom), 2000.

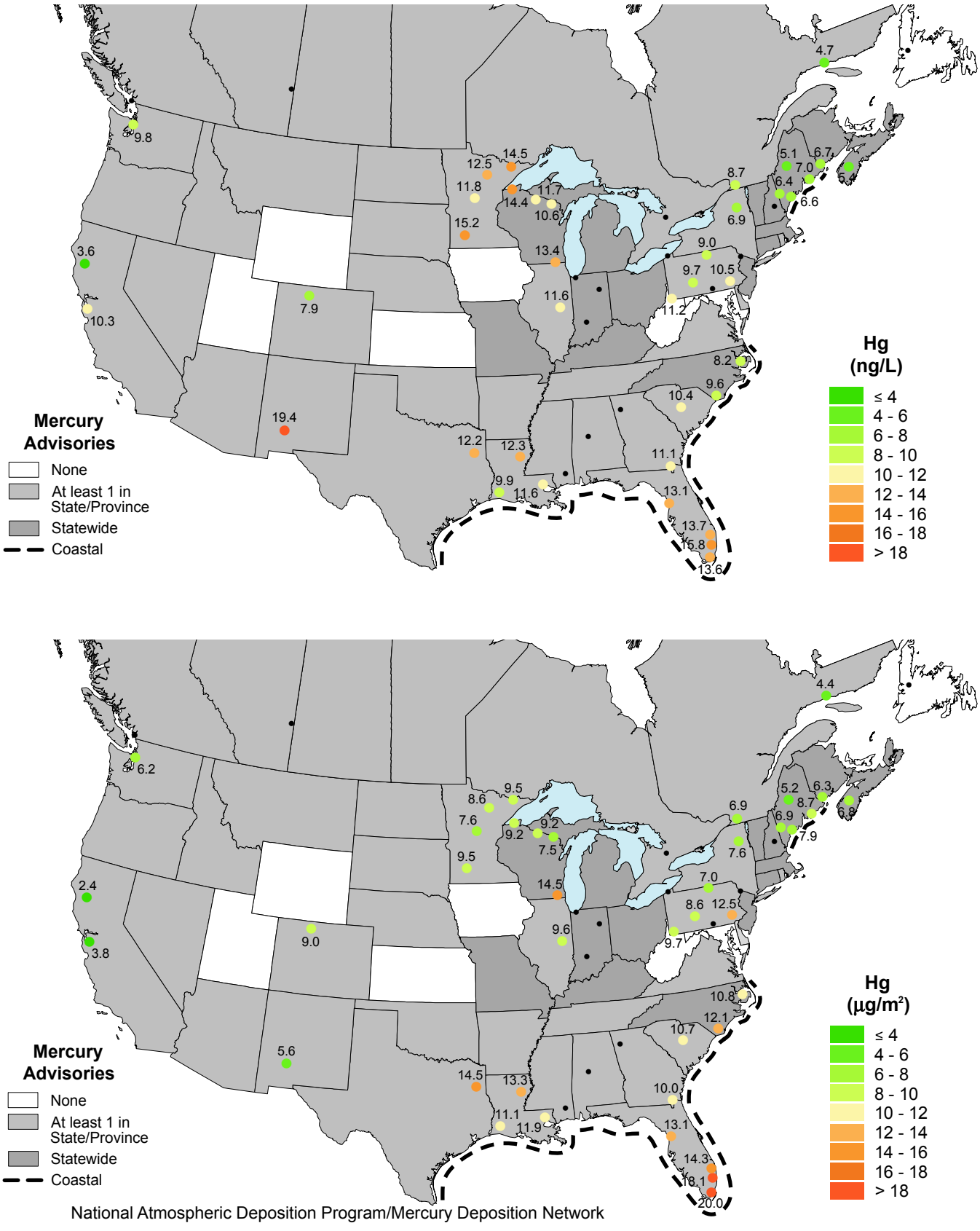



Total precipitation, 2000.

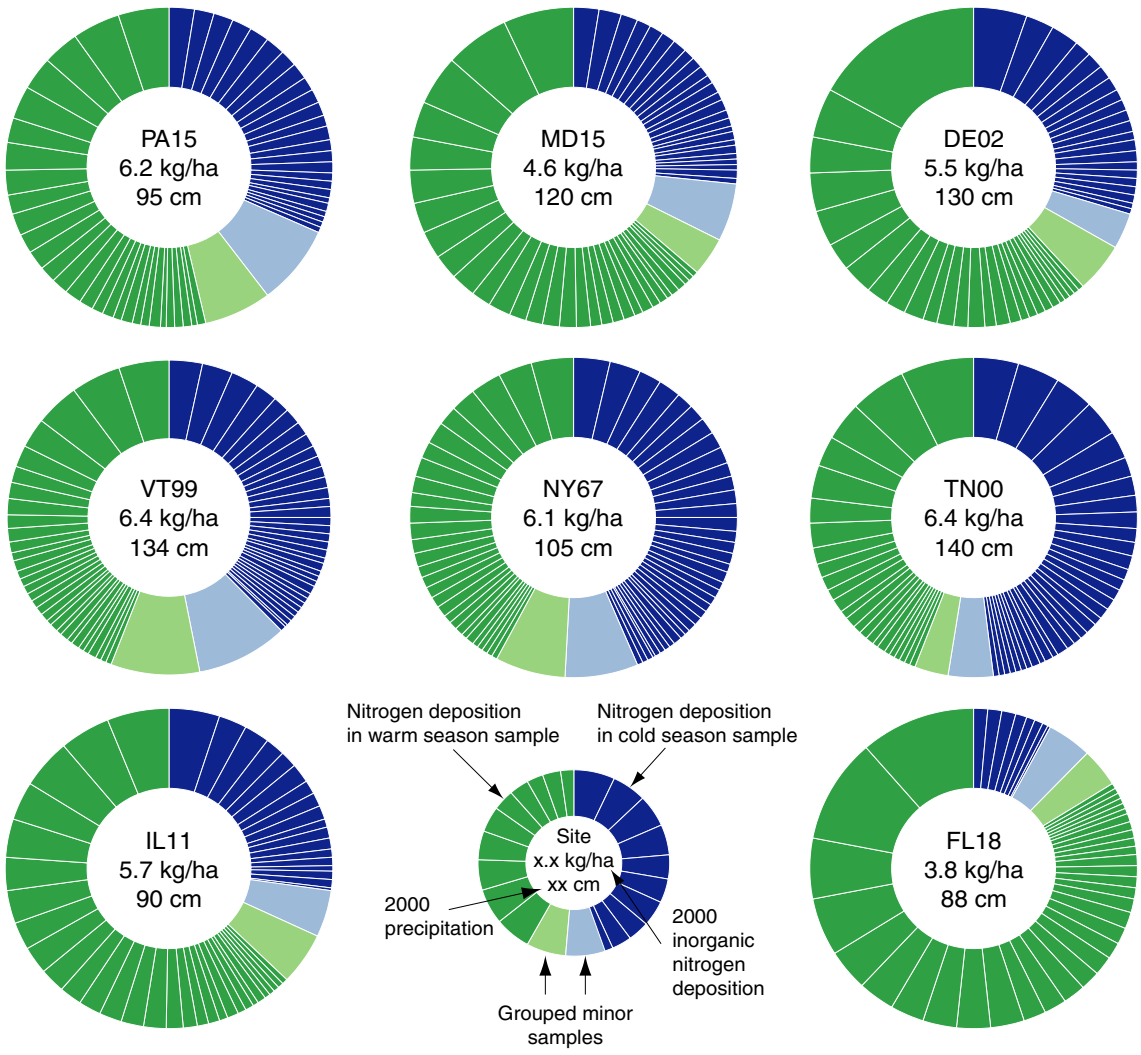
## MDN Data

The MDN maps on the next page show the average precipitation-weighted concentrations and annual wet depositions of total mercury in precipitation. Colored dots mark MDN sites meeting prescribed data completeness criteria. In 2000, 39 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 2000 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 the wet deposition of mercury 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.




Mercury concentration (top) and wet deposition (bottom), 2000.
Mercury advisories are for fish and wildlife consumption, not deposition.




Contributions of individual samples to inorganic nitrogen wet deposition at AIRMoN sites, 2000. Minor samples contributing less than 0.5 percent are grouped.

## AIRMoN Data

The donut graphs, above, show the inorganic nitrogen deposition from nitrate ($NO_3^-$-N) and ammonium ($NH_4^+$-N) in warm and cold season samples at AIRMoN sites active through 2000. Warm season samples (green) occur in May-October, approximating the northern U.S. growing season. Cold season samples (blue) occur in January-April and November-December, approximating the northern U.S. dormant season. White lines demarcate nitrogen deposition in individual samples, arranged in descending amounts by seasons. Annual nitrogen deposition from $NO_3^-$-N and $NH_4^+$-N was calculated from the total annual precipitation and precipitation-weighted average $NO_3^-$-N and $NH_4^+$-N concentrations. (See the NADP Internet site for an explanation of precipitation-weighted averages.) Not shown are graphs from the Ohio (OH09) site, which ended operations in October, and the West Virginia (WV99) site, which began in June 2000.

The green and blue portions of the donut indicate the relative amounts of nitrogen deposited by precipitation in the warm and cold seasons, respectively. For the Tampa Bay (FL18) site, warm season deposition was about 86 percent of the total, and just nine warm season samples (i.e., nine slices) accounted for about half of the annual nitrogen deposition.

## NTN Operations

NTN is the only network providing a long-term record of precipitation chemistry across the United States. NTN sites are predominantly located away from urban areas and point sources of pollution. Each site has 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. Rigorous siting criteria and standard operational procedures ensure the comparability and representativeness of NTN data.

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

Field and laboratory data are reviewed at the CAL for completeness and accuracy. Data are also screened to identify or flag samples for which the quality is compromised: samples that are not wet-only deposition or samples that are 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 any discrepancies are resolved on a case-by-case basis. At that point the data are made available on the NADP Internet site.

## AIRMoN Operations

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. AIRMoN 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.

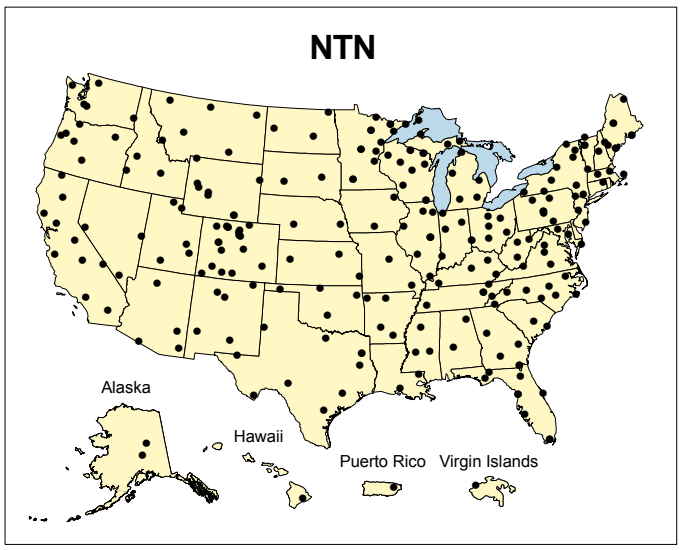
## MDN Operations

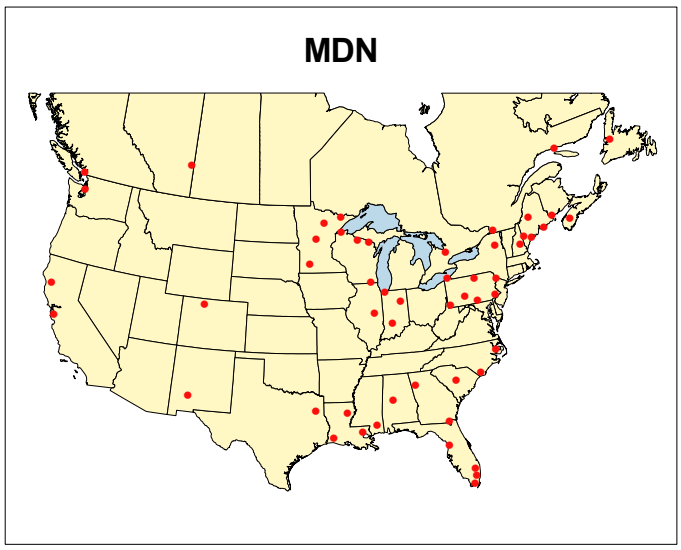
MDN sites collect samples weekly using a precipitation chemistry collector especially modified to preserve mercury and equipped with ultraclean glassware. Rigorous sample handling procedures are followed. All samples are analyzed for total mercury (Hg) at the Hg Analytical Laboratory (HAL) at Frontier Geosciences, Inc., in Seattle, Washington. Data are reviewed and validated by the NADP Program Office before being made available on the NADP Internet site.

## Recent NADP Accomplishments

In a recent report using NADP data (*Deposition of Air Pollutants to the Great Waters - Third Report to Congress.* EPA-453/R-00-005, U.S. Environmental Protection Agency, June 2000) **:**

- Scientists report that "the rates of inorganic nitrogen wet deposition to many of the Great Waters watersheds [Great Lakes, Lake Champlain, Chesapeake Bay] have been relatively constant for the past two decades."
- "Atmospheric nitrogen deposition, including wet deposition, contributes roughly 10 to 40 percent of total nitrogen loads reaching bays and estuaries in east and Gulf coastal areas."
- "The MDN site in the Lake Champlain basin at Underhill, VT, is now the longest continuous monitoring program in the world for total mercury wet deposition."
- AIRMoN data support the observation that "about a third of the new nitrogen delivered to Tampa Bay comes from atmospheric deposition direct to the bay surface."





**Note:**

When referencing maps or information in this report, please use the citation: National Atmospheric Deposition Program. 2001. *National Atmospheric Deposition Program 2000 Annual Summary*. NADP Data Report 2001-01. 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 220 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 view 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.*
*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