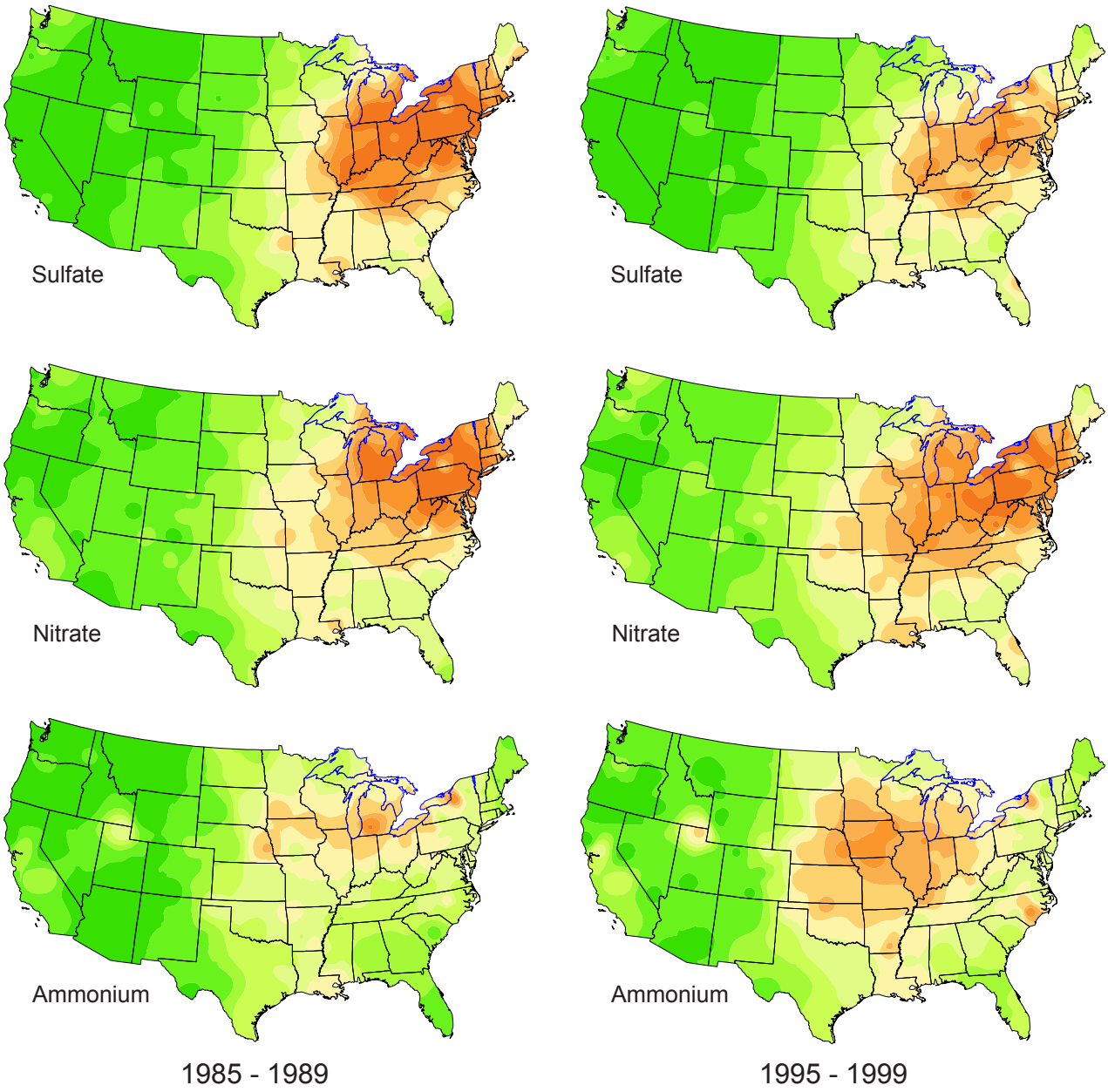
National Atmospheric Deposition Program
1999 Annual Summary



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 1999, scientists, students, educators, and others interested in National Atmospheric Deposition Program (NADP) data made more than 17,000 data retrievals and viewed nearly 70,000 maps from the NADP Internet site (see the back cover for the address). Registered on-line users of NADP data increased by 64 percent in 1999 over 1998 users. Sixty-three percent used NADP data to address research questions about the chemicals in precipitation and their environmental effects, and 37 percent used the 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. By 1999, 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.

Another network, the Mercury Deposition Network (MDN), joined NADP in 1996. All samples from the 40 sites collecting weekly samples are analyzed for total mercury, and some are analyzed for the more toxic methyl mercury. Nearly 40 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 estimated average annual wet deposition of sulfate, nitrate, and ammonium for 1985-1989 and 1995-1999. Units of millimoles per square meter were used to facilitate direct comparisons among the maps.]

This Report

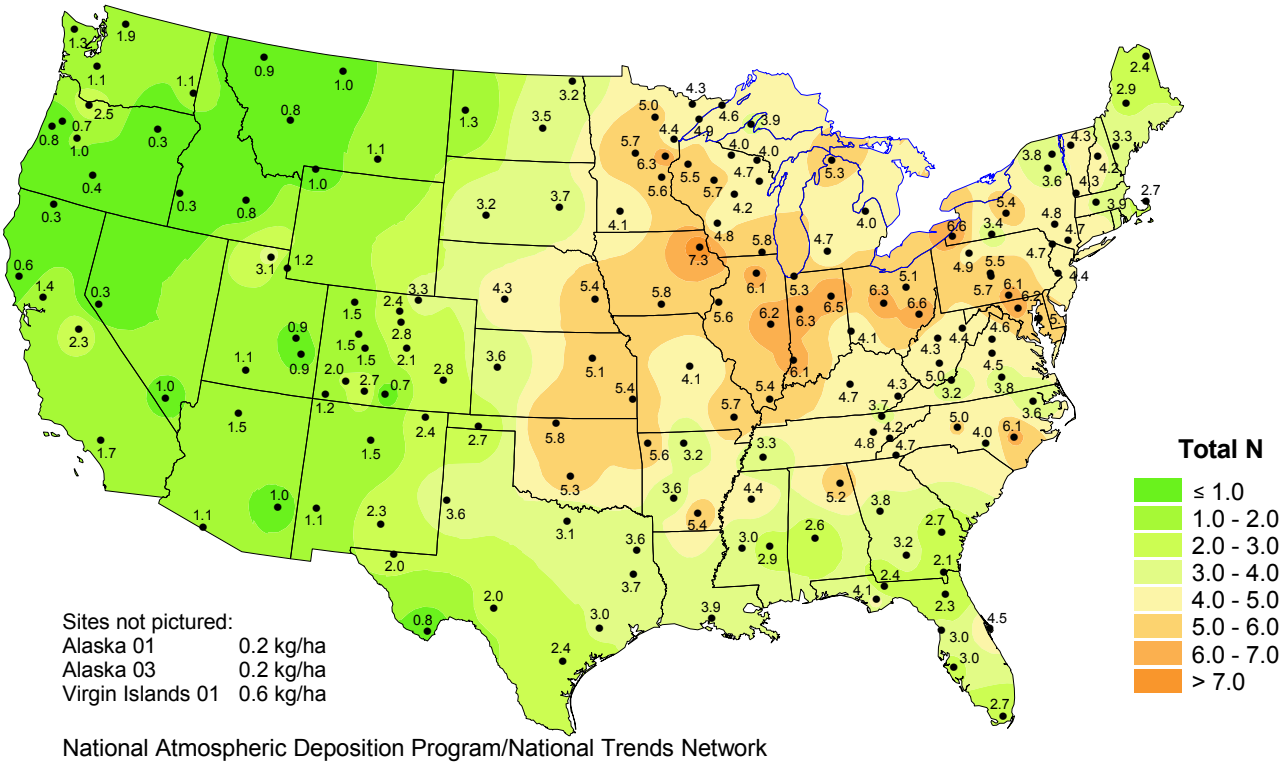
NTN Data

The NTN maps portray spatial variability in the concentration and estimated deposition of selected acids, nutrients, and base cations on regional and national scales. Only sites that meet prescribed data completeness criteria are included. In 1999, 172 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.)

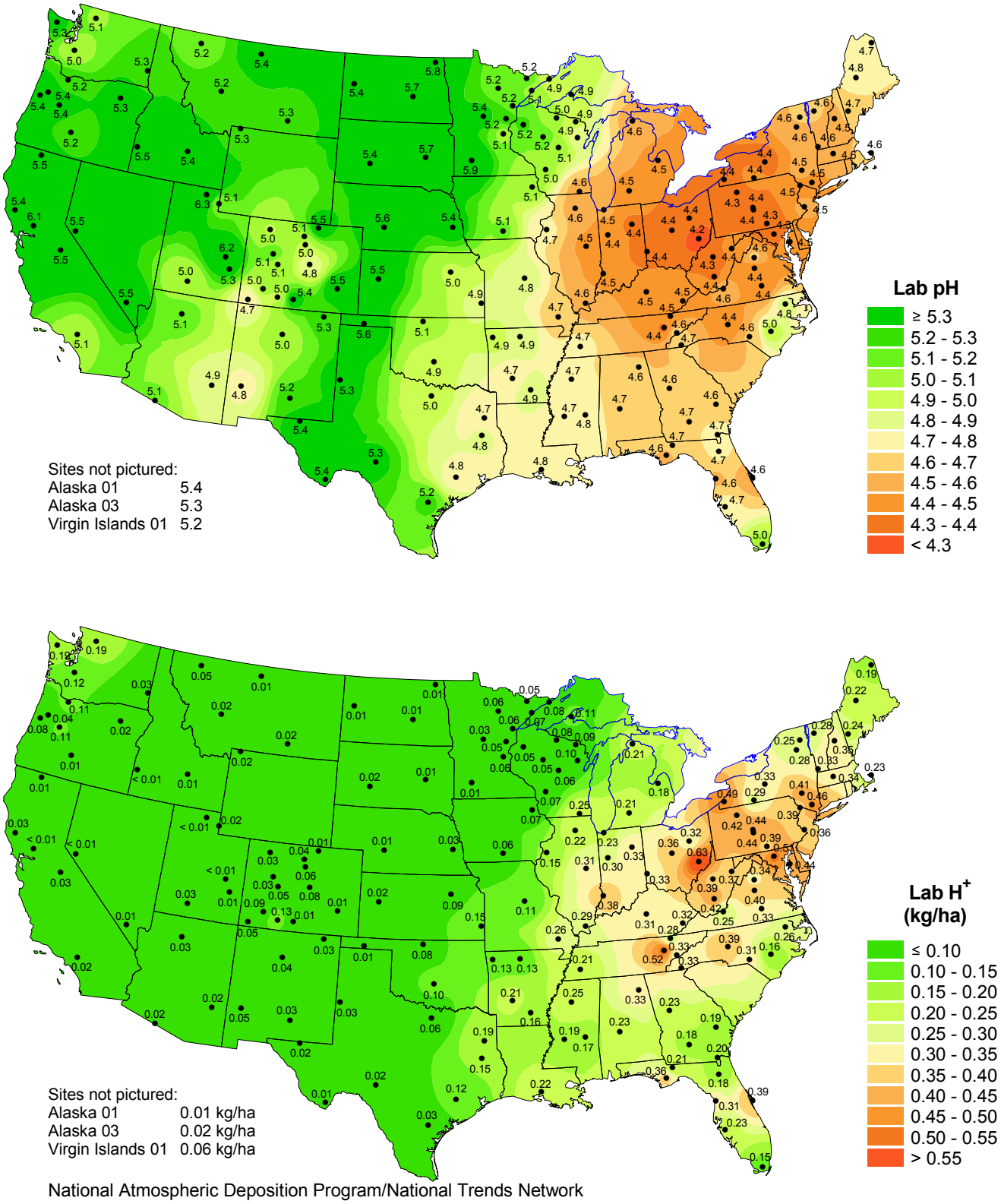
Color contours on the NTN maps were created by using site values to compute an array of regularly spaced grid-point values covering the country. Sites within 500 kilometers of each grid point were used in computations. Color contours were drawn on this array of grid-point values. Each contour represents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

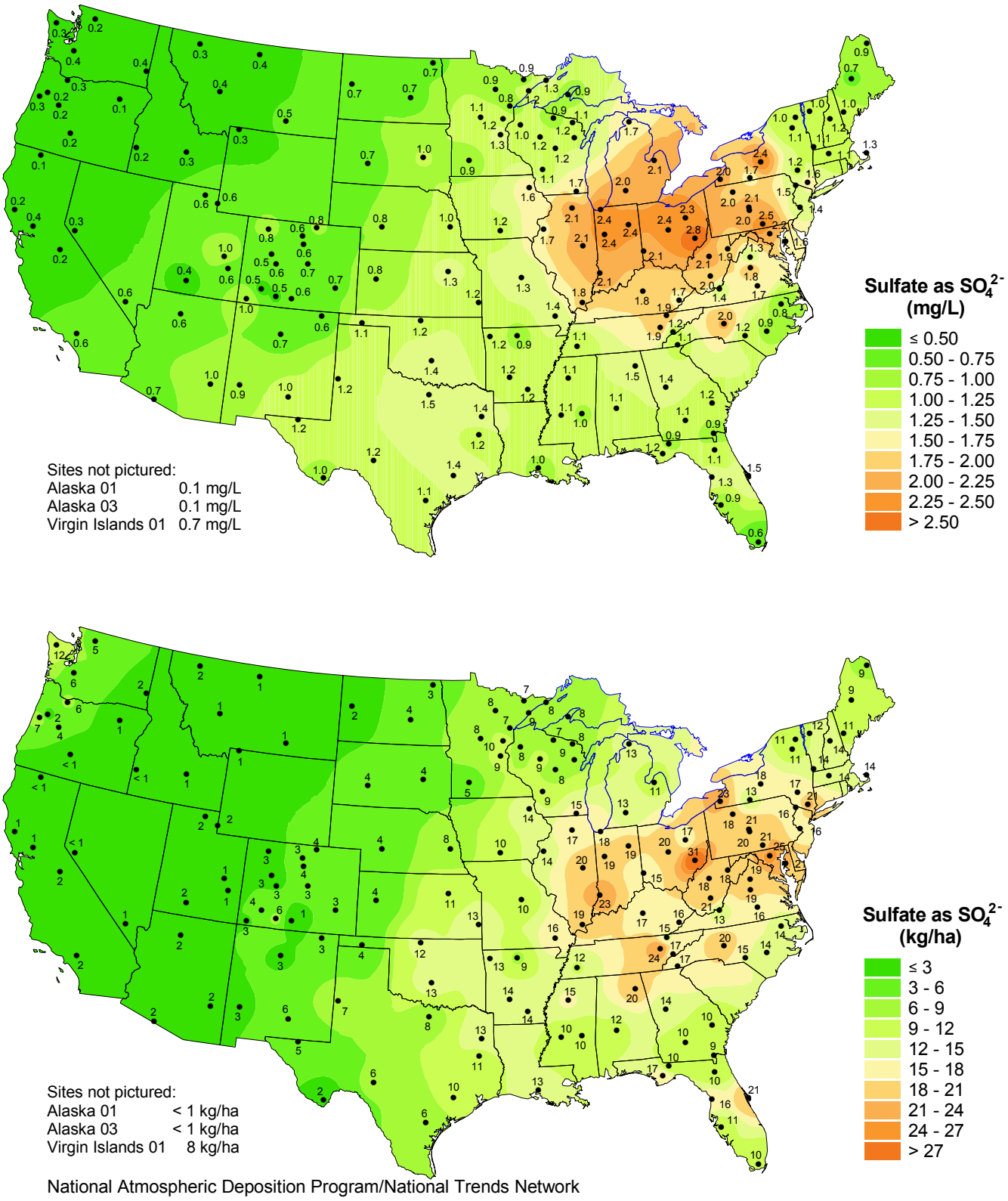
Explanation of NTN Color Contours: Refer to the figure below, which has eight inorganic nitrogen deposition classes or contours. The light green contour in the middle represents 3.0 - 4.0 kilograms per hectare (kg/ha). Nitrogen deposition values in the area covered by this contour are greater than 3.0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



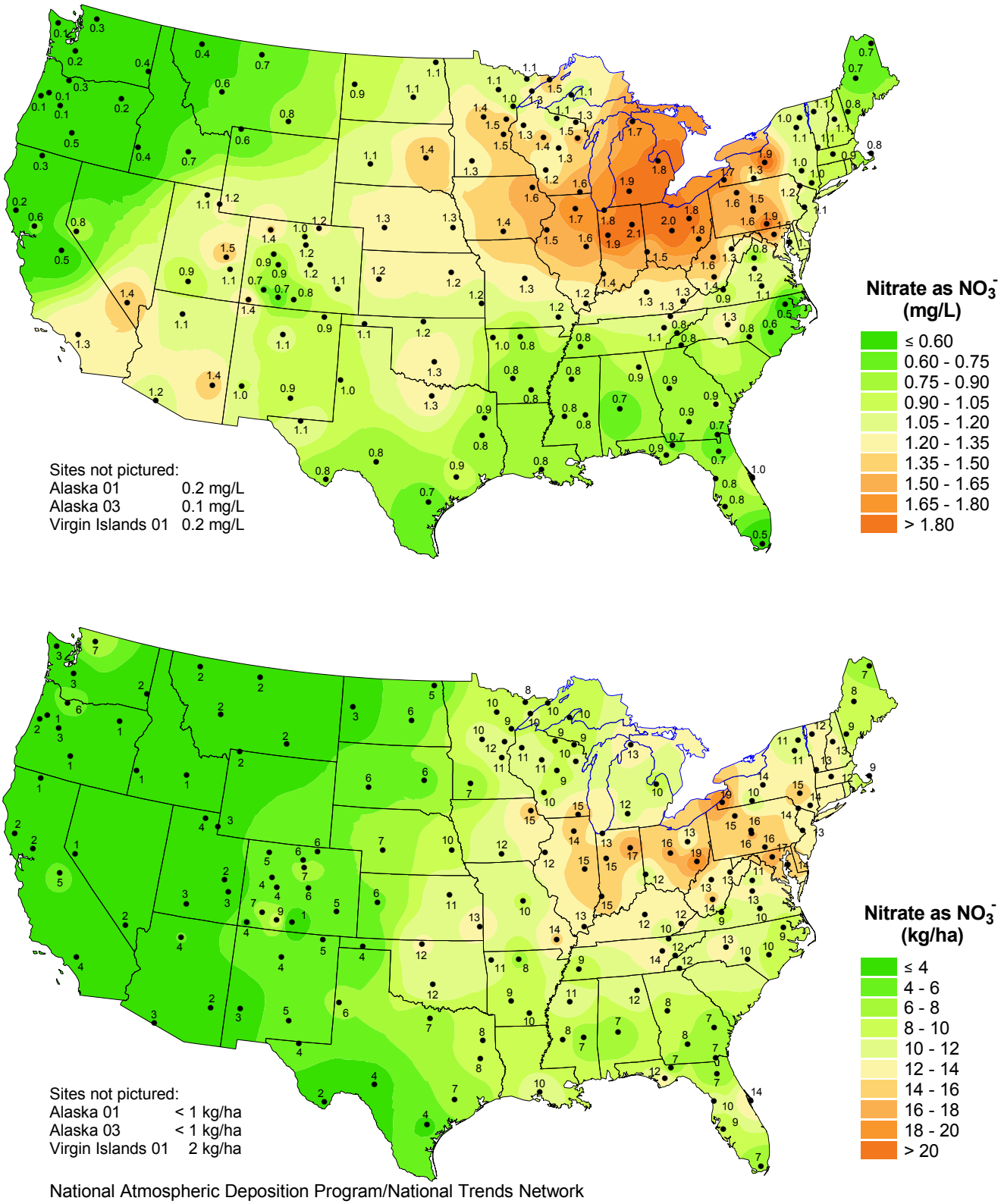
Estimated inorganic nitrogen from nitrate and ammonium, 1999.



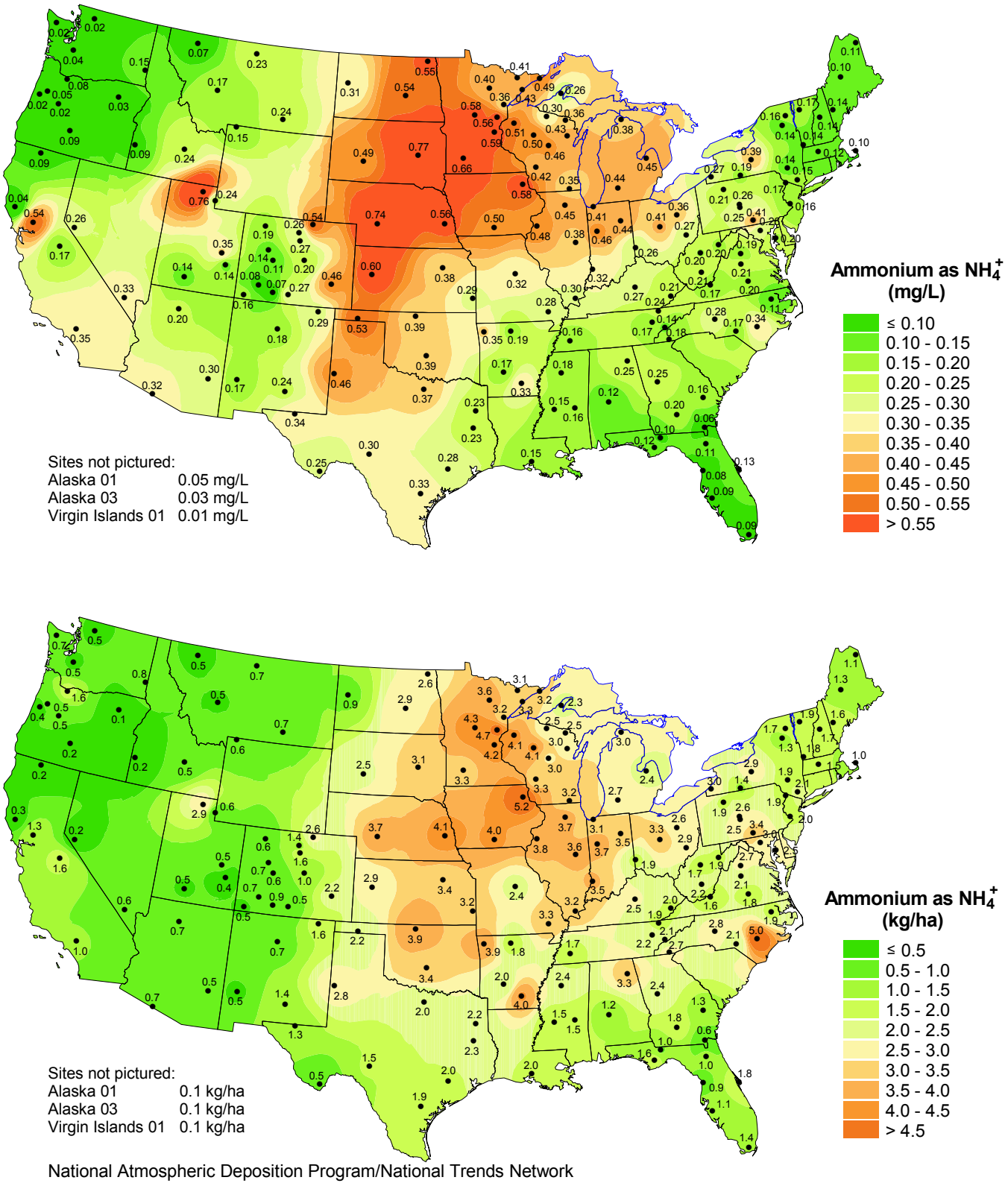
Hydrogen ion concentration as pH (top) and estimated deposition (bottom) from measurements made at the Central Analytical Laboratory, 1999.



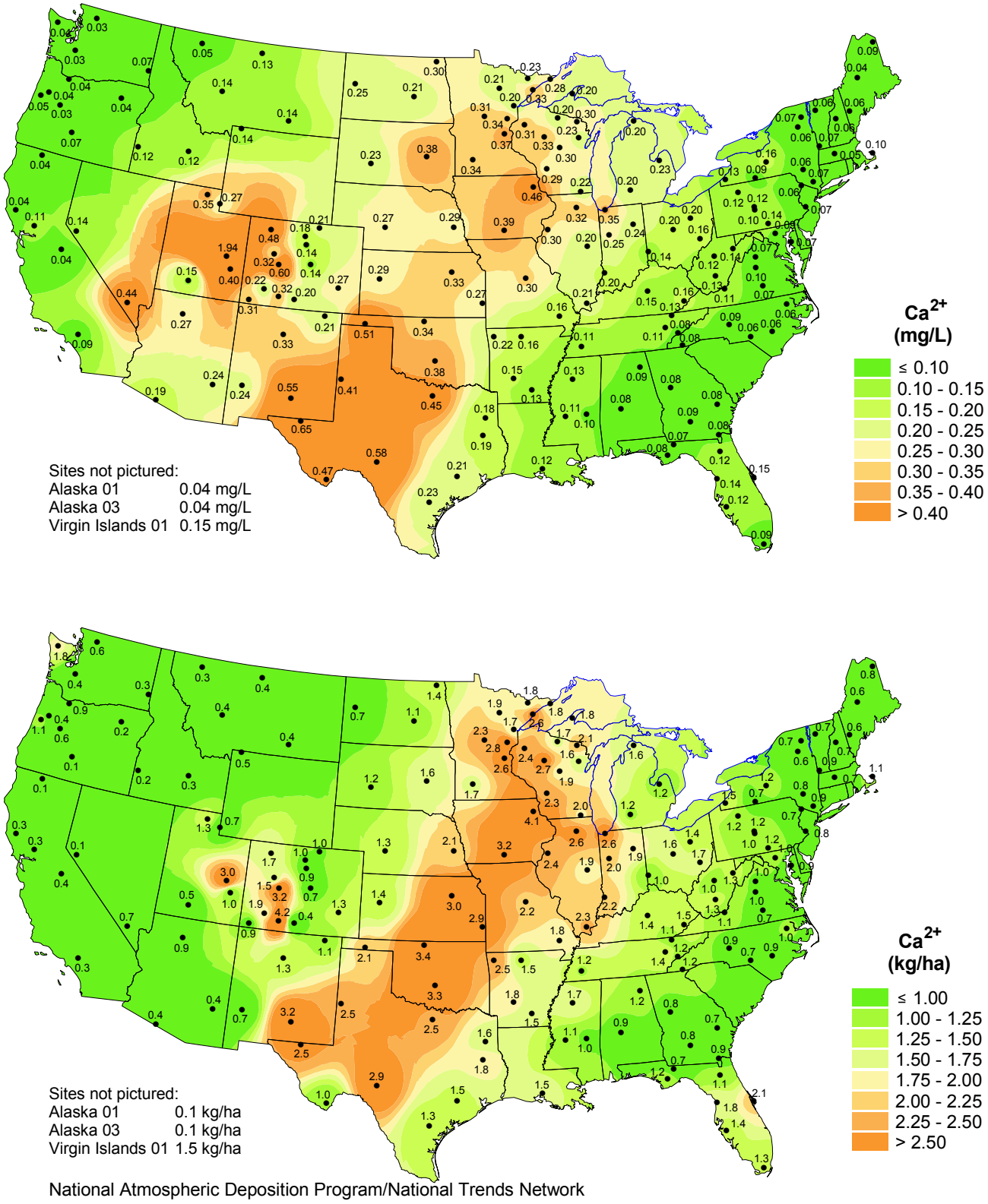
Sulfate ion concentration (top) and estimated deposition (bottom), 1999.



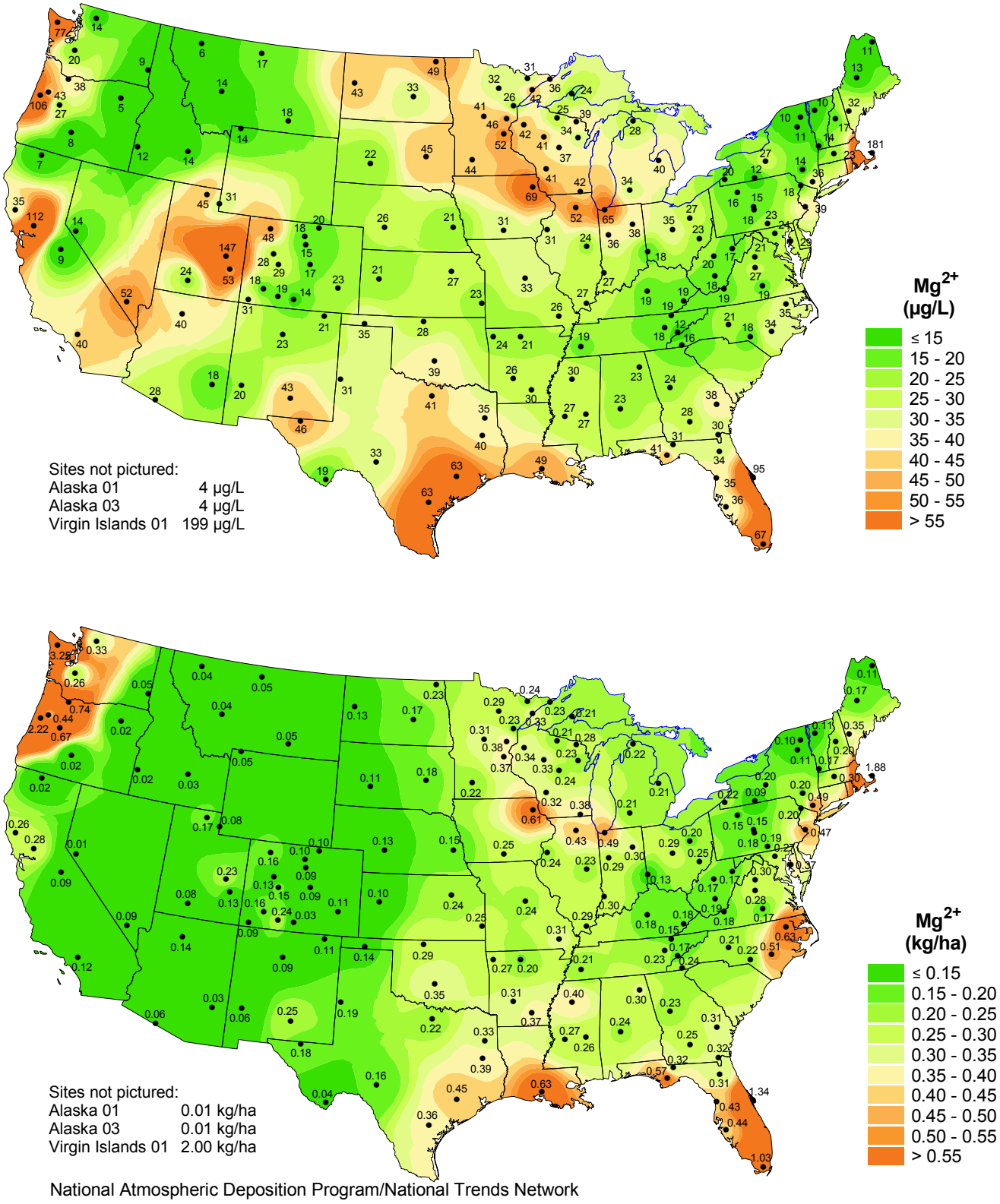
Nitrate ion concentration (top) and estimated deposition (bottom), 1999.



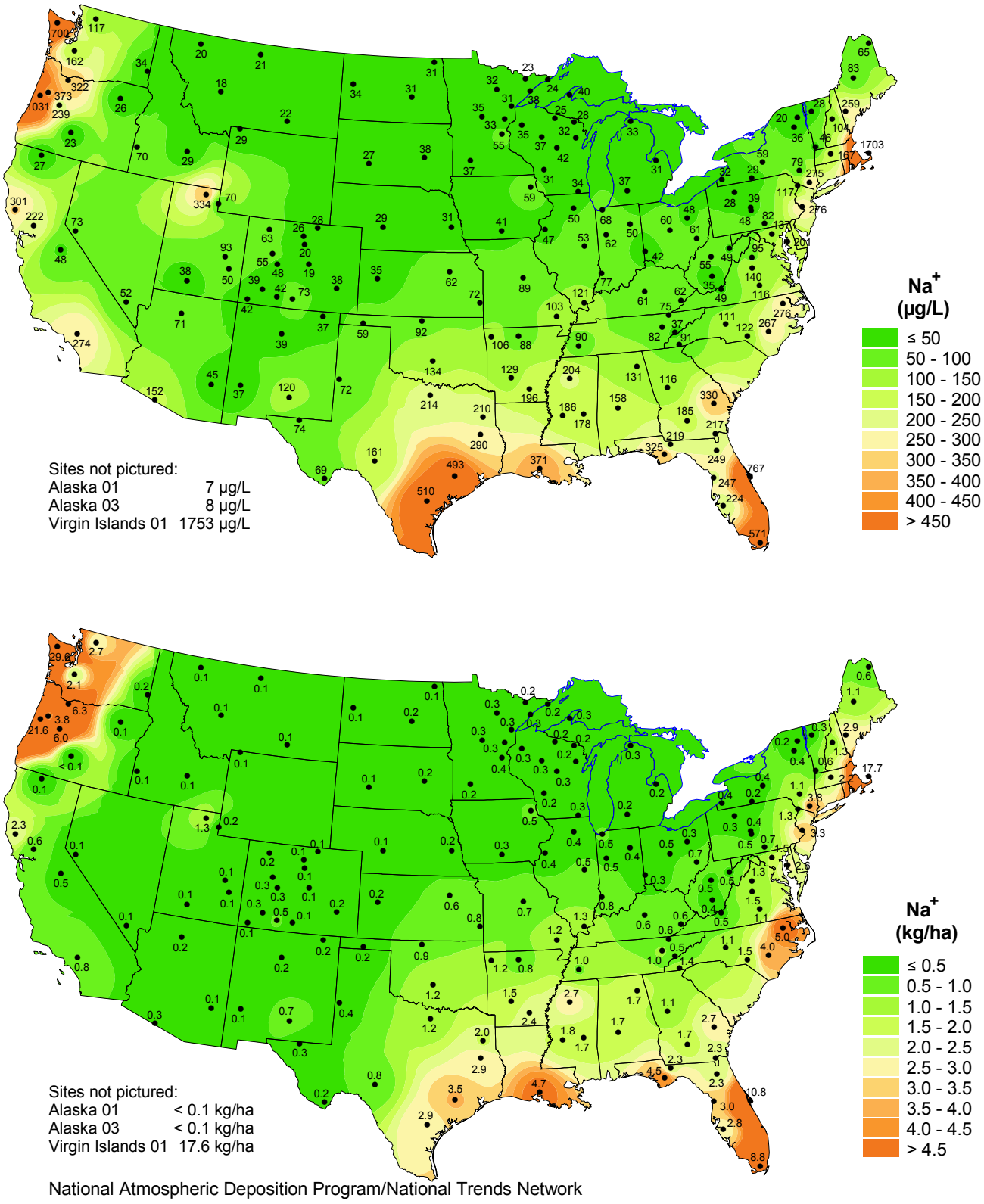
Ammonium ion concentration (top) and estimated deposition (bottom), 1999.



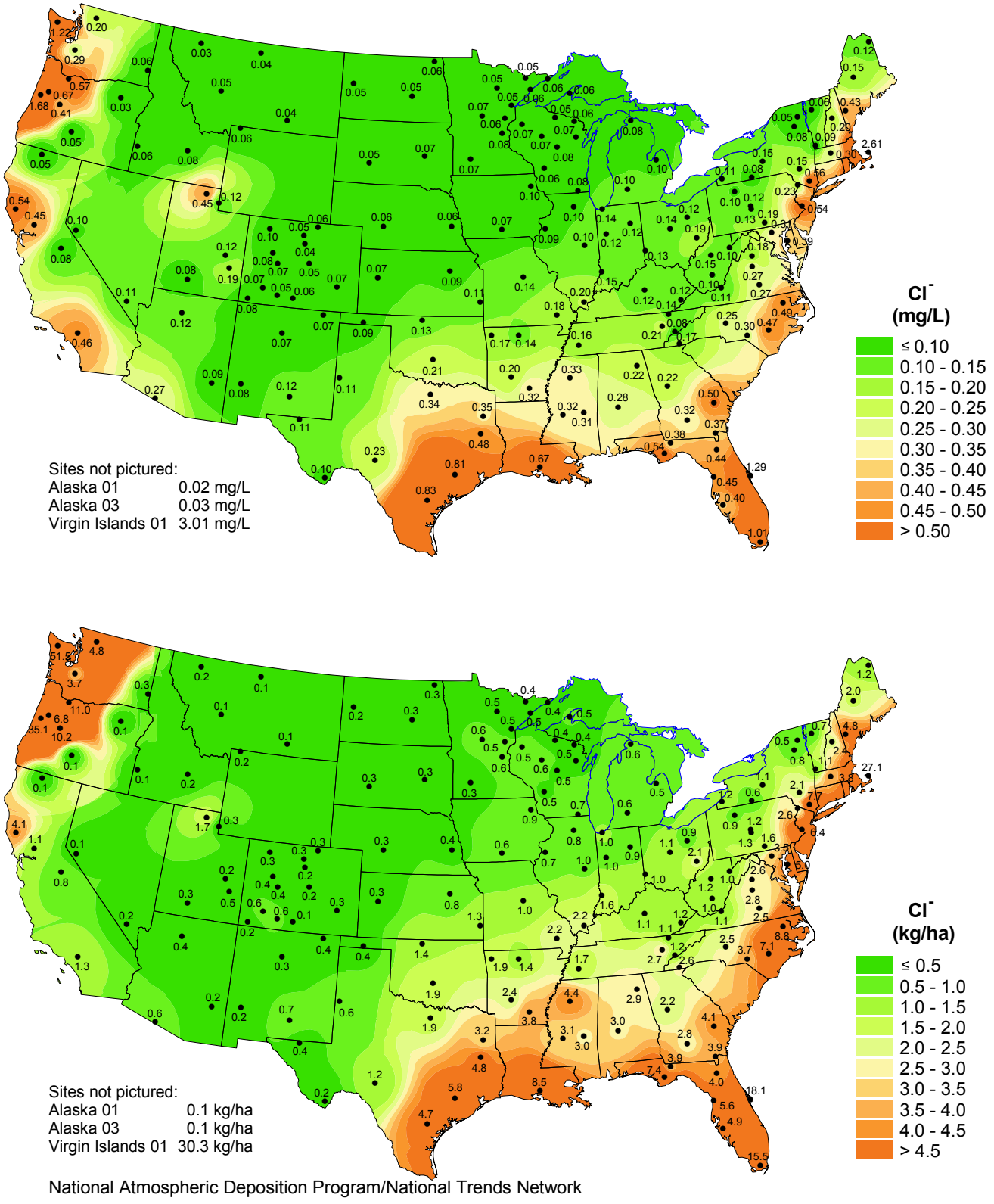
Calcium ion concentration (top) and estimated deposition (bottom), 1999.



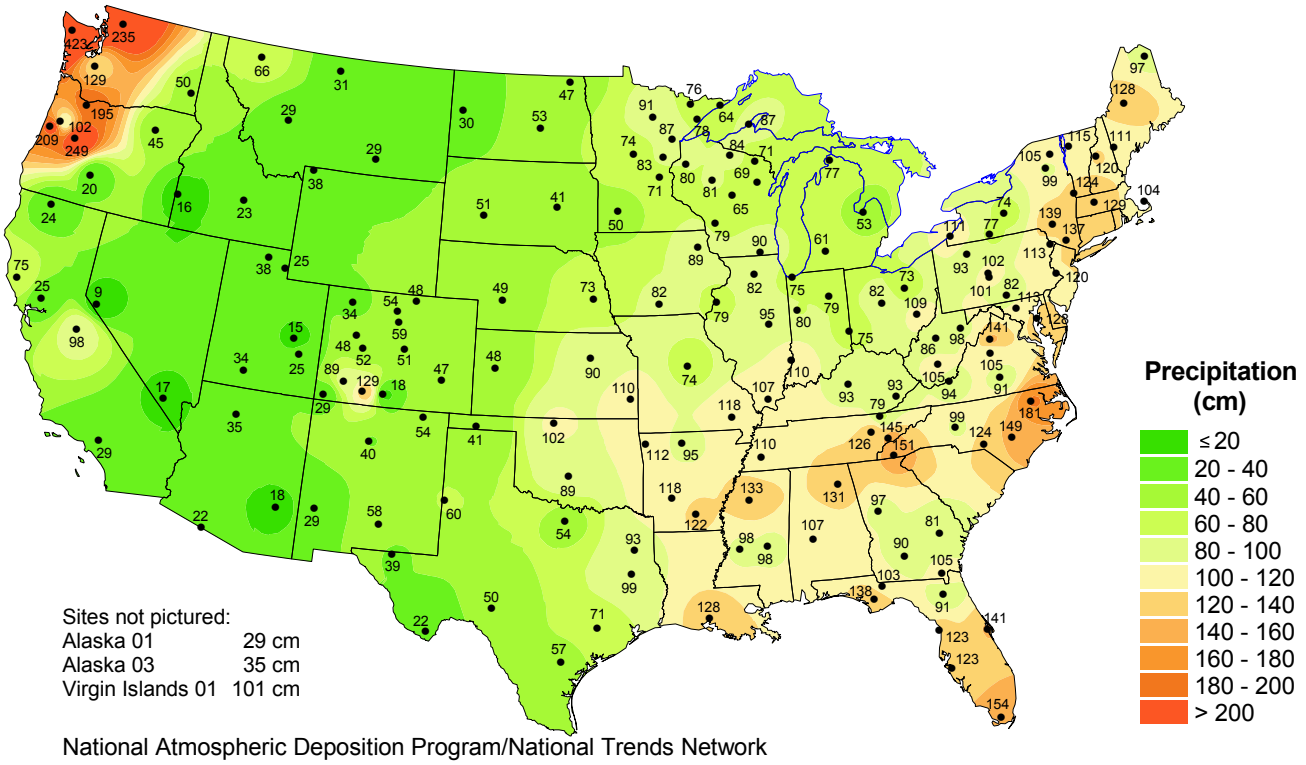
Magnesium ion concentration (top) and estimated deposition (bottom), 1999.



Sodium ion concentration (top) and estimated deposition (bottom), 1999.



Chloride ion concentration (top) and estimated deposition (bottom), 1999.

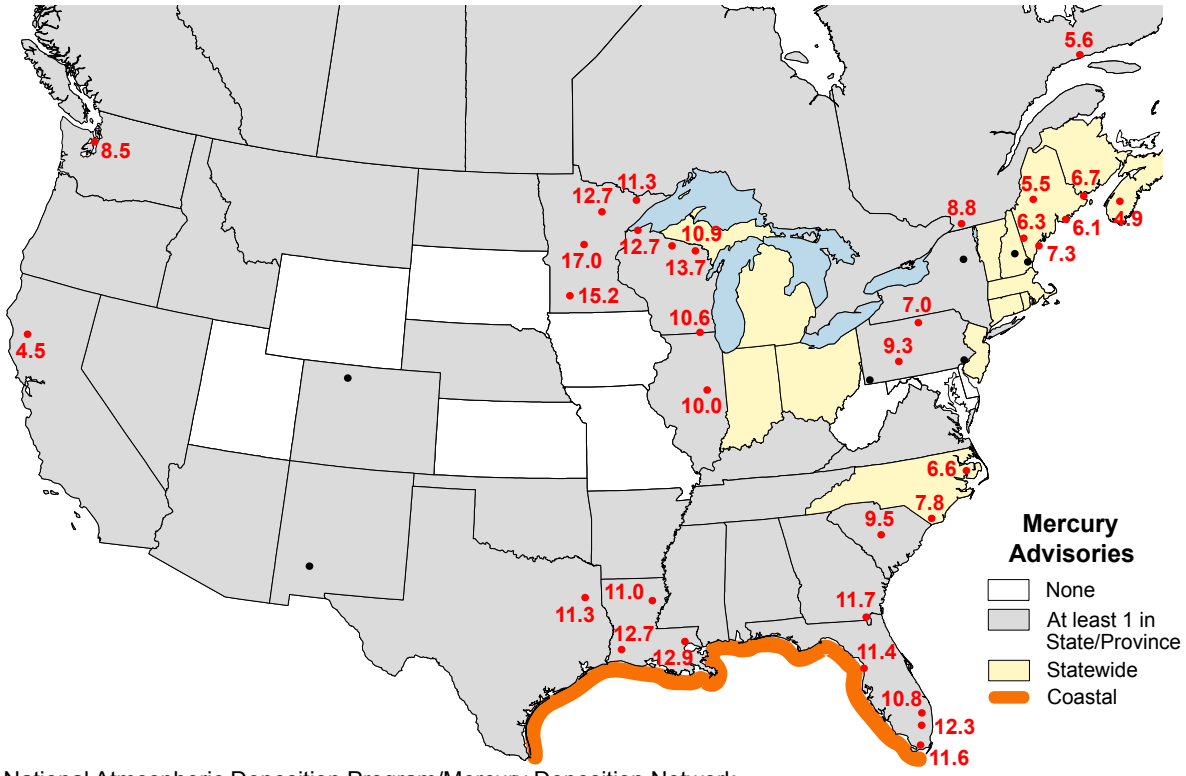


Total precipitation, 1999.

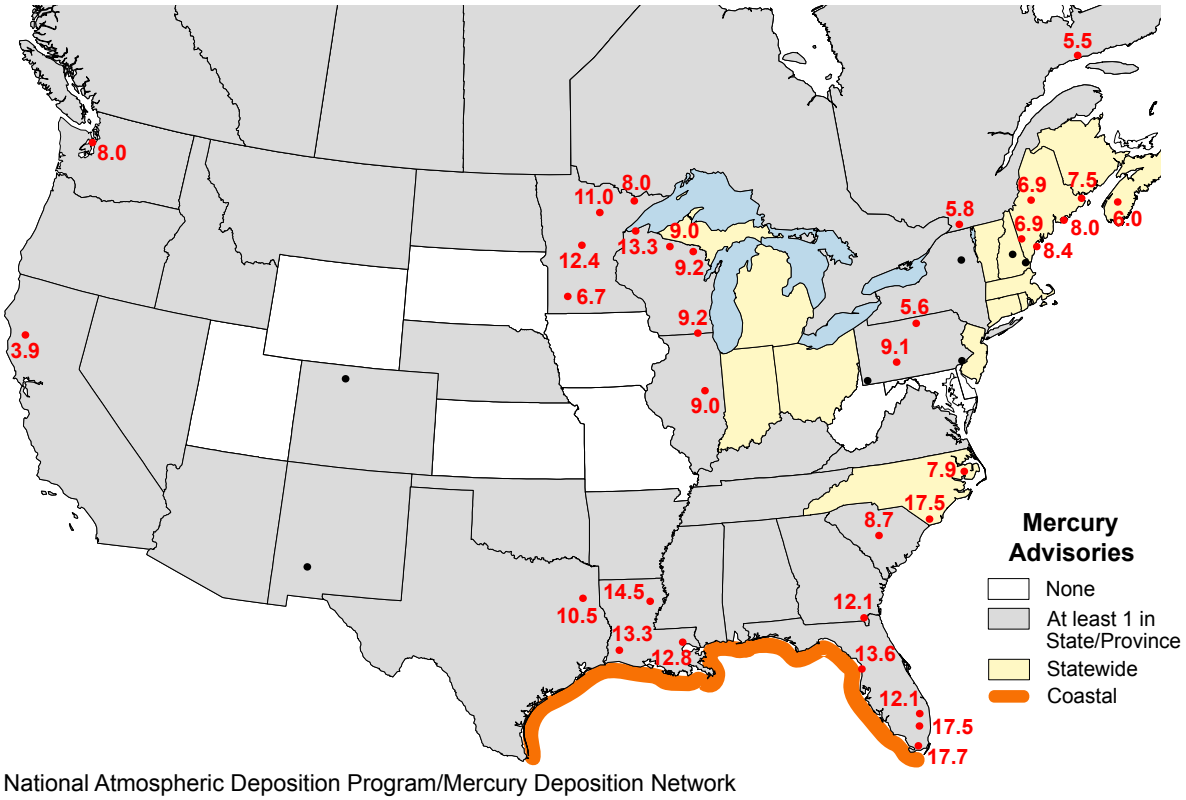
MDN Data

The MDN maps on the next page show the concentration and estimated deposition of total mercury in precipitation. Only sites meeting prescribed data completeness criteria are included. In 1999, 33 sites met these criteria. Red dots mark site locations. Annual concentration or deposition values are printed next to each site. The concentrations are precipitation-weighted averages. Black dots indicate the locations of MDN sites that were active in 1999 but did not meet all completeness criteria. (For an explanation of the data completeness criteria and how precipitation-weighted averages or deposition fluxes were calculated, see the NADP Internet site.)

Mercury concentrations and estimated 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. For more information about mercury advisories, see the U.S. Environmental Protection Agency Internet site at http://www.epa.gov/ost/fish.

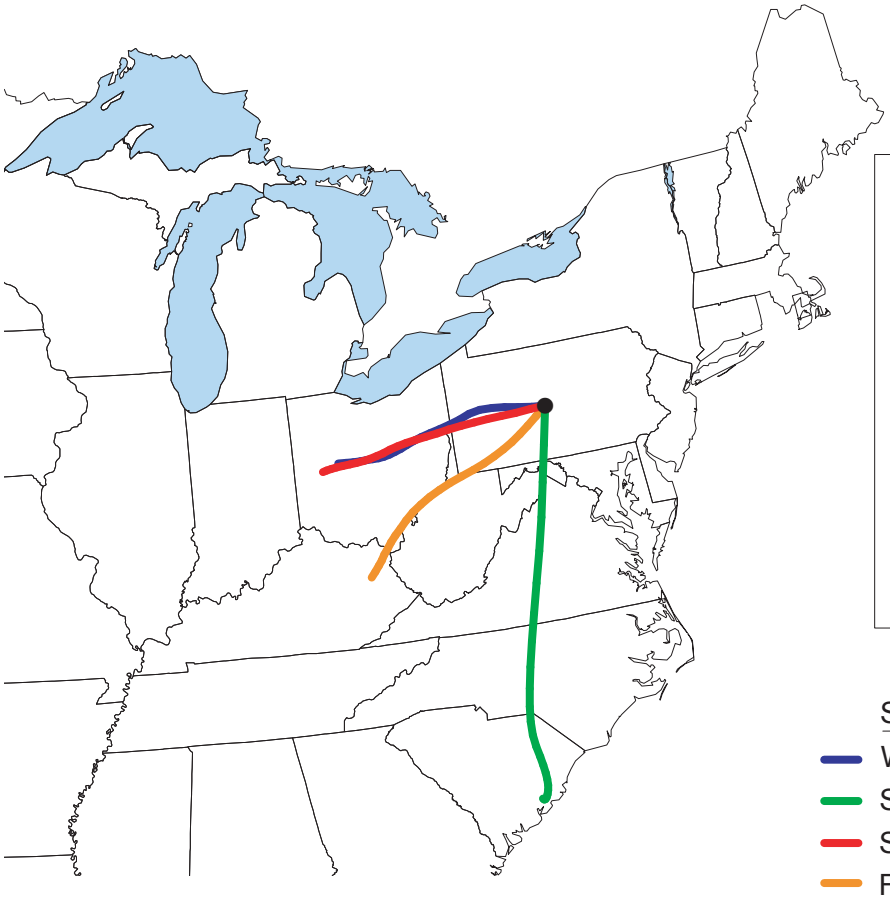


National Atmospheric Deposition Program/Mercury Deposition Network



National Atmospheric Deposition Program/Mercury Deposition Network

Mercury concentration in ng/L (top) and estimated deposition in µg/m^2(bottom), 1999.



Using the National Oceanic and Atmospheric Administration's (NOAA) HYSPLIT model, you can now run trajectories for selected AIRMoN samples on the NADP Internet site (http://nadp.sws.uiuc.edu/hysplit). For information about HYSPLIT, see NOAA's Air Resources Laboratory site (http://www.arl.noaa.gov/ss/models/hysplit.html).

Season	Date	SO_4^{2-} (µeq/L)	pH
Winter	25 Jan 99	87	3.88
Spring	03 Mar 99	119	3.84
Summer	05 Aug 99	113	3.79
Fall	20 Sep 99	121	3.90

Air parcel trajectories for four storms at the Penn State AIRMoN site.

AIRMoN Data

The above map depicts the paths of four air parcels moving from different locations toward the Penn State site (40.79 N, 77.95 W), where the paths end and precipitation was collected in AIRMoN samples. Each sample had a sulfate concentration in the highest 25th percentile (above 81.9 micro-equivalents per liter) and a pH in the lowest 25th percentile (below 4.01). For illustrative purposes, one sample meeting these criteria was chosen from each season: winter (light snow, 25 January), spring (light rain, 3 March), summer (thundershower, 5 August), and fall (rain, 20-21 September). Among the ten AIRMoN sites active in 1999, the Penn State site was selected because of its central location in the network.

The National Oceanic and Atmospheric Administration's (NOAA) HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) model was used to compute these air parcel paths or trajectories. HYSPLIT used meteorological data from NOAA's National Centers for Environmental Prediction to calculate these trajectories. Although not displayed on this map, HYSPLIT calculated both horizontal and vertical parcel motions, from the vertical velocities in the meteorological data.

Trajectories in this map follow the modeled 24-hour track of air parcels arriving at the approximate bottom of the cloud layer, 500 meters above ground in winter, 1000 meters in spring and fall, and 1500 meters in summer.

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 an Aerochem Metrics precipitation chemistry collector and a Belfort recording precipitation gage. The precipitation collection bucket on the Aerochem is open only when precipitation is occurring. This is wet-only sampling. Rigorous siting criteria and standard operational procedures ensure the comparability and representativeness of NTN data.

Samples are collected on a weekly basis. The site operator then transfers the precipitation sample from the collection bucket to a shipping bottle. All collection buckets and sample bottles are cleaned at the Central Analytical Laboratory (CAL) at the Illinois State Water Survey. If there is sufficient sample, the site operator pours off a portion and measures pH and conductivity. The sample is then shipped to the CAL for analysis, data entry, and data validation. The CAL has served as the sole analytical laboratory since the program began. The following measurements are made in samples of sufficient 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. Once the CAL finishes data review and validation, data are delivered 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 have the same siting criteria and equipment as NTN sites, with one exception: AIRMoN sites are equipped with a National Weather Service standard precipitation gage. AIRMoN operators collect samples daily within 24 hours of the start of precipitation. Samples are refrigerated after collection and until analysis at the CAL. 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.

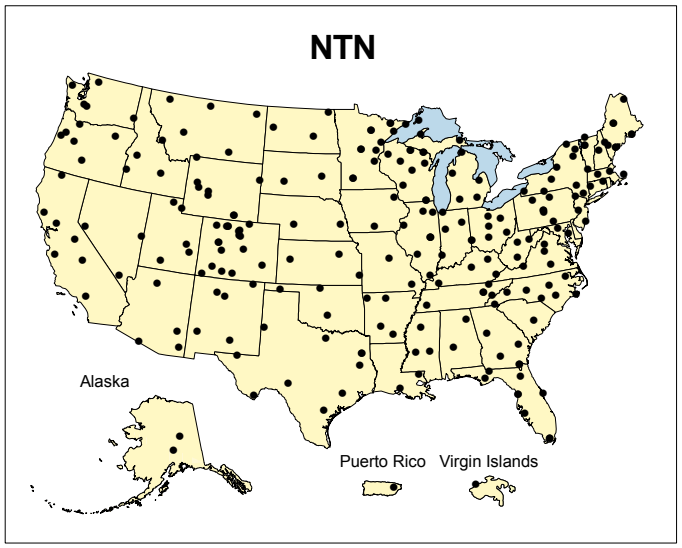
MDN Operations

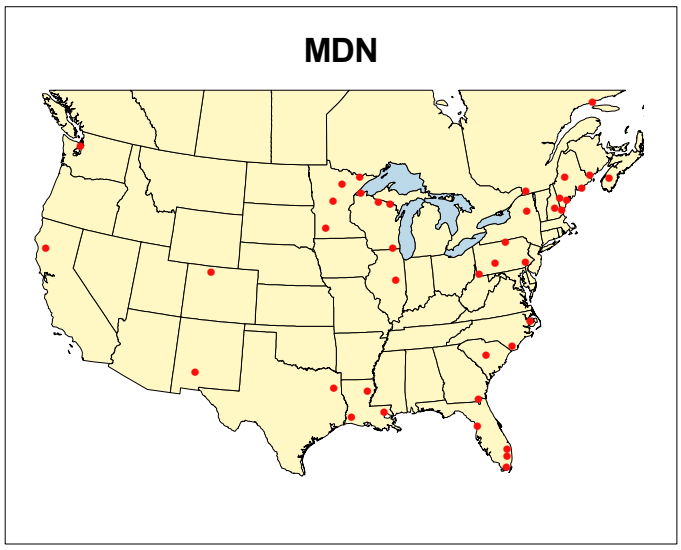
MDN sites collect samples weekly using a modified Aerochem Metrics collector equipped with ultraclean glassware. Rigorous sample handling procedures are followed. Samples are analyzed for total mercury (Hg) at the Hg Analytical Laboratory (HAL) at Frontier Geosciences, Inc., in Seattle, Washington. Data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

Recent NADP Accomplishments

NADP has:

- Provided data for a report on deposition trends in three environmentally sensitive areas of the eastern United States. See *Acid Rain, Emissions Trends and Effects in the Eastern United States* at Internet site (http://www.gao.gov/cgi-bin/getrpt?GAO/RCED-00-47).
- Contributed seven papers for a special NADP section in the journal, *Atmospheric Environment*, Volume 34, Number 11.
- Cooperated with the National Science Teachers Association to develop a science activity book in which students (grades 9-12) use on-line NADP data. See Internet site (http://www.nsta.org/pubs/nstapress).





Note:
When referencing maps or information in this report, please use the citation: National Atmospheric Deposition Program. 2000. *National Atmospheric Deposition Program 1999 Annual Summary.* NADP Data Report 2000-02a. Illinois State Water Survey, Champaign, IL.

Support for NADP comes from a diverse group of sponsors and participants, ranging from landowners who provide a site location to federal agencies that fund dozens of sites. These include a high school, the U.S. Military Academy, the Kennedy Space Center, Native American tribal organizations, private companies, city governments, state agencies, universities, Forest Experiment Stations, State Agricultural Experiment Stations, national laboratories, agencies of the Canadian government, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the National Park Service, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service, the Tennessee Valley Authority, and the Cooperative State Research, Education, and Extension Service.

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.
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