PRECIPITATION CHEMISTRY TRENDS IN THE UNITED STATES: 1980-1993

Summary Report

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Program of the
State Agricultural Experiment Stations (NRSP-3)
Federal Acid Precipitation Task Force
State Agencies and Private Research Organizations

The National Atmospheric Deposition Program (NADP) was initiated in 1977 under the leadership of the State Agricultural Experiment Stations (SAES) to address the problem of atmospheric deposition and its effects on agricultural crops, forests, rangelands, surface waters and other natural and cultural resources. In 1978, the first sites of the NADP's precipitation chemistry network were established to provide information about geographical patterns and temporal trends in the deposition of acidic chemicals and nutrients. Initially organized as Regional Project NC-141 by the North Central Region of the SAES, the NADP was endorsed by all four regions in 1982, at which time it became Interregional Project IR-7. A decade later, the SAES reclassified IR-7 as a National Research Support Project, NRSP-3.

In 1982, the federally-supported National Acid Precipitation Assessment Program (NAPAP) was established to provide broadened support for research into the causes and effects of acid deposition. This program includes research, monitoring and assessment activities that emphasize the timely development of a firm scientific basis for decision making. Because of its experience in designing, organizing and operating a national-scale monitoring network, the NADP was asked to assume responsibility for coordinating the operation of the National Trends Network (NTN) of NAPAP. As the NADP and NTN had common siting criteria and operational procedures, and shared a common analytical laboratory, the networks were merged with the designation NADP/NTN. Many of the NTN sites are supported by the U.S. Geological Survey (USGS), which serves as the lead federal agency for deposition monitoring under NAPAP.

Seven federal agencies support NADP/NTN research and monitoring under NAPAP: the USGS, U.S. Department of Agriculture (USDA) Cooperative State Research, Education, and Extension Service (CSREES) and U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land Management (BLM), National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA). Additional support is provided by various other federal agencies, state agencies, universities, public utilities and industry, as well as the SAES. The current network consists of approximately 200 sites.

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Precipitation Chemistry Trends in the United States: 1980-1993

Summary Report

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National Atmospheric Deposition Program
1995

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INTRODUCTION

Purpose of Report

One of the primary objectives of the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is to determine geographical patterns and temporal trends in precipitation chemistry in the United States. To meet this objective, the NADP/NTN established and maintains nearly 200 monitoring stations throughout the United States. The NADP/NTN Coordination Office publishes annual reports describing precipitation chemistry at each site. These reports also contain graphics depicting geographical patterns of precipitation chemistry across the U.S. (NADP, 1980-1995). This report complements the annual reports by describing long-term (multiple-year) trends in precipitation chemistry at selected NADP/NTN sites.

Over the past decade, reports of temporal trends in NADP/NTN data have appeared sporadically in the scientific literature (Hirsch and Peters, 1989; Sisterson et al., 1990; Kessler et al., 1992; Baier and Cohn, 1993; Oehlert, 1993; Sirois, 1993; Hedin et al., 1994; Lynch et al., 1995). Many of the analyses have addressed a relatively small number of sites and/or a few analytes. This report covers the entire network, includes all NADP/NTN analytes, and incorporates data from the inception of the network (1978) through 1993. Trends in analyte concentrations are examined over three time periods: 1980-1993, 1983-1993, and 1985-1993. Trends at each site are additionally examined for the entire period of site operation. These latter results do not permit direct comparisons among sites because the number of years of record varies, a factor that can affect the direction, magnitude, and significance of temporal trends.

The information in this report provides a baseline against which changes in wet deposition resulting from implementation of the 1990 Amendments to the Clean Air Act can be assessed. As with other NADP/NTN data reports, this document emphasizes statistical description and summarization of the data. Interpretation is left largely to the reader; however, partial interpretation by the authors do appear in the accompanying text.

Program Overview

NADP/NTN monitoring stations are located in rural and semi-rural areas, away from large urban centers and point sources of atmospheric pollution. Stations are maintained under the sponsorship of various cooperating agencies and organizations. Candidate sites are evaluated for their ability to meet long-term spatial and temporal monitoring objectives of the program (Bigelow, 1984; Robertson and Wilson, 1985). Once a new location has been approved, instruments are installed and operated according to standardized criteria and protocols (Bigelow, 1984).

Cumulative, weekly samples of "wet deposition" are collected in Aerochem-Metrics Wet/Dry precipitation collectors. The samples are automatically covered between precipitation events to reduce evaporation and contamination. At each site, a Belfort recording gage provides a graphic record of the timing and amounts of precipitation over the seven-day sampling period. Sample volume, pH and specific conductance determinations are made by site personnel in the field laboratory. The sample is then sent to the program's Central Analytical Laboratory (CAL) at the Illinois State Water survey where measurements of sulfate, nitrate, chloride, ammonium, sodium, potassium, calcium, magnesium and orthophosphate ions; acidity (pH); and specific conductance are made (Peden, 1986; James, 1993). The samples and date are screened by the CAL for adherence to sample collection protocols and data quality criteria (Bowersox, 1984; Stensland et al., 1983).

Standardization of equipment and protocols help ensure uniformity of sample collection and processing and field laboratory operations (Bigelow and Dossett, 1988). Centralized data management, use of a single chemical analytical laboratory, and various quality assurance programs contribute to the comparability of data from different stations and over different periods of time (Aubertin et al., 1990). Annual reports of quality assurance results address laboratory operations (James, 1993; Nilles et al., 1993), site operations (Bigelow, 1986; Nilles et al., 1993), and overall program methodology, including data management. A network data base is maintained by the Program Coordination Office (NADP, 1980-1995) located at Colorado State University in Fort Collins, Colorado.

Organizational leadership for the NADP/NTN is provided by the State Agricultural Experiment Stations, through National Research Support Project 3 (NRSP-3), the Cooperative State Research, Education and Extension Service (CSREES), and the U.S. Geological Survey (USGS), the lead agency for wet deposition monitoring under the National Acid Precipitation Assessment Program. Independent quality assurance programs are operated by the USGS and the U.S. Environmental Protection Agency. Decisions regarding scientific and technical aspects of the program are made by a Technical Committee comprised of program participants, including scientists, technical specialists, and representatives of industry and government agencies. Program accomplishments and Technical Committee decisions are summarized in annual technical reports (e.g., NADP, 1995b). Research results are presented at annual Technical Committee meetings and in scientific literature. Overall program management and data services are provided by the NADP/NTN Program Coordination Office.

METHODS

Ecoregion Designations

Geographic regions in this report are derived from **Bailey's Ecoregions of the United States** (Bailey, 1976, 1980). Bailey's classification was selected because it served as the ecological framework for the design of the National Trends Network (Robertson and Wilson, 1985) and it reflects environmental factors (climate, physiography, vegetation, soils, etc.) that can influence the quantity, chemical composition, and environmental effects of atmospheric deposition in a region.

Bailey's classification is hierarchical, consisting of four levels: Domain, Division, Province, and Section. In this report, the conterminous U.S. was divided into 11 regions based largely on Bailey's Divisions. In a few cases, divisions were divided or combined to produce regions of more similar size. The regions are identified by number and by labels reflecting predominant climate, vegetation, or topography (Figures la-lc).

Five sites outside the conterminous U.S. were classified into four additional, numerical regions. The two sites in Alaska were assigned to region 12; sites in Puerto Rico, American Samoa, and Hawaii were assigned to regions 13, 14, and 15, respectively. Sites in these regions are included in summary tables, but are not shown on any of the summary maps.

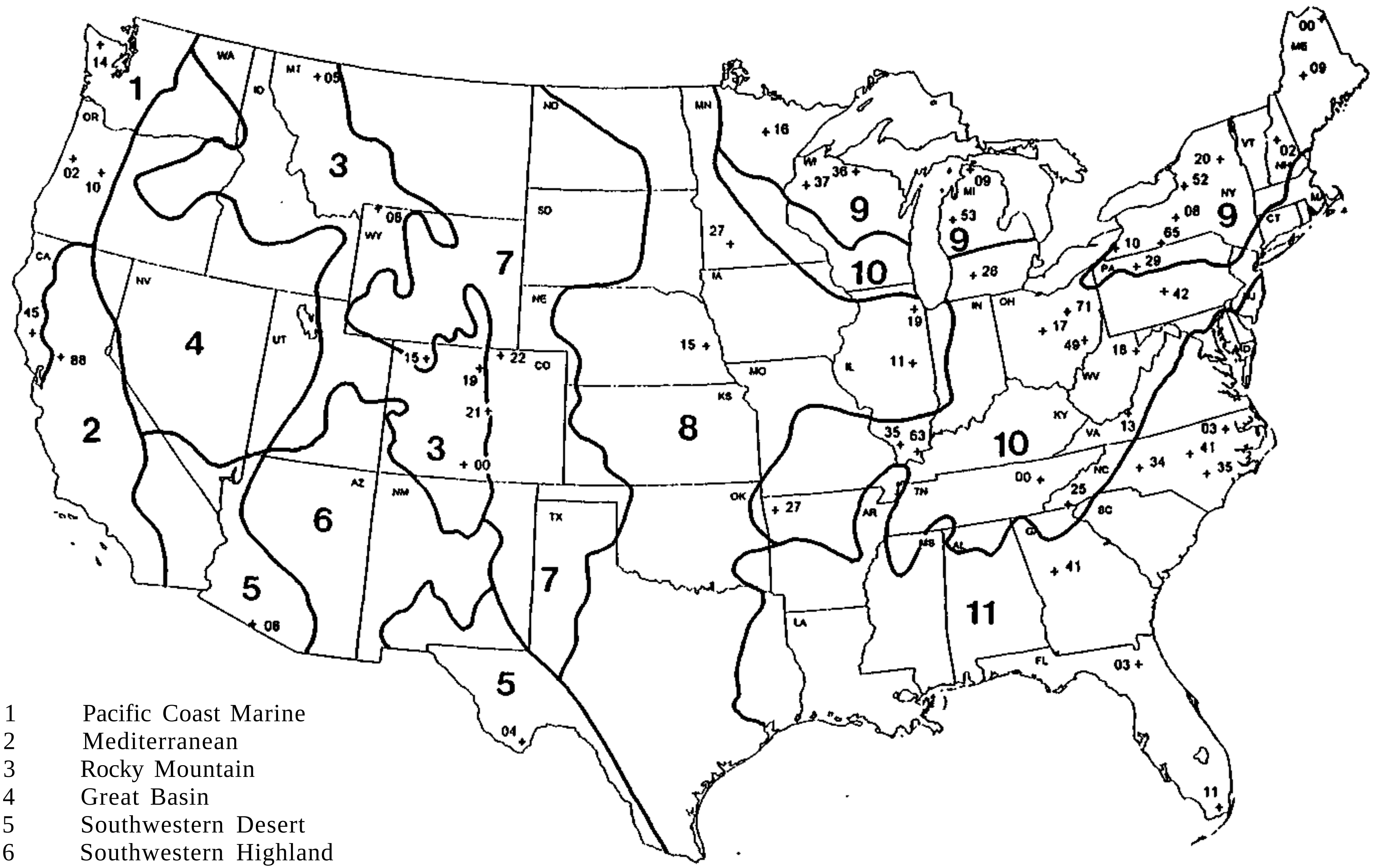
Summary Periods

Trends in analyte concentrations were examined for sites in continuous operation throughout the summary period. Three summary periods were chosen: 1980-1993, 1983-1993, and 1985-1993. Major network growth occurred between 1980 and 1985. Choosing successively later start dates allows comparisons of the results among larger numbers of sites having greater spatial coverage. Site specifics including site name, CAL code, etc. are listed in Table 1. Site locations for each summary period are shown in Figures la-lc. In addition to the three fixed-length periods, trends at each site were examined for the entire period of site operation. Sites were included in this portion of the analysis if they had a minimum of five years of continuous operation. All sites included in this "non-standard trend period" analysis are also listed in Table 1. These latter results do not permit direct comparison between sites because the length (number of years) of record varies between sites, a factor that can affect the direction, magnitude, and significance of temporal trends.

The NADP/NTN data base was divided into three summary periods to facilitate data interpretation and to assess the effects of the length of the summary period on temporal trends. Twenty NADP sites have been in operation since 1978, too few to perform meaningful spatial comparisons. In order to optimize the number of sites and the length of record, data from 1980 through 1993 were selected to be representative of the longest data record. A total of 52 sites were in operation over this summary period. Although relatively large in number, the lack of sites in some regions of the country (Figure la) makes it very difficult to provide meaningful spatial analyses. Shortening the length of the summary period by three years (1983-1993) weakens somewhat temporal analyses, but significantly improves spatial resolution. During this period, 86 sites were in operation in the Network with all regions of the country being represented, although some by only one site (Figure lb). The number of sites was increased to 155 by limiting the analyses to sites in operation from 1985 through 1993. Although this summary period provides the best spatial resolution and each region contains multiple sites (Figure lc), the ability to detect temporal trends is weakened because only nine years of continuous monitoring data are included in the analysis. Despite these shortcomings trend analyses from the three summary periods provide information on the degree of change over time and the importance of changes in the early to mid-1980s.

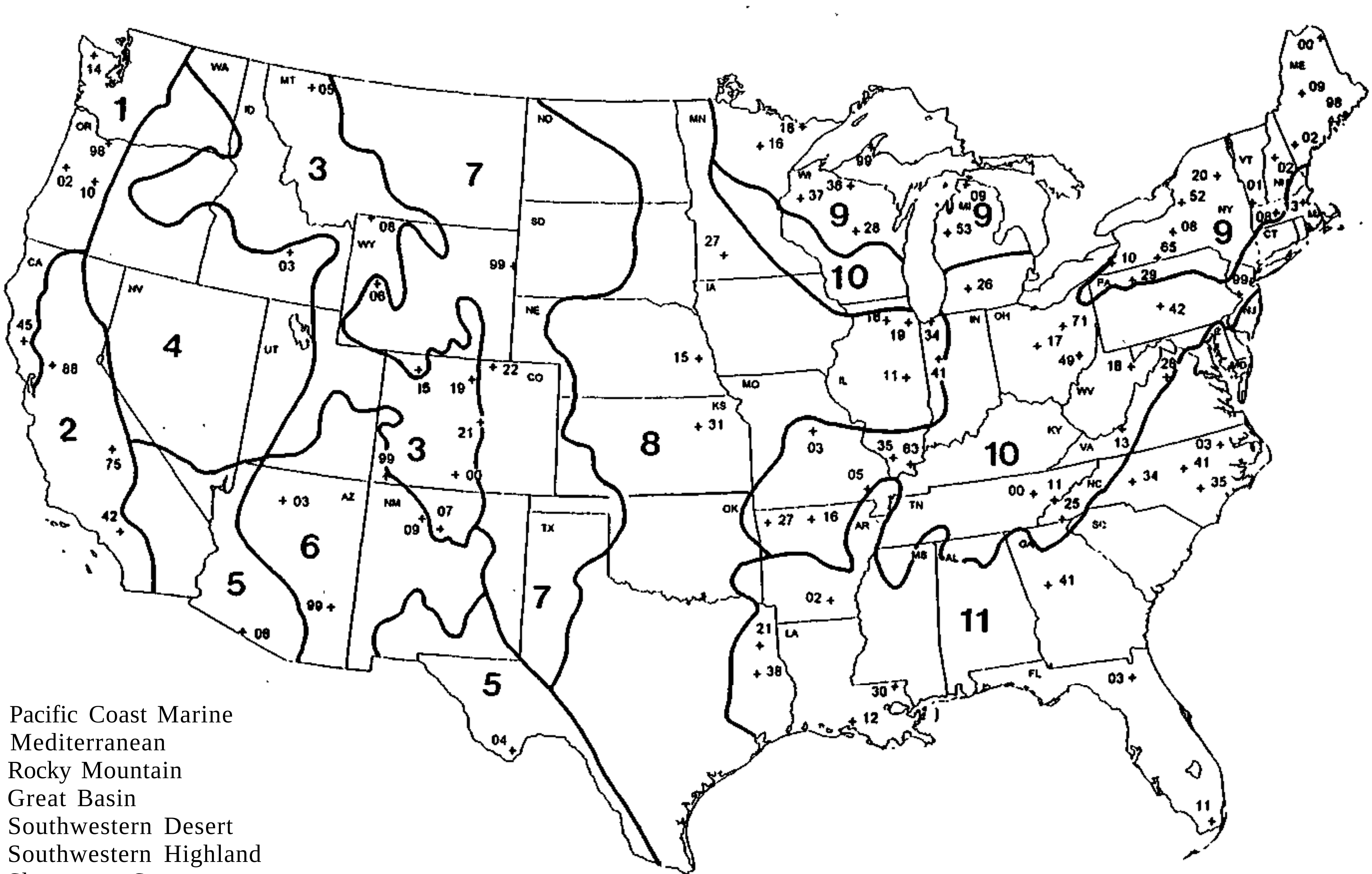
Trend Analyses

For use in trend analyses, weekly precipitation volume and chemistry observations from each network site for each summary period discussed above (1980-1993, 1983-1993, 1985-1993) were accumulated into bi-monthly precipitation totals and volume-weighted mean concentrations



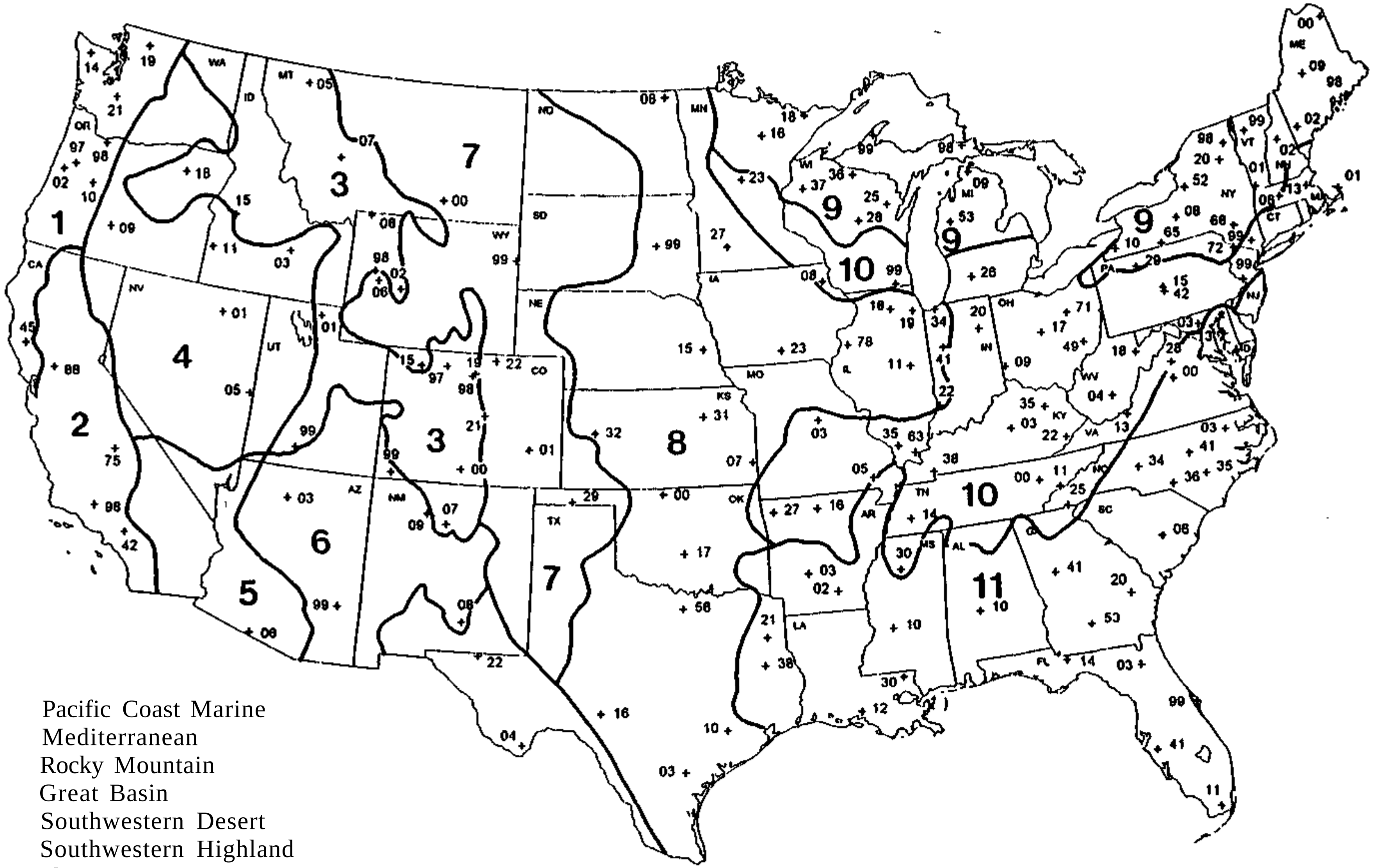
1 Pacific Coast Marine
2 Mediterranean
3 Rocky Mountain
4 Great Basin
5 Southwestern Desert
6 Southwestern Highland
7 Shortgrass Steppe
8 Prairie
9 Northeastern Mixed Forest
10 Eastern Deciduous Forest
11 Southeastern Subtropical Forest

Figure la. Location of NADP/NTN sites by ecoregion for the 1980-1993 summary period.



1 Pacific Coast Marine
2 Mediterranean
3 Rocky Mountain
4 Great Basin
5 Southwestern Desert
6 Southwestern Highland
7 Shortgrass Steppe
8 Prairie
9 Northeastern Mixed Forest
10 Eastern Deciduous Forest
11 Southeastern Subtropical Forest

Figure lb. Location of NADP/NTN sites by ecoregion for the 1983-1993 summary period.



1 Pacific Coast Marine
2 Mediterranean
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5 Southwestern Desert
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8 Prairie
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Figure lc. Location of NADP/NTN sites by ecoregion for the 1985-1993 summary period.

Table 1. Alphabetical listing of NADP/NTN sites. Sites are identified by state, CAL code, name, and ecoregion in which they are located. Dates of operation and specific trend periods included in this report are also indicated.

				Dates of Operation		Trend Periods			
State	Site	Station	Region	Start	Stop	80-93	83-93	85-93	NS*
Alaska	ak01	Poker Creek	12	92/12/29					
	ak03	Denali National Park	12	80/06/17		+	+	+	+
Alabama	al10	Black Belt Substation	11	83/08/31				+	+
	al99	Sand Mountain Experiment Station	10	84/10/02					+
Arkansas	ar02	Warren 2USU	11	82/05/25			+	+	+
	ar03	Caddo Valley	11	83/12/30				+	+
	ar16	Buffalo National River	10	82/07/13			+	+	+
	ar27	Fayetteville	10	80/05/13		+	+	+	+
Arizona	az01	Tombstone	6	79/03/27	81/09/01				
	az03	Grand Canyon Nat'l Park	6	81/08/11			+	+	+
	az06	Organ Pipe Cactus Nat'l Mon.	5	80/04/15		+	+	+	+
	az99	Oliver Knoll	6	81/08/25			+	+	+
California	ca34	Bishop	4	80/04/15	82/06/22				
	ca42	Tanbark Flat	2	82/01/12			+	+	+
	ca45	Hopland	1	79/10/03		+	+	+	+
	ca68	Palomar Mountain	2	83/03/15	88/01/12				+
	ca75	Sequoia Nat'l Park-Giant Forest	2	80/07/08			+	+	+
	ca76	Montague	2	85/06/25					+
	ca85	Channel Islands Nat'l Park	2	80/07/22	82/02/19				
	ca88	Davis	2	78/09/04		+	+	+	+
	ca98	Chuchupate Ranger Station	2	83/08/02				+	+
	ca99	Yosemite National Park	2	81/12/08					+
Colorado	co00	Alamosa	3	80/04/22		+	+	+	+
	co01	Las Animas Fish Hatchery	7	83/10/04				+	+
	co02	Niwot Saddle	3	84/06/05					+
	co08	Four Mile Park	3	87/12/29					+
	co15	Sand Spring	7	79/03/20		+	+	+	+
	co19	Rocky Mountain Nat'l Park-Beaver Meadows	3	80/05/29		+	+	+	+
	co21	Manitou	3	78/10/17		+	+	+	+
	co22	Pawnee	7	79/05/22		+	+	+	+
	co91	Wolf Creek Pass	3	92/05/26					
	co92	Sunlight Peak	3	88/01/13					+
	co93	Dry Lake	3	86/10/14					+
	co94	Sugarloaf	3	86/11/04					+
	co95	Engineer Mountain Guard Station	3	86/07/29	90/01/02				
	co96	Molas Pass	3	86/07/29					+
	co97	Buffalo Pass	3	84/02/07				+	+
	co98	Rocky Mountain Nat'l Park-Loch Vale	3	83/08/16				+	+
	co99	Mesa Verde National Park	6	81/04/28			+	+	+
Florida	fl00	Austin-Cary Forest		78/10/10	81/07/14				
	fl03	Bradford Forest		78/10/10		+	+	+	+
	fl11	Everglades National Park		80/06/17		+	+	+	+
	fl14	Quincy		84/03/13				+	+
	fl41	Verna Well Field		83/08/25				+	+
	fl99	Kennedy Space Center		83/08/02				+	+
Georgia	ga20	Bellville		83/04/26				+	+
	ga23	Fort Frederics Nat'l Monument		85/09/03	88/09/27				
	ga41	Georgia Station		78/10/03		+	+	+	+
	ga50	Tifton ARS		83/10/04	94/02/10			+	+
	ga99	Chula		94/02/10					
Hawaii	hi00	Mauna Loa	15	80/06/10	93/09/28				+
Iowa	ia08	Big Springs Fish Hatchery	10	84/08/14				+	+
	ia23	McNay Research Center	8	84/09/11				+	+
Idaho	id03	Craters of the Moon Nat'l Monument	4	80/08/22			+	+	+
	id04	Headquarters	3	82/07/20	91/09/25				+
	id11	Reynolds Creek	4	83/11/22				+	+
	id15	Smiths Ferry	3	84/10/09				+	+
Illinois	il11	Bondville	8	79/02/27		+	+	+	+
	il18	Shabbona	8	81/05/26			+	+	+
	il19	Argonne	8	80/03/11		+	+	+	+
	il35	Southern Illinois University	10	79/07/31	94/01/04	+	+	+	+
	il47	Salem	8	80/04/15	88/11/22				+
	il63	Dixon Springs Ag. Center	1	79/01/30		+	+	+	+
	il78	Monmouth	8	85/01/08				+	+
	il99	Omega	8	89/09/26	93/09/28				

*Non-standard trend period

Table 1 (continued).

State	Site	Station	Region	Dates of Operation Start	Stop	Trend Periods 80-93	83-93	85-93	NS*
Indiana	in20	Huntington Reservoir	10	83/08/22				+	+
	in22	Southwest Purdue Agricultural Center	8	84/09/25				+	+
	in34	Indiana Dunes Nat'l Lakeshore	8	80/07/15			+	+	+
	in41	Purdue Agricultural Research Center	8	82/07/13			+	+	+
Kansas	ks07	Farlington Fish Hatchery	8	84/03/27				+	+
	ks31	Konza Prairie	8	82/08/17			+	+	+
	ks32	Lake Scott State Park	8	84/03/27				+	+
Kentucky	ky03	Mackville	10	83/11/29				+	+
	ky22	Lilley Cornett Woods	10	83/09/06				+	+
	ky35	Clark State Fish Hatchery	10	83/08/30				+	+
	ky38	Land Between the Lakes	10	84/10/02				+	+
Louisiana	la06	Hill Farm Research Station	11	82/11/16	88/01/26				+
	la12	Iberia Research Station	11	82/11/16			+	+	+
	la30	Southeast Research Station	11	83/01/18			+	+	+
Hassachusettes	ma01	North Atlantic Coastal Lab	10	81/12/15				+	+
	ma08	Quabbin Reservoir	9	82/03/05			+	+	+
	ma13	East	10	82/02/02			+	+	+
Maryland	md03	White Rock	10	84/10/03				+	+
	md13	Wye	11	83/03/08				+	+
	meOO	Caribou	9	80/04/14		+	+	+	+
Maine	me02	Bridgton	9	80/09/30			+	+	+
	me09	Greenville Station	9	79/11/20		+	+	+	+
	me97	Presque Isle	9	84/06/05	88/09/27				
	me98	Acadia Nat'l Park-McFarland Hill	9	81/11/03			+	+	+
	me99	Acadia Nat'l Park-Paradise Hill	9	80/11/18	81/11/03				
Michigan	mi09	Douglas Lake	9	79/07/03		+	+	+	+
	mi22	Houghton	9	80/10/26	83/02/15				
	mi25	Isle Royale Nat'l Park-Windigo	9	80/08/12	84/10/22				
	mi26	Kellogg Biological Station	10	79/06/26		+	+	+	+
	mi53	Uellston	9	78/10/10		+	+	+	+
	mi97	Isle Royale Nat'l Park-Wallace Lake	9	85/05/22					+
	mi98	Raco	9	84/05/01				+	+
	mi99	Chassell	9	83/02/15			+	+	+
Minnesota	mn16	Marcell Experimental Forest	9	78/07/06		+	+	+	+
	mn18	Fernberg	9	80/11/18			+	+	+
	mn23	Camp Ripley	10	83/10/18				+	+
	mn27	Lamberton	8	79/01/02		+	+	+	+
Missouri	mo03	Ashland Wildlife Area	10	81/10/20			+	+	+
	mo05	University Forest	10	81/10/27			+	+	+
	mo50	Baker Observatory	10	86/10/14	88/05/10				
Mississippi	ms10	Clinton	11	84/07/10				+	+
	ms14	Meridian	11	80/04/15	90/01/02				+
	ms19	Newton	11	86/11/11					+
	ms30	Coffeeville	10	84/07/17				+	♦
Montana	mtOO	Little Big Horn Battlefield N.M.	7	84/07/13				+	+
	mt05	Glacier Nat'l Park-Fire Weather Station	3	80/06/03		+	+	+	+
	mt07	Clancy	3	84/01/24				+	+
	mt13	Give Out Morgan	7	82/09/14					+
	mt97	Lost Trail Pass	3	90/09/25					
	mt98	Havre Experiment Station	7	85/07/30					+
	mt99	Glacier Nat'l Park-St. Mary Station	7	83/01/25	89/11/28				+
North Carolina	nc03	Lewiston	11	78/10/31		+	+	+	+
	nc11	Research Triangle Institute	11	80/10/14	83/01/04				
	nc25	Coweeta	10	78/07/05		+	+	+	+
	nc33	Research Triangle Park	11	80/04/15	83/03/01				
	nc34	Piedmont Research Station	11	78/10/17		+	+	+	+
	nc35	Clinton Crops Research Station	11	78/10/24		+	+	+	+
	nc36	Jordan Creek	11	83/10/18				+	+
	nc41	Finley Farm	11	78/10/03		+	+	+	+
	nc45	Mt. Mitchell	10	85/11/26					+
North Dakota	nd07	Theodore Roosevelt Nat'l Park	7	81/05/05					+
	nd08	Icelandic State Park	8	83/10/25				+	+
	nd11	Uoodworth	7	83/11/29					+
Nebraska	ne15	Mead	8	78/07/25		+	+	+	+
	ne99	North Platte Ag. Experiment Station	8	85/09/24					+
New Hampshire	nh02	Hubbard Brook	9	78/07/25		+	+	+	+
New Jersey	nj29	Princeton	10	80/08/06	81/07/07				
	nj99	Washington Crossing	10	81/08/04			+	+	+

Table 1 (continued).

State	Site	Station	Region	Dates of Operation Start	Stop	Trend Periods 80-93	83-93	85-93	NS*
New Mexico	nm01	Gila Cliff Dwellings Nat'l Monument	6	85/07/29					+
	nm07	Bandelier National Monument	3	82/06/22			+	+	+
	nm08	Mayhill	6	84/01/24				+	+
	nm09	Cuba	6	82/02/03			+	+	+
	nm12	Caput in Volcano Nat'l Monument	7	84/11/15					+
Nevada	nv00	Red Rock Canyon	5	85/01/22					+
	nv01	Saval Ranch	4	84/07/18				+	+
	nv03	Smith Valley	4	85/08/07					+
	nv05	Great Basin Nat'l Park-Lehman Caves	4	85/01/15				+	+
New York	ny08	Aurora Research Farm	9	79/04/17		+	+	+	+
	ny10	Chautauqua	9	80/06/10		+	+	+	+
	ny12	Knobit	9	80/01/02	85/08/06				+
	ny20	Huntington Wildlife	9	78/10/31		+	+	+	+
	ny51	Stilwell Lake	10	79/06/26	84/10/02				+
	ny52	Bennett Bridge	9	80/06/10		+	+	+	+
	ny65	Jasper	9	80/02/19		+	+	+	+
	ny68	Biscuit Brook	9	83/10/11				+	+
	ny98	Whiteface Mountain	9	84/07/03				+	+
	ny99	West Point	10	83/09/13				+	+
Ohio	oh09	Oxford	10	84/08/14				+	+
	oh17	Delaware	10	78/10/03		+	+	+	+
	oh49	Caldwell	10	78/09/26		+	+	+	+
	oh71	Wooster	10	78/09/26		+	+	+	+
Oklahoma	ok00	Salt Plains Nat'l Wildlife Refuge	8	83/12/13				+	+
	ok17	Great Plains Apiaries	8	83/03/29				+	+
	ok25	Clayton Lake	8	83/02/01	86/08/12				
	ok29	Goodwell Research Station	7	85/01/08				+	+
Oregon	or02	Alsea Guard Ranger Station	1	79/12/27		+	+	+	+
	or08	Lost Creek Dam	1	80/10/21	83/12/06				
	or09	Silver Lake Ranger Station	4	83/08/23				+	+
	or10	H. J. Andrews Experimental Forest	1	80/05/13		+	+	+	+
	or11	Vines Hill	4	80/07/15	93/03/30				+
	or17	Pendleton	4	80/04/15	82/06/15				
	or18	Starkey Experimental Forest	3	84/03/06				+	+
	or97	Hyslop Farm	1	83/04/26				+	+
	or98	Bull Run	1	82/07/13			+	+	+
	or99	Schmidt Farm	1	79/12/26	83/04/26				
Pennsylvania	pa15	Penn State	10	83/06/07				+	+
	pa29	Kane Experimental Forest	9	78/07/18		+	+	+	+
	pa42	Leading Ridge	10	79/04/25		+	+	+	+
	pa72	Milford	9	83/12/27				+	+
South Carolina	sc06	Santee Nat'l Wildlife Refuge	11	84/07/19				+	+
	sc18	Clemson	11	79/03/27	86/06/17				+
South Dakota	sd00	Huron	8	80/04/30	83/09/20				
	sd08	Cottonwood	7	83/10/11					+
	sd99	Huron Well Field	8	83/11/29				+	+
Tennessee	tn00	Walker Branch Watershed	10	80/03/11		+	+	+	+
	tn11	Great Smoky Mountains Nat'l Park-Elkmont	10	80/08/12			+	+	+
	tn14	Hatchie Nat'l Wildlife Refuge	10	84/10/02				+	+
	tn98	Wilburn Chapel	10	90/01/02					
	tn99	Giles County	10	84/10/02	90/01/02				+
Texas	tx02	Muleshoe Nat'l Wildlife Refuge	7	85/06/18					+
	tx03	Beeville	8	84/02/07				+	+
	tx04	Big Bend Nat'l Park-K-Bar	5	80/04/10		+	+	+	+
	tx10	Attwater Prairie Chicken NWR	8	84/07/03				+	+
	tx16	Sonora	8	84/06/26				+	+
	tx18	Y Experimental Ranch	8	92/06/30					
	tx21	Longview	11	82/06/29			+	+	+
	tx22	Guadalupe Mountains Nat'l Park	5	84/06/05				+	+
	tx38	Forest Seed Center	11	81/08/18			+	+	+
	tx51	Throckmorton	8	84/05/29	92/05/19				+
	tx53	Victoria	8	80/04/15	88/09/27				+
	tx56	L.B.J. National Grasslands	8	83/09/20				+	+
Utah	ut01	Logan	3	83/12/06				+	+
	ut02	Cedar Mountain	6	81/05/11	84/01/17				
	ut08	Murphy Ridge	3	86/03/25					+
	ut98	Green River	6	85/04/25					+
	ut99	Bryce Canyon National Park	3	85/01/29				+	+

Table 1 (continued).

State	Site	Station	Region	Dates of Operation Start	Stop	Trend Periods 80-93	83-93	85-93	NS*
Virginia	va00	Charlottesville	11	84/10/02				+	+
	va13	Norton's Station	10	78/07/25		+	+	+	+
	va28	Shenandoah Nat'l Park-Big Meadows	10	81/05/12			+	+	+
	va33	Love's Mill	10	84/10/02	85/07/02				
Vermont	vt01	Bennington	9	81/04/28			+	+	+
	vt99	Underbill	9	84/06/12				♦	♦
Washington	wa14	Olympic Nat'l Pk-Hoh Ranger Station	1	80/05/20		+	+	+	+
	wa15	Sullivan Lake	3	84/05/08	87/11/24				
	wa19	Cascades Nat'l Park-Marblemount	1	84/02/07				+	+
	wa21	La Grande	1	84/04/24				+	+
	wa24	Palouse Conservation Farm	4	85/08/20					+
Wisconsin	wi09	Popple River	9	86/12/30					+
	wi25	Suring	9	85/01/23				+	+
	wi28	Lake Dubay	9	82/06/29			+	+	+
	wi36	Trout Lake	9	80/01/22		+	+	+	+
	wi37	Spooner	9	80/06/03		+	♦	+	+
	wi98	Wildcat Mountain	10	89/08/01					+
	wi99	Lake Geneva	10	84/06/05				+	♦
West Virginia	uv04	Babcock State Park	10	83/09/06				+	+
	uv18	Parsons	10	78/07/05		+	+	+	+
Wyoming	wy00	Snowy Range	3	86/04/22					+
	wy02	Sinks Canyon	3	84/08/21				+	+
	wy06	Pinedale	7	82/01/26			+	+	♦
	wy08	Yellowstone Nat'l Park-Tower Falls	3	80/06/05		+	+	+	+
	wy95	Brooklyn Lake	3	92/09/22					
	uy96	Nash Fork	3	86/11/18	92/09/17				+
	wy97	South Pass City	7	85/04/30					+
	uy98	Gypsum Creek	3	84/12/26				+	+
	wy99	Newcastle	7	81/08/11			+	+	+
American Samoa	as01	Samoa	14	80/05/20	92/10/13				+
Puerto Rico	pr20	El Verde	13	85/02/12					

of hydrogen (from pH), sulfate, nitrate, chloride, ammonium, calcium, magnesium, potassium, and sodium ions. Orthophosphate was not included in the temporal trend analysis because a large percentage (>80%) of the weekly samples contain concentrations that are below the detection limit (0.003 mg/L). Only valid weekly observations were used to calculate bi-monthly volume-weighted mean concentrations. All samples had to have an adequate volume for a complete set of analyses. Sites and bimonthly records were selected for the trend analyses according to the following completeness criteria:

(1) Only those monitoring sites having weekly precipitation chemistry records from January 1980, January 1983, or January 1985 through December 1993, were considered. Further, at least 75 percent of the precipitation recorded during each summary period had to have valid chemical analyses in order for the site's data to be accepted for trend analyses.

(2) For a bi-monthly record to be accepted, at least 90 percent of the precipitation recorded during that period must have had a valid analysis for each ion.

(3) During each bi-monthly period, at least 50 percent of the weekly samples having sufficient volume to analyze (>35 mL) must have had a valid analysis for each ion.

Trends in the ionic concentration of precipitation at each site were evaluated using a two-stage, least squares general linear model (SAS Inst., 1988). The form of the model for both stages was,

$$\log(C_y) = b_0 + b_y{*}y + \sum_{s=1}^{6} b_s I_s$$

where, C_y = estimated concentration of a given ion at time y.
b_0 = intercept
b_y = slope of the long-term log-concentration trend.
y = mid-point of the bi-monthly observation period expressed as decimal years. For example, y for a May-June 1990 observation was coded as 90+(5/12) or 90.4167.
b_s = adjustment to estimate for bimonthly period, s. The array of 6 b_s coefficients account for the seasonal variation in precipitation chemistry.
I_s = an element of an array of 6 indicator variables set to 1 for bi-monthly period, s, and set to 0, otherwise.

Log-transformed concentrations were used because they have a more nearly normal distribution (Dana and Easter, 1987). After initially fitting the model to a site's concentration data (expressed as micro-equivalents/L) for a given ion, studentized residuals were calculated. Any bi-monthly observations having a studentized residual >3.5 in absolute value were eliminated from the data set and a second calculation of model coefficients was performed using the remaining observations. The selected cut-off value applied to the studentized residuals would be exceeded by chance at a rate less than 0.001 under the assumption of normally distributed residuals of constant variance.

Trends in concentration data were graphically represented by plotting each site's observed bi-monthly mean concentrations for each ion and two corresponding estimates of concentration against time, expressed as decimal years as illustrated in Figures 2a, 2b and 3a, 3b for the Bondville, IL site (IL11) and the Piedmont Research Station (NC34), respectively. One set of concentration estimates (solid line) was from the least-squares general linear model described above. The other set of plotted estimates (dashed line) was obtained from LOWESS regression of the observed bi-monthly mean concentrations (solid circles) against time. The LOWESS smoothing method, described by Cleveland (1979 and 1985), was added to the trend plots because it does not assume a functional relationship between variables and can depict nonlinearities in trends. The LOWESS method was not used to statistically assess concentration trends because assessment of changes in ionic concentration from one point in time to another, by definition, involves linear hypotheses and because LOWESS regressions do not provide an overall test of trend or model fit for the data set as a whole. The "moving window" of data points for LOWESS smoothing was set at 1.5 years or nine bi-monthly points before and after the date to be estimated. The distance weighting function for the LOWESS regressions was,

$$d_i=(1-p_i^3)^3$$

where, $p_1 = |x_1-x_1|/W$ for $|x_1-x_1| < W$; otherwise, 1
x_1 = date of point to be estimated in decimal years
x_1 = date of i^{th} sample point in decimal years
W = width of moving window in each direction (i.e., 1.5 years)

The robustness weights for the second stage of the LOWESS estimation procedure were calculated as,

$$w_i=(1-p_i^2)^2$$

where, $p_1 = (|r_1|/R)$ for $|r_1| < R$; otherwise, 1.0
r_1 = studentized residual of i^{th} sample point from the first stage LOWESS regression
R = Maximum absolute value of studentized residual for sample points to be used in the second stage regression. R was set to 4 here.

In order to illustrate how the ionic composition of precipitation changed from the beginning to the end of each trend analysis period at each site, a mean annual concentration value (µeq/L) was estimated for each ion for 1980, 1983, and 1985 and for 1993. These annual

IL11 -Bondville

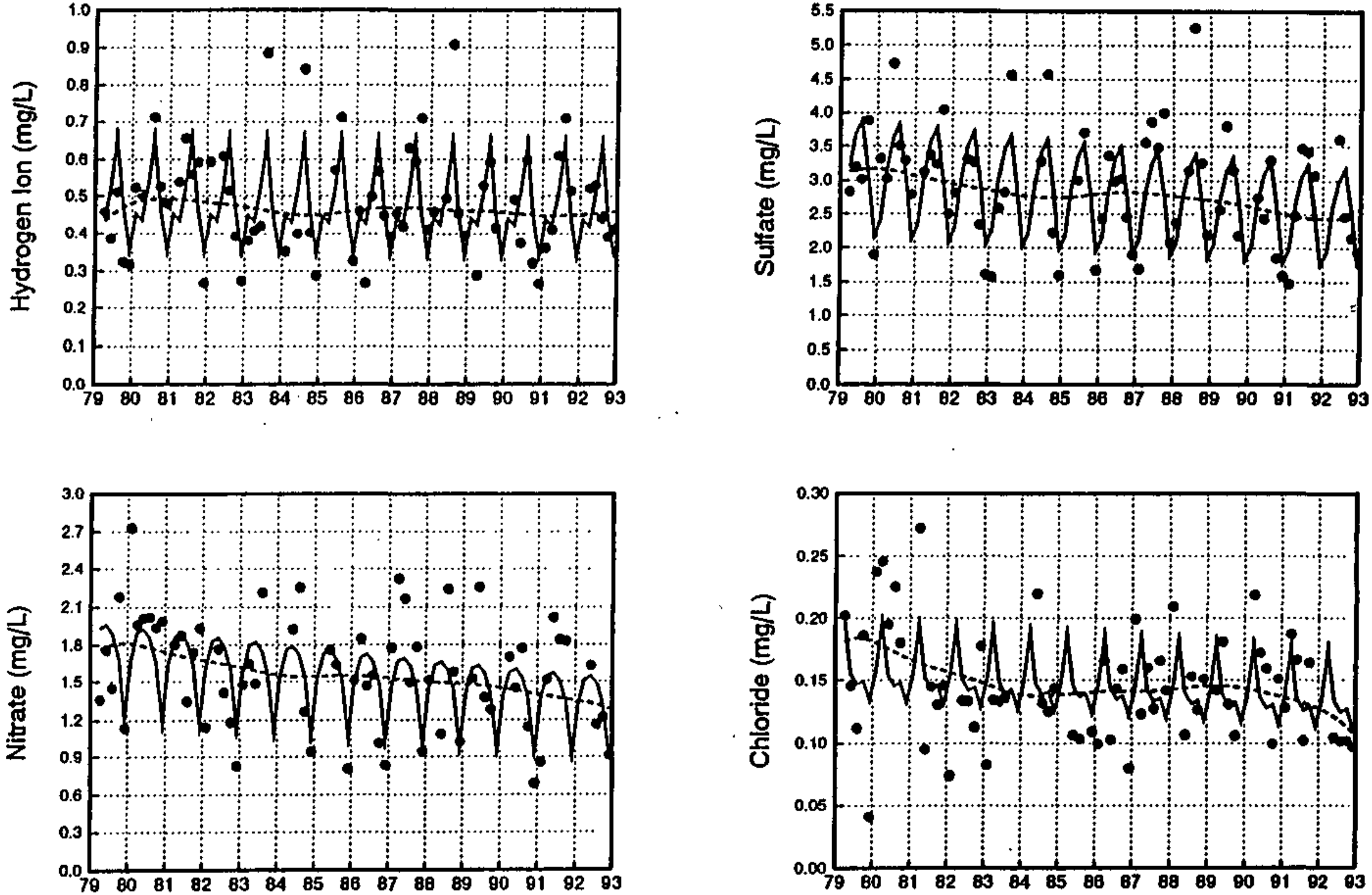

Figure 2a. Observed and predicted ionic concentrations of H^+, SO_4^{2-}, NO_3^-, and Cl^- in precipitation at the Bondville, IL monitoring site (IL11) from 1979-1993. The solid lines are estimates from the linear least squares model of concentrations which incorporates both seasonal and long-term trends effect. The dashed lines represents the LOWESS regression of the observed bi-monthly data against time.

IL11 -Bondville

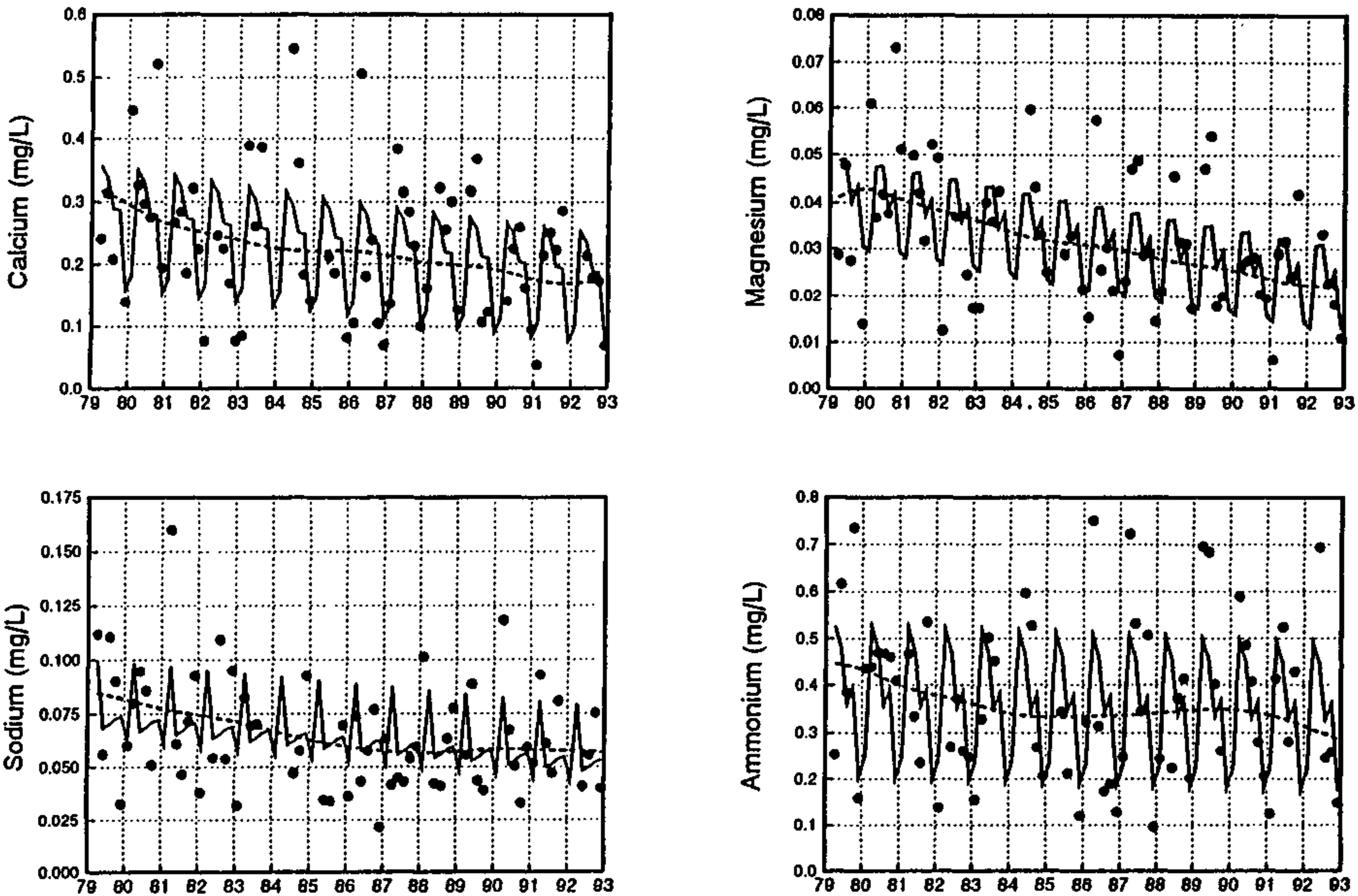

Figure 2b. Observed and predicted ionic concentrations of Ca^{2+}, Mg^{2+}, Na^{+}, and NH_4^{+} in precipitation at the Bondville, IL monitoring site (IL11) from 1979-1993. The solid lines are estimates from the linear least squares model of concentrations which incorporates both seasonal and long-term trends effect. The dashed lines represents the LOWESS regression of the observed bi-monthly data against time.

NC34 - Piedmont Research Station

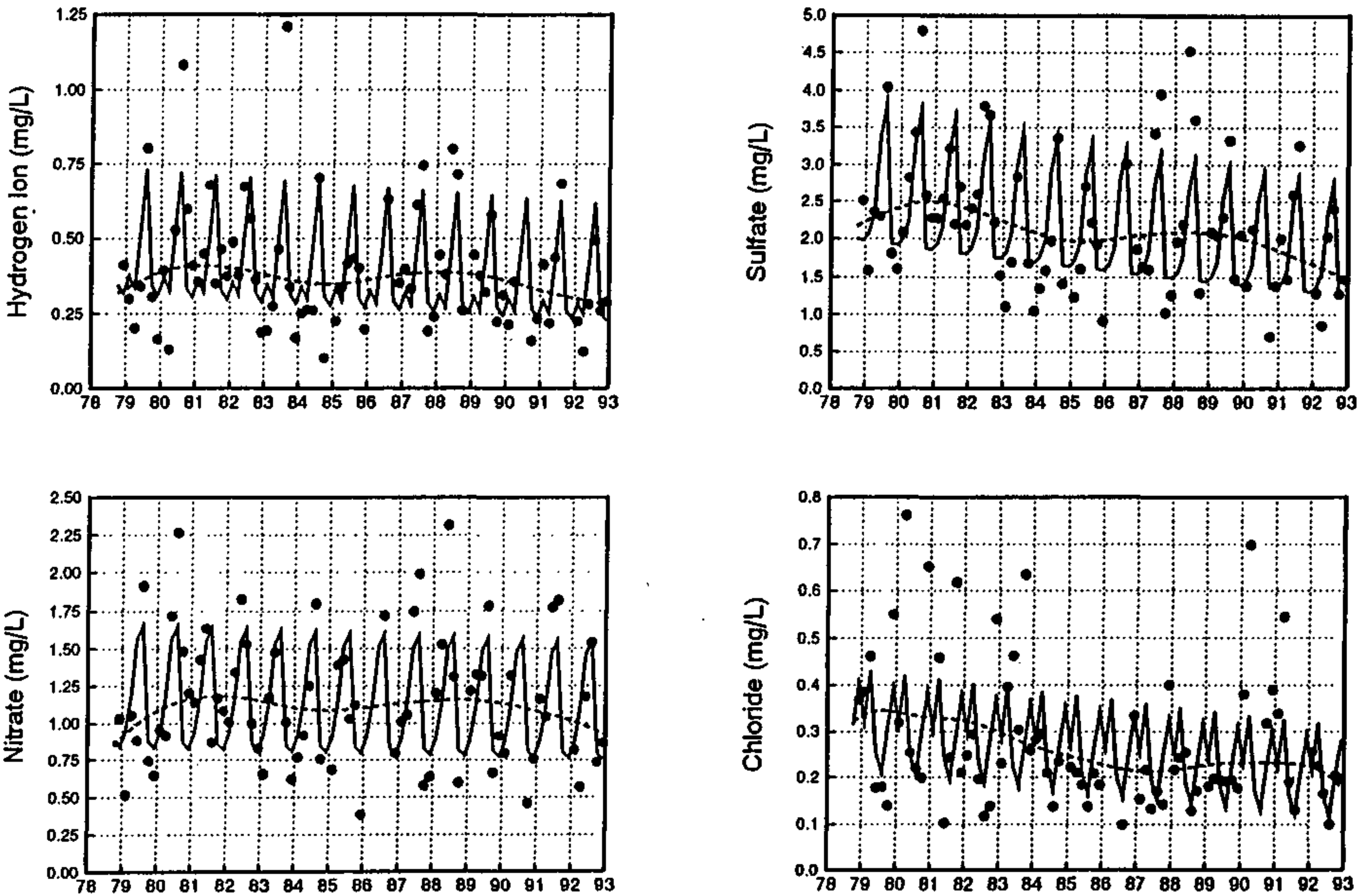

Figure 3a. Observed and predicted ionic concentrations of H^+ SO_4^{2-}, NO_3^-, and Cl^- in precipitation at the Piedmont Research Station monitoring site (NC34) from 1979-1993. The solid lines are estimates from the linear least squares model of concentrations which incorporates both seasonal and long-term trends effect. The dashed lines represents the LOWESS regression of the observed bi-monthly data against time.

NC34 - Piedmont Research Station

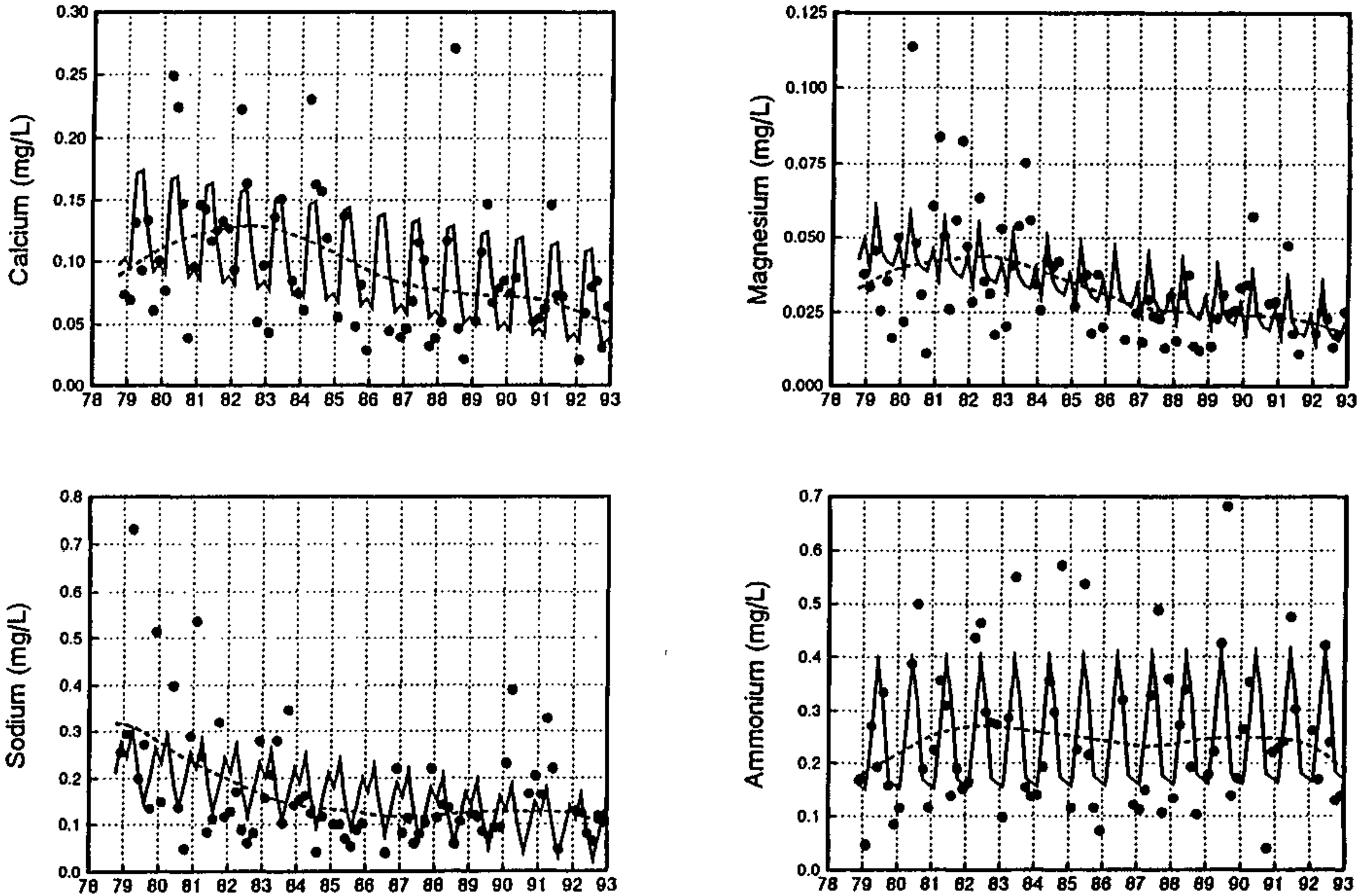

Figure 3b. Observed and predicted ionic concentrations of Ca^{2+}, $Mg2^{+}$, Na^{+}, and NH_4^{+} in precipitation at the Piedmont Research Station monitoring site (NC34) from 1979-1993. The solid lines are estimates from the linear least squares model of concentrations which incorporates both seasonal and long-term trends effect. The dashed lines represents the LOWESS regression of the observed bi-monthly data against time.

concentration values were obtained by estimating concentrations for each of the six bi-monthly periods per year and calculating the arithmetic means. Differences in predicted annual concentrations between each summary period were calculated for each ion.

RESULTS

Trend results are presented in tabular and graphic form for each analyte (except orthophosphate) and summary period. Trends in ionic concentration for each analyte (except potassium and orthophosphate) at each site with at least five years of continuous operation are graphically presented in the appendix. Each graph shows a plot of the observed bi-monthly means (solid circles) over time and two estimates of the modeled trend, one from the least squares regression model (solid line) and the other from the LOWESS regression (dashed line).

Tables 2, 4, and 6 contain information on the direction and statistical significance of deseasonalized trends in each analyte for each site in the respective summary periods. Sites are identified by the CAL code and region. The region number corresponds to the ecoregions illustrated in Figures la-lc and Table 1. The direction and statistical significance are determined from the "p-value" given under the column identified as "year". A value of -0.0054 (Table 2, Site CA45, H^+) indicates a statistically significant ($p<0.05$) decreasing trend in H^+ concentrations at CA45 for the period 1980 through 1993. The four asterisks (****) under the month column indicate that a highly significant ($p<0.001$) seasonal pattern is evident at this site for H^+. One, two, or three asterisks indicate significant seasonal patterns at $p<0.10$, $p<0.05$, and $p<0.01$ level of confidence, respectively. No asterisk under the month column indicates that a statistically significant seasonal pattern is not evident for the analyte at that site. Each table also contains r values which describe the fraction of variability (from 0.000 to 1.000) explained by the linear least squares model for each analyte; the higher the value the greater the fraction of variability explained by the model.

The direction and statistical significance ($p<0.05$) of trends for each analyte and summary period are presented graphically using a solid or open triangle pointed upward or downward to indicate the direction of the trend (Figures 4-30). An solid triangle indicates a statistically significant ($p<0.05$) trend; an open triangle indicates that the trend is not significant ($p>0.05$). All sites and all analytes (except orthophosphate) for each summary period (1980-1983, Figures 4-12; 1983-1993, Figures 13-21; and 1985-1993, Figures 22-30) are plotted on the conterminous U.S. The U.S. is separated along the Mississippi River to indicate those sites located in the eastern and western sections of the country. This separation was made for comparison purposes as discussed in the discussion section. Sites located in Alaska, Hawaii, Puerto Rico, and American Samoa are not shown on the maps.

Predicted changes in ionic concentrations (µeq/L) of individual anions and cations for each summary period are presented in Tables 3, 5, and 7. Percent changes are also given for each ion. Statistical significance ($p<0.05$) is indicated by an asterisk (*). As with the trend results, these data are presented for each site identified by the CAL code and listed by ecoregion.

Mean predicted concentration and percent changes for all sites in each summary period and for sites with statistically significant trends ($p<0.05$) are also discussed in the report. These means represent an average of both increasing and decreasing trends. Consequently, it is possible for increasing concentration trends to offset decreasing trends resulting in relatively small regional or nationwide changes in analyte concentration or percent changes during each summary period. This is particularly true for nitrate concentrations because they exhibit both increasing and decreasing trends across the country. Because mean ionic concentration change is estimated independent of mean percent change, it is possible to have mean concentration and percent changes of opposite sign.

The results presented in Tables 2-7 are summarized by period and by region (east and west of the Mississippi River) and presented by analyte in the discussion section. Unequal numbers or too few sites are located in each ecoregion to permit meaningful comparisons by ecoregion. This is particularly true for the shortest summary period.

A summary of trend results for all sites with at least five years of continuous operation are presented in Table 8. This table contains the same information discussed above. Included in Table 8 are the beginning and ending dates of site activity used in the analysis. The summary periods are not uniform between sites, making site by site comparisons difficult. In addition, the trend results for a site over its entire period of operations may differ from results in either the 1980-93,1983-93, or 1985-93 summary periods.

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PRECIPITATION CHEMISTRY TRENDS
IN THE UNITED STATES
1980-1993

Table 2. Direction and statistical significance of "deseasonalized" trends in ionic concentrations (μeq/L) in precipitation at 52 NADP/NTN sites from 1980 through 1993.

		log(H)			log(S04)			log(N03)			log(NH4)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	-0.0054	****	0.403	-0.0001	***	0.358	-0.3969		0.129	+0.2367		0.125
1	or02	-0.1731	***	0.245	-0.0001		0.343	+0.0100		0.169	+0.0005	***	0.362
1	or10	+0.3967		0.053	-0.0001	»***	0.706	+0.1235	****	0.506	+0.1281	***	0.337
1	wa14	-0.2683	***	0.280	-0.0001	**	0.577	+0.0094	***	0.314	+0.7233		0.068
2	ca88	-0.0840		0.182	-0.0002	****	0.526	-0.6015	****	0.325	+0.7974	***	0.305
3	co00	-0.2718	****	0.450	-0.0001	***	0.475	-0.0006	****	0.559	-0.0975	****	0.462
3	co19	-0.0004	****	0.517	-0.0001	****	0.783	-0.8449	****	0.540	+0.0921	****	0.691
3	co21	+0.7742	****	0.429	-0.0279	****	0.791	+0.6133	****	0.394	+0.1398	****	0.514
3	mt05	-0.0922	****	0.370	-0.0001	****	0.663	-0.8416	****	0.323	+0.7507	****	0.329
3	wy08	-0.0001	****	0.596	-0.0360	****	0.703	+0.7382	****	0.465	+0.1106	****	0.476
5	az06	+0.8686	***	0.259	-0.0008	****	0.545	-0.2794	****	0.579	-0.8441	****	0.567
5	tx04	-0.2972	*	0.167	-0.3107		0.113	+0.3977	***	0.255	-0.7793	**	0.186
7	co15	-0.0363	****	0.475	-0.0006	****	0.689	+0.7592	****	0.457	-0.9548	****	0.647
7	co22	-0.0077	****	0.380	-0.0001	****	0.515	-0.0913		0.092	-0.7027	****	0.644
8	il11	-0.0034	****	0.559	-0.0001	****	0.651	-0.0087	****	0.492	-0.8103	****	0.516
8	il19	-0.0006	***	0.393	-0.0011	****	0.589	-0.2448	****	0.385	+0.4347	****	0.372
8	mn27	+0.9060	**	0.218	-0.0020	****	0.435	-0.1838	***	0.287	-0.3436	***	0.318
8	ne15	-0.2724		0.081	-0.0295	***	0.292	+0.6905	*	0.149	-0.7145	****	0.338
9	me00	-0.3892		0.087	-0.1100	***»	0.505	+0.3195	***	0.258	+0.3696	****	0.434
9	me09	-0.2128	***	0.255	-0.0025	****	0.593	-0.6796		0.103	-0.5858	****	0.470
9	mi09	-0.0212		0.162	-0.0006	****	0.665	-0.4637	***	0.311	+0.6976	****	0.331
9	mi53	-0.0063		0.184	-0.0017	****	0.630	-0.1597	****	0.451	-0.7727	***	0.239
9	mn16	-0.5302	****	0.310	-0.0001	****	0.452	-0.0736	****	0.594	-0.4551	****	0.371
9	nh02	-0.1892	****	0.362	-0.0297	****	0.645	-0.6925		0.039	+0.8729	****	0.541
9	ny08	-0.0515	****	0.599	-0.0184	****	0.749	-0.2083	***	0.216	+0.6844	****	0.517
9	ny10	-0.0028	****	0.683	-0.0001	****	0.709	-0.1858	***	0.288	-0.2635	****	0.305
9	ny20	-0.1440	****	0.399	-0.0011	****	0.755	-0.2297	*	0.189	-0.0456	****	0.621
9	ny52	-0.0251	****	0.575	-0.0088	****	0.789	-0.4539	****	0.359	-0.4051	****	0.340
9	ny65	+0.5234	****	0.691	-0.2955	***»	0.789	-0.8061	**•*	0.377	-0.9618	****	0.620
9	pa29	-0.0139	****	0.785	-0.1653	****	0.828	-0.9059	****	0.333	+0.4970	****	0.579
9	wi36	-0.0005	*	0.318	-0.0001	****	0.630	-0.0262	**	0.275	-0.2001	****	0.388
9	wi37	-0.4958	**	0.201	-0.0038	****	0.440	-0.5994	*	0.160	+0.2436	****	0.396
10	ar27	-0.1551	***	0.269	-0.0001	****	0.432	-0.1681	****	0.582	-0.0432	***	0.286
10	il35	-0.0616		0.142	-0.0003	***	0.345	-0.0214	****	0.437	-0.6824	****	0.448
10	il63	-0.1707	**	0.214	-0.0001	****	0.455	-0.0176	****	0.465	-0.0029	****	0.626
10	mi26	-0.0159	*	0.270	-0.0001	****	0.588	-0.0968	**	0.267	-0.7386	****	0.461
10	nc25	-0.0173	****	0.574	-0.0003	****	0.671	-0.0401	****	0.563	-0.8911	****	0.523
10	oh17	-0.0701	****	0.508	-0.0143	****	0.688	-0.2847	****	0.443	+0.7918	****	0.542
10	oh49	-0.0474	****	0.627	-0.0161	••••	0.718	-0.2787	***	0.269	-0.3618	****	0.521
10	oh71	-0.0500	***•	0.532	-0.0146	****	0.626	-0.1239	****	0.531	-0.9854	***»	0.514
10	pa42	-0.7061	****	0.771	-0.0278	****	0.796	-0.5205	****	0.450	-0.4603	****	0.573
10	tn00	-0.0554	****	0.391	-0.0001	****	0.543	-0.5484	****	0.407	+0.4601	****	0.373
10	va13	-0.9107	****	0.645	-0.0184	**•*	0.732	-0.9842	****	0.621	+0.0713	****	0.645
10	wv18	+0.8088	****	0.703	-0.2894	****	0.728	-0.6808	****	0.341	-0.8547	****	0.453
11	fl03	+0.2615	****	0.547	-0.1397	*	0.198	+0.2628	****	0.531	-0.3605	***	0.294
11	fl11	•0.0018	**	0.329	-0.3101		0.161	+0.6713		0.176	+0.1656	**	0.249
11	ga41	-0.6103	****	0.465	-0.0007	****	0.575	-0.1264	»***	0.593	-0.4231	****	0.348
11	nc03	-0.0260	***	0.271	-0.0018	***	0.306	-0.0559	****	0.308	-0.4828	****	0.405
11	nc34	-0.0076	****	0.511	-0.0001	****	0.645	-0.0145	****	0.570	-0.2092	****	0.417
11	nc35	-0.0071	****	0.399	-0.0004	***	0.413	-0.0629	****	0.394	+0.1624	****	0.325
11	nc41	-0.0377	***	0.343	-0.0066	****	0.421	-0.1144	•***	0.394	+0.1200	***	0.258
12	ak03	-0.0048	***	0.432	-0.0073	*	0.367	+0.3108		0.164	+0.3263	*	0.196

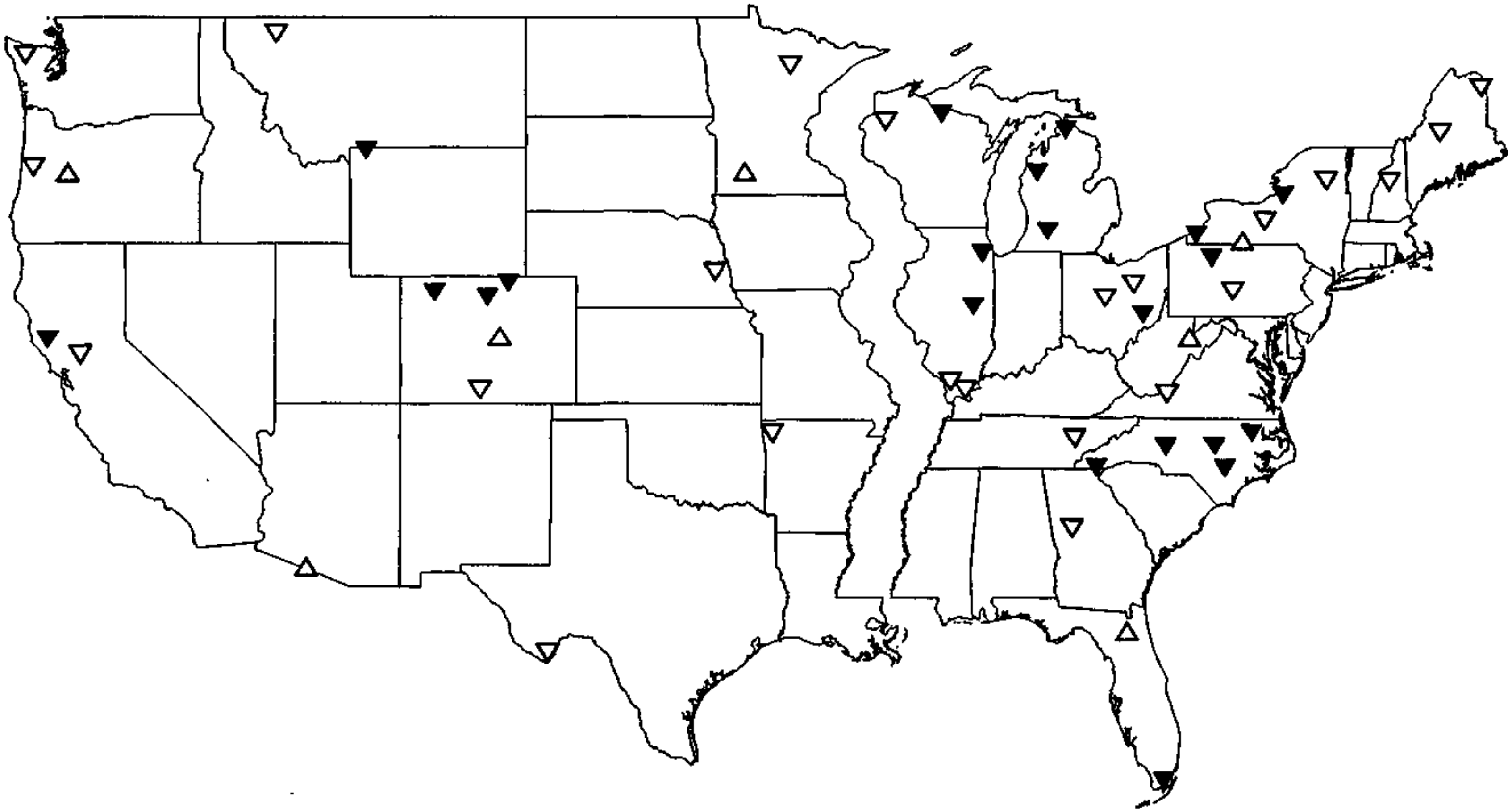
Table 2 (continued).

		log(Ca)			log(Mg)			log(K)			log(Na)			log(Cl)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	-0.0001	****	0.586	-0.0005	**	0.333	-0.0024		0.173	-0.1621	****	0.372	-0.0372	****	0.471
1	or02	-0.0001		0.295	-0.0014	****	0.538	-0.0012		0.235	-0.0013	****	0.512	-0.0020	****	0.518
1	or10	-0.0001	****	0.627	-0.0001		0.291	-0.0154	***	0.336	-0.0026	****	0.351	-0.0029	****	0.402
1	wa14	-0.0001		0.442	-0.0001	****	0.554	-0.0245	***	0.323	-0.0001	****	0.531	-0.0001	****	0.617
2	ca88	-0.0540	****	0.405	-0.0235	**	0.239	-0.4541	***	0.306	-0.0116	**	0.255	-0.0165		0.202
3	coOO	-0.0096	**	0.353	-0.0001	**	0.619	-0.0103		0.232	-0.0001	****	0.619	-0.0001	**	0.447
3	co19	-0.0081	****	0.555	-0.0001	****	0.557	-0.2714	****	0.382	-0.2219	*	0.182	-0.1829	***	0.318
3	co21	-0.0105	****	0.469	-0:0001	****	0.473	-0.0009	****	0.548	-0.0483		0.157	-0.0266		0.192
3	mt05	-0.0038	****	0.520	-0.0001	****	0.482	-0.0839	****	0.671	-0.0105		0.190	-0.0001		0.395
3	wy08	-0.8254	****	0.550	-0.0399	****	0.640	-0.0140	****	0.693	-0.6890	*	0.250	-0.0014	***	0.508
5	az06	-0.0094	*	0.279	-0.0124		0.228	-0.1392	**	0.264	-0.2776	**	0.209	-0.3136	***	0.272
5	tx04	+0.9118	**	0.200	-0.0790		0.174	-0.5994	**	0.201	-0.9489	*	0.164	-0.2774		0.147
7	co15	-0.0045	****	0.456	-0.0001	***	0.378	-0.2146	****	0.416	-0.0520	*	0.186	-0.0029	****	0.357
7	co22	-0.0001	****	0.579	-0.0001	***	0.515	-0.0012	****	0.463	-0.0172		0.171	-0.0014		0.214
8	il11	-0.0003	****	0.653	-0.0001	****	0.553	-0.0001	****	0.631	-0.0706	**	0.219	-0.0094	**	0.293
S	il19	-0.1192	****	0.394	-0.0344	****	0.388	-0.2839	***	0.331	-0.2806	****	0.399	-0.1000	****	0.551
8	mn27	-0.0006	*	0.364	-0.0001		0.384	-0.0001	***	0.476	-0.0001	*	0.344	-0.0001	***	0.553
8	ne15	-0.0506	****	0.381	-0.0001	****	0.449	-0.0008	***	0.403	-0.0008		0.224	-0.0001		0.308
9	me00	-0.0007	****	0.433	-0.0001	****	0.620	-0.0001	**	0.435	-0.5205	****	0.595	-0.2125	****	0.589
9	me09	-0.0001	****	0.546	-0.0001	*	0.516	-0.0001	**	0.456	-0.0147	*	0.200	-0.0765	**	0.190
9	mi09	-0.0107	***	0.360	-0.0001	****	0.484	-0.0297	****	0.365	-0.5367		0.140	-0.0276	*	0.227
9	mi53	-0.0156	**	0.266	-0.0076		0.242	-0.0100	****	0.430	-0.7682	****	0.430	-0.0240	****	0.622
9	mn16	-0.0005		0.232	-0.0001		0.325	-0.0001		0.373	-0.0022	**	0.289	-0.0001	**	0.371
9	nh02	-0.0001	****	0.458	-0.0001		0.443	-0.0004	****	0.629	-0.4447	***	0.232	+0.5435	***	0.222
9	ny08	-0.0026	****	0.460	-0.0001	****	0.503	-0.0001	****	0.499	-0.0005	**	0.305	-0.0008		0.221
9	ny10	-0.0007	***	0.381	-0.0001	***	0.451	-0.0031		0.215	-0.0078	***	0.314	-0.0001	****	0.507
9	ny20	-0.0001	****	0.616	-0.0001	****	0.683	-0.0001	****	0.646	-0.0007	*	0.284	-0.0009	**	0.294
9	ny52	-0.0451	**	0.250	-0.0001		0.319	-0.0002	**	0.361	-0.0254	****	0.653	-0.0005	****	0.635
9	ny65	-0.0001	****	0.484	-0.0001	****	0.514	-0.0001	****	0.522	-0.0090		0.207	-0.0440		0.143
9	pa29	-0.1162	****	0.487	-0.0042	****	0.452	-0.1840	****	0.543	-0.1498		0.167	-0.0126	***	0.299
9	wi36	-0.0018	***	0.348	-0.0003	***	0.391	-0.0001	****	0.518	-0.0100		0.202	-0.0001		0.301
9	wi37	-0.0039	**	0.319	-0.0004	****	0.466	-0.0003	**	0.375	-0.0068	****	0.347	-0.0008	*	0.277
10	ar27	-0.0001	****	0.539	-0.0012	***	0.320	-0.2970	**	0.181	-0.9199		0.063	-0.4041		0.049
10	il35	-0.0001	****	0.572	-0.0001	****	0.458	-0.0002	****	0.497	-0.1827		0.110	-0.0707	**	0.211
10	il63	-0.0001	****	0.684	-0.0001	***	0.430	-0.0040	****	0.501	-0.0049		0.184	-0.0060	***	0.275
10	mi26	-0.0002	****	0.475	-0.0002	***	0.425	-0.0026	****	0.501	-0.0628		0.215	-0.0101		0.258
10	nc25	-0.0001	****	0.647	-0.0001	***	0.429	-0.1618	****	0.517	-0.0094	***	0.367	-0.1322	***	0.337
10	oh17	-0.0001	****	0.517	-0.0002	****	0.446	-0.1930	***	0.314	-0.1096	*	0.190	-0.0265	****	0.339
10	oh49	-0.0003	****	0.513	-0.0001	***	0.432	+0.6749	**	0.204	-0.0123		0.200	-0.0586	****	0.331
10	oh71	-0.0012	****	0.521	-0.0001	****	0.492	-0.0003	****	0.533	-0.0577	***	0.252	-0.0234	***	0.276
10	pa42	-0.0001	****	0.468	-0.0001	**	0.476	-0.0002	***	0.372	-0.0014	***	0.300	-0.0004		0.241
10	tnOO	-0.0001	****	0.628	-0.0001	***	0.560	-0.0013	****	0.532	-0.0311	****	0.334	-0.0036	***	0.287
10	va13	-0.0576	****	0.463	-0.0022	**	0.362	+0.1360	***	0.341	-0.0029	*	0.301	-0.0435		0.172
10	wv18	-0.0003	****	0.430	-0.0001	****	0.507	-0.0001	****	0.413	-0.0155	**	0.204	-0.0195	**	0.226
11	fl03	-0.0001	***	0.389	-0.0025	****	0.427	-0.0001		0.358	-0.7819	****	0.471	-0.3518	****	0.491
11	fill	-0.0029	*	0.303	-0.1320	****	0.639	-0.9041	***	0.304	+0.7868	****	0.655	+0.5474	****	0.687
11	ga41	-0.0001	****	0.609	-0.0001	**	0.405	-0.6061		0.098	-0.0042	****	0.436	-0.0037	***	0.318
11	nc03	-0.0001	****	0.571	-0.0001	****	0.586	-0.3130	****	0.289	-0.0391	****	0.547	-0.1528	****	0.557
11	nc34	-0.0001	****	0.571	-0.0001	**	0.398	-0.2559	**	0.195	-0.0166	****	0.317	-0.0098	****	0.321
11	nc35	-0.0001	****	0.565	-0.0009	****	0.508	-0.0005	****	0.473	-0.6381	****	0.569	-0.8838	****	0.579
11	nc41	-0.0001	****	0.602	-0.0001	**	0.343	+0.7575	*	0.151	-0.0040	****	0.453	-0.0992	****	0.513
12	ak03	-0.1501		0.235	-0.0142		0.274	-0.1356	**	0.305	-0.0600	***	0.364	-0.0781	**	0.305

Figure 4

National Atmospheric Deposition Program / National Trends Network

Trends in Hydrogen Ion Concentration
1980 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

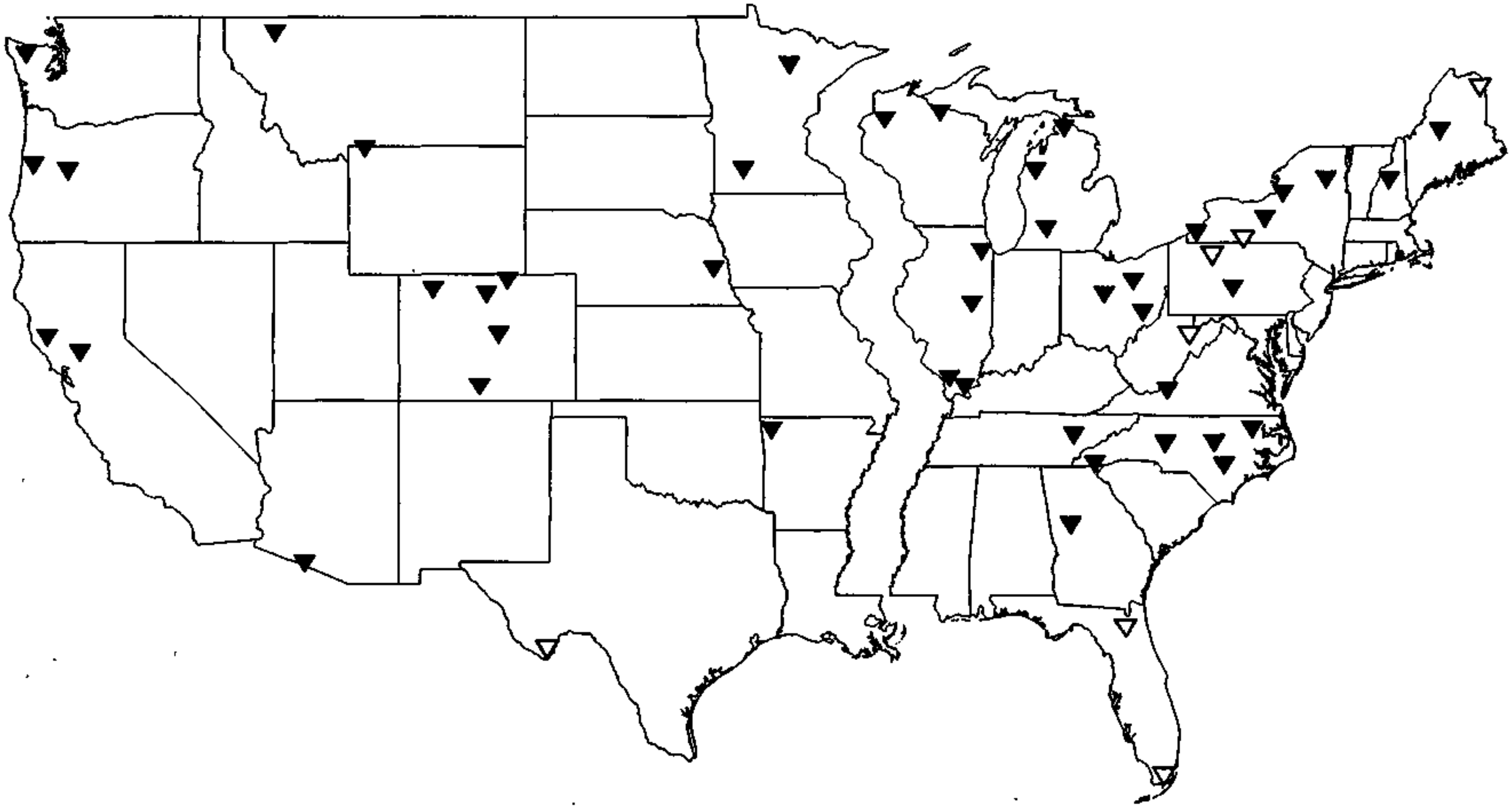
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 5

National Atmospheric Deposition Program / National Trends Network

Trends in Sulfate Ion Concentration
1980 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

△ Positive slope estimate, p>0.05

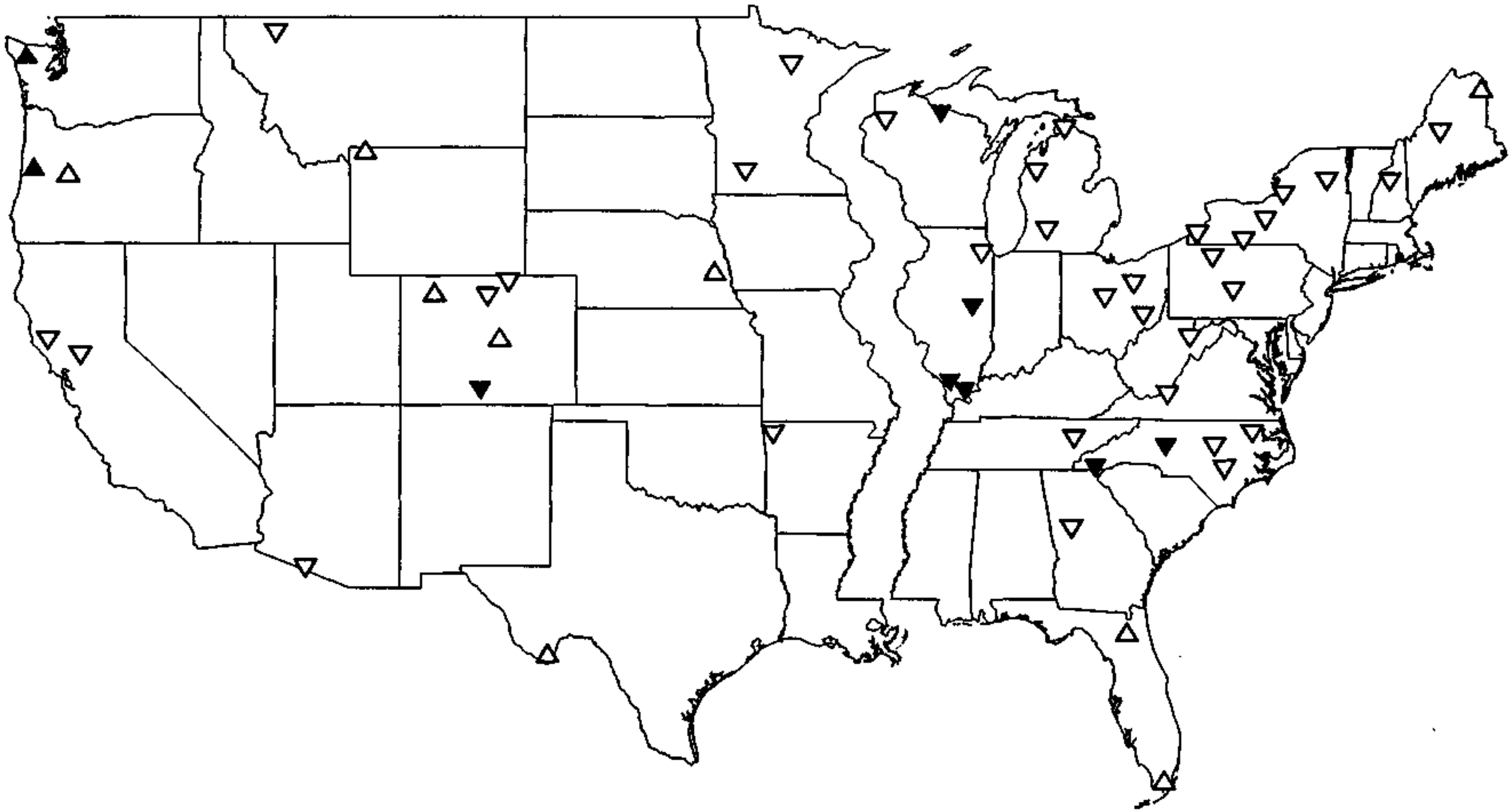
▲ Positive slope estimate, p<0.05

Figure 6

National Atmospheric Deposition Program / National Trends Network

Trends in Nitrate Ion Concentration

1980 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

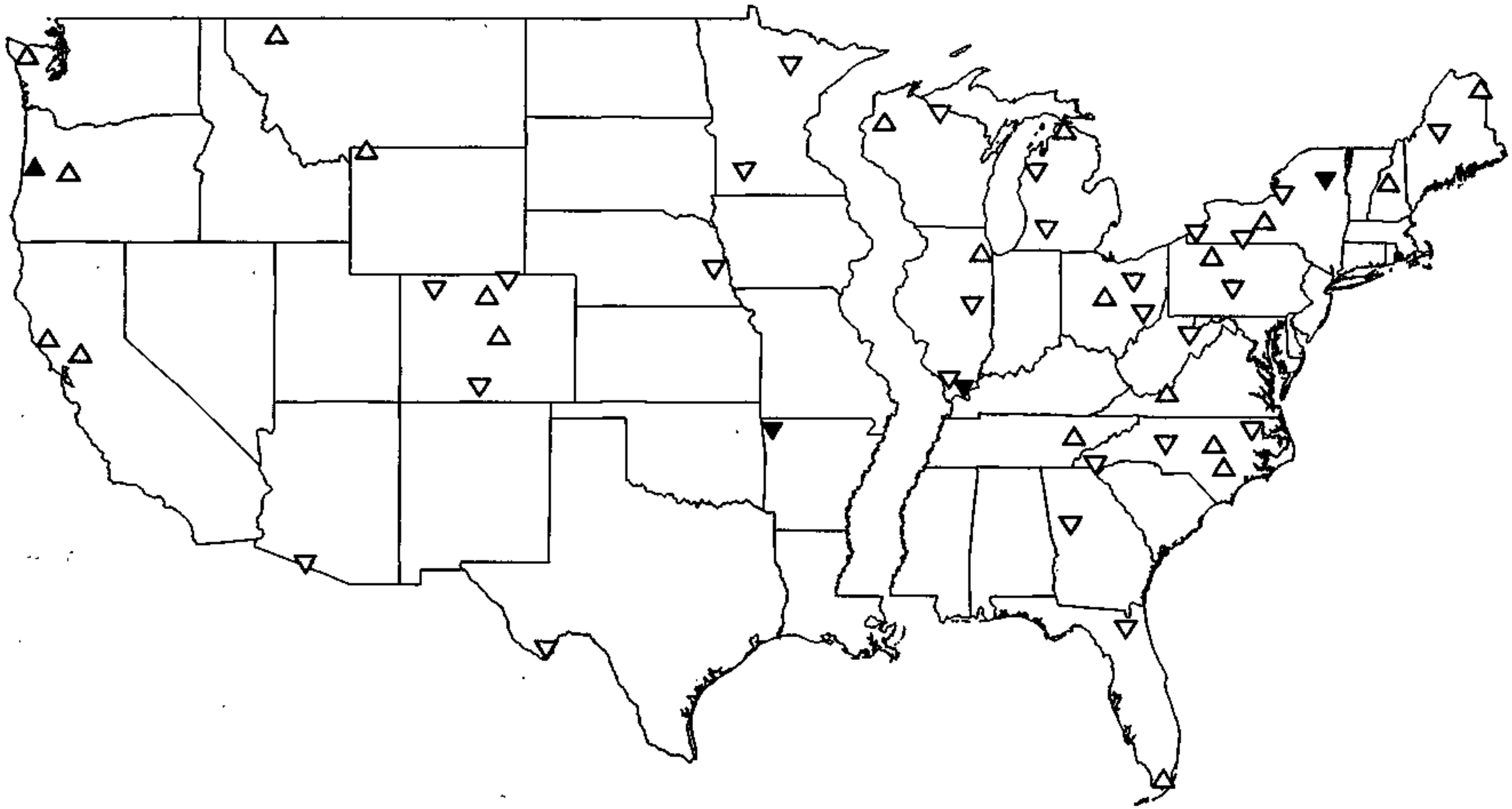
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 7

National Atmospheric Deposition Program / National Trends Network

Trends in Ammonium Ion Concentration
1980 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

△ Positive slope estimate, p>0.05

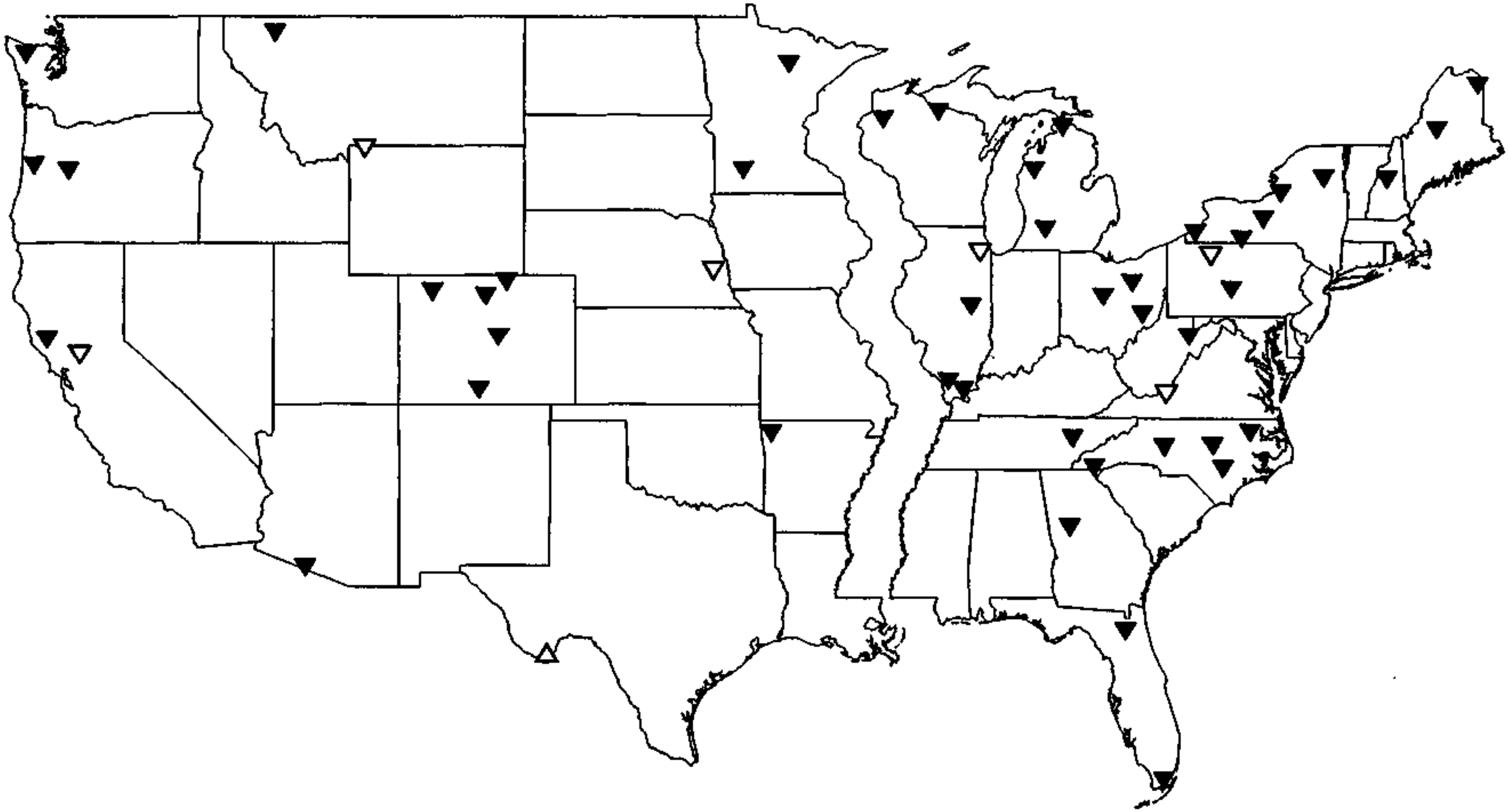
▲ Positive slope estimate, p<0.05

Figure 8

National Atmospheric Deposition Program / National Trends Network

Trends in Calcium Ion Concentration

1980 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

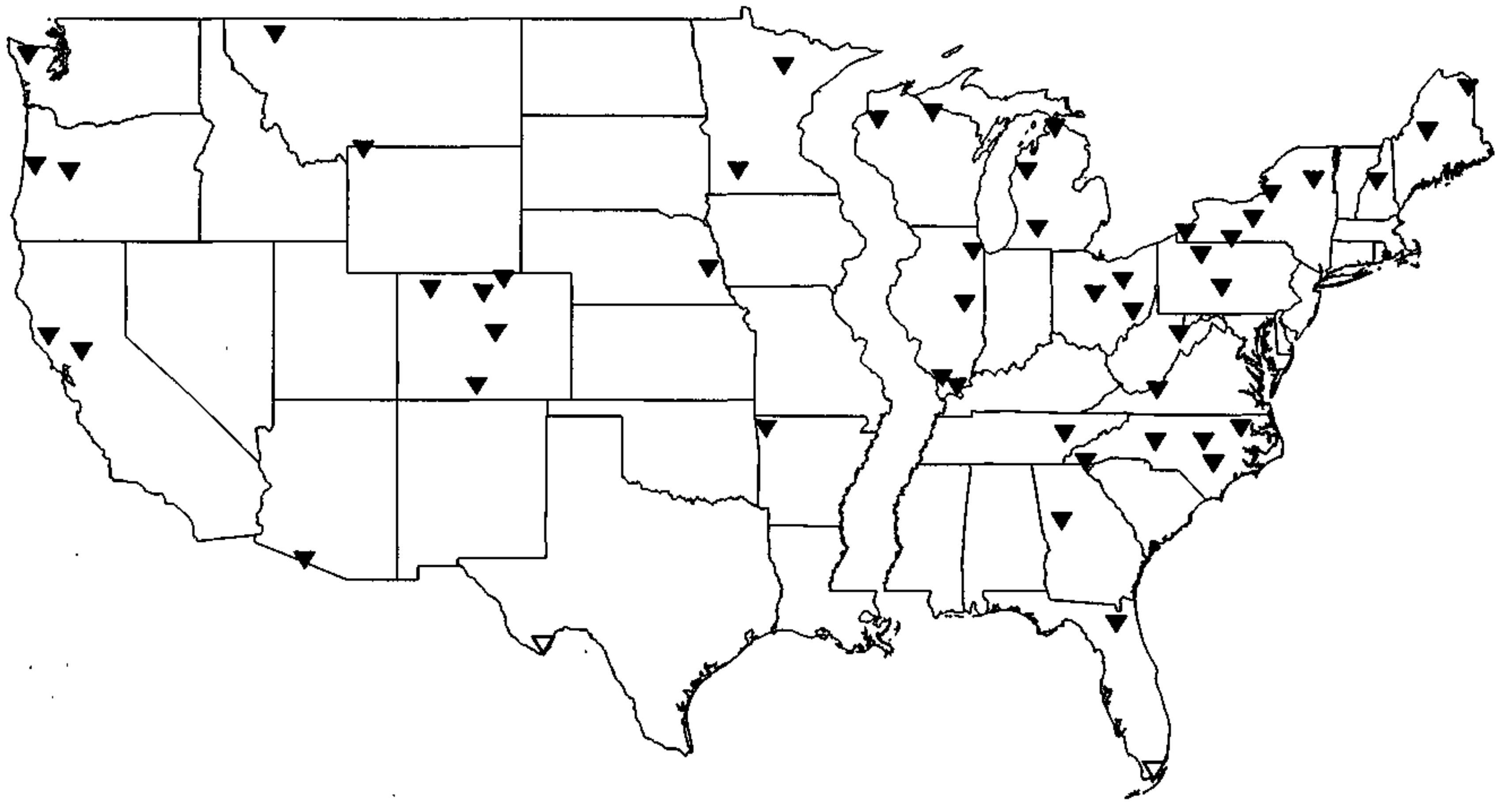
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 9

National Atmospheric Deposition Program / National Trends Network

Trends in Magnesium Ion Concentration
1980 through 1993



∇ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

△ **Positive slope estimate, p>0.05**

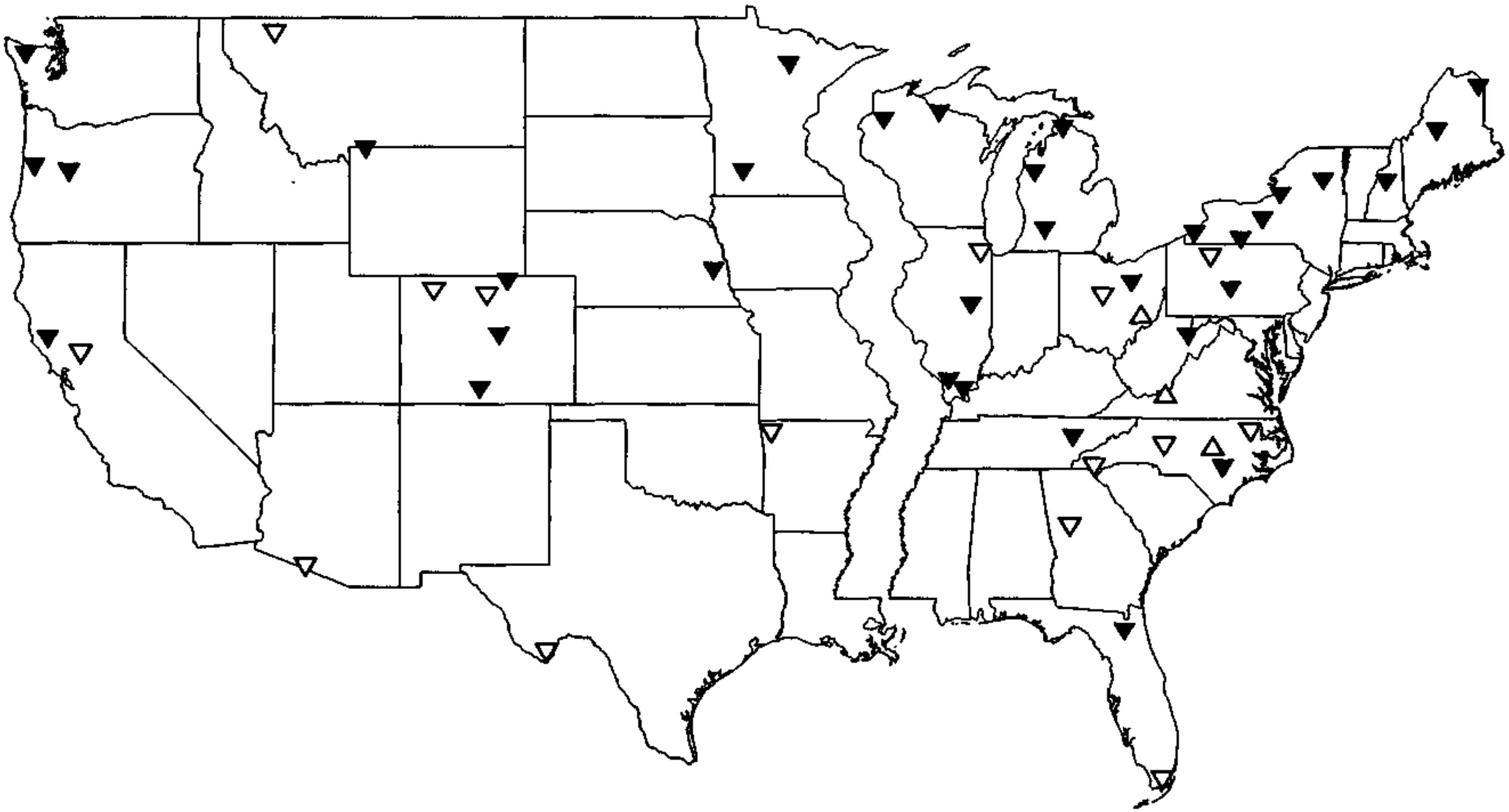
▲ **Positive slope estimate, p<0.05**

Figure 10

National Atmospheric Deposition Program / National Trends Network

Trends in Potassium Ion Concentration

1980 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

△ **Positive slope estimate, p>0.05**

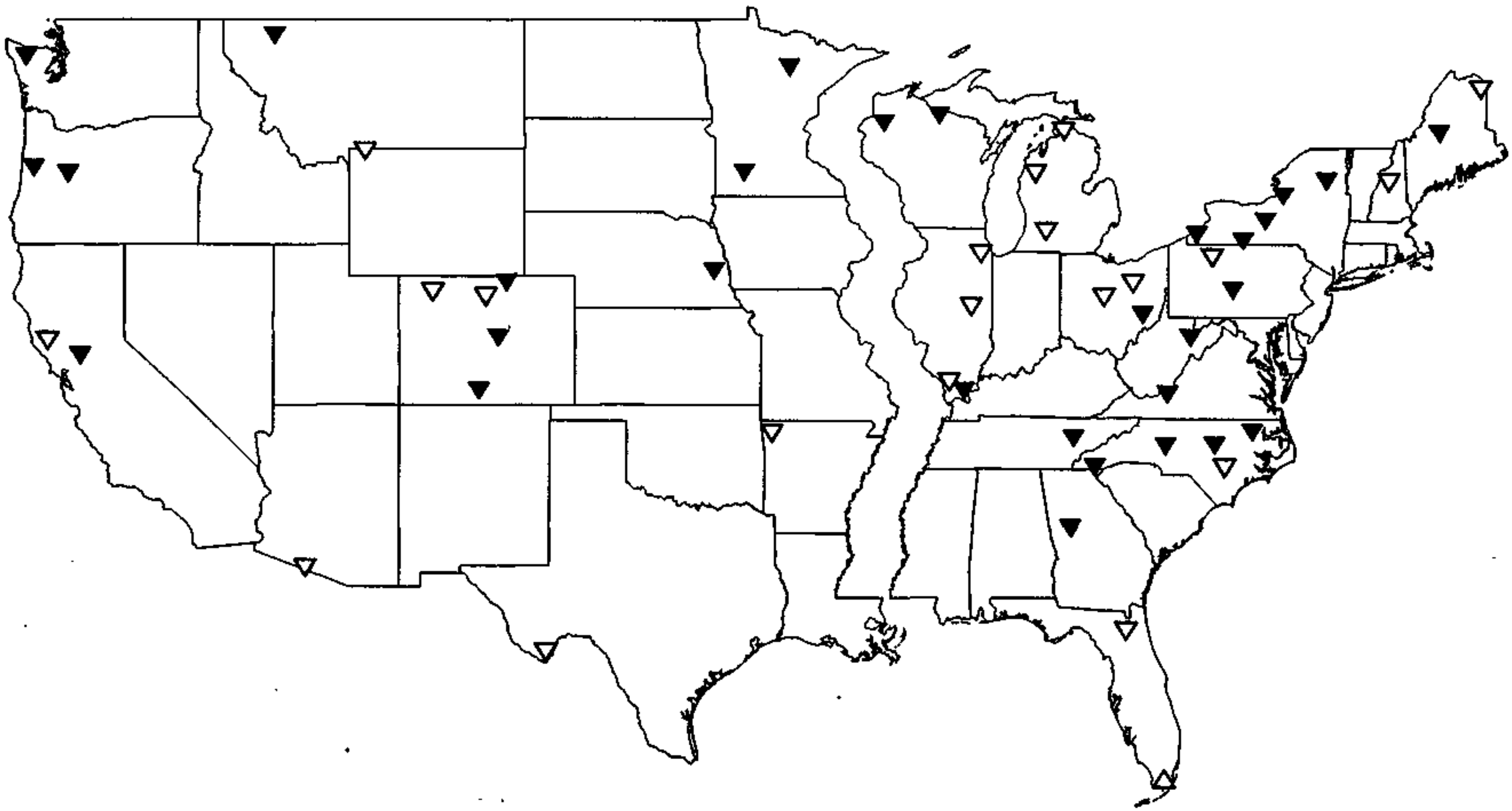
▲ **Positive slope estimate, p<0.05**

Figure 11

National Atmospheric Deposition Program / National Trends Network

Trends in Sodium Ion Concentration

1980 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

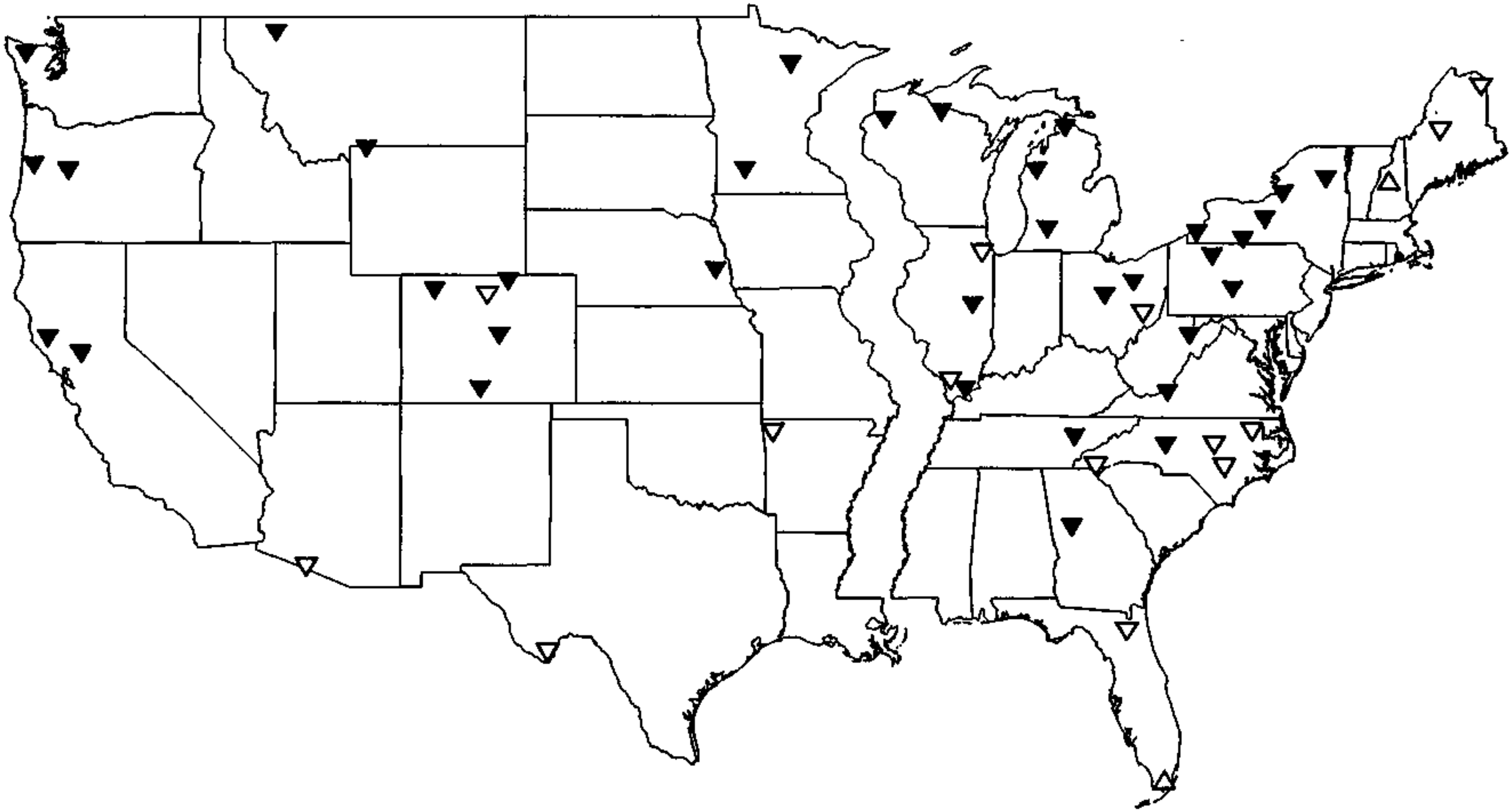
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 12

National Atmospheric Deposition Program / National Trends Network

Trends in Chloride Ion Concentration
1980 through 1993



▽ Negative slope estimate, $p>0.05$

▼ Negative slope estimate, $p<0.05$

△ Positive slope estimate, $p>0.05$

▲ Positive slope estimate, $p<0.05$

Table 3. Predicted changes in concentrations (µeq/L) of individual anions and cations in precipitation at 52 NADP/NTN sites from 1980 to 1993.

		Hydrogen Ion		Sulfate		Nitrate		Ammonium	
Region	Site	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change
1	ca45	-1.329*	-35.72	-4.681*	-48.00	-1.038	-18.00	1.189	39.21
	or02	-0.666	-17.03	-6.269*	-49.86	1.237*	90.65	1.094*	153.22
	or10	0.498	12.66	-3.781*	-48.60	0.933	36.95	0.606	53.51
	wa14	-0.510	-11.46	-6.728*	-63.23	0.761*	76.88	0.054	7.37
2	ca88	-0.600	-45.07	-8.415*	-39.11	-1.717	-8.46	1.455	4.18
3	co00	-0.788	-26.69	-18.573*	-58.28	-6.435*	-41.43	-6.308	-36.22
	co19	-5.596*	-52.18	-12.574*	-52.39	-0.422	-2.59	3.470	43.25
	co21	0.611	6.66	-5.385*	-27.45	1.232	6.76	3.229	47.50
	mt05	-1.307	-19.80	-5.425*	-42.41	-0.152	-2.42	0.299	7.54
	wy08	-3.823*	-63.26	-4.125*	-34.05	0.579	7.44	2.954	64.66
5	az06	0.188	5.49	-18.810*	-52.54	-3.439	-24.10	-0.542	-5.20
	tx04	-0.821	-28.74	-4.147	-17.60	1.608	15.84	-0.764	-6.85
7	co15	-2.773*	-30.05	-7.365*	-33.77	0.470	3.33	-0.078	-1.04
	co22	-3.117*	-55.03	-13.287*	-50.19	-4.896	-21.51	-1.416	-6.14
8	il11	-11.855*	-21.96	-16.902*	-25.47	-5.830*	-21.06	-0.612	-3.20
	il19	-17.193*	-32.27	-15.243*	-21.83	-3.352	-11.10	2.042	9.16
	mn27	0.228	4.36	-12.499*	-34.26	-4.654	-16.27	-4.689	-12.59
	ne15	-1.932	-31.74	-10.253*	-26.81	1.102	5.03	-1.949	-5.41
9	me00	-3.531	-13.00	-5.897	-18.63	2.102	15.68	1.161	19.56
	me09	-4.494	-16.17	-10.979*	-34.40	-0.794	-5.59	-0.777	-11.72
	mi09	-10.085*	-25.98	-13.359*	-27.69	-2.017	-7.28	1.011	5.93
	mi53	-12.650*	-29.27	-13.946*	-26.75	-4.496	-13.68	-0.868	-4.14
	mn16	-1.397	-12.58	-9.962*	-34.59	-3.293	-15.25	-2.052	-10.83
	nh02	-6.249	-14.01	-9.414*	-22.28	-1.085	-4.76	0.244	2.79
	ny08	-10.346	-15.30	-12.855*	-18.18	-3.876	-10.86	1.026	5.48
	ny10	-11.292*	-17.59	-20.403*	-27.69	-3.222	-9.59	-2.508	-12.75
	ny20	-6.482	-15.03	-13.276*	-29.31	-2.753	-11.39	-3.006*	-24.41
	ny52	-12.118*	-18.55	-13.290*	-20.50	-2.165	-5.93	-2.291	-11.22
	ny65	2.596	5.17	-4.240	-7.96	-0.551	-2.06	-0.087	-0.67
	pa29	-9.795*	-14.52	-6.044	-9.56	-0.283	-0.96	1.161	8.78
	wi36	-9.495*	-40.56	-19.670*	-50.51	-5.557*	-24.12	-4.629	-25.52
	wi37	-2.157	-15.82	-10.972*	-31.60	-1.139	-5.17	4.906	26.62
10	ar27	-2.531	-20.51	-10.542*	-33.35	-2.199	-14.00	-5.364*	-28.26
	il35	-7.519	-19.14	-15.831*	-29.82	-4.840*	-22.56	-0.777	-5.66
	il63	-5.742	-13.35	-17.294*	-29.38	-4.219*	-19.95	-4.647*	-27.28
	mi26	-10.148*	-20.98	-21.473*	-32.36	-4.437	-13.86	-0.845	-3.95
	nc25	-8.181*	-25.89	-12.693*	-33.69	-2.949*	-21.93	-0.168	-2.18
	oh17	-8.349	-14.17	-11.855*	-17.24	-2.859	-9.22	0.677	3.69
	oh49	-8.927*	-12.45	-12.415*	-15.86	-2.793	-9.47	-1.805	-11.78
	oh71	-7.586	-12.64	-11.516*	-16.26	-3.512	-11.40	-0.048	-0.23
	pa42	-1.917	-2.86	-12.097*	-17.52	-1.761	-5.26	-1.459	-9.17
	tn00	-9.430	-18.42	-19.623*	-31.98	-1.035	-5.70	1.106	12.58
	va13	-0.499	-1.56	-11.531*	-25.47	-0.040	-0.24	2.889	38.65
	Wv18	1.084	1.99	-5.038	-8.37	-0.998	-3.76	-0.293	-2.46
11	fl03	2.887	15.33	-5.078	-18.10	1.518	14.76	-1.100	-18.04
	fl11	-5.553*	-52.05	-3.069	-16.35	0.772	10.43	2.459	75.87
	ga41	-2.079	-7.49	-12.912*	-33.34	-2.049	-14.94	-1.148	-13.50
	nc03	-8.648*	-25.78	-13.221*	-32.33	-3.672	-21.35	-1.126	-11.13
	nc34	-12.931*	-29.51	-20.628*	-37.52	-4.781*	-22.94	-3.413	-21.43
	nc35	-9.750*	-32.13	-13.407*	-34.55	-3.007	-19.47	2.211	24.18
	nc41	-10.038*	-29.66	-12.224*	-29.29	-2.844	-16.61	3.865	33.83
12	ak03	-1.716*	-39.54	-2.973*	-46.24	0.461	27.57	0.365	38.31

* $p<0.05$

Table 3 (continued).

Region	Site	Calcium Change (μeq/l)	Calcium Percent Change	Magnesium Change (μeq/L)	Magnesium Percent Change	Potassium Change (μeq/L)	Potassium Percent Change	Sodium Change (μeq/L)	Sodium Percent Change	Chloride Change (μeq/L)	Chloride Percent Change
1	ca45	-2.601*	-67.61	-1.983*	-50.50	-0.265*	-41.81	-2.985	-26.28	-4.404*	-33.77
	or02	-2.514*	-55.77	-4.226*	-47.32	-0.583*	-47.45	-21.682*	-53.11	-23.905*	-51.61
	or	-2.212*	-65.47	-1.527*	-55.81	-0.151*	-34.44	-3.924*	-44.18	-4.386*	-44.88
	wa14	-2.317*	-67.63	-4.358*	-61.53	-0.277*	-37.55	-19.455*	-62.79	-20.863*	-60.46
2	ca88	-2.228	-35.30	-1.823*	-39.24	-0.164	-15.66	-5.497*	-45.21	-5.179*	-42.92
3	co00	-8.973*	-48.52	-5.497*	-82.78	-0.800*	-55.94	-9.074*	-67.84	-2.957*	-55.45
	co19	-5.775*	-43.22	-2.236*	-61.41	-0.320	-30.69	-0.776	-23.93	-0.761	-24.54
	co21	-6.317*	-45.78	-2.405*	-59.30	-0.772*	-58.00	-1.776*	-43.68	-1.060*	-32.71
	mt05	-2.696*	-45.22	-1.336*	-60.60	-0.217	-27.43	-1.067*	-35.66	-1.732*	-57.33
	wy08	-0.607	-6.60	-0.986*	-38.05	-0.401*	-42.65	-0.295	-9.71	-1.802*	-44.07
5	az06	-10.077*	-59.33	-4.149*	-55.20	-0.387	-30.45	-5.670	-32.01	-5.281	-29.20
	tx04	0.867	3.76	-1.018	-33.09	-0.143	-14.34	-0.071	-1.47	-0.928	-21.84
7	co15	-7.309*	-46.28	-2.838*	-59.43	-0.160	-23.25	-1.432	-33.62	-1.303*	-35.44
	co22	-8.318*	-54.99	-2.515*	-66.78	-0.544*	-52.08	-1.946*	-43.73	-1.664*	-42.58
8	il11	-5.136*	-40.70	-1.714*	-51.34	-0.547*	-64.28	-0.697	-22.38	-1.006*	-22.02
	il19	-4.159	-25.55	-1.913*	-31.22	-0.149	-19.58	-0.662	-16.52	-0.842	-15.34
	mn27	-9.283*	-45.62	-3.212*	-51.74	-0.838*	-56.08	-2.431*	-53.61	-2.822*	-54.32
	ne15	-6.141	-30.82	-2.052*	-50.46	-0.689*	-50.72	-2.557*	-50.92	-2.294*	-50.27
9	me00	-2.750*	-45.06	-2.017*	-69.70	-0.399*	-62.11	-0.427	-11.02	-0.786	-17.40
	me09	-2.680*	-61.72	-1.632*	-69.24	-0.459*	-72.30	-1.595*	-39.69	-1.229	-30.02
	mi09	-4.318*	-36.99	-2.291*	-52.23	-0.263*	-35.88	-0.190	-8.68	-0.862*	-26.10
	mi53	-4.645*	-34.71	-2.212*	-41.58	-0.252*	-36.51	-0.125	-4.75	-1.089*	-24.38
	mn16	-4.973*	-41.84	-2.032*	-52.83	-0.493*	-50.97	-1.405*	-42.92	-1.500*	-47.00
	nh02	-2.538*	-55.07	-1.795*	-67.17	-0.163*	-37.31	-0.538	-14.60	0.406	11.00
	ny08	-3.398*	-38.35	-2.089*	-58.54	-0.321*	-54.14	-1.728*	-47.16	-1.777*	-32.97
	ny10	-4.524*	-43.56	-2.055*	-55.44	-0.519*	-54.50	-1.367*	-37.05	-2.374*	-39.36
	ny20	-2.984*	-50.15	-1.588*	-66.40	-0.308*	-59.97	-1.478*	-48.81	-1.228*	-35.81
	ny52	-2.392*	-27.52	-1.575*	-46.91	-0.367*	-44.70	-0.845*	-24.24	-1.691*	-30.39
	ny65	-4.038*	-54.48	-1.671*	-62.79	-0.226*	-49.82	-1.051*	-37.31	-0.835*	-22.68
	pa29	-1.443	-22.30	-0.733*	-34.41	-0.119	-22.27	-0.530	-20.88	-1.065*	-22.14
	wi36	-5.843*	-48.40	-1.881*	-53.69	-0.468*	-65.15	-1.443*	-47.84	-1.715*	-51.78
	wi37	-6.761*	-46.23	-2.118*	-51.87	-0.535*	-56.48	-1.406*	-40.63	-1.228*	-38.57
10	ar27	-6.478*	-49.27	-1.110*	-41.65	-0.188	-21.64	-0.074	-1.68	-0.566	-11.78
	il35	-6.167*	-50.49	-1.261*	-44.81	-0.398*	-49.85	-0.860	-20.84	-1.074	-20.38
	il63	-7.117*	-56.07	-1.751*	-56.39	-0.367*	-42.30	-2.300*	-41.96	-1.816*	-27.35
	mi26	-6.797*	-48.47	-2.580*	-51.96	-0.228*	-33.70	-1.120	-32.62	-1.331*	-29.87
	nc25	-2.525*	-55.85	-1.076*	-52.34	-0.124	-21.89	-2.212*	-40.49	-1.245	-23.20
	oh17	-6.118*	-47.47	-1.970*	-46.56	-0.167	-23.66	-0.979	-25.76	-1.260*	-24.43
	oh49	-5.529*	-45.50	-2.017*	-50.79	0.070	10.47	-1.372*	-36.79	-1.164	-19.78
	oh71	-4.357*	-38.57	-1.772*	-46.34	-0.272*	-42.05	-0.741	-23.56	-1.135*	-23.06
	pa42	-4.791*	-53.75	-2.050*	-61.39	-0.563*	-54.23	-1.467*	-36.54	-1.940*	-30.75
	tn00	-5.870*	-60.74	-2.212*	-65.62	-0.307*	-42.01	-1.199*	-27.03	-2.084*	-30.97
	va13	-2.142	-29.86	-1.200*	-43.55	0.475	65.67	-2.305*	-48.66	-1.109*	-25.59
	wv18	-4.170*	-38.96	-1.310*	-50.23	-0.336*	-41.07	-0.648*	-24.68	-0.927*	-22.14
11	ft03	-3.914*	-50.44	-1.794*	-37.84	-0.623*	-56.00	-0.586	-4.27	-2.258	-13.57
	fl11	-4.565*	-45.77	-1.730	-20.13	-0.056	-3.47	1.236	4.16	3.227	9.69
	ga41	-3.975*	-62.15	-1.948*	-58.02	-0.139	-15.56	-2.583*	-34.34	-2.959*	-34.05
	nc03	-3.991*	-63.04	-2.569*	-52.70	-0.136	-16.87	-4.243*	-30.86	-3.066	-20.99
	nc34	-4.495*	-62.69	-2.277*	-60.48	-0.399	-29.64	-2.509*	-35.84	-2.785*	-33.26
	nc35	-2.864*	-52.67	-1.811*	-41.07	-0.372*	-41.17	-0.918	-7.68	-0.317	-2.40
	nc41	-2.609*	-52.47	-1.765*	-47.68	0.063	8.45	-5.056*	-44.42	-2.447	-22.60
12	ak03	-0.923	-36.98	-0.734*	-57.77	-0.197	-45.57	-1.184	-41.72	-1.117	-38.38

* $p<0.05$

PRECIPITATION CHEMISTRY TRENDS IN THE UNITED STATES 1983-1993

Table 4. Direction and statistical significance of "deseasonalized" trends in ionic concentrations (μeq/L) in precipitation at 86 NAOP/NTN sites from 1983 through 1993.

		log(H)			log(SO4)			log(NO3)			log(NH4)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	-0.0043	****	0.465	-0.0028	*	0.306	+0.7469	*	0.169	+0.0415		0.207
	or02	-0.0987	**	0.269	-0.0547		0.117	+0.0005	***	0.403	+0.0043	***	0.399
	orl0	-0.8495		0.099	-0.0012	****	0.668	+0.0312	****	0.539	+0.8353	***	0.323
	or98	-0.0242	****	0.472	-0.0379	****	0.640	+0.2294	****	0.655	+0.0040	****	0.605
	wa14	+0.6818		0.181	-0.0002	*	0.399	+0.0010	**	0.368	+0.6871		0.101
2	ca42	-0.0365	**	0.349	-0.3057	***	0.385	-0.6954	****	0.460	+0.9325	***	0.338
	ca75	-0.0257		0.275	-0.6896	****	0.573	+0.0581	***	0.470	+0.0059	***	0.470
	ca88	-0.3528		0.200	-0.1915	****	0.524	+0.6743	***	0.353	+0.0330	****	0.485
3	co00	-0.1183	****	0.561	-0.0002	****	0.625	-0.0360	****	0.524	+0.9068	****	0.556
	co19	-0.0560	***	0.400	-0.0006	****	0.791	+0.3027	****	0.607	+0.0047	****	0.762
	co21	+0.5216	****	0.460	-0.0564	****	0.777	+0.6048	***	0.338	+0.0615	****	0.506
	mt05	-0.2826	***	0.347	-0.0046	****	0.609	+0.4963	**	0.271	+0.9753	*****	0.368
	nm07	+0.4737	***	0.304	-0.0069	****	0.507	-0.7861	****	0.458	+0.2782	****	0.478
	wy08	-0.0371	****	0.602	+0.2006	****	0.732	+0.0139	****	0.541	+0.0040	****	0.548
4	id03	-0.4585	****	0.535	-0.6005	***	0.351	+0.0937	****	0.486	+0.0217	****	0.562
5	az06	-0.5779	****	0.426	-0.3389	****	0.479	+0.8673	****	0.618	+0.7401	****	0.609
	tx04	-0.7856		0.134	-0.5659		0.127	+0.1503	**	0.252	+0.3488	*	0.206
6	az03	-0.9287		0.073	-0.0216	****	0.493	+0.4011	****	0.507	+0.0698	****	0.570
	az99	-0.0013	**	0.390	-0.0373	****	0.494	+0.5713	****	0.601	+0.0611	****	0.420
	co99	-0.0436	****	0.485	-0.0004	****	0.757	-0.6096	****	0.521	+0.8575	****	0.429
	nm09	-0.1065	****	0.447	-0.0001	****	0.672	-0.0745	****	0.616	+0.8094	****	0.500
7	co15	-0.3416	****	0.547	-0.1087	****	0.675	+0.7532	****	0.402	+0.2260	****	0.675
	co22	-0.0178	****	0.583	-0.0028	****	0.546	-0.2928	**	0.275	+0.9415	****	0.684
	wy06	+0.5186		0.196	-0.0704	****	0.483	+0.4928	****	0.518	+0.4086	***	0.471
	wy99	-0.5004	***	0.341	-0.0654	****	0.473	+0.9902	***	0.344	+0.4907	****	0.480
8	il11	-0.1076	****	0.575	-0.0546	****	0.687	-0.4188	****	0.627	+0.2122	****	0.634
	il18	-0.6363		0.081	-0.3269	****	0.405	+0.2732	***	0.308	+0.0672	****	0.354
	il19	-0.0662	*	0.271	-0.0693	****	0.571	-0.9505	****	0.455	+0.5628	***	0.377
	in34	-0.1133	****	0.349	-0.0656	****	0.662	-0.7526	***	0.287	+0.9731	****	0.484
	in41	-0.0344	*	0.292	-0.1034	****	0.566	-0.1779	***	0.381	-0.1909	****	0.557
	ks31	-0.4419	*	0.201	-0.1324	*	0.214	-0.9712	*	0.177	+0.1663	**	0.270
	mn27	+0.8453	***	0.395	-0.0228	**	0.385	-0.2217	***	0.357	-0.8787	***	0.316
	ne15	-0.2273		0.087	-0.1452	***	0.295	+0.3469	***	0.299	+0.7343	****	0.371
9	ma08	-0.7966	***	0.319	-0.5401	****	0.427	+0.9110		0.157	+0.1851	****	0.620
	me00	-0.1922		0.062	-0.2654	****	0.455	+0.5361	***	0.286	+0.5134	****	0.384
	me02	+0.6413	****	0.419	-0.7567	****	0.573	+0.1275	**	0.261	+0.0589	****	0.590
	me09	+0.9777	**	0.241	-0.2940	****	0.575	+0.2868		0.112	-0.9857	****	0.486
	me98	+0.1349	****	0.597	-0.9824	****	0.554	+0.0113	****	0.471	+0.1855	****	0.602
	mi09	-0.4057		0.150	-0.2949	****	0.720	+0.3929	****	0.401	+0.3018	***	0.333
	mi53	-0.0462		0.141	-0.0118	****	0.616	-0.2352	****	0.443	-0.9486	**	0.212
	mi99	-0.2279		0.202	-0.0535	****	0.589	-0.9601	****	0.377	+0.3750	****	0.446
	mn16	-0.1932	***	0.360	-0.0102	****	0.447	-0.0658	****	0.596	-0.3028	****	0.368
	mn18	+0.2860		0.101	-0.0591	****	0.706	+0.0837	****	0.449	+0.7794	****	0.461
	nh02	-0.9518	****	0.345	-0.8503	****	0.617	+0.6722		0.117	+0.4021	****	0.454
	ny08	-0.5726	****	0.576	-0.5347	****	0.756	+0.8901	**	0.206	+0.2032	****	0.527
	ny10	-0.0086	****	0.653	-0.0069	****	0.734	-0.3448	**	0.254	-0.3020	***	0.343
	ny20	-0.7657	****	0.359	-0.1663	****	0.720	-0.7853	*	0.194	-0.7033	****	0.582
	ny52	-0.0836	****	0.596	-0.0561	****	0.783	-0.1938	****	0.380	-0.5591	***	0.308
	ny65	+0.1218	****	0.772	+0.9133	****	0.842	+0.4243	****	0.464	+0.2983	****	0.760
	pa29	-0.0843	****	0.753	-0.1880	****	0.806	+0.3872	***	0.349	+0.7602	****	0.608
	vt01	+0.0645	****	0.441	+0.2068	****	0.623	+0.0473		0.199	+0.1979	****	0.512
	wi28	-0.0011	***	0.433	-0.0001	***	0.498	-0.0552	****	0.449	-0.3998	***	0.324
	wi36	-0.1149		0.237	-0.0156	****	0.511	-0.8461	**	0.228	+0.6254	***	0.309
	wi37	-0.6302	**	0.218	-0.0934	****	0.417	-0.7084		0.164	+0.1291	***	0.363

Table 4 (continued).

Region	Site	log(H) Year	Month	r2	log(SO4) Year	Month	r2	log(NO3) Year	Month	r2	log(Cl) Year	Month	r2	log(NH4) Year	Month	r2
10	ar16	-0.9355		0.196	-0.6035		0.230	+0.5660	***	0.465	-0.1396	***	0.446	-0.5237	****	0.463
	ar27	-0.2112	***	0.331	-0.0026	***	0.412	-0.2166	****	0.640	-0.6202		0.028	-0.1350	***	0.336
	il35	-0.2820		0.088	-0.0375	***	0.302	-0.2467	****	0.516	-0.2437		0.156	+0.6718	****	0.409
	il63	-0.6591	*	0.192	-0.0284	****	0.453	-0.4177	****	0.486	-0.4144	**	0.227	-0.1068	****	0.686
	mal3	-0.0471	****	0.518	-0.7048	****	0.536	+0.3392	****	0.380	-0.0652	****	0.428	+0.2364	****	0.544
	mi26	-0.0288		0.278	-0.0056	****	0.607	-0.1324	****	0.478	-0.1304	**	0.374	+0.6004	****	0.564
	mo03	-0.0220	*	0.272	-0.0004		0.316	-0.3194	***	0.386	-0.0458		0.241	-0.7290	***	0.376
	mo05	+0.5376		0.081	-0.3987		0.139	-0.3182	****	0.426	-0.0197		0.248	-0.6934	****	0.536
	nc25	-0.5580	****	0.611	-0.0622	****	0.708	-0.4772	****	0.631	-0.2476	**	0.310	-0.7910	****	0.535
	nj99	-0.3417	****	0.506	-0.6069	****	0.583	-0.9506	****	0.434	-0.1481	****	0.565	+0.3128	****	0.487
	oh17	-0.8274	****	0.433	-0.5587	****	0.649	-0.8840	****	0.482	+0.8184	****	0.391	+0.5007	****	0.553
	oh49	+0.9269	****	0.635	-0.7491	****	0.763	+0.9960	****	0.479	-0.6745	**	0.270	-0.7735	****	0.536
	oh71	-0.3879	****	0.493	-0.2431	****	0.633	-0.1244	****	0.581	-0.1361	**	0.273	-0.5960	****	0.538
	pa42	-0.9002	****	0.708	-0.7124	****	0.797	+0.9197	****	0.427	-0.8158		0.073	+0.6717	****	0.617
	tn00	-0.9873	****	0.355	-0.0521	****	0.461	+0.7526	****	0.412	-0.0235	*	0.245	+0.3040	****	0.468
	tn11	+0.2161	****	0.744	+0.7076	****	0.788	+0.5597	****	0.697	-0.0597	**	0.380	+0.7867	****	0.700
	va13	+0.4940	****	0.619	+0.8400	****	0.705	+0.4338	****	0.645	-0.1493		0.100	+0.5677	****	0.741
	va28	-0.0242	****	0.796	-0.0233	****	0.807	-0.4490	****	0.556	-0.0085		0.344	+0.3141	****	0.706
	wv18	+0.0940	****	0.760	+0.1818	****	0.827	+0.2434	****	0.461	-0.6605	**	0.193	+0.37407	****	0.537
11	ar02	+0.7223	**	0.261	-0.1350	**	0.289	-0.9150	****	0.511	+0.4229	****	0.496	+0.8915	***	0.380
	fl03	+0.1930	****	0.629	+0.7433	***	0.298	+0.0401	****	0.629	-0.1657	****	0.451	+0.5289	****	0.447
	fl11	-0.0134	**	0.306	+0.5173	**	0.248	+0.0885	*	0.266	+0.4107	****	0.725	+0.0133	***	0.349
	ga41	+0.7113	****	0.398	-0.0724	****	0.536	-0.2121	****	0.636	-0.0015	**	0.351	-0.4403	****	0.476
	la12	+0.8514	****	0.695	-0.0296	***	0.341	-0.5265	****	0.527	-0.0541	****	0.396	-0.2577	***	0.321
	la30	+0.6219	****	0.551	-0.1059	***	0.300	-0.2419	****	0.669	-0.0087	****	0.691	-0.1755	****	0.409
	nc03	-0.1036	***	0.319	-0.0705	***	0.317	-0.3266	****	0.321	-0.0106	****	0.631	+0.7625	****	0.327
	nc34	-0.4951	****	0.557	-0.2064	****	0.678	-0.3343	****	0.639	-0.1475	**	0.265	-0.4208	****	0.471
	nc35	-0.3124	****	0.409	-0.0568	***	0.408	-0.4795	****	0.441	-0.9076	****	0.570	+0.0432	****	0.489
	nc41	-0.4921	***	0.346	-0.2637	****	0.425	-0.4617	****	0.432	-0.0368	****	0.562	+0.0806	***	0.301
	tx21	+0.9270	****	0.469	-0.0887	**	0.287	-0.2617	****	0.496	-0.1152		0.196	-0.6937	****	0.468
	tx38	+0.8872	***	0.396	-0.3057		0.199	+0.6892		0.211	-0.0130	**	0.368	+0.5634	*	0.243
12	ak03	-0.0366	**	0.403	-0.0564	**	0.411	+0.0115		0.295	-0.7855	**	0.288	+0.2602	**	0.302

Table 4 (continued).

		log(Ca)			log(Mg)			log(K)			log(Na)			log(Cl)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	-0.0001	***	0.482	-0.0027	****	0.453	-0.0012		0.250	-0.3602	****	0.436	-0.0222	****	0.597
	or02	-0.0355		0.150	-0.0125	****	0.570	-0.1395		0.171	-0.0151	****	0.610	-0.0111	****	0.635
	or10	-0.0001	****	0.631	-0.0001	**	0.383	-0.0170	**	0.337	-0.0069	****	0.482	-0.0023	****	0.513
	or98	-0.0404	****	0.476	-0.0062	****	0.489	+0.6221	**	0.361	-0.1675	****	0.464	-0.1543	****	0.493
	wa14	-0.0028		0.305	-0.0039	****	0.573	-0.0578	***	0.388	-0.0310	****	0.590	-0.0101	****	0.633
2	ca42	-0.5467	***	0.332	-0.1981	**	0.266	-0.4187	**	0.274	-0.4604	**	0.271	-0.3751	***	0.317
	ca75	-0.3692	****	0.522	-0.0215	***	0.436	-0.1573	****	0.567	-0.5100		0.143	-0.1756		0.132
	ca88	-0.2602	****	0.425	-0.2528	*	0.217	-0.6132	***	0.355	-0.1397	*	0.228	-0.2114		0.160
3	co00	-0.0013	*	0.389	-0.0001	**	0.598	-0.0006	*	0.426	-0.0025	*	0.379	-0.0002	**	0.508
	co19	-0.0810	****	0.562	-0.0001	****	0.602	-0.6998	****	0.425	-0.2054		0.195	+0.9773	****	0.404
	co21	-0.0161	****	0.515	-0.0001	****	0.561	-0.0005	****	0.562	-0.1383		0.151	-0.0585		0.187
	mt05	-0.0083	****	0.489	-0.0001	****	0.519	-0.0859	****	0.649	-0.0283		0.188	-0.0002		0.283
	nm07	-0.0085	****	0.555	-0.0001	****	0.632	-0.0001	****	0.596	-0.0001	****	0.507	-0.0001	***	0.513
	wy08	+0.6109	****	0.515	-0.1655	****	0.600	-0.0179	****	0.695	+0.5987	*	0.258	-0.0983	***	0.406
4	id03	-0.2423	****	0.548	-0.0147	****	0.512	-0.2239	****	0.618	-0.9118	***	0.348	-0.1950	**	0.312
5	az06	-0.5148		0.173	-0.2839	**	0.254	+0.9369	**	0.265	-0.9894	***	0.336	-0.7538	***	0.349
	tx04	-0.3708	*	0.194	-0.0181	*	0.264	-0.2010	**	0.253	-0.6815		0.145	-0.2693		0.177
6	az03	-0.2557	**	0.291	-0.0666	***	0.325	-0.1384	****	0.466	-0.7612	**	0.278	-0.6275	****	0.424
	az99	+0.9639	*	0.222	-0.0204	****	0.525	+0.9877	****	0.565	+0.3836		0.111	+0.9945	*	0.220
	co99	-0.3016	***	0.292	-0.1130	***	0.349	-0.0763	****	0.452	-0.4910	****	0.414	-0.2619	****	0.521
	nm09	-0.0005	****	0.561	-0.0001	****	0.648	-0.0001	****	0.668	-0.0021	***	0.396	-0.0010	****	0.539
7	co15	-0.0313	****	0.443	-0.0024	****	0.503	-0.0423	****	0.431	-0.3213		0.148	-0.0351	***	0.338
	co22	-0.0005	****	0.629	-0.0001	***	0.556	-0.0061	****	0.466	-0.0119	***	0.396	-0.0371	***	0.344
	uy06	-0.0360	***	0.426	-0.0021	**	0.451	-0.0101		0.304	-0.1585		0.311	-0.0412		0.251
	wy99	-0.0233	****	0.480	-0.0001	***	0.569	-0.0007	****	0.687	-0.0280		0.184	-0.0002	*	0.394
8	il11	-0.0035	****	0.700	-0.0012	****	0.678	-0.0043	****	0.653	+0.5073	**	0.260	-0.8658	**	0.218
	il18	-0.0944	****	0.479	-0.0368	****	0.415	+0.6768	****	0.443	+0.5787		0.131	-0.8891	**	0.203
	il19	-0.0864	****	0.464	-0.0452	****	0.507	-0.2707	***	0.412	+0.7926	***	0.343	-0.8937	****	0.583
	in34	+0.6248	***	0.299	+0.9646	***	0.261	-0.0046	***	0.373	-0.2145	****	0.346	+0.6972	***	0.313
	in41	-0.0515	****	0.585	-0.0105	****	0.588	-0.0078	****	0.503	-0.2611		0.137	-0.0013	*	0.373
	ks31	-0.6355		0.143	-0.0117	**	0.336	-0.0211	***	0.384	-0.2926		0.136	-0.4020	**	0.257
	mn27	-0.0019	**	0.438	-0.0004	*	0.411	-0.0008	****	0.579	-0.0310		0.188	-0.0013	***	0.410
	ne15	-0.2824	****	0.487	-0.0024	***	0.420	-0.2323	****	0.359	-0.1692		0.083	-0.0144	*	0.266
9	ma08	-0.0337	**	0.312	-0.0138		0.272	-0.0209	**	0.329	-0.6529	****	0.408	-0.4924	***	0.337
	me00	-0.0742	****	0.488	-0.0001	****	0.623	-0.0006	**	0.393	-0.2981	****	0.606	-0.1056	****	0.647
	me02	-0.1309	****	0.454	-0.0021	*	0.313	+0.9404	**	0.231	-0.5315	**	0.252	-0.8338	**	0.253
	me09	-0.0007	****	0.470	-0.0001	*	0.399	-0.0001	****	0.618	-0.5808	***	0.299	-0.3927	**	0.251
	me98	-0.0014		0.343	-0.0053	****	0.719	-0.9416	****	0.413	-0.0987	****	0.738	-0.0735	****	0.735
	mi09	-0.4319	**	0.289	-0.0452	***	0.413	-0.3843	***	0.372	+0.7961		0.201	-0.8108	***	0.359
	mi53	-0.0373	**	0.273	-0.0431		0.205	-0.0159	**	0.311	-0.8858	****	0.448	-0.4016	****	0.633
	mi99	-0.0066	***	0.421	-0.0001	**	0.501	-0.0034	**	0.308	-0.0002	****	0.652	-0.0085	****	0.532
	mn16	-0.0098		0.220	-0.0018		0.266	-0.0051	**	0.337	-0.0018	***	0.399	-0.0002	**	0.421
	mn18	-0.0050	***	0.368	-0.0001	**	0.461	-0.0001	*	0.485	-0.0022	*	0.317	-0.0021	**	0.372
	nh02	-0.0147	***	0.392	-0.0002	*	0.358	-0.0061	****	0.666	-0.6472	***	0.311	-0.6230	**	0.241
	ny08	-0.0760	****	0.449	-0.0007	****	0.480	-0.0005	****	0.540	-0.1839		0.176	-0.4122	*	0.171
	ny10	-0.0237	****	0.498	-0.0008	****	0.521	-0.0001	***	0.555	-0.0410		0.261	-0.0001	***	0.531
	ny20	-0.0026	****	0.511	-0.0001	****	0.630	-0.0001	****	0.598	-0.1698	****	0.371	-0.0093		0.259
	ny52	-0.0631	*	0.220	-0.0011		0.240	-0.0001	***	0.493	-0.0302	****	0.657	-0.0004	****	0.641
	ny65	-0.0106	****	0.498	-0.0001	****	0.556	-0.0022	****	0.533	-0.0674		0.168	-0.9526		0.181
	pa29	-0.2355	****	0.502	-0.0033	***	0.468	-0.3843	****	0.495	-0.5301	**	0.236	-0.3187	**	0.249
	vt01	-0.8121	***	0.380	-0.0004	***	0.497	-0.0574	****	0.439	+0.7831	****	0.580	-0.7639	***	0.352
	wi28	-0.0081	***	0.391	-0.0002	**	0.445	-0.0001	****	0.511	-0.0402	****	0.439	-0.0002	****	0.613
	wi36	-0.0267	***	0.376	-0.0028	***	0.380	-0.0006	****	0.480	-0.0858		0.235	-0.1343	**	0.251
	wi37	-0.0211	***	0.382	-0.0010	****	0.494	-0.0001	***	0.511	-0.0220	***	0.342	-0.0007		0.330

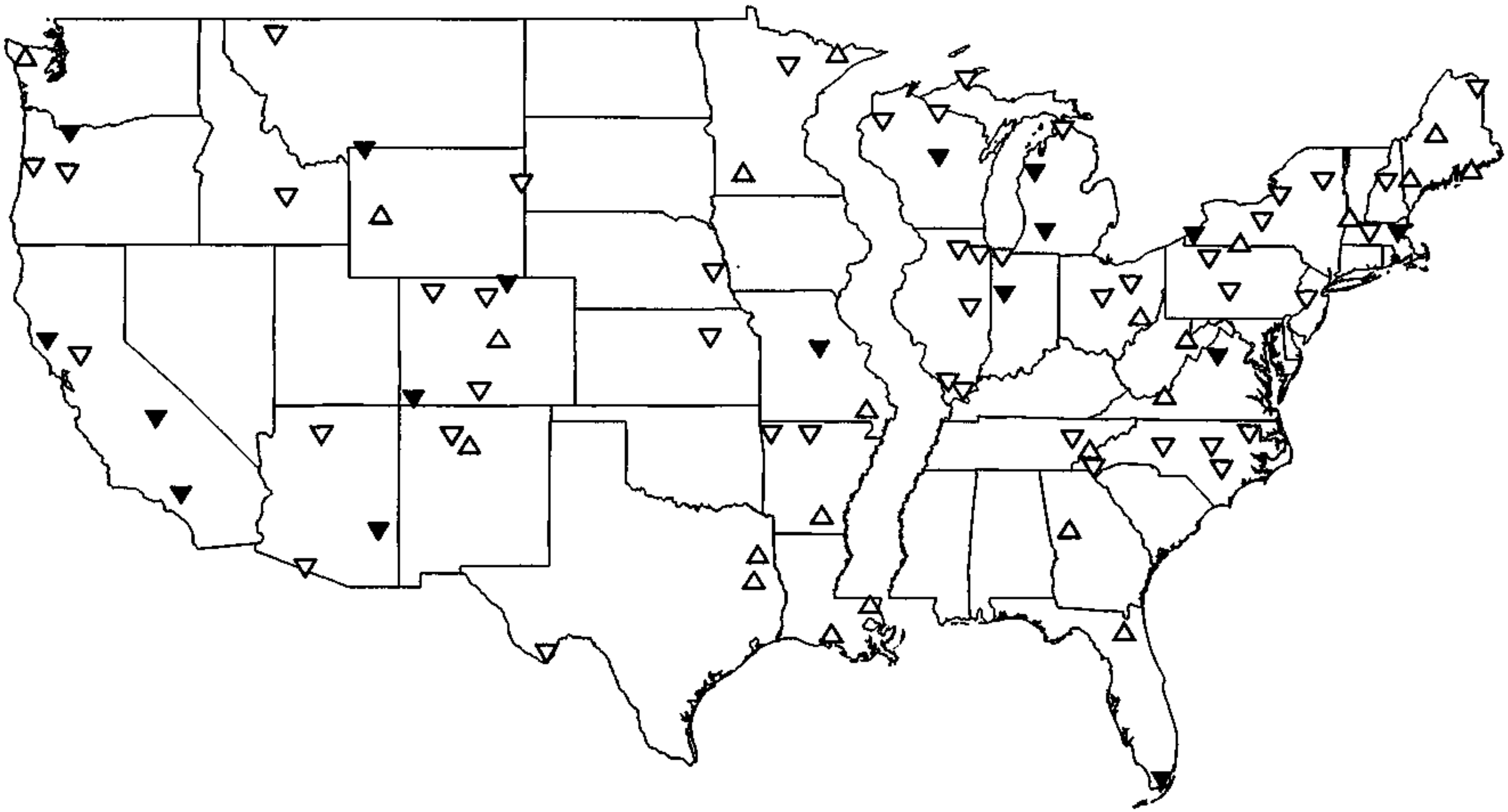
Table 4 (continued).

Region	Site	log(Ca)			log(Hg)			log(K)			log(Na)			log(Cl)		
		Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
10	ar16	-0.1520	****	0.514	-0.0011	**	0.448	-0.5966	**	0.286	-0.2127	*	0.284	-0.1396	***	0.446
	ar27	-0.0014	****	0.561	-0.0109	**	0.309	-0.4239		0.168	-0.4784		0.032	-0.6202		0.028
	il35	-0.0224	****	0.606	-0.0011	****	0.477	-0.0131	****	0.474	-0.2552		0.106	-0.2437		0.156
	il63	-0.0005	****	0.710	-0.0001	****	0.538	-0.0255	****	0.546	-0.1442		0.147	-0.4144	**	0.227
	ma13	+0.6782	*	0.192	-0.0123	**	0.324	+0.9247	**	0.196	-0.2907	****	0.599	-0.0652	****	0.428
	mi26	-0.1023	****	0.480	-0.0077	****	0.570	-0.5197	****	0.471	-0.3861	**	0.289	-0.1304	**	0.374
	mo03	-0.0269	***	0.422	-0.0122		0.306	-0.0052	**	0.364	+0.9781		0.094	-0.0458		0.241
	mo05	-0.0017	****	0.569	-0.0001	**	0.431	-0.0545	**	0.355	-0.0136		0.242	-0.0197		0.248
	nc25	-0.0007	****	0.703	-0.0061	**	0.470	-0.1070	****	0.604	-0.4905	***	0.378	-0.2476	**	0.310
	nj99	-0.0051	****	0.409	-0.0001	*	0.391	-0.0047		0.256	-0.3165	****	0.607	-0.1481	****	0.565
	oh17	-0.0117	****	0.505	-0.0033	****	0.500	-0.3948	***	0.362	+0.8307	***	0.379	+0.8184	****	0.391
	oh49	-0.0068	****	0.693	-0.0009	****	0.526	-0.8519	*	0.199	-0.5373		0.093	-0.6745	**	0.270
	oh71	-0.0700	****	0.534	-0.0083	****	0.518	-0.0121	****	0.553	-0.5341	*	0.175	-0.1361	**	0.273
	pa42	-0.0287	****	0.506	-0.0002	***	0.456	-0.0526	***	0.330	-0.7211	***	0.306	-0.8158		0.073
	tn00	-0.0001	****	0.630	-0.0001	***	0.632	-0.0008	****	0.573	-0.0943	***	0.303	-0.0235	*	0.245
	tn11	-0.0045	****	0.579	-0.0001	***	0.643	-0.0023	****	0.584	-0.4824	**	0.312	-0.0597	**	0.380
	va13	-0.1848	****	0.510	-0.0008	****	0.495	+0.6092	****	0.426	-0.1333		0.203	-0.1493		0.100
	va28	-0.0100	****	0.612	-0.0001		0.511	-0.3961	**	0.317	-0.0222	**	0.446	-0.0085		0.344
	wv18	-0.5735	****	0.536	-0.0001	****	0.545	-0.0163	****	0.418	-0.2720		0.133	-0.6605	**	0.193
11	ar02	-0.0086	***	0.448	-0.0080	****	0.493	-0.1507	***	0.384	+0.2140	***	0.437	+0.4229	****	0:496
	fl03	-0.0192	***	0.418	-0.0074	***	0.406	-0.0005	**	0.441	-0.3278	****	0.441	-0.1657	****	0.451
	fl11	-0.3292	**	0.281	-0.6597	****	0.679	+0.2323	***	0.388	+0.2362	**•*	0.722	+0.4107	****	0.725
	ga41	-0.0001	****	0.697	-0.0001	***	0.536	-0.0439		0.221	-0.0032	***	0.410	-0.0015	**	0.351
	la12	-0.0156	****	0.540	-0.0074	****	0.439	-0.0013	****	0.470	-0.0402	****	0.515	-0.0541	****	0.396
	la30	-0.0004	****	0.497	-0.0005	****	0.553	-0.0019	****	0.528	-0.0566	****	0.618	-0.0087	****	0.691
	nc03	-0.0001	****	0.564	-0.0001	****	0.656	-0.1901	***	0.300	-0.0194	****	0.630	-0.0106	****	0.631
	nc34	-0.0003	****	0.528	-0.0002	*	0.351	-0.2151	**	0.257	-0.3788	****	0.362	-0.1475	**	0.265
	nc35	-0.0002	**	0.469	-0.0172	****	0.510	-0.0014	****	0.487	+0.9435	****	0.567	-0.9076	****	0.570
	nc41	-0.0001	****	0.524	-0.0001	**	0.373	-0.7044		0.187	-0.0285	****	0.527	-0.0368	****	0.562
	tx21	-0.0046	****	0.448	-0.0045	*	0.297	-0.1629	****	0.514	-0.2054		0.170	-0.1152		0.196
	tx38	-0.0585	**	0.369	-0.0009		0.407	-0.2819		0.216	-0.0219	**	0.366	-0.0130	**	0.368
12	ak03	-0.4441		0.209	-0.0002		0.484	-0.2742	**	0.349	-0.2884	***	0.385	-0.7855	**	0.288

Figure 13

National Atmospheric Deposition Program / National Trends Network

Trends in Hydrogen Ion Concentration
1983 through 1993



∇ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

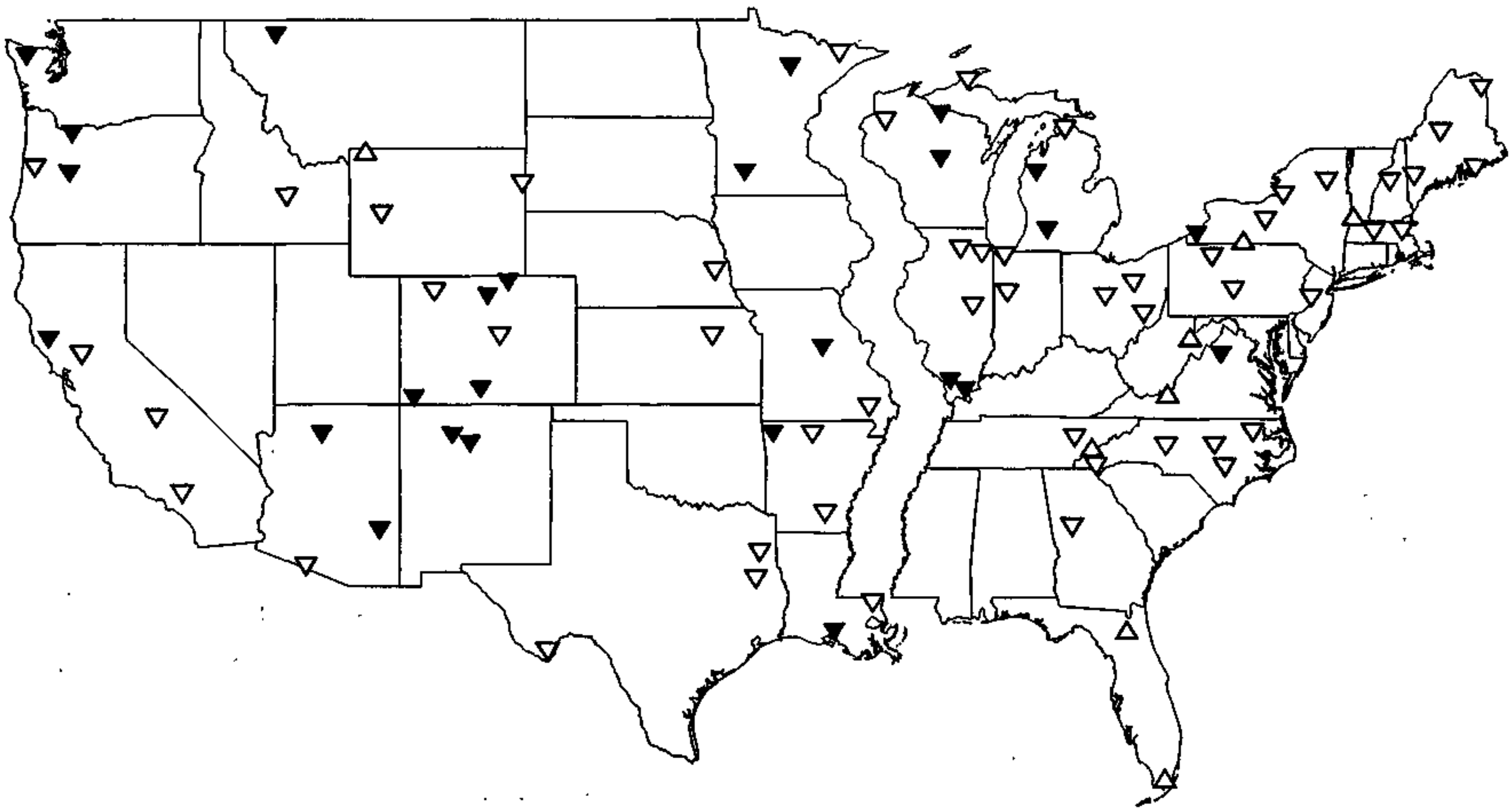
△ Positive slope estimate, p>0.05

▲ Positive slope estimate, p<0.05

Figure 14

National Atmospheric Deposition Program / National Trends Network

Trends in Sulfate Ion Concentration
1983 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

△ Positive slope estimate, p>0.05

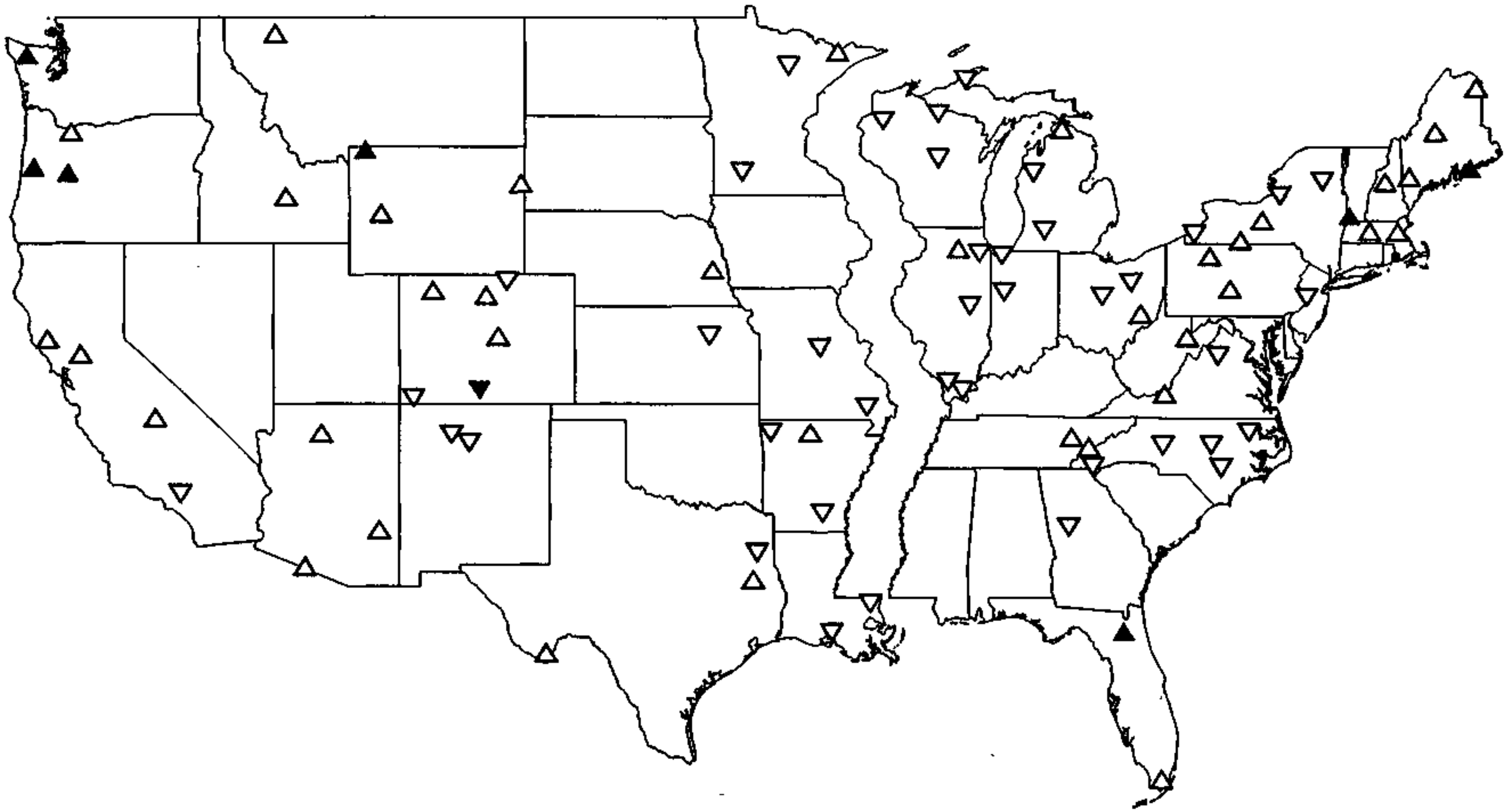
▲ Positive slope estimate, p<0.05

Figure 15

National Atmospheric Deposition Program / National Trends Network

Trends in Nitrate Ion Concentration

1983 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

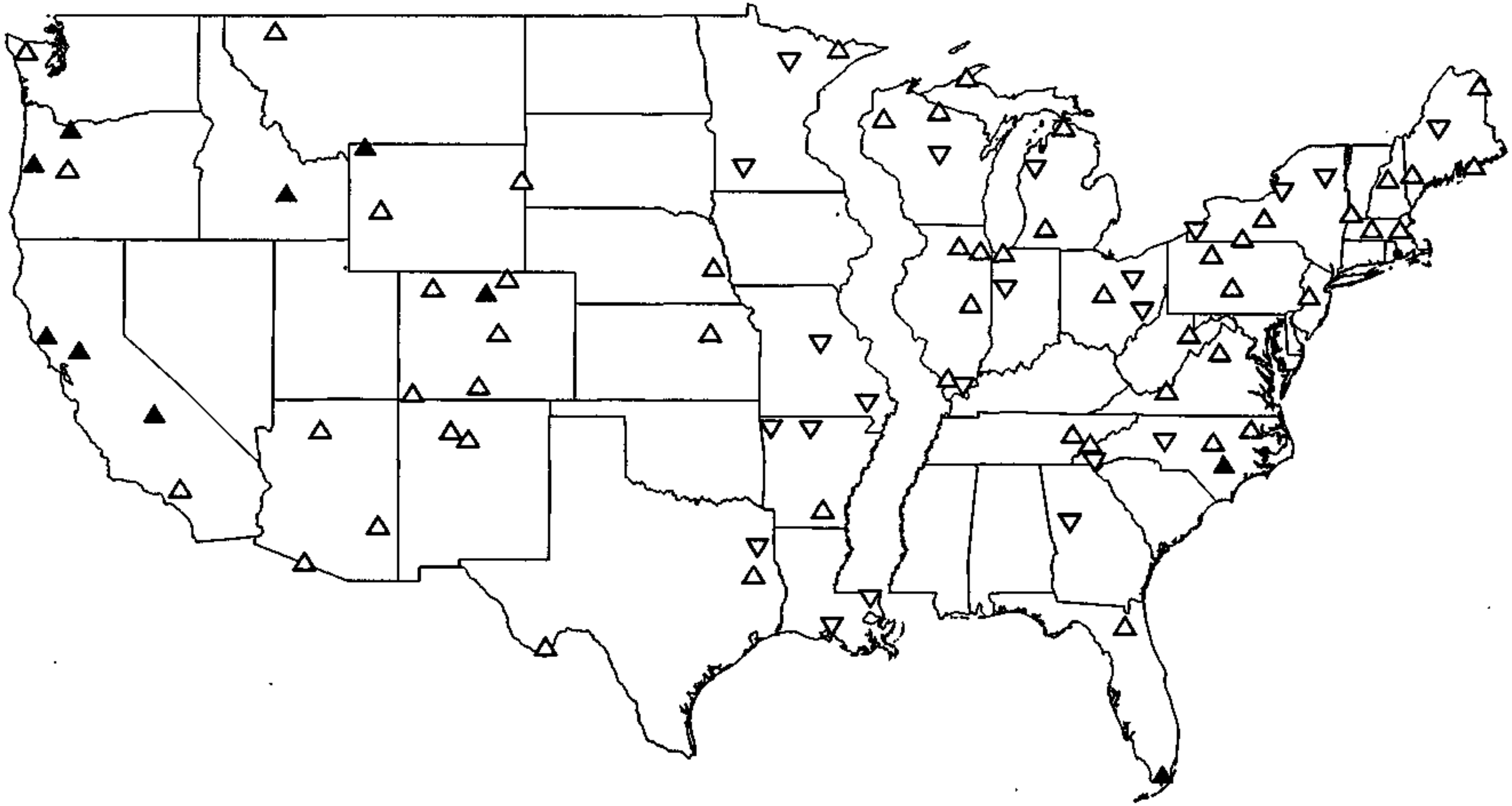
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 16

National Atmospheric Deposition Program / National Trends Network

Trends in Ammonium Ion Concentration
1983 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

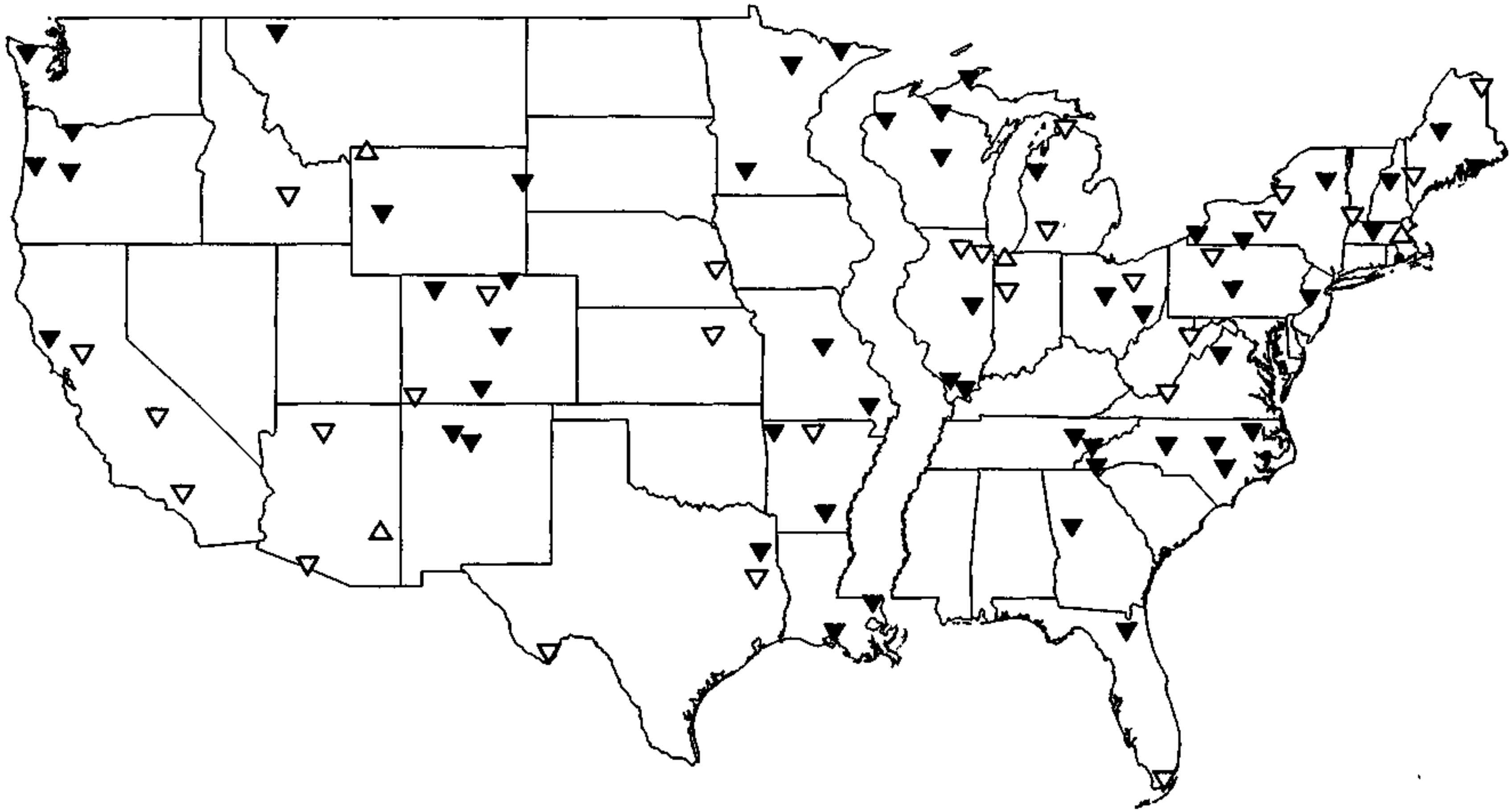
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 17

National Atmospheric Deposition Program / National Trends Network

Trends in Calcium Ion Concentration
1983 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

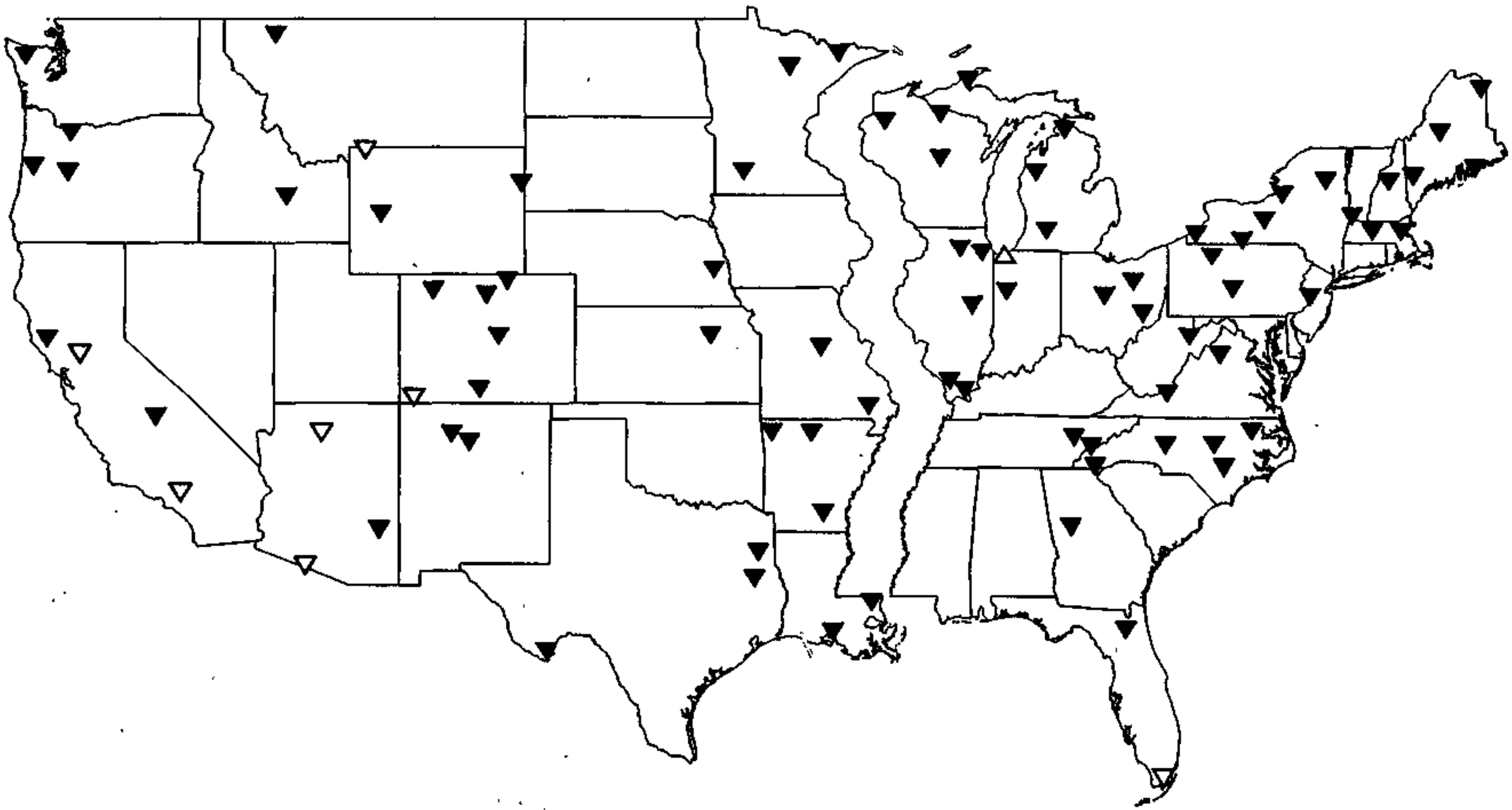
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 18

National Atmospheric Deposition Program / National Trends Network

Trends in Magnesium ion Concentration
1983 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

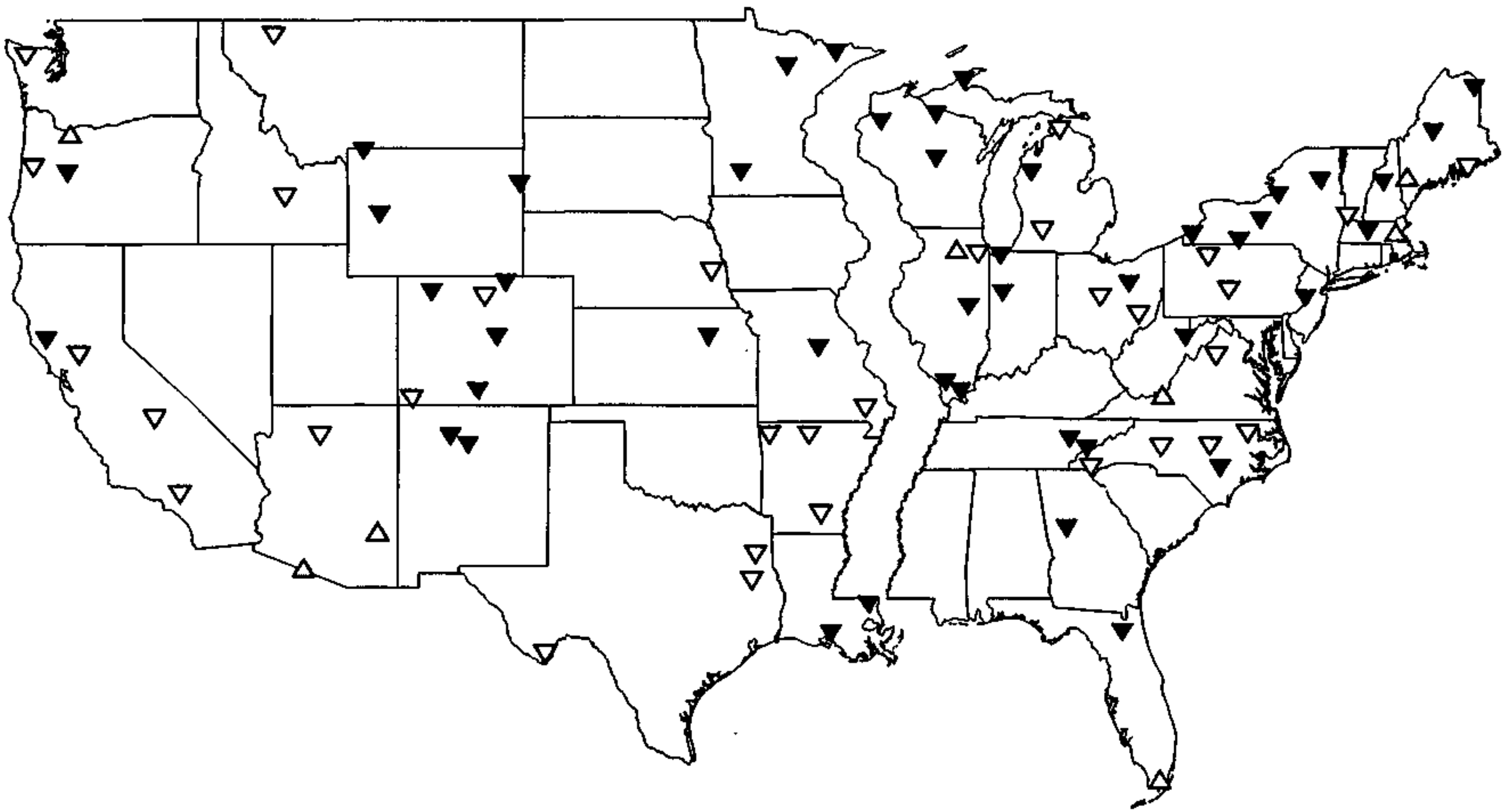
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 19

National Atmospheric Deposition Program / National Trends Network

Trends in Potassium Ion Concentration
1983 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

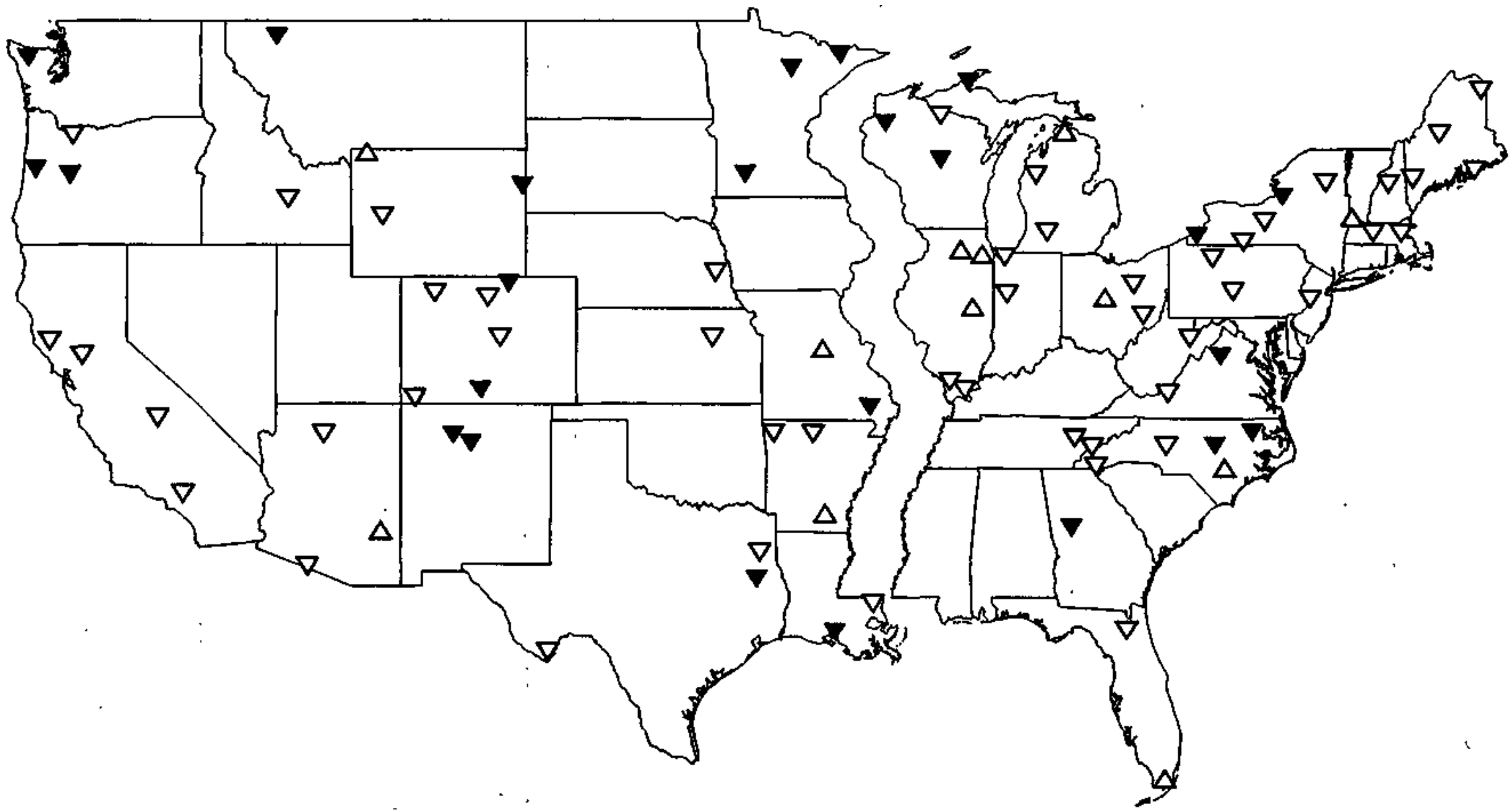
△ Positive slope estimate, p>0.05

▲ Positive slope estimate, p<0.05

Figure 20

National Atmospheric Deposition Program / National Trends Network

Trends in Sodium Ion Concentration
1983 through 1993



▽ Negative slope estimate, p>0.05 △ Positive slope estimate, p>0.05

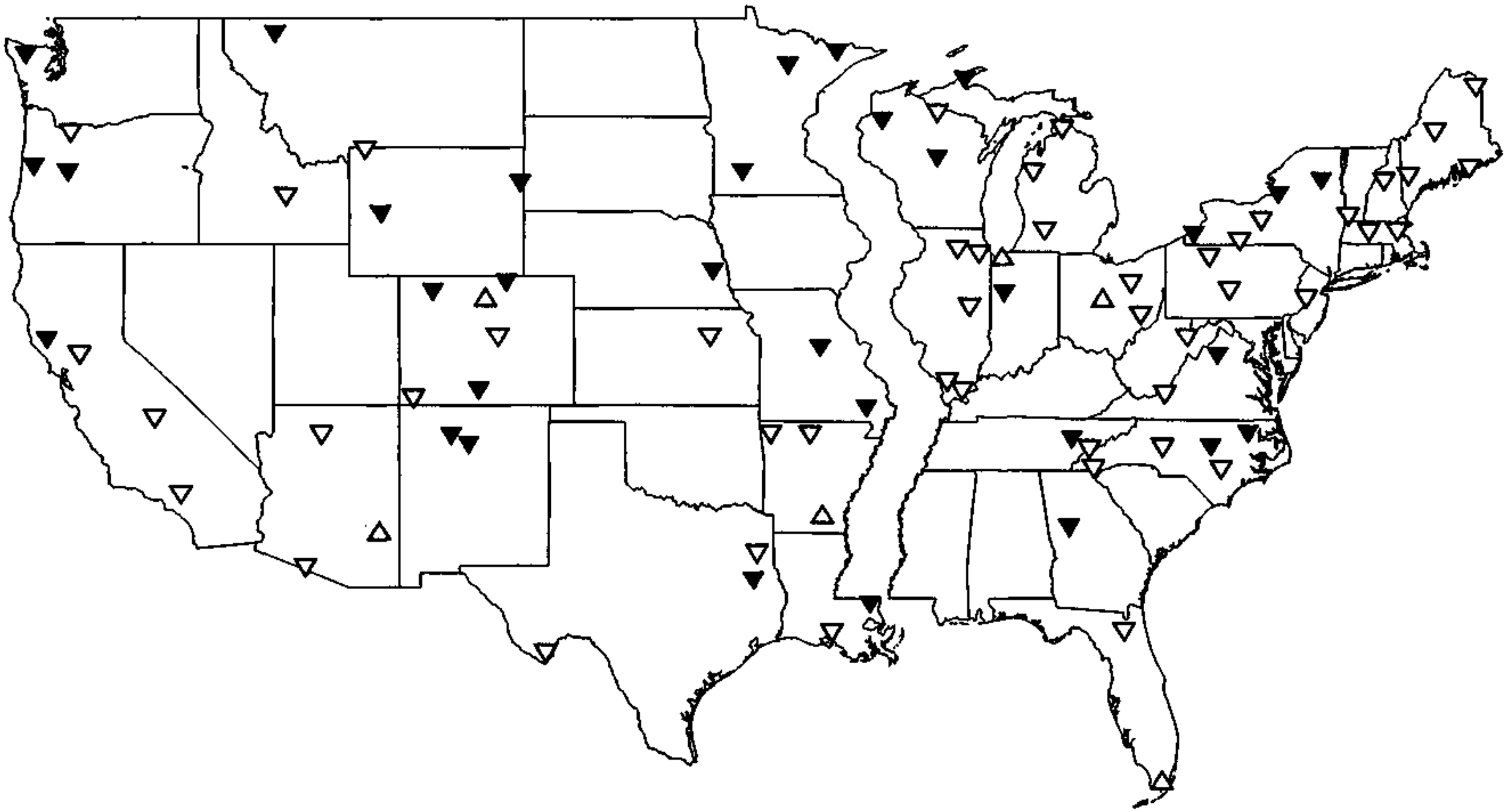
▼ Negative slope estimate, p<0.05 ▲ Positive slope estimate, p<0.05

Figure 21

National Atmospheric Deposition Program / National Trends Network

Trends in Chloride Ion Concentration

1983 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Table 5. Predicted changes in concentrations (μeq/L) of individual anions and cations in precipitation at 86 NADP/NTN sites from 1983 to 1993.

		Hydrogen Ion		Sulfate		Nitrate		Ammonium	
Region	Site	Change (μeq/L)	Percent Change	Change (μeq/l)	Percent Change	Change (μeq/L)	Percent Change	Change (μeq/L)	Percent Change
1	ca45	-1.521*	-40.42	-3.448*	-40.72	0.429	9.01	2.318*	90.71
	or02	-0.804	-20.33	-2.307	-25.54	1.999*	158.12	1.067*	130.32
	or10	-0.124	-2.79	-2.050*	-33.04	1.494*	65.75	0.088	6.27
	or98	-1.929*	-26.02	-2.444*	-23.01	1.087	20.52	3.584*	120.17
	wa14	0.147	3.73	-2.824*	-38.75	0.973*	104.60	0.061	8.39
2	ca42	-9.952*	-51.49	-4.548	-23.53	-2.714	-10.42	0.455	3.08
	ca75	-1.733*	-46.14	-1.117	-8.79	10.725	85.28	24.276*	203.31
	ca88	-0.256	-25.85	-2.778	-16.65	1.587	8.88	11.180*	38.20
3	co00	-1.188	-36.82	-16.873*	-58.10	-4.341*	-32.22	0.433	3.58
	co19	-3.006	-36.72	-7.777*	-39.54	2.209	14.96	5.945*	81.11
	co21	1.221	13.73	-4.122	-22.50	1.177	6.41	3.873	57.84
	mt05	-0.797	-12.95	-3.084*	-29.00	0.563	9.81	0.031	0.75
	nm07	1.146	14.56	-5.822*	-27.72	-0.476	-3.57	1.619	24.35
	wy08	-1.450*	-37.17	1.827	25.14	3.929*	72.51	5.416*	169.73
4	id03	-0.513	-16.74	-1.374	-11.08	3.849	42.85	7.325*	100.21
5	az06	-0.573	-14.34	-4.168	-17.41	0.690	4.01	1.318	9.27
	tx04	-0.216	-9.13	-2.463	-11.08	3.329	38.00	2.680	29.78
6	az03	-0.119	-2.84	-7.433*	-37.63	2.067	16.66	2.753	49.29
	az99	-15.706*	-71.12	-14.124*	-39.72	1.685	14.21	6.475	118.94
	co99	-5.301*	-36.92	-8.589*	-31.52	-1.089	-6.91	0.272	4.28
	nm09	-3.102	-28.51	-10.964*	-45.87	-3.314	-22.27	0.412	6.20
7	co15	-1.085	-13.55	-3.271	-18.07	0.598	4.26	1.868	29.79
	co22	-2.778*	-49.20	-8.566*	-38.94	-2.586	-13.04	0.291	1.33
	wy06	1.054	24.41	-5.154	-31.04	1.254	11.93	1.779	32.32
	wy99	-0.665	-12.82	-4.355	-22.62	0.023	0.16	1.836	20.29
8	il11	-7.256	-14.50	-9.363	-15.59	-1.761	-7.12	3.420	20.33
	il18	-2.370	-7.33	-4.945	-9.60	3.561	15.41	7.149	36.56
	il19	-10.150	-21.69	-9.297	-14.39	-0.184	-0.66	1.915	8.46
	in34	-6.796	-16.88	-7.534	-12.11	-0.885	-3.13	0.095	0.44
	in41	-8.964*	-18.13	-8.657	-13.80	-4.300	-14.84	-4.055	-17.18
	ks31	-1.779	-14.92	-4.777	-15.88	-0.072	-0.35	4.017	23.51
	mn27	0.366	7.09	-10.281*	-30.07	-4.749	-16.51	-0.847	-2.46
	ne15	-2.318	-37.07	-6.549	-18.42	2.355	11.24	1.875	5.61
9	ma08	-2.190	-4.92	-4.693	-11.41	0.543	2.49	2.829	37.51
	me00	-5.388	-19.00	-3.956	-13.23	1.417	9.94	0.908	14.69
	me02	2.195	7.43	-1.341	-4.40	3.630	27.61	2.906	56.14
	me09	0.101	0.42	-3.613	-14.00	2.270	19.04	-0.028	-0.45
	me98	6.060	23.77	-0.088	-0.29	5.321*	51.48	1.606	32.73
	mi09	-3.371	-10.05	-3.112	-7.86	2.383	9.62	2.805	17.54
	mi53	-8.909*	-22.48	-9.950*	-20.64	-3.787	-11.80	-0.190	-0.93
	mi99	-3.322	-16.79	-5.286	-17.65	-0.080	-0.45	2.253	17.93
	mn16	-3.487	-27.47	-7.559*	-28.80	-4.040	-18.45	-3.530	-17.78
	mn18	2.271	23.82	-3.482	-16.68	2.628	18.87	0.675	5.71
	nh02	-0.328	-0.81	-0.905	-2.52	1.314	6.12	1.577	20.39
	ny08	-2.951	-4.79	-3.315	-5.24	0.425	1.31	3.393	19.59
	ny10	-11.036*	-17.45	-13.524*	-20.08	-2.453	-7.50	-2.494	-12.72
	ny20	-1.442	-3.68	-5.800	-14.91	-0.623	-2.79	-0.602	-5.79
	ny52	-8.407	-13.53	-8.772	-14.44	-3.738	-9.99	-1.564	-7.91
	ny65	6.413	13.35	0.450	0.90	1.859	7.42	1.704	14.41
	pa29	-7.388	-11.37	-6.227	-9.94	2.194	7.92	0.550	4.01
	vt01	12.198	32.75	7.424	19.28	7.570*	36.13	3.339	34.30
	wi28	-15.598*	-51.17	-19.812*	-40.58	-4.862	-17.85	-3.038	-12.06
	wi36	-4.526	-23.58	-10.315*	-32.96	-0.527	-2.73	2.031	15.62
	wi37	-1.602	-12.26	-6.434	-21.02	-0.901	-4.15	6.379	34.23

* $p<0.05$

Table 5 (continued).

Region	Site	Hydrogen Ion Change (μeq/L)	Hydrogen Ion Percent Change	Sulfate Change (μeq/L)	Sulfate Percent Change	Nitrate Change μeq/L)	Nitrate Percent Change	Ammonium Change μeq/L)	Ammonium Percent Change
10	ar16	-0.264	-1.35	-1.803	-6.76	1.087	8.12	-1.270	-10.69
	ar27	-2.446	-19.96	-8.441*	-28.77	-1.950	-12.61	-4.023	-22.71
	il35	-4.841	-13.10	-9.282*	-19.61	-2.374	-12.10	1.004	8.09
	il63	-1.642	-4.11	-8.811*	-16.92	-1.453	-7.58	-2.433	-15.76
	ma13	-11.215*	-21.85	-1.920	-4.09	3.021	17.92	1.747	27.48
	mi26	-10.671*	-22.14	-13.705*	-22.79	-4.144	-13.37	1.480	7.14
	mo03	-8.411*	-31.31	-15.695*	-36.45	-2.404	-11.41	-0.828	-5.03
	mo05	2.800	10.89	-4.007	-11.06	-2.128	-11.54	-0.715	-5.37
	nc25	-2.357	-8.50	-7.690	-22.53	-1.204	-9.82	-0.475	-6.00
	nj99	-5.505	-11.83	-2.780	-5.89	-0.188	-0.83	2.227	22.37
	oh17	-1.138	-2.11	-3.234	-5.18	-0.453	-1.53	2.096	11.79
	oh49	0.451	0.69	-1.654	-2.35	0.013	0.05	-0.674	-4.63
	oh71	-3.693	-6.50	-5.772	-8.73	-3.727	-12.12	-1.481	-6.83
	pa42	-0.817	-1.26	-2.289	-3.70	0.341	1.07	0.931	6.47
	tnOO	-0.086	-0.19	-10.194	-19.15	0.609	3.57	1.723	19.84
	tn11	4.371	15.40	1.423	4.28	0.802	5.68	0.431	5.03
	va13	3.329	11.42	1.031	2.91	1.693	11.13	0.914	10.20
	va28	-8.658*	-24.57	-10.561*	-27.24	-1.830	-12.33	2.148	24.99
	wv18	7.839	15.46	5.787	10.89	2.853	11.77	1.525	14.02
11	ar02	1.151	8.58	-4.561	-17.51	-0.178	-1.42	0.351	3.22
	fl03	3.391	17.89	1.039	4.41	2.965*	31.33	0.648	13.64
	flll	-3.467*	-38.51	1.714	11.04	2.995	48.46	4.492*	180.43
	ga41	1.672	6.79	-6.636	-20.14	-1.723	-13.05	-1.162	-13.96
	la12	0.405	2.75	-6.146*	-23.65	-1.087	-8.59	-3.076	-25.08
	la30	1.357	8.51	-5.516	-20.69	-1.909	-14.22	-3.286	-26.69
	nc03	-7.111	-22.19	-8.423	-22.95	-2.178	-13.61	0.623	7.27
	nc34	-3.397	-9.41	-5.958	-13.68	-2.039	-10.85	-2.492	-16.33
	nc35	-3.864	-15.02	-7.687	-22.67	-1.243	-8.80	3.152*	35.22
	nc41	-3.653	-12.52	-5.611	-15.23	-1.659	-9.98	5.540	50.15
	tx21	0.293	1.40	-5.588	-16.53	-1.691	-11.82	-0.691	-6.72
	tx38	0.360	2.70	-3.537	-13.51	0.794	6.91	1.141	13.93
12	ak03	-1.317*	-33.33	-2.039	-36.98	1.302*	109.30	0.456	48.30

* $p<0.05$

Table 5 (continued).

Region	Site	Calcium Change (ttea/L)	Calcium Percent Change	Magnesium Change (ttea/L)	Magnesium Percent Change	Potassium Change (ttea/L)	Potassium Percent Change	Sodium Change (ttea/L)	Sodium Percent Change	Chloride Change (ttea/L)	Chloride Percent Change
1	ca45	-1.857*	-61.03	-1.566*	-45.28	-0.349*	-51.24	-1.814	-17.51	-4.685*	-35.40
	or02	-1.095*	-33.76	-3.410*	-42.11	-0.265	-27.63	-15.188*	-43.00	-18.923*	-44.94
	or10	-1.278*	-52.70	-1.587*	-58.91	-0.150*	-35.47	-3.729*	-43.18	-4.950*	-49.07
	or98	-0.759*	-27.83	-1.495*	-38.35	0.082	12.95	-3.370	-23.52	-4.014	-24.57
	wa14	-1.021*	-44.88	-2.488*	-46.31	-0.190	-30.40	-8.085*	-38.23	-11.259*	-43.67
2	ca42	-1.217	-19.50	-1.450	-33.41	-0.213	-25.31	-3.098	-22.62	-3.868	-26.38
	ca75	-1.171	-23.81	-1.148*	-46.80	-0.514	-33.15	-0.860	-19.74	-1.629	-34.15
	ca88	-1.408	-25.33	-1.040	-26.33	-0.134	-13.21	-3.468	-33.67	-2.953	-29.24
3	co00	-14.326*	-66.75	-4.127*	-79.29	-1.512*	-74.49	-6.600*	-59.29	-3.021*	-58.38
	co19	-3.591	-31.41	-1.961*	-59.65	-0.109	-12.38	-0.758	-23.88	0.015	0.59
	co21	-4.993*	-40.16	-1.807*	-52.53	-0.714*	-57.97	-1.049	-30.55	-0.803	-26.89
	mt05	-2.532*	-44.61	-1.015*	-54.83	-0.234	-29.63	-0.819*	-29.73	-1.043*	-43.79
	nm07	-6.490*	-41.58	-2.223*	-66.99	-1.059*	-77.57	-2.804*	-59.39	-2.277*	-55.39
	wy08	1.548	20.02	-0.725	-30.69	-0.417*	-44.46	0.380	14.99	-0.824	-25.58
4	id03	-3.657	-30.44	-1.585*	-48.23	-0.194	-25.47	-0.146	-3.32	-1.414	-27.22
5	az06	-2.748	-19.30	-2.025	-28.68	0.022	1.90	-0.081	-0.47	-2.289	-10.86
	tx04	-8.950	-29.45	-1.472*	-43.93	-0.390	-33.58	-0.473	-9.44	-1.029	-23.99
6	az03	-6.112	-32.08	-2.716	-41.85	-0.207	-30.40	-0.320	-6.93	-0.388	-9.56
	az99	0.178	1.93	-1.735*	-49.98	0.003	0.46	1.366	39.70	0.009	0.20
	co99	-6.402	-28.96	-1.410	-33.35	-0.194	-30.21	-0.435	-12.35	-0.573	-17.70
	nm09	-8.906*	-59.96	-2.541*	-71.33	-0.472*	-58.45	-1.845*	-44.59	-1.321*	-37.74
7	co15	-5.963*	-41.84	-1.858*	-48.50	-0.310*	-39.80	-0.833	-22.12	-0.967*	-28.69
	co22	-6.662*	-49.77	-2.232*	-66.02	-0.514*	-52.06	-1.980*	-41.17	-0.911*	-26.71
	wy06	-8.122*	-52.85	-2.767*	-65.44	-0.592*	-66.25	-1.585	-30.49	-1.777*	-39.80
	wy99	-5.175*	-31.99	-2.443*	-58.72	-0.372*	-45.31	-1.582*	-41.13	-1.515*	-45.52
8	it11	-4.483*	-37.52	-0.965*	-35.70	-0.226*	-38.48	0.256	10.37	-0.065	-1.70
	il18	-4.095	-29.48	-1.511*	-33.16	0.052	8.81	0.238	8.99	-0.066	-1.82
	il19	-5.589	-32.28	-2.007*	-32.52	-0.175	-22.59	0.142	4.38	-0.066	-1.35
	in34	1.752	9.62	0.047	0.80	-0.294*	-38.45	-0.644	-18.03	0.245	5.02
	in41	-4.507	-33.21	-1.483*	-36.24	-0.305*	-40.85	-0.614	-17.76	-2.015*	-37.41
	ks31	-1.409	-9.17	-0.943*	-33.71	-0.294*	-35.10	-0.612	-17.41	-0.412	-12.00
	mn27	-7.611*	-40.04	-2.852*	-49.36	-0.666*	-50.42	-0.939*	-29.46	-1.259*	-33.43
	ne15	-2.854	-16.65	-1.382*	-40.59	-0.189	-19.84	-0.781	-22.75	-1.042*	-30.01
9	ma08	-1.358*	-38.80	-0.947*	-39.29	-0.235*	-43.78	-0.521	-9.17	-0.943	-12.96
	me00	-1.158	-24.03	-1.484*	-63.28	-0.271*	-51.52	-0.728	-17.92	-0.966	-20.99
	me02	-0.588	-21.42	-1.093*	-48.37	0.008	2.16	-0.846	-14.99	-0.329	-5.37
	me09	-1.465*	-45.51	-0.792*	-49.76	-0.191*	-48.40	-0.293	-9.77	-0.513	-14.55
	me98	-1.769*	-43.22	-2.894*	-40.57	-0.011	-1.53	-8.016	-30.33	-10.290	-32.84
	mi09	-1.365	-14.76	-1.039*	-31.67	-0.108	-17.74	0.072	3.58	-0.073	-2.67
	mi53	-3.808*	-30.60	-1.556*	-33.24	-0.250*	-38.28	-0.057	-2.19	-0.343	-8.93
	mi99	-3.328*	-37.50	-1.921*	-57.56	-0.283*	-42.76	-1.426*	-42.57	-0.968*	-31.21
	mn16	-4.334*	-39.03	-1.554*	-46.52	-0.346*	-40.36	-1.245*	-40.57	-1.137*	-40.18
	mn18	-2.931*	-35.61	-1.575*	-56.21	-0.465*	-63.78	-0.885*	-38.37	-0.762*	-33.45
	nh02	-1.215*	-35.05	-0.999*	-51.26	-0.145*	-35.03	-0.300	-8.57	-0.358	-8.43
	ny08	-1.954	-25.67	-1.140*	-42.33	-0.212*	-43.07	-0.506	-19.10	-0.360	-8.45
	ny10	-2.761*	-31.86	-1.152*	-40.77	-0.692*	-67.34	-0.887*	-28.24	-2.103*	-37.29
	ny20	-2.210*	-42.27	-1.260*	-61.99	-0.255*	-56.23	-0.401	-18.66	-0.898*	-28.83
	ny52	-1.983	-24.11	-1.080*	-37.45	-0.452*	-54.11	-0.767*	-22.78	-1.613*	-30.05
	ny65	-2.357*	-40.12	-1.482*	-61.63	-0.170*	-42.99	-0.721	-28.73	-0.021	-0.70
	pa29	-1.110	-18.08	-0.792*	-37.50	-0.085	-16.97	-0.195	-8.60	-0.407	-9.53
	vt01	-0.169	-3.40	-1.016*	-39.43	-0.173	-30.00	0.133	4.26	-0.165	-4.17
	wi28	-6.386*	-44.04	-2.103*	-50.56	-0.480*	-51.04	-0.820*	-25.61	-1.272*	-32.87
	wi36	-4.491*	-41.86	-1.730*	-53.06	-0.368*	-59.95	-0.803	-32.71	-0.550	-23.00
	wi37	-5.582*	-41.86	-2.040*	-52.40	-0.601*	-62.65	-0.982*	-33.32	-1.088*	-36.24

* $p<0.05$

Table 5 (continued).

Region	Site	Calcium Change μeq/L)	Calcium Percent Change	Magnesium Change (μeq/L)	Magnesium Percent Change	Potassium Change μeq/L)	Potassium Percent Change	Sodium Change (μeq/L)	Sodium Percent Change	Chloride Change (μeq/L)	Chloride Percent Change
10	ar16	-2.196	-28.89	-1.202*	-47.74	-0.123	-14.46	-0.771	-16.63	-0.723	-15.43
	ar27	-5.328*	-45.03	-0.859*	-35.83	-0.151	-18.24	-0.539	-11.45	-0.347	-7.48
	il35	-3.057*	-31.96	-0.994*	-39.82	-0.296*	-42.48	-0.778	-.19.37	-0.776	-15.58
	il63	-3.804*	-38.87	-1.200*	-46.51	-0.283*	-36.16	-1.067	-24.11	-0.471	-8.59
	ma13	0.325	8.76	-1.623*	-34.98	0.011	1.85	-2.454	-16.83	-6.122	-29.91
	mi26	-3.075	-28.15	-1.431*	-38.77	-0.054	-9.84	-0.455	-14.18	-0.712	-16.40
	mo03	-5.042*	-37.64	-1.100*	-37.76	-0.470*	-46.54	0.019	0.52	-0.905*	-21.25
	mo05	-4.035*	-47.49	-1.718*	-56.33	-0.469	-43.32	-1.889*	-37.16	-1.636*	-30.58
	nc25	-2.044*	-50.17	-0.820*	-45.60	-0.209	-32.07	-0.581	-13.98	-1.172	-22.36
	nj99	-2.108*	-37.83	-2.316*	-52.46	-0.352*	-49.27	-1.425	-15.95	-2.346	-20.01
	oh17	-4.459*	-39.31	-1.663*	-42.95	-0.131	-19.46	0.110	3.71	0.130	3.08
	oh49	-3.388*	-33.58	-1.443*	-42.43	-0.040	-5.31	-0.338	-11.60	-0.285	-5.50
	oh71	-2.533	-25.99	-1.196*	-36.39	-0.196*	-34.07	-0.257	-9.36	-0.720	-15.81
	pa42	-1.897*	-29.71	-1.049*	-43.75	-0.292	-35.98	-0.123	-4.15	-0.121	-2.45
	tnOO	-5.057*	-58.25	-2.002*	-65.44	-0.401*	-50.46	-1.119	-26.08	-1.849*	-28.74
	tn11	-2.507*	-44.47	-1.545*	-65.86	-0.747*	-59.24	-0.312	-11.27	-0.817	-23.09
	va13	-1.496	-22.71	-1.256*	-46.68	0.210	20.26	-0.799	-23.40	-0.764	-19.07
	va28	-1.290*	-39.15	-1.278*	-64.11	-0.076	-20.28	-2.084*	-48.90	-3.159*	-53.41
	wv18	-0.409	-5.42	-0.771*	-36.63	-0.184*	-26.70	-0.272	-11.74	-0.141	-3.92
11	ar02	-3.030*	-43.48	-0.787*	-30.83	-0.372	-30.05	0.999	17.90	0.672	10.75
	fl03	-2.047*	-33.69	-1.547*	-35.21	-0.497*	-51.23	-2.097	-14.56	-3.514	-20.61
	fl11	-1.303	-17.71	-0.485	-6.30	0.527	42.17	5.183	18.63	4.307	13.02
	ga41	-3.694*	-62.97	-1.728*	-57.37	-0.603*	-53.00	-2.848*	-37.96	-3.459*	-39.28
	la12	-1.975*	-33.10	-1.286*	-29.96	-0.626*	-54.84	-4.181*	-25.51	-5.009	-25.60
	la30	-2.916*	-50.60	-1.582*	-40.69	-0.436*	-47.47	-3.234	-25.28	-4.625*	-30.98
	nc03	-2.547*	-50.27	-2.284*	-50.65	-0.217	-25.43	-4.635*	-34.45	-5.716*	-35.88
	nc34	-2.948*	-51.94	-1.507*	-49.74	-0.501	-35.54	-0.824	-14.52	-1.525	-20.97
	nc35	-2.200*	-46.28	-1.362*	-34.49	-0.382*	-44.16	0.152	1.36	-0.283	-2.15
	nc41	-2.085*	-47.71	-1.929*	-52.23	-0.098	-11.00	-3.338*	-33.64	-3.429*	-29.74
	tx21	-4.299*	-43.73	-1.326*	-37.73	-0.319	-28.62	-1.832	-19.78	-2.371	-23.42
	tx38	-3.610	-39.94	-1.870*	-43.28	-0.536	-26.99	-3.908*	-33.45	-4.734*	-36.92
12	ak03	-0.505	-24.39	-0.849*	-72.27	-0.146	-39.21	-0.604	-26.44	-0.171	-8.04

* $p<0.05$

PRECIPITATION CHEMISTRY TRENDS
IN THE UNITED STATES
1985-1993

Table 6. Direction and statistical significance of "deseasonalized" trends in ionic concentrations ($\mu eq/L$) in precipitation at 155 NADP/NTN sites from 1985 through 1993.

		log(H)			log(S04)			log(N03)			log(NH4)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	-0.0211	****	0.533	-0.0861		0.232	+0.0541		0.199	+0.0129		0.221
	or02	-0.0156	***	0.421	-0.6353		0.070	+0.0001	***	0.541	+0.0001	****	0.583
	or10	-0.3475	*	0.241	-0.2717	****	0.688	+0.0020	****	0.654	+0.1509	***	0.323
	or97	-0.0516	*	0.310	+0.7757	**	0.316	+0.0001	****	0.755	+0.0001	****	0.595
	or98	-0.0070	****	0.493	-0.0395	****	0.672	+0.2654	****	0.663	+0.0165	****	0.635
	wa14	-0.5175		0.117	-0.0446		0.235	+0.0001	**	0.574	+0.0336		0.250
	wa19	-0.0003	****	0.655	-0.1318	****	0.611	+0.0306	****	0.738	+0.0022	****	0.578
	ua21	-0.9184	****	0.674	-0.4779	****	0.729	+0.0247	****	0.728	+0.1033	**	0.472
2	ca42	-0.0829	*	0.327	-0.6533	**	0.362	-0.7409	***	0.460	+0.2045		0.306
	ca75	-0.0078	**	0.536	-0.7956	***	0.506	+0.6858	**	0.432	+0.2918	***	0.515
	ca88	-0.3423		0.217	+0.7148	****	0.578	+0.5631	***	0.389	+0.2302	***	0.415
	ca98	-0.0648	*	0.342	-0.1131	****	0.825	-0.0676	****	0.701	-0.2019	****	0.638
3	co00	-0.0094	****	0.607	-0.0090	****	0.660	-0.7615	****	0.594	+0.0763	****	0.619
	co19	-0.0092	***	0.455	-0.0223	****	0.824	+0.3622	****	0.579	+0.0129	****	0.753
	co21	-0.2434	****	0.420	+0.6588	****	0.888	+0.4369	***	0.339	+0.0008	****	0.632
	co97	+0.7964	*	0.355	+0.0371	***	0.481	+0.0015	***	0.596	+0.0001	****	0.698
	co98	-0.2270	****	0.587	-0.0001	****	0.831	-0.0470	****	0.673	-0.3014	****	0.650
	id15	-0.9159		0.244	-0.0694	****	0.585	+0.7144	****	0.644	+0.0194	***	0.496
	mt05	-0.1422	**	0.317	-0.4615	****	0.604	+0.2736		0.253	+0.1363	*	0.284
	mt07	+0.8812	*	0.224	-0.8553	****	0.559	+0.3149	**	0.296	+0.1521	****	0.586
	nm07	-0.1938	****	0.512	-0.0088	***	0.460	-0.8266	***	0.411	+0.1143	****	0.429
	or18	-0.0103	****	0.522	+0.6323	****	0.747	+0.0201	****	0.693	+0.0014	****	0.531
	ut01	-0.0016	**	0.514	+0.3435		0.219	+0.4033	***	0.492	+0.0008		0.488
	ut99	-0.7418		0.193	-0.6047	**	0.372	+0.3838	**	0.432	+0.1485	*	0.395
	wy02	-0.0065	*	0.367	-0.0026	****	0.768	+0.5689	***	0.428	+0.6101	****	0.653
	wy08	-0.2256	****	0.502	+0.1388	****	0.725	+0.0285	***	0.552	+0.0052	***	0.553
	wy98	-0.0287		0.174	-0.1232	****	0.718	+0.6417	****	0.513	+0.1112	****	0.575
4	id03	-0.9980	****	0.553	+0.9202	**	0.395	+0.1737	***	0.479	+0.0061	***	0.586
	id11	-0.0045	*	0.334	+0.6789	****	0.530	+0.0241	****	0.650	+0.0101	****	0.626
	nv01	-0.0050	****	0.635	+0.3262	****	0.554	+0.0019	****	0.810	+0.0018	****	0.768
	nv05	+0.5113	*	0.335	-0.5988	***	0.509	-0.3925	****	0.671	+0.6346	****	0.742
	or09	-0.1028	***	0.428	+0.6066	****	0.619	+0.0793	****	0.615	+0.0833	**	0.388
5	az06	-0.4190	**	0.285	-0.1703	***	0.415	-0.1668	****	0.634	+0.8194	****	0.597
	tx04	-0.8150		0.194	-0.7826		0.190	+0.2695	*	0.254	+0.1158		0.240
	tx22	-0.0213	**	0.435	-0.1164	***	0.399	+0.7116	****	0.496	+0.1194		0.244
6	az03	-0.2482		0.148	-0.0414	****	0.622	+0.3317	****	0.528	+0.1460	****	0.596
	az99	-0.0008		0.395	-0.0789	***	0.466	-0.8808	****	0.612	+0.1035	***	0.425
	co99	-0.0908	***	0.416	-0.0046	****	0.760	-0.8198	****	0.543	+0.5449	****	0.432
	nm08	-0.0049	****	0.616	-0.2941	***	0.468	+0.2098	****	0.601	+0.1240	**	0.383
	nm09	-0.0089	****	0.459	-0.0017	****	0.640	-0.3023	****	0.578	+0.0986	****	0.500
7	co01	-0.3460		0.191	+0.9841	***	0.373	+0.3972		0.064	+0.0140	**	0.354
	co15	-0.1940	****	0.564	-0.8881	****	0.761	+0.0508	***	0.450	+0.0250	****	0.722
	co22	-0.2907	****	0.669	-0.0498	****	0.502	-0.3756		0.179	+0.9665	****	0.671
	mt00	-0.2478		0.162	-0.4981	****	0.435	+0.4056		0.155	+0.0178	***	0.474
	ok29	-0.2572		0.318	-0.2655		0.193	-0.5417	****	0.742	+0.5322		0.272
	wy06	+0.9861		0.148	+0.8558	****	0.627	+0.2045	***	0.560	+0.2525	**	0.434
	wy99	-0.7734	**	0.281	-0.1591	***	0.465	-0.8897	**	0.287	+0.0338	****	0.506

Table 6 (continued).

		log(H)			log(S04)			log(N03)			log(NH4)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
8	ia23	-0.5055		0.205	-0.3033	**	0.294	+0.5221	***	0.340	+0.0037	****	0.516
	il11	-0.2168	****	0.554	-0.0225	****	0.665	-0.7411	****	0.601	+0.0874	****	0.684
	il18	-0.3913		0.153	-0.1275	****	0.468	+0.6819	***	0.369	+0.1553	****	0.411
	il19	-0.2410	***	0.444	-0.0023	****	0.700	-0.5400	***	0.471	+0.8159	***	0.394
	il78	-0.5631		0.192	-0.0088	***	0.444	+0.9072	***	0.349	+0.2333	***	0.384
	in22	-0.9233		0.089	+0.8958	**	0.297	+0.1460		0.247	+0.0067	***	0.483
	in34	-0.0249	****	0.469	-0.3463	****	0.605	+0.6929	**	0.308	+0.4677	****	0.538
	in41	-0.0251		0.307	-0.0003	****	0.737	-0.1617	****	0.510	-0.5057	****	0.670
	ks07	-0.1064		0.219	-0.0965	**	0.314	+0.3489	****	0.411	+0.0437	****	0.501
	ks31	-0.4789		0.174	-0.1797	*	0.239	+0.3413		0.196	+0.0123	**	0.374
	ks32	-0.6475	**	0.282	+0.6366	**	0.283	+0.1484		0.227	+0.0244		0.260
	mn27	+0.2802	**	0.377	-0.2850	**	0.360	-0.9204	****	0.470	+0.1502	***	0.464
	nd08	+0.6196	***	0.397	+0.7627	***	0.439	+0.5008		0.238	+0.0671	****	0.508
	ne15	+0.7046		0.094	-0.1611	**	0.289	+0.3893	**	0.273	+0.4166	****	0.475
	okOO	-0.5135	****	0.431	+0.8960		0.153	+0.1693		0.225	+0.1776	**	0.344
	ok17	-0.5872	*	0.270	-0.2273		0.130	+0.7918	**	0.318	+0.1672		0.248
	sd99	-0.9490		0.060	-0.3922	****	0.544	-0.5360	***	0.512	+0.0425	****	0.610
	tx03	+0.9788	***	0.401	-0.5406		0.211	-0.9775		0.080	+0.1882	***	0.353
	tx10	+0.2926		0.224	+0.7328		0.208	+0.2887		0.211	+0.3215	***	0.396
	tx16	-0.1647	*	0.307	+0.2023	**	0.381	+0.1395	***	0.414	+0.0180	***	0.508
	tx56	-0.0415	*	0.287	-0.1180	****	0.454	+0.2790	***	0.402	+0.0135	****	0.516
9	ma08	-0.3059	***	0.350	-0.2031	****	0.451	-0.8577		0.153	+0.4559	****	0.627
	me00	-0.0168		0.155	-0.0443	****	0.518	-0.1852	****	0.445	+0.5528	***	0.399
	me02	-0.7993	***	0.401	-0.6330	****	0.600	+0.6830		0.189	+0.0047	****	0.657
	me09	-0.3661		0.219	-0.2859	****	0.576	+0.6008		0.142	+0.3568	****	0.591
	me98	+0.9966	****	0.553	-0.4652	****	0.607	+0.1143	***	0.387	+0.0887	****	0.627
	mi09	-0.8260		0.142	-0.3780	****	0.717	+0.6505	****	0.421	+0.7851	**	0.321
	mi53	+0.9154		0.120	-0.1498	****	0.648	-0.5457	****	0.424	+0.8109	**	0.292
	mi98	-0.3673		0.126	-0.3248	***	0.434	-0.9368	***	0.438	+0.0643	*	0.337
	mi99	+0.9594		0.154	-0.1390	****	0.588	+0.9263	***	0.361	+0.5161	****	0.480
	mn16	+0.7991	**	0.263	-0.4192	***	0.388	-0.8488	****	0.582	+0.9294	****	0.448
	mn18	+0.0998		0.165	-0.1934	****	0.648	+0.7362	****	0.516	-0.8950	****	0.454
	nh02	-0.0609	***	0.423	-0.3232	****	0.625	-0.2464		0.226	+0.3432	****	0.418
	ny08	-0.3775	****	0.580	-0.3900	****	0.786	-0.7053	**	0.247	+0.4753	****	0.508
	ny10	-0.0035	****	0.684	-0.0001	****	0.806	-0.0467	**	0.390	-0.0570	***	0.456
	ny20	-0.1503	**	0.326	-0.0940	****	0.703	-0.1730		0.245	-0.7232	****	0.555
	ny52	-0.0031	****	0.684	-0.0097	****	0.794	-0.0046	****	0.473	-0.4146	**	0.306
	ny65	+0.4693	****	0.778	-0.3215	****	0.846	-0.6111	****	0.440	-0.3884	****	0.723
	ny68	+0.8882	***	0.400	-0.6528	****	0.535	+0.4993	***	0.387	+0.2975	****	0.575
	ny98	-0.3267	*	0.270	-0.1408	****	0.662	-0.5847	**	0.325	-0.9894	**	0.329
	pa29	-0.0362	****	0.771	-0.0521	****	0.821	-0.2837	***	0.391	+0.7507	****	0.632
	pa72	-0.0272	****	0.532	-0.0275	****	0.628	-0.1298	***	0.419	-0.2672	****	0.554
	vt01	-0.7654	***	0.426	-0.7060	****	0.641	-0.9136		0.177	+0.2911	****	0.526
	vt99	-0.9853		0.164	-0.1494	****	0.624	+0.6473	****	0.404	+0.6078	***	0.434
	wi25	-0.7430	**	0.263	-0.0629	****	0.564	+0.8564	****	0.373	+0.5979	**	0.239
	wi28	-0.4873	*	0.232	-0.0033	**	0.470	-0.1611	***	0.430	-0.5609	***	0.390
	wi36	-0.1203	**	0.324	-0.1099	***	0.389	-0.6420		0.188	+0.7211	**	0.274
	ui37	+0.1664		0.239	-0.4568	***	0.402	-0.8119		0.174	-0.9431	***	0.366

Table 6 (continued).

Region	Site	log(H) Year	log(H) Month	log(H) r2	log(S04) Year	log(S04) Month	log(S04) r2	log(N03) Year	log(N03) Month	log(N03) r2	log(NH4) Year	log(NH4) Month	log(NH4) r2
10	ar16	-0.8771		0.233	-0.5959		0.232	+0.6074	***	0.510	+0.7844	*	0.307
	ar27	-0.1832	**	0.320	-0.3586		0.224	+0.6086	****	0.629	+0.9767		0.227
	ia08	+0.3029		0.259	+0.8507	***	0.354	+0.2141	***	0.434	+0.0034	***	0.481
	il35	-0.0470		0.178	-0.0242	*	0.286	-0.4407	****	0.463	+0.1106	***	0.344
	il63	-0.4658		0.222	-0.0082	***	0.487	-0.4552	****	0.499	-0.6872	****	0.630
	in20	-0.4217	***	0.359	-0.0034	****	0.657	-0.6375	*	0.243	-0.1327	****	0.525
	ky03	-0.6569	****	0.737	-0.1921	****	0.771	+0.3201	****	0.626	+0.1846	****	0.649
	ky22	-0.0505	****	0.753	-0.0036	****	0.735	-0.3857	****	0.509	+0.6246	****	0.465
	ky35	-0.1849	****	0.679	-0.0412	****	0.901	-0.9062	**	0.407	+0.5463	****	0.671
	ky38	-0.1728		0.219	-0.0720	***	0.397	-0.3479	****	0.523	+0.2272	****	0.425
	ma01	-0.2437		0.135	-0.3284		0.085	-0.3128		0.132	-0.7065		0.351
	ma13	-0.0009	****	0.555	-0.0530	****	0.567	-0.5992	***	0.325	+0.5764	****	0.529
	md03	-0.9840	****	0.793	-0.7213	****	0.805	-0.8233	****	0.794	+0.0611	****	0.774
	mi26	-0.1004		0.313	-0.0018	****	0.672	-0.1656	***	0.493	-0.8776	****	0.618
	mn23	-0.7027	**	0.379	-0.6550	***	0.439	+0.9807	**	0.317	+0.9895	**	0.338
	no03	-0.0360		0.271	-0.0027		0.313	+0.9667	**	0.304	+0.7806	**	0.318
	no05	-0.6194		0.159	-0.2797		0.208	-0.6770	***	0.427	+0.6230	**	0.398
	ms30	-0.1968	**	0.310	-0.0419		0.272	-0.7945	***	0.373	+0.4647	***	0.394
	nc25	-0.0054	****	0.705	-0.0067	****	0.732	-0.0880	****	0.632	+0.5832	***	0.456
	nj99	-0.3190	****	0.513	-0.2802	****	0.576	+0.8554	****	0.480	+0.1886	****	0.483
	ny99	-0.0734	****	0.477	-0.0663	****	0.585	-0.1293	***	0.355	+0.8652	****	0.422
	oh09	-0.9889	****	0.532	-0.9278	****	0.628	+0.7386	***	0.380	+0.0406	****	0.663
	oh17	-0.2557	***	0.477	-0.1180	****	0.681	-0.5445	***	0.476	+0.5357	****	0.495
	oh49	-0.0635	****	0.699	-0.0825	****	0.784	-0.5177	****	0.481	-0.6572	****	0.508
	oh71	-0.0250	****	0.583	-0.0053	****	0.727	-0.0694	****	0.688	-0.5290	****	0.631
	pa15	-0.0242	****	0.656	-0.0110	****	0.784	-0.0897	****	0.474	-0.8796	****	0.663
	pa42	-0.4095	****	0.752	-0.2593	****	0.800	-0.6490	****	0.461	+0.7670	****	0.652
	tn00	-0.0144	****	0.515	-0.0014	*•**	0.591	-0.2619	****	0.454	+0.6113	****	0.461
	tn11	-0.5594	****	0.783	-0.1344	****	0.812	+0.8355	****	0.693	+0.8038	****	0.705
	tn14	+0.7340	**	0.348	-0.7908		0.172	+0.0583	***	0.444	+0.0565	***	0.470
	va13	-0.1633	****	0.683	-0.0326	****	0.753	-0.9464	****	0.674	+0.6433	****	0.641
	va28	-0.0188	****	0.799	-0.0152	****	0.813	-0.2850	****	0.557	+0.5127	****	0.706
	wi99	+0.7952		0.145	-0.2431	***	0.409	+0.9702	**	0.294	+0.9942	**	0.342
	wv04	-0.0003	****	0.725	-0.0001	****	0.808	-0.0240	****	0.505	-0.3334	***	0.366
	wv18	-0.2524	****	0.807	-0.1188	****	0.870	-0.4833	****	0.479	-0.3794	****	0.538
11	al10	+0.2294	**	0.312	-0.2945	**	0.337	+0.8330	****	0.585	-0.8719	**	0.286
	ar02	-0.9864		0.188	-0.1823		0.192	+0.5545	***	0.484	+0.7232	*	0.298
	ar03	-0.1679	****	0.461	-0.3779	***	0.373	-0.7738	****	0.608	+0.0705	****	0.681
	fl03	+0.5185	****	0.641	+0.4953	**	0.291	+0.0425	****	0.642	+0.1807	***	0.448
	flll	-0.0259		0.258	+0.5717	*	0.248	+0.0504	*	0.350	+0.0045	**	0.418
	fl14	-0.8353	****	0.559	+0.7656	***	0.401	+0.4942	****	0.704	+0.0917	*	0.312
	fl41	-0.7788	***	0.420	-0.7393		0.201	+0.1719	***	0.494	+0.1845	***	0.486
	fl99	+0.0111	****	0.521	+0.0474	**	0.288	+0.0340	****	0.430	+0.0050	****	0.533
	ga20	-0.4376	****	0.504	-0.3677	****	0.486	+0.5031	****	0.601	+0.1042	****	0.524
	ga41	-0.2983	***	0.421	-0.0357	****	0.550	-0.0994	****	0.659	-0.9295	***	0.410
	ga50	+0.8945	****	0.502	-0.8284	****	0.528	+0.2739	****	0.592	+0.1593	****	0.548
	la12	+0.6731	****	0.695	-0.0191	**	0.369	-0.6600	****	0.506	-0.4297	*	0.257
	la30	-0.1498	****	0.613	-0.0081	***	0.424	-0.0899	****	0.677	-0.3154	****	0.422
	md13	-0.0641	****	0.466	-0.0682	****	0.581	-0.0867	***	0.343	-0.4706	****	0.607
	ms10	+0.8302	****	0.439	-0.0941	****	0.551	+0.7432	****	0.695	+0.2450	**	0.298
	nc03	-0.0384	***	0.347	-0.0937	***	0.331	-0.2918	***	0.348	+0.2101	***	0.357
	nc34	-0.0462	****	0.583	-0.1215	****	0.683	-0.2846	****	0.639	+0.8320	****	0.560
	nc35	-0.4015	*	0.279	-0.2308	*	0.299	-0.3613	**	0.382	+0.2063	**	0.372
	nc36	+0.7610	**	0.313	+0.3577	***	0.379	+0.4457	****	0.466	+0.0050	****	0.559
	nc41	-0.0773	**	0.352	-0.0492	***	0.448	-0.0404	***	0.485	+0.1451	**	0.281
	sc06	-0.5544	****	0.530	-0.5560	****	0.599	+0.9137	**	0.371	+0.1421	***	0.451
	tx21	-0.2137	****	0.487	-0.0025	***	0.446	-0.5704	****	0.499	+0.2813	***	0.397
	tx38	+0.8979	***	0.430	-0.5622		0.212	+0.6579	*	0.303	+0.5226		0.192
	va00	-0.1357	***	0.513	-0.4423	****	0.598	-0.2002	**	0.373	+0.7479	****	0.540
12	ak03	-0.0716	**	0.363	+0.5025	**	0.360	+0.0007	**	0.462	+0.7108	***	0.405

Table 6 (continued).

		log(Ca)			tog(Mg)			log(K)			log(Na)			log(Cl)		
Region	Site	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca4S	-0.0027	***	0.479	-0.0616	***	0.445	-0.0252		0.251	-0.6840	***	0.354	-0.1193	****	0.557
	or02	-0.7827		0.085	-0.2078	****	0.522	+0.6900		0.137	-0.3336	****	0.527	-0.2900	****	0.553
	or10	-0.0010	****	0.625	-0.0027	***	0.410	-0.5245	**	0.287	-0.0314	****	0.519	-0.0124	****	0.551
	or97	-0.3507	****	0.453	-0.4211	****	0.536	+0.3965	***	0.359	+0.9267	****	0.625	-0.7211	****	0.606
	or98	-0.3285	***	0.430	-0.0303	****	0.496	+0.9287	***	0.393	-0.1932	****	0.476	-0.1461	****	0.509
	wa14	-0.1925		0.144	-0.0453	****	0.624	-0.7061	*	0.252	-0.1525	****	0.636	-0.0459	****	0.690
	wa19	-0.0927	**	0.353	-0.0032		0.267	+0.5963		0.076	-0.2907	***	0.374	-0.0605	****	0.472
	wa21	-0.0143		0.294	-0.0005	**	0.586	-0.6146		0.192	-0.0008	****	0.682	-0.0004	****	0.714
2	ca42	-0.3156	***	0.439	-0.3790		0.274	-0.2692		0.253	-0.6219		0.190	-0.6405		0.249
	ca75	-0.6713		0.274	-0.0549		0.309	-0.0941	*	0.364	-0.4196		0.108	-0.2062		0.117
	ca88	+0.9689	****	0.479	+0.9541		0.234	+0.6262	***	0.387	-0.9004		0.148	-0.7971		0.076
	ca98	-0.0349	****	0.698	-0.0027	***	0.582	-0.1839	****	0.560	-0.1376	**	0.394	-0.0384	*	0.389
3	coOO	-0.0671	*	0.377	-0.0013	**	0.550	-0.0286		0.339	-0.0268	**	0.464	-0.0199	**	0.473
	co19	-0.5275	****	0.610	-0.0177	****	0.697	+0.7561	****	0.563	+0.8945		0.156	+0.5410	****	0.498
	co21	-0.2647	****	0.588	-0.0082	****	0.594	-0.3097	****	0.627	+0.4179		0.114	-0.6851	**	0.292
	co97	+0.7033	****	0.617	-0.3397		0.373	+0.3323	***	0.516	+0.1210		0.196	+0.0309	***	0.507
	co98	-0.0028	****	0.747	-0.0001	****	0.701	-0.0214	****	0.559	-0.2240		0.217	-0.1144	****	0.586
	id15	-0.0428	**	0.437	-0.0020	***	0.597	-0.7131	****	0.596	-0.3655		0.140	-0.4105		0.225
	mt05	-0.0168	****	0.528	-0.0153	****	0.495	-0.1696	****	0.652	-0.7442		0.129	-0.0215		0.172
	mt07	-0.0612	****	0.492	-0.0003	****	0.660	-0.0527	***	0.439	-0.2411		0.233	-0.2889	*	0.276
	nm07	-0.0918	****	0.489	-0.0024	****	0.583	-0.0010	****	0.628	-0.0908	**	0.355	-0.0062	***	0.463
	or18	-0.1565	****	0.426	-0.0031	***	0.405	-0.4564	****	0.484	-0.2333		0.136	-0.0887		0.158
	ut01	+0.7942		0.241	-0.9812		0.255	-0.1079	***	0.572	+0.7936		0.103	-0.8043		0.126
	ut99	-0.7111	****	0.546	-0.4196	****	0.606	-0.2584	**	0.353	-0.0630	**	0.388	-0.2131	***	0:440
	uy02	-0.0172	****	0.660	-0.0033	***	0.523	-0.0229	****	0.632	-0.7441	*	0.290	-0.0001	****	0.685
	uy08	-0.5557	****	0.555	-0.1032	****	0.674	-0.0997	****	0.628	+0.6785		0.260	-0.2572	**	0:334
	wy98	-0.3079	****	0.496	-0.2288	****	0.506	-0.9394		0.108	-0.8351		0.154	-0.5282	*	0.280
4	id03	-0.3626	****	0.574	-0.1032	****	0.538	-0.1007	****	0.634	-0.7927	*	0.309	-0.3427	*	0.307
	id11	-0.4718	***	0.410	-0.0163	****	0.460	-0.7925	**	0.317	+0.3385		0.142	-0.8290		0.087
	nv01	+0.1477	****	0.512	+0.7801	***	0.446	+0.8920	**	0.360	+0.8718		0.256	-0.8304	**	0.375
	nv05	-0.0071	***	0.518	-0.0097	***	0.520	-0.3528		0.206	-0.0418		0.229	-0.2652	**	0.372
	or09	-0.6971	***	0.382	-0.0668	*	0.329	-0.0001	**	0.553	-0.1087		0.260	-0.0003	***	0.544
5	az06	-0.3326		0.176	-0.0877	*	0.288	+0.8953	**	0.286	-0.1784	***	0.377	-0.1209	***	0.393
	tx04	-0.5361	*	0.238	-0.1041	**	0.354	-0.2939	**	0.317	-0.9250		0.162	-0.4332		0.205
	tx22	-0.9376	***	0.431	-0.4511	***	0.427	+0.3509	**	0.314	-0.6222	***	0.425	+0.7360	***	0.371
6	az03	-0.9726	**	0.349	-0.5360	***	0.389	+0.6548	**	0.357	+0.4861	**	0.364	+0.7624	***	0.411
	az99	+0.4786		0.197	-0.3722	**	0.343	+0.2728	****	0.570	+0.4611		0.082	+0.5115		0.184
	co99	-0.7462	***	0.366	-0.3888	****	0.418	-0.2199	****	0.480	+0.7658	****	0.491	-0.8017	****	0.526
	nm08	+0.5213	****	0.604	-0.2671	****	0.642	-0.5886	**	0.386	-0.4223	**	0.379	-0.8562	***	0.463
	nm09	-0.0320	****	0.536	-0.0023	****	0.521	-0.0276	****	0.637	-0.2785		0.186	-0.0087	****	0.528
7	co01	-0.9650	**	0.281	-0.4861	**	0.329	+0.2992		0.246	+0.8663		0.120	+0.6073		0.161
	co15	-0.2247	****	0.542	-0.0066	****	0.641	-0.0620	****	0.463	-0.7025	**	0.255	-0.1018	***	0.395
	co22	-0.0167	****	0.684	-0.0003	****	0.578	-0.2065	****	0.547	-0.3341	***	0.416	-0.5619		0.219
	mt00	-0.1259	***	0.392	-0.0798	****	0.488	-0.4927	****	0.688	-0.2542		0.115	-0.0379	**	0.359
	ok29	-0.7560	***	0.515	-0.6469	***	0.489	-0.3584	****	0.680	+0.7983	**	0.402	-0.8255	****	0.575
	wy06	-0.6212	****	0.611	-0.1422	****	0.658	+0.3147	****	0.730	+0.9209		0.269	-0.8640	**	0.378
	wy99	-0.0547	****	0.471	-0.0005	***	0.537	-0.0275	****	0.710	-0.2211		0.071	-0.0536		0.273

Table 6 (continued).

Region	Site	log(Ca)			log(Mg)			log(K)			log(Na)			log(Cl)		
		Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
8	ia23	-0.3582	***	0.397	-0.1684	****	0.567	-0.1222	****	0.572	-0.1564	****	0.454	-0.2219	***	0.405
	il11	-0.0198	****	0.682	-0.0097	****	0.681	-0.1435	****	0.667	+0.1399	***	0.334	-0.7315	**	0.266
	il18	-0.5169	****	0.451	-0.4000	***	0.393	+0.3797	****	0.465	+0.4843		0.196	-0.7236	***	0.342
	il19	-0.2268	***	0.401	-0.0759	***	0.465	-0.5894	**	0.404	+0.6194	***	0.388	-0.5728	****	0.622
	il78	-0.1815	****	0.478	-0.0509	****	0.495	-0.1035	****	0.476	+0.5767	**	0.250	-0.7757	**	0.281
	in22	+0.4796	**	0.326	+0.5317		0.247	+0.0546		0.193	+0.4946		0.156	+0.5645		0.188
	in34	+0.1151	***	0.332	+0.1693	***	0.323	-0.5787	***	0.362	+0.6953	****	0.429	+0.5756	****	0.468
	in41	-0.0058	****	0.677	-0.0163	****	0.617	-0.0121	****	0.602	-0.2217		0.236	-0.0850	**	0.443
	ks07	-0.7136	***	0.366	-0.1130	**	0.309	-0.4484	***	0.376	-0.7765		0.097	-0.2654		0.190
	ks31	+0.9529		0.105	-0.2132	*	0.249	-0.4224	**	0.306	-0.8101		0.091	-0.9373	**	0.251
	ks32	-0.9567	**	0.302	-0.1837		0.261	-0.5779	**	0.287	-0.5183		0.087	-0.4420		0.236
	mn27	-0.0103	**	0.442	-0.0050		0.362	-0.0413	***	0.480	-0.2271		0.155	-0.1040	***	0.438
	nd08	-0.5978		0.208	+0.6685		0.220	+0.5877		0.226	+0.2810	*	0.335	+0.3823		0.279
	ne15	-0.2286	****	0.465	-0.0253	***	0.435	-0.6466	****	0.418	-0.9224		0.139	-0.2824		0.197
	okOO	+0.9833	****	0.495	-0.1065	**	0.376	-0.5128	**	0.273	-0.2171	***	0.369	-0.1392	***	0.422
	ok17	-0.5628	****	0.624	-0.1326	***	0.471	+0.6097	**	0.309	-0.1264	**	0.350	-0.1696	**	0.339
	sd99	-0.0517		0.264	-0.0028		0.394	-0.0829		0.390	-0.5014	**	0.380	-0.0906	**	0.467
	tx03	-0.5521		0.173	-0.5908		0.088	-0.4138		0.176	-0.8418		0.107	-0.4275		0.216
	tx10	-0.3924	**	0.335	-0.1401		0.156	+0.2165		0.227	-0.4613		0.165	-0.2956		0.154
	tx16	+0.0741		0.296	-0.8982		0.190	+0.6135	****	0.536	+0.5008		0.191	+0.5697		0.153
	tx56	-0.9765	****	0.424	-0.0606	**	0.337	-0.2685		0.192	-0.2232		0.235	-0.0892		0.229
9	ma08	-0.1210	**	0.310	-0.0778		0.251	-0.1546	***	0.369	-0.8525	***	0.385	-0.9616	***	0.353
	meOO	-0.0580	****	0.575	-0.0001	****	0.665	-0.0072	**	0.377	-0.1781	****	0.639	-0.1305	****	0.705
	me02	-0.9149	****	0.478	-0.2336	*	0.274	+0.1474	**	0.293	+0.7498	**	0.316	+0.7694	**	0.260
	me09	-0.0035	****	0.598	-0.0084	**	0.383	-0.2363	****	0.546	-0.5628	***	0.341	-0.6898	**	0.284
	me98	-0.1450		0.229	-0.0813	****	0.678	+0.2871	**	0.328	-0.2997	****	0.709	-0.1525	****	0.711
	mi09	-0.6005	*	0.239	-0.1555	**	0.347	+0.7599	***	0.358	-0.7804		0.207	-0.1339	****	0.536
	mi53	-0.0432		0.248	-0.0431		0.235	-0.5484	*	0.247	+0.4667	****	0.437	+0.5858	****	0.656
	mi98	-0.1822	**	0.358	-0.0102	***	0.505	-0.6932	**	0.350	-0.5767	***	0.435	-0.7631	***	0.475
	mi99	-0.0543	**	0.366	-0.0004	**	0.446	-0.2415		0.206	-0.2789	****	0.433	-0.3270	****	0.467
	mn16	-0.0690		0.126	-0.0139		0.203	-0.0989		0.245	-0.0656	**	0.317	-0.0836	***	0.417
	mn18	-0.0001	***	0.518	-0.0001	***	0.577	-0.0003		0.393	-0.0166		0.285	-0.0694	****	0.468
	nh02	-0.2740	***	0.366	-0.0359		0.272	-0.9775	****	0.658	-0.8945	***	0.332	-0.7474	**	0.289
	ny08	-0.0929	****	0.587	-0.0049	****	0.560	-0.1251	****	0.524	+0.8132	***	0.333	-0.8446		0.186
	ny10	-0.0059	****	0.627	-0.0069	***	0.521	-0.0001	****	0.679	-0.0207		0.265	-0.0001	**	0.587
	ny20	-0.0381	****	0.473	-0.0004	***	0.533	-0.0010	****	0.643	-0.3687	****	0.429	-0.0270	**	0.372
	ny52	-0.1358		0.151	-0.0343		0.192	-0.0028	*	0.342	-0.3624	****	0.641	-0.0099	****	0.647
	ny65	-0.1288	****	0.502	-0.0213	****	0.565	-0.3915	****	0.512	-0.7610		0.137	-0.7193	*	0.236
	ny68	-0.2394	***	0.366	-0.0161	*	0.313	-0.9831	***	0.409	+0.8232	***	0.379	+0.7069	**	0.307
	ny98	-0.2866	***	0.420	-0.0758	**	0.326	-0.1997	***	0.438	+0.4024	***	0.429	+0.7819	*	0.281
	pa29	-0.3803	****	0.465	-0.0194	***	0.428	+0.9348	****	0.517	-0.7038	*	0.232	-0.6514	*	0.224
	pa72	-0.0487	****	0.533	-0.0921	*	0.290	-0.3382	***	0.349	+0.5983	****	0.472	-0.9873	***	0.370
	vt01	-0.4328	**	0.353	-0.0068		0.352	-0.2513	***	0.380	+0.7546	****	0.638	-0.7984	***	0.411
	vt99	-0.0617	****	0.531	-0.0002	**	0.538	+0.3346	***	0.423	+0.1640	****	0.537	+0.2207	****	0.605
	wi25	-0.0389	***	0.341	-0.0002	****	0.612	-0.1084	**	0.288	-0.2876		0.169	-0.9520	**	0.250
	wi28	-0.0319	**	0.393	-0.0083	*	0.411	-0.0023	***	0.525	-0.1698	**	0.327	-0.0018	****	0.600
	wi36	-0.0702	*	0.293	-0.0089	*	0.342	-0.0158	**	0.375	-0.0559		0.253	-0.2413	*	0.282
	wi37	-0.0372	**	0.407	-0.0031	****	0.557	-0.0019	****	0.536	-0.0158	*	0.306	-0.0354		0.285

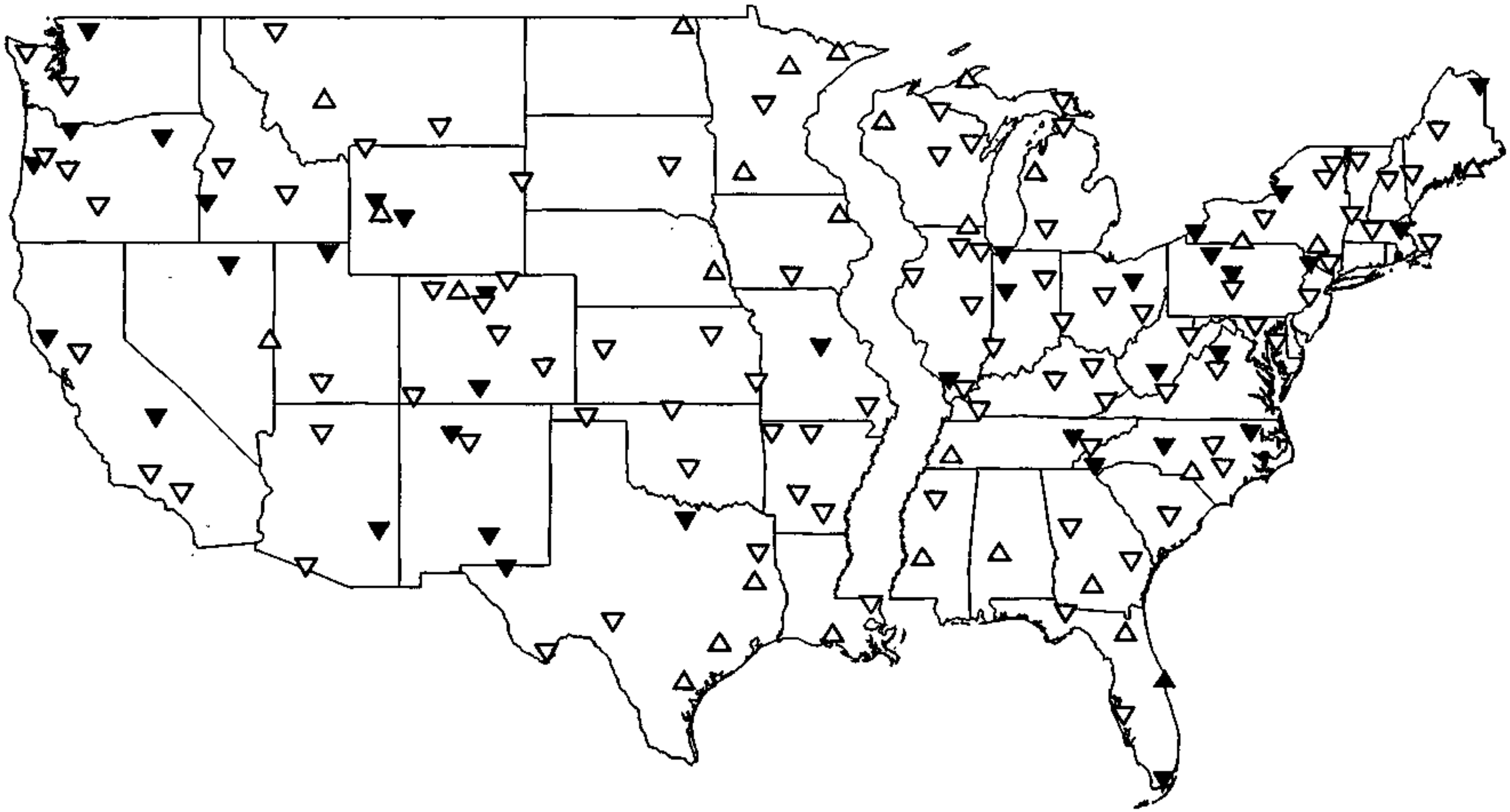
Table 6 (continued).

Region	Site	log(Ca)			log(Mg)			log(K)			log(Na)			log(Cl)		
		Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
10	ar16	-0.7514	***	0.445	-0.0703	**	0.386	-0.7863		0.286	-0.7770		0.192	-0.1209	***	0.457
	ar27	-0.9709	****	0.611	+0.8790	*	0.265	+0.1002		0.216	+0.3018		0.099	+0.4488		0.068
	ia0S	-0.2862	***	0.419	-0.5668	****	0.573	+0.6200	***	0.432	+0.4654	*	0.237	+0.9141	**	0.338
	il35	-0.6435	****	0.605	-0.1628	****	0.443	-0.7039	****	0.416	+0.7850		0.117	+0.8174		0.178
	il63	-0.0136	****	0.732	-0.0007	***	0.524	-0.0804	****	0.518	-0.4481		0.166	-0.2756	**	0.265
	in20	-0.0009	****	0.783	-0.0001	****	0.788	-0.0003	****	0.559	-0.0439		0.234	-0.0072	*	0.342
	ky03	-0.2649	****	0.561	-0.0143	***	0.484	+0.7695	***	0.375	-0.6319		0.187	-0.1999		0.154
	ky22	-0.0001	***	0.547	-0.0001	**	0.571	-0.0363	****	0.499	-0.0417		0.135	-0.0043		0.322
	ky35	-0.4195	****	0.610	-0.0287	**	0.459	+0.8795	*	0.326	-0.5100		0.142	-0.0961		0.269
	ky38	-0.0513	****	0.537	-0.0104	***	0.381	-0.7098	****	0.525	-0.4646		0.105	-0.2811	*	0.224
	ma01	-0.9621	****	0.697	+0.5423	****	0.875	+0.8714	****	0.775	+0.3313	****	0.886	+0.6713	****	0.892
	ma13	+0.2213		0.212	-0.3102	**	0.269	+0.2834	*	0.243	+0.8973	****	0.616	-0.3676	****	0.604
	md03	-0.0137	****	0.769	-0.0007	*	0.428	-0.5861	****	0.498	-0.0647	****	0.597	-0.0689	****	0.534
	mi26	-0.2901	**	0.445	-0.1502	***	0.509	+0.8453	***	0.516	-0.4221	*	0.340	-0.0252	***	0.543
	mn23	-0.8161	*	0.257	-0.4600	***	0.377	+0.9943		0.188	+0.8097		0.095	+0.6806		0.245
	mo03	-0.2837	**	0.387	-0.2259		0.271	-0.0106	**	0.477	+0.9752		0.112	-0.5496		0.182
	mo05	-0.5347	****	0.571	-0.2283	*	0.309	+0.7267	****	0.534	-0.2425		0.167	-0.1289		0.195
	ms30	-0.2502	****	0.520	-0.0137	***	0.431	-0.0177	****	0.558	-0.6251	***	0.322	-0.4640	***	0.362
	nc25	-0.0041	****	0.685	-0.0546	**	0.422	-0.5052	***	0.449	-0.8032	***	0.427	-0.7170	**	0.373
	nj99	-0.0695	***	0.397	-0.0036		0.309	-0.0504		0.243	-0.6788	****	0.563	-0.3474	****	0.513
	ny99	-0.0450	****	0.517	-0.4174	**	0.319	+0.2631		0.232	+0.1934	****	0.419	+0.0504	***	0.398
	oh09	+0.8697	****	0.494	-0.1626	****	0.483	+0.0296	****	0.578	+0.7010		0.174	-0.8350		0.196
	oh17	-0.0775	****	0.543	-0.0347	***	0.516	-0.8087	***	0.466	+0.6119	***	0.404	-0.8619	***	0.437
	oh49	-0.2176	****	0.734	-0.0388	****	0.506	+0.4278		0.067	-0.6243		0.119	-0.5631		0.243
	oh71	-0.2206	****	0.597	-0.0960	****	0.574	-0.2555	****	0.554	+0.8181	**	0.244	-0.4543	***	0.370
	pa15	-0.0079	****	0.660	-0.0001	**	0.451	+0.5823	****	0.419	-0.0344	****	0.457	-0.0045		0.314
	pa42	-0.2946	****	0.553	-0.0101	***	0.430	-0.9114		0.206	+0.8085	****	0.415	-0.4732	**	0.117
	tn00	-0.0011	****	0.630	-0.0001	****	0.666	-0.0274	****	0.544	-0.0149	****	0.435	-0.0013	**	0.390
	tn11	-0.1377	***	0.495	-0.0002	*	0.546	-0.0012	***	0.591	-0.4049	*	0.329	-0.1675	**	0.382
	tn14	-0.4973	**	0.316	-0.1706		0.222	-0.2677	****	0.563	+0.8911	*	0.255	-0.4846		0.216
	va13	-0.2529	****	0.490	-0.0395	**	0.368	-0.6586	***	0.441	-0.9238	**	0.308	-0.2909		0.103
	va28	-0.0208	****	0.616	-0.0012	*	0.444	-0.6213	**	0.327	-0.2381	**	0.339	-0.1630		0.180
	wi99	-0.0077	***	0.481	-0.0055	****	0.657	-0.2264		0.210	-0.5524	*	0.254	-0.0947	****	0.540
	wv04	-0.0014	***	0.476	-0.0001	**	0.572	-0.0026	***	0.493	-0.0318	*	0.295	-0.0002	****	0.544
	wv18	-0.4957	****	0.508	-0.0008	****	0.565	-0.1239	***	0.395	-0.0020	**	0.392	-0.0075	*	0.333
11	al10	-0.0181	****	0.520	-0.0073	**	0.392	-0.5269	**	0.333	-0.6514	***	0.383	-0.3994	****	0.446
	ar02	-0.1730	*	0.336	-0.5257	***	0.455	-0.3756	**	0.384	+0.0410	***	0.473	+0.1702	***	0.511
	ar03	+0.9720	****	0.525	+0.9849	*	0.209	+0.0367	****	0.466	+0.3217		0.155	+0.5912		0.195
	fl03	-0.0667	***	0.400	-0.1320	***	0.402	-0.0768	**	0.349	-0.7476	****	0.462	-0.4435	****	0.467
	fl11	-0.7888		0.235	-0.2697	****	0.692	+0.2988	***	0.490	-0.8656	****	0.741	-0.4795	****	0.749
	fl14	-0.6537	***	0.358	+0.9873		0.197	-0.7794		0.235	+0.3726	***	0.379	+0.6339	***	0.356
	fl41	-0.4049	*	0.296	-0.3224	****	0.517	-0.3225		0.276	+0.8641	****	0.589	-0.8457	****	0.580
	fl99	-0.3387		0.168	-0.9688	****	0.465	+0.4222	***	0.371	+0.5723	****	0.569	+0.8136	****	0.546
	ga20	-0.0320	****	0.579	-0.5180		0.144	+0.2352		0.193	+0.8163	***	0.415	-0.8973	***	0.389
	ga41	-0.0013	****	0.631	-0.0017	**	0.414	-0.3342		0.229	-0.0324	**	0.392	-0.0083	**	0.386
	ga50	-0.0175	****	0.602	-0.1373	**	0.325	+0.3498	**	0.340	-0.3116	****	0.509	-0.2376	****	0.486
	la12	-0.0938	****	0.550	-0.0552	***	0.412	-0.0449	**	0.383	-0.1074	****	0.488	-0.0748	**	0.350
	la30	-0.0156	****	0.522	-0.0117	****	0.615	-0.1270	****	0.548	-0.4730	****	0.692	-0.1126	****	0.692
	md13	-0.0034	****	0.598	-0.0396	**	0.325	-0.0894	***	0.419	-0.2742	***	0.367	-0.2637	***	0.342
	ms10	-0.0510	****	0.639	-0.0250	**	0.328	-0.3453	*	0.267	-0.1219	****	0.456	-0.0422	****	0.484
	nc03	-0.0035	****	0.567	-0.0089	****	0.575	-0.6713	**	0.277	-0.1363	****	0.575	-0.0907	****	0.578
	nc34	-0.1343	****	0.475	-0.0282	***	0.364	-0.6226	*	0.229	+0.1801	***	0.417	+0.4824	**	0.329
	nc35	-0.0315	***	0.444	-0.7032	****	0.493	+0.9606	***	0.467	+0.2309	****	0.533	+0.3430	****	0.519
	nc36	-0.1918	****	0.538	-0.2453	****	0.492	-0.2290	****	0.679	+0.7237	****	0.509	+0.8501	****	0.465
	nc41	-0.0137	***	0.479	-0.0137	*	0.297	-0.5978		0.159	-0.1082	****	0.490	-0.0214	****	0.477
	sc06	-0.0584	****	0.636	-0.7155	***	0.416	+0.0733		0.284	+0.9325	****	0.540	-0.9775	***	0.493
	tx21	-0.1482	***	0.380	-0.0804		0.200	-0.6133	****	0.432	-0.8755		0.115	-0.3633		0.132
	tx38	-0.6462	*	0.291	-0.2219		0.236	-0.3675		0.232	-0.8171		0.208	-0.5721		0.205
	va00	-0.1228	****	0.550	-0.0032	**	0.487	-0.0293	***	0.519	-0.7168	****	0.564	-0.4443	***	0.478
12	ak03	+0.1067	*	0.310	-0.8938	**	0.378	+0.4276	**	0.331	-0.6904	**	0.390	+0.2572	**	0.392

Figure 22

National Atmospheric Deposition Program / National Trends Network

Trends in Hydrogen Ion Concentration
1985 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

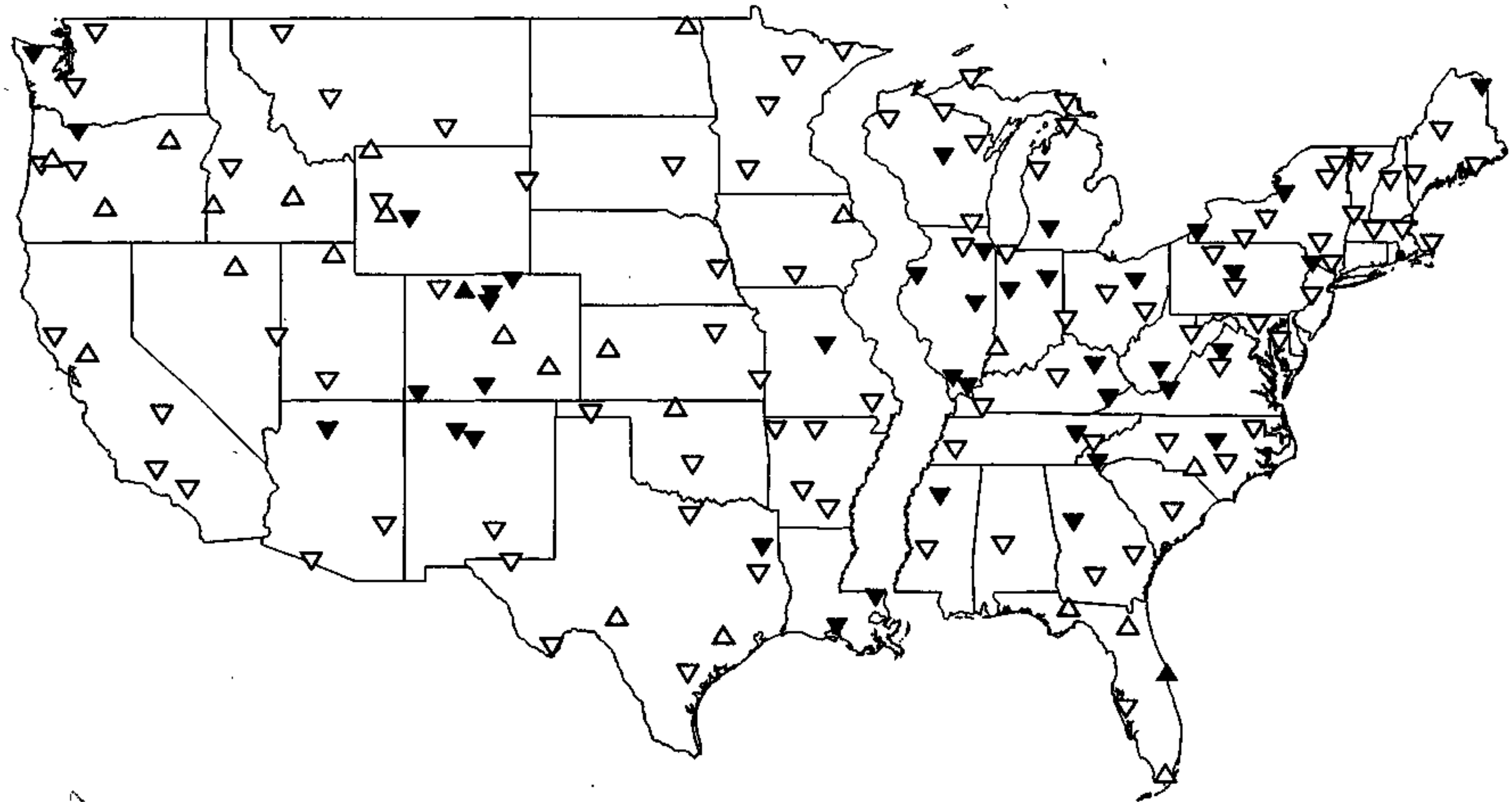
△ Positive slope estimate, p>0.05

▲ Positive slope estimate, p<0.05

Figure 23

National Atmospheric Deposition Program / National Trends Network

Trends in Sulfate Ion Concentration
1985 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

△ Positive slope estimate, p>0.05

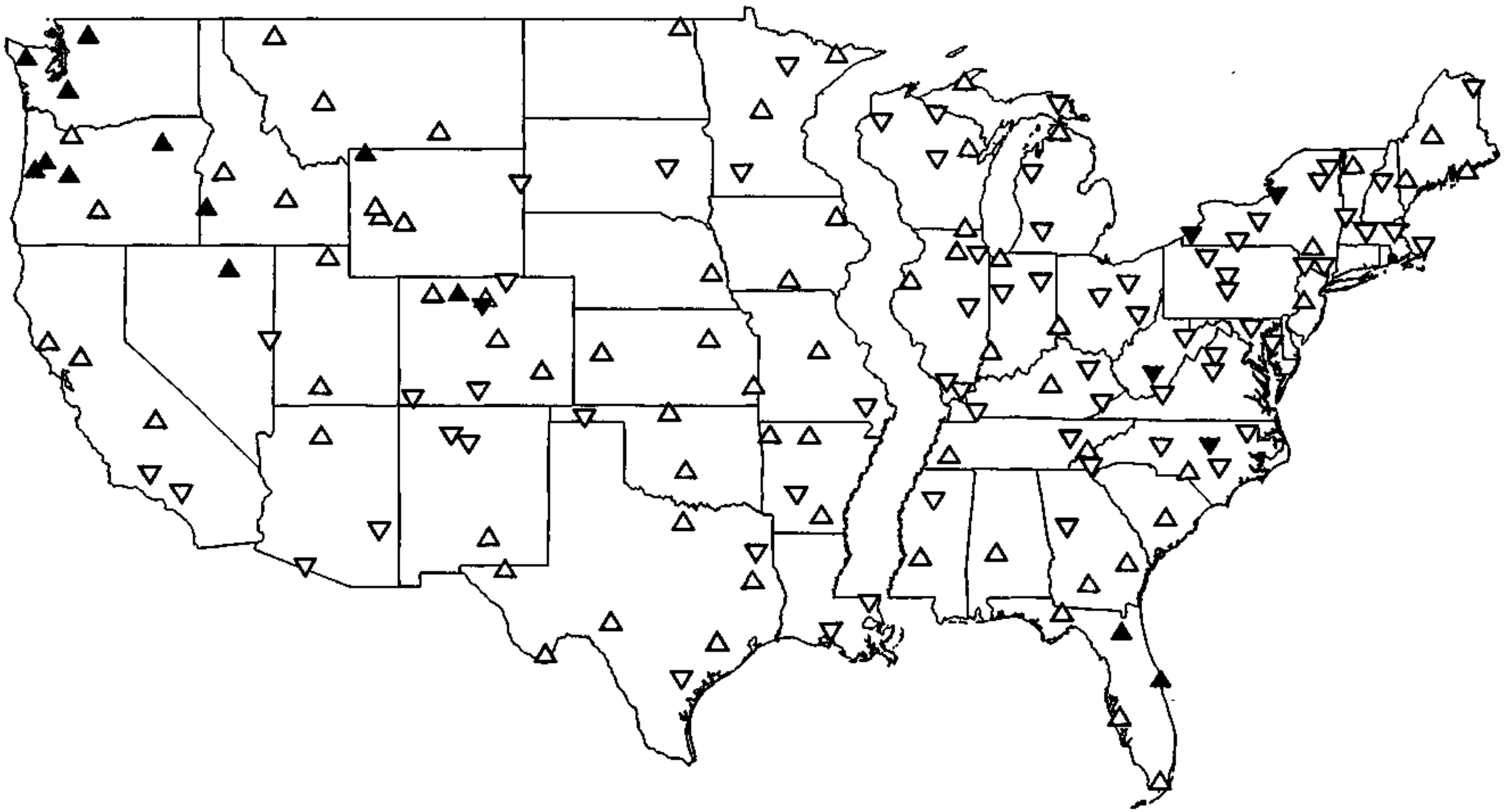
▲ Positive slope estimate, p<0.05

Figure 24

National Atmospheric Deposition Program / National Trends Network

Trends in Nitrate Ion Concentration

1985 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

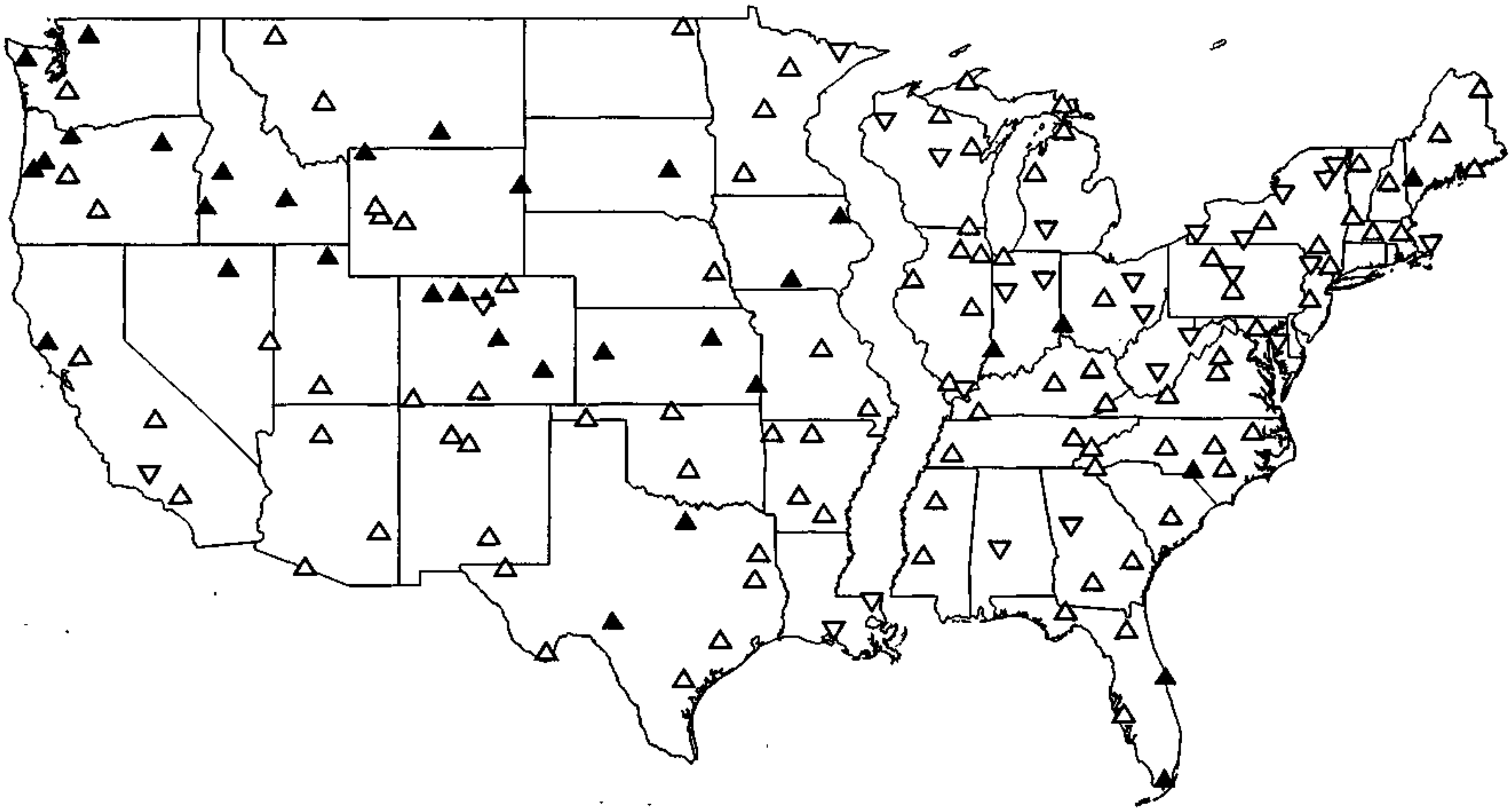
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 25

National Atmospheric Deposition Program / National Trends Network

Trends in Ammonium Ion Concentration
1985 through 1993

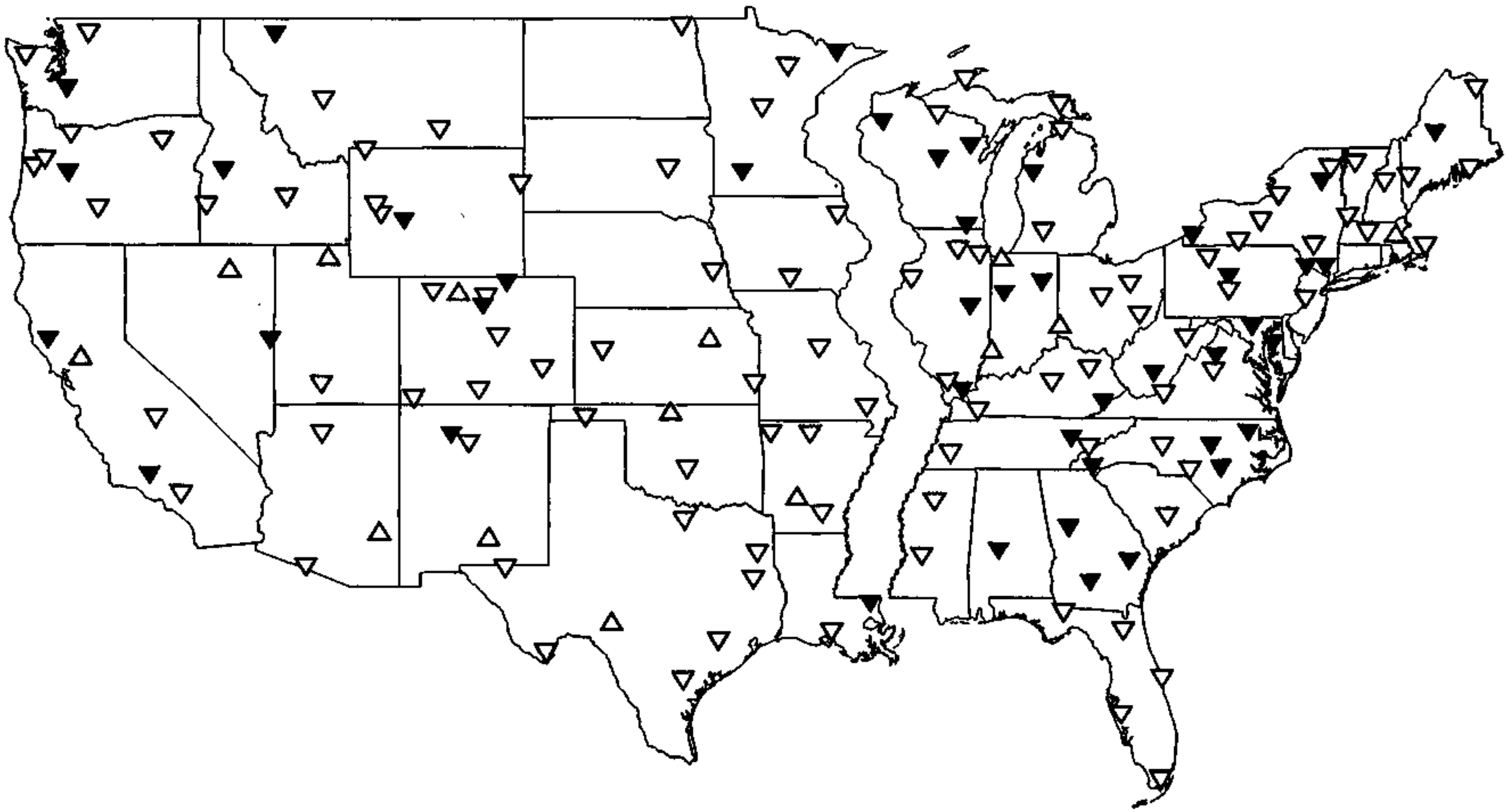


▽ Negative slope estimate, p>0.05
▼ Negative slope estimate, p<0.05
△ Positive slope estimate, p>0.05
▲ Positive slope estimate, p<0.05

Figure 26

National Atmospheric Deposition Program / National Trends Network

Trends in Calcium Ion Concentration
1985 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

△ Positive slope estimate, p>0.05

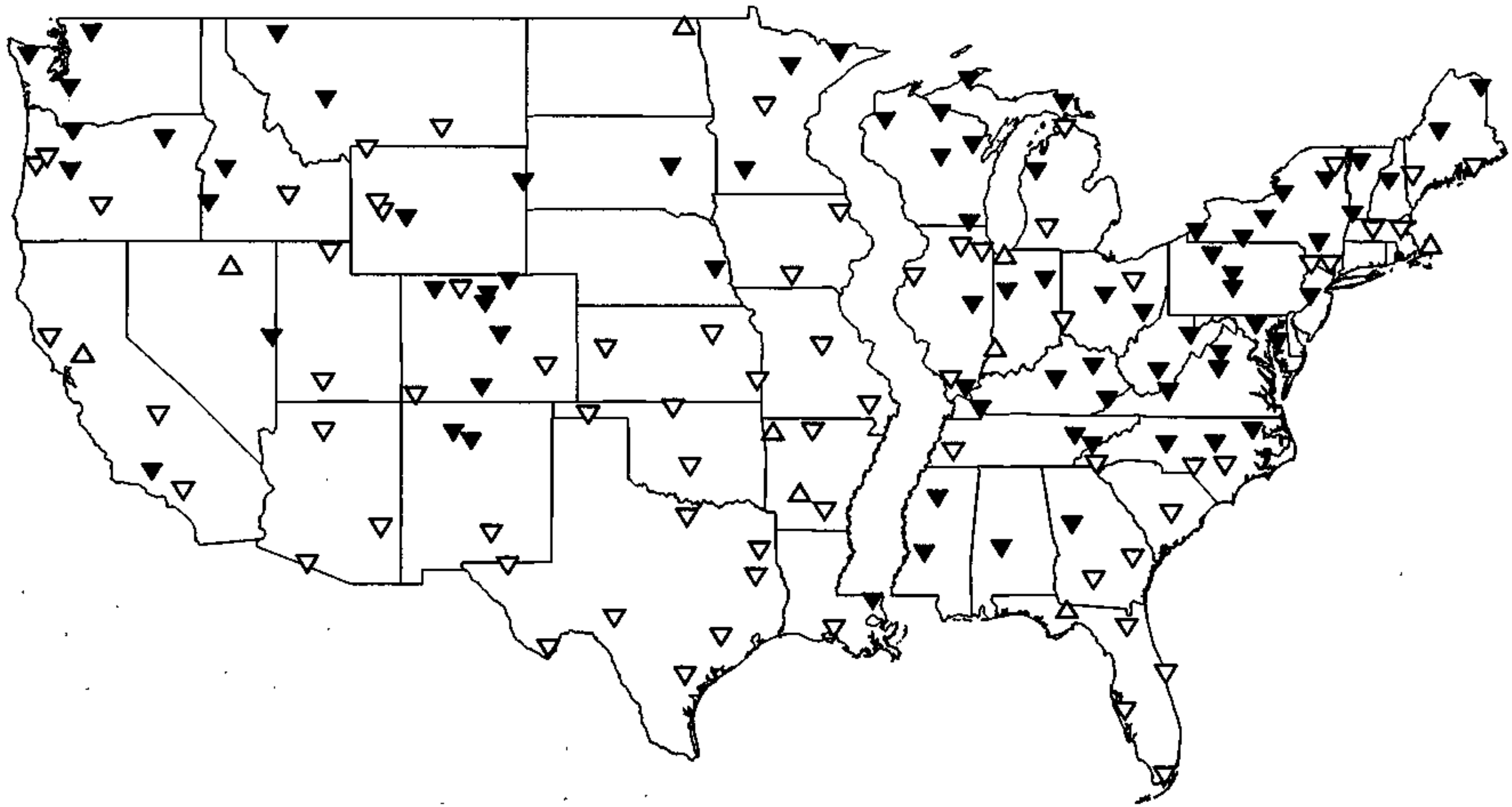
▲ Positive slope estimate, p<0.05

Figure 27

National Atmospheric Deposition Program / National Trends Network

Trends in Magnesium Ion Concentration

1985 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

△ **Positive slope estimate, p>0.05**

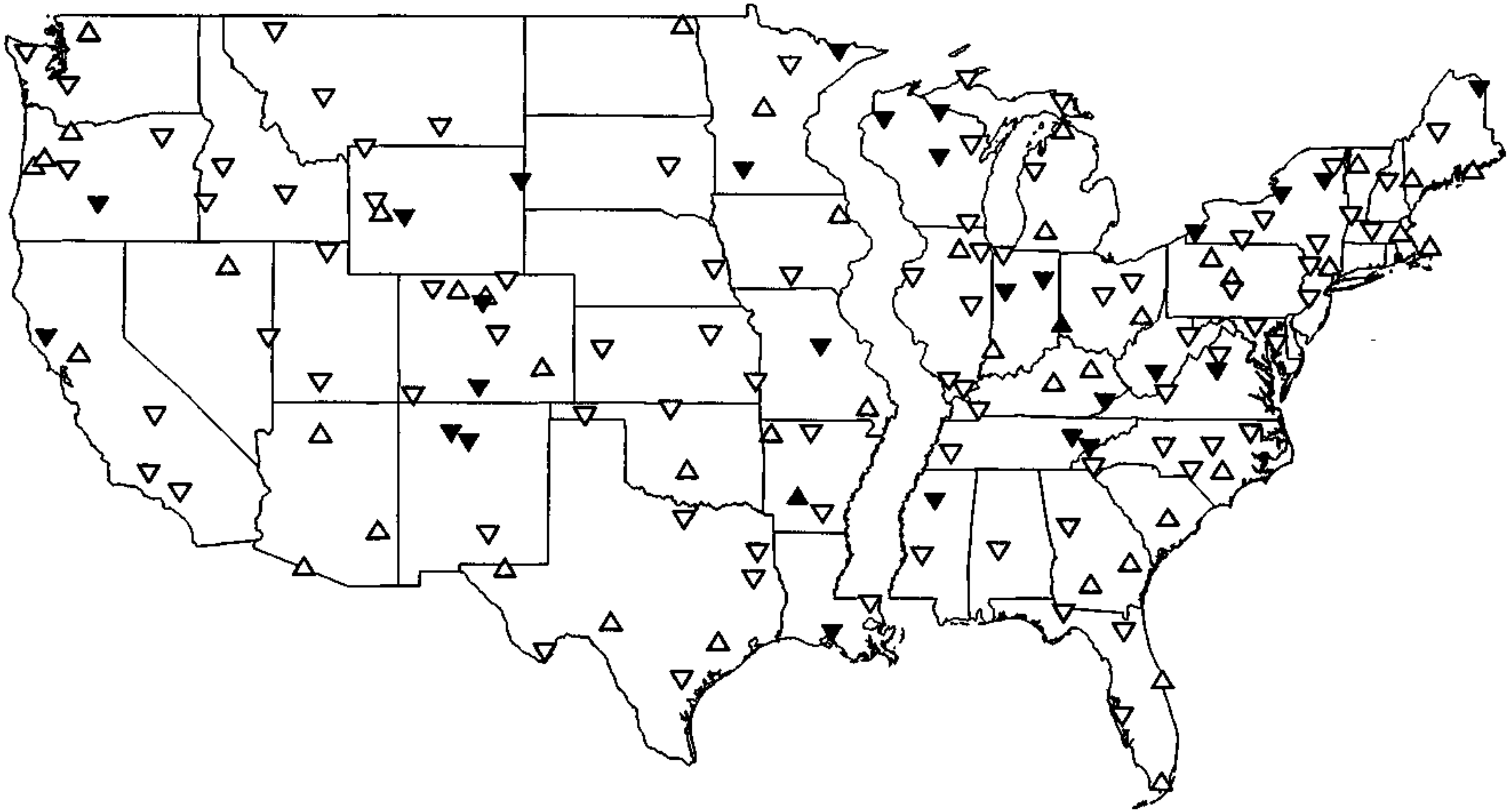
▲ **Positive slope estimate, p<0.05**

Figure 28

National Atmospheric Deposition Program / National Trends Network

Trends in Potassium Ion Concentration

1985 through 1993



▽ **Negative slope estimate, p>0.05**

▼ **Negative slope estimate, p<0.05**

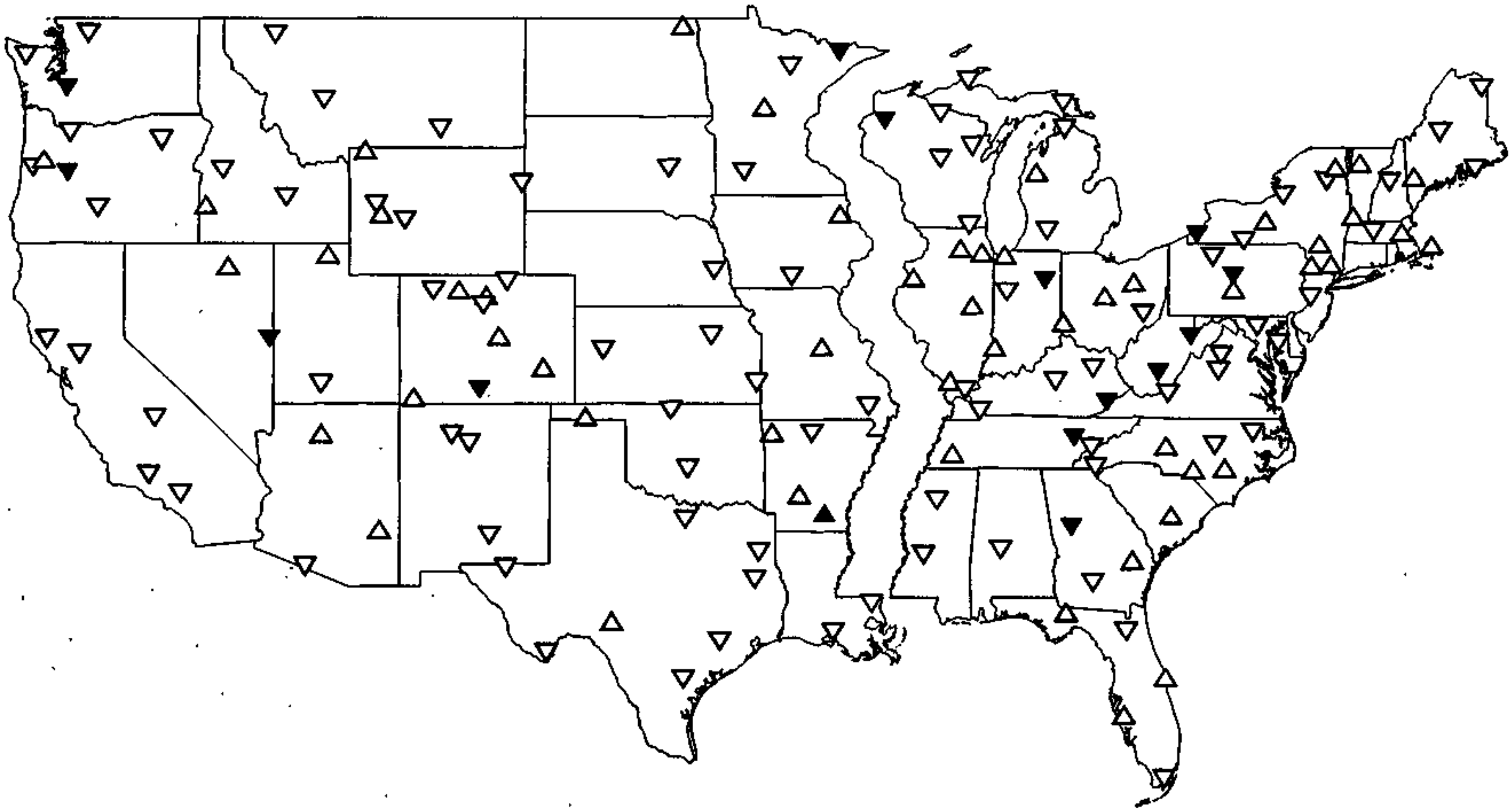
△ **Positive slope estimate, p>0.05**

▲ **Positive slope estimate, p<0.05**

Figure 29

National Atmospheric Deposition Program / National Trends Network

Trends in Sodium Ion Concentration
1985 through 1993



▽ Negative slope estimate, p>0.05

▼ Negative slope estimate, p<0.05

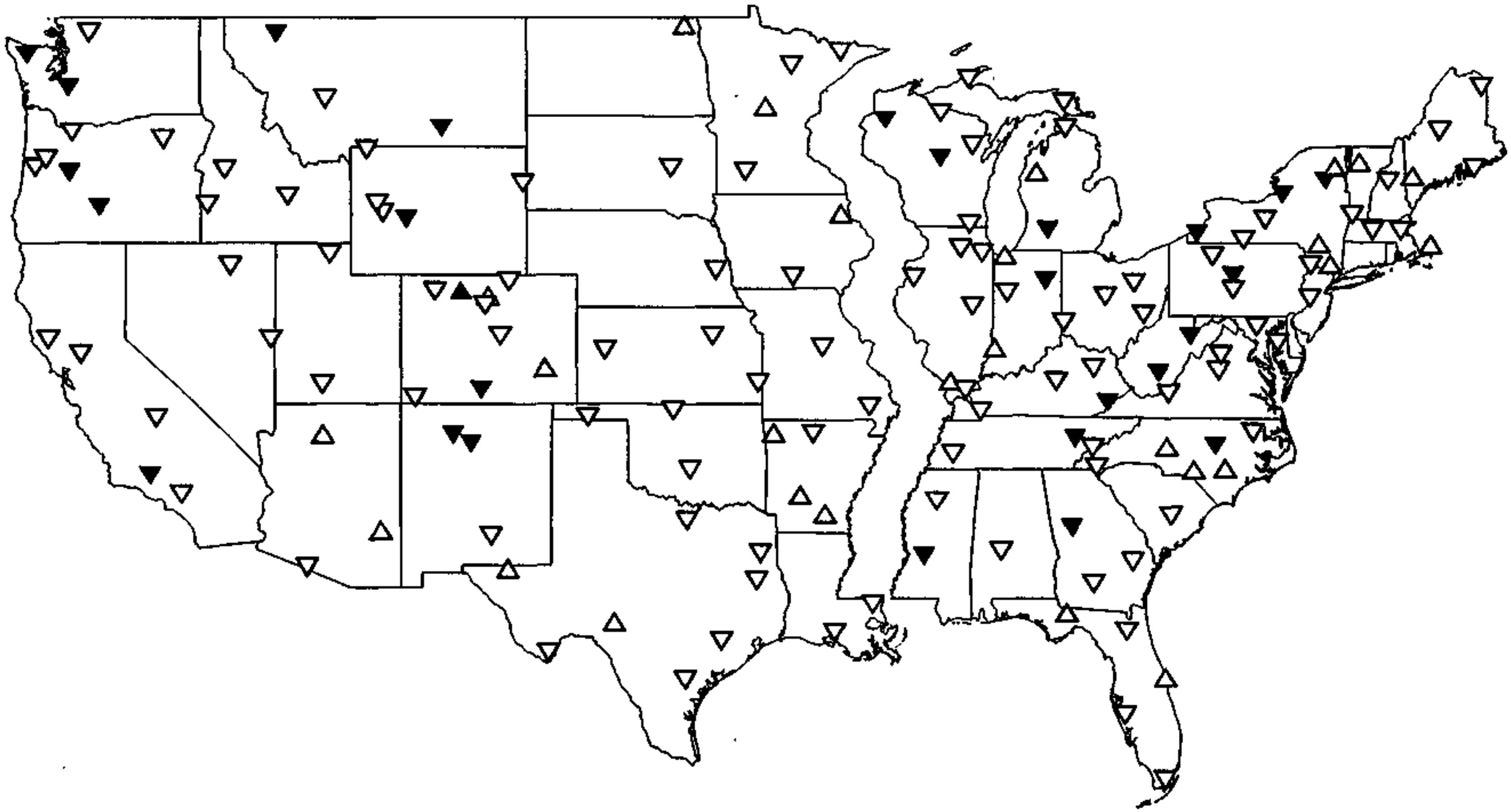
△ Positive slope estimate, p>0.05

▲ Positive slope estimate, p<0.05

Figure 30

National Atmospheric Deposition Program / National Trends Network

Trends in Chloride Ion Concentration
1985 through 1993



▽ Negative slope estimate, $p>0.05$

▼ Negative slope estimate, $p<0.05$

△ Positive slope estimate, $p>0.05$

▲ Positive slope estimate, $p<0.05$

Table 7. Predicted changes in concentrations (μeq/L) of individual anions and cations in precipitation at 155 NADP/NTN sites from 1985 through 1993.

		Hydrogen Ion		Sulfate		Nitrate		Ammonium	
Region	Site	Change (μeq/L)	Percent Change	Change (μeq/L)	Percent Change	Change (μeq/L)	Percent Change	Change (μeq/L)	Percent Change
1	ca45	-1.281*	-36.45	-2.115	-29.49	2.683	87.02	3.206*	161.21
	or02	-1.184*	-28.08	-0.547	-7.18	2.650*	243.38	1.668*	295.18
	or10	-0.610	-12.38	-0.590	-11.66	1.977*	94.67	0.578	52.92
	or97	-1.297	-33.73	0.250	3.30	3.574*	132.27	5.392*	288.58
	or98	-2.407*	-31.59	-2.382*	-22.84	1.231	21.88	3.319*	95.06
	wa14	-0.255	-6.02	-1.607*	-26.63	1.489*	208.41	0.288*	50.60
	wa19	-3.841*	-33.84	-2.000	-20.81	2.227*	44.72	1.758*	167.01
	wa21	-0.212	-1.85	-1.798	-12.00	2.909*	58.03	1.821	90.65
2	ca42	-7.500	-47.90	-2.179	-13.02	-2.613	-10.26	6.005	65.04
	ca75	-1.787*	-56.74	-0.989	-7.75	2.588	16.65	12.320	57.91
	ca88	-0.344	-32.67	0.883	6.36	2.787	16.27	9.868	32.84
	ca98	-4.018	-54.94	-5.795	-30.27	-11.785	-45.76	-6.459	-40.87
3	co00	-2.326*	-56.78	-10.955*	-46.93	-0.504	-4.82	6.095	70.85
	co19	-4.438*	-48.31	-5.258*	-29.76	2.425	16.43	6.149*	83.09
	co21	-2.409	-21.22	0.690	4.65	1.894	10.57	6.902*	129.73
	co97	0.510	4.76	4.521*	31.96	5.871*	71.07	6.080*	173.86
	co98	-1.910	-24.04	-6.711*	-40.29	-2.908*	-21.99	-1.615	-22.44
	id15	-0.101	-2.77	-1.866	-27.09	0.434	6.57	4.402*	136.75
	mt05	-1.077	-17.16	-0.646	-7.63	1.031	18.95	1.658	57.15
	mt07	0.148	2.98	-0.290	-2.89	1.234	18.14	1.692	43.55
	nm07	-1.854	-19.03	-5.902*	-28.63	-0.440	-3.33	2.718	45.60
	or18	-1.888*	-33.65	0.293	6.29	2.017*	45.97	2.565*	196.36
	ut01	-0.652*	-69.66	3.413	22.42	2.245	15.34	36.158*	140.46
	ut99	-0.677	-14.46	-2.182	-16.23	3.259	33.60	3.459	88.30
	wy02	-2.760*	-40.04	-5.057*	-33.97	0.741	8.43	0.771	12.89
	wy08	-0.745	-23.11	2.067	29.06	3.528*	60.10	5.361*	158.13
	wy98	-3.416*	-52.97	-3.229	-24.49	1.034	10.42	3.193	75.79
4	id03	-0.002	-0.07	0.308	2.73	3.946	42.25	10.453*	173.75
	id11	-1.412*	-53.41	0.673	8.07	3.994*	52.31	7.687*	127.28
	nv01	-2.431*	-51.88	4.088	41.33	9.163*	107.45	7.127*	181.21
	nv05	0.743	28.12	-2.170	-12.98	-3.493	-17.60	1.616	13.49
	or09	-1.484	-30.96	0.748	13.45	3.146	60.84	2.154	92.56
5	az06	-1.041	-24.45	-8.202	-30.23	-7.572	-31.61	1.098	7.59
	tx04	-0.206	-8.74	-1.213	-5.72	2.995	32.40	5.288	71.73
	tx22	-4.104*	-56.69	-6.469	-23.49	0.709	6.84	3.473	42.65
6	az03	-1.911	-30.96	-7.523*	-37.52	3.044	25.74	3.040	52.67
	az99	-16.348*	-76.06	-12.283	-37.42	-0.471	-3.60	6.351	106.71
	co99	-4.767	-35.26	-6.335*	-25.51	-0.488	-3.22	0.980	16.91
	nm08	-3.838*	-54.52	-4.943	-21.75	2.500	24.70	3.963	73.12
	nm09	-4.723*	-40.47	-7.386*	-35.95	-2.037	-14.77	2.924	56.49
7	co01	-0.561	-29.19	0.060	0.33	2.946	16.15	14.462*	98.09
	co15	-1.466	-17.83	-0.251	-1.56	4.095	34.19	3.587*	64.94
	co22	-1.214	-25.09	-5.590*	-29.00	-2.554	-12.55	0.194	0.88
	mt00	-1.358	-26.30	-1.283	-9.06	1.415	14.37	4.402*	80.09
	ok29	-1.165	-42.59	-4.331	-15.88	-1.324	-6.85	3.462	10.96
	wy06	0.034	0.67	0.406	3.43	2.651	27.74	3.059	62.86
	wy99	-0.316	-6.73	-3.268	-17.98	-0.298	-2.11	5.932*	89.21

* $p<0.05$

Table 7 (continued).

Region	Site	Hydrogen Ion Change (μeq/L)	Hydrogen Ion Percent Change	Sulfate Change (μeq/L)	Sulfate Percent Change	Nitrate Change (μeq/L)	Nitrate Percent Change	Ammonium Change (μeq/L)	Ammonium Percent Change
8	ia23	-2.907	-19.56	-5.030	-14.27	1.991	9.54	12.939*	81.00
	il11	-5.498	-11.42	-11.649*	-19.19	-0.760	-3.18	4.820	29.30
	il18	-5.002	-14.60	-9.184	-16.89	1.539	6.22	6.468	31.59
	il19	-6.745	-14.88	-17.655*	-25.04	-2.284	-7.75	0.921	3.92
	il78	-2.875	-10.43	-14.658*	-27.18	0.341	1.45	5.140	23.39
	in22	-0.524	-1.13	0.772	1.40	3.865	20.78	7.218*	69.76
	in34	-9.761*	-23.22	-4.743	-7.76	1.218	4.54	2.182	10.64
	in41	-11.316*	-22.46	-20.429*	-28.87	-4.778	-16.47	-2.059	-9.41
	ks07	-4.685	-25.93	-6.561	-20.50	2.087	13.19	6.036*	51.43
	ks31	-2.020	-17.26	-4.698	-15.77	2.017	10.59	7.726*	50.66
	ks32	-0.326	-13.68	1.629	9.21	3.739	22.67	11.966*	59.24
	mn27	1.891	49.37	-4.776	-16.18	-0.365	-1.44	7.567	26.18
	nd08	0.813	25.02	1.032	6.21	2.417	15.92	10.230	73.96
	ne15	0.704	17.26	-6.816	-19.28	2.444	11.59	4.470	13.92
	ok00	-1.484	-16.75	0.577	2.40	4.211	25.30	4.873	30.03
	ok17	-1.390	-13.36	-3.877	-15.22	0.576	3.64	3.971	33.98
	sd99	-0.058	-3.07	-3.129	-14.71	-1.940	-9.71	10.587*	50.53
	tx03	0.082	0.81	-3.103	-10.59	-0.074	-0.54	5.861	52.81
	tx10	3.749	33.75	1.571	7.03	3.133	28.31	2.875	32.63
	tx16	-2.864	-42.81	5.812	29.28	3.565	37.01	8.931*	114.37
	tx56	-4.786*	-41.34	-3.915	-15.44	2.845	21.24	9.065*	84.72
9	ma08	-7.979	-16.43	-8.885	-20.24	-0.805	-3.54	1.492	17.37
	me00	-10.456*	-33.13	-7.755*	-24.06	-3.079	-17.72	0.908	14.55
	me02	-1.266	-4.03	-2.268	-7.34	1.095	7.40	4.796*	111.14
	me09	-3.771	-14.05	-4.291	-16.49	1.264	9.98	1.386	27.16
	me98	0.020	0.07	-3.304	-10.13	3.917	33.74	2.362	51.19
	mi09	-0.964	-3.05	-2.842	-7.26	1.453	5.67	0.878	5.02
	mi53	0.512	1.57	-6.297	-13.97	-2.238	-7.32	0.839	4.24
	mi98	-4.672	-14.07	-5.922	-15.02	-0.315	-1.23	9.947	76.11
	mi99	0.142	0.82	-4.516	-15.47	0.173	0.99	1.829	14.01
	mn16	0.754	8.15	-2.677	-12.35	-0.419	-2.24	0.314	1.84
	mn18	3.852	43.88	-2.600	-13.24	0.479	3.07	-0.327	-2.63
	nh02	-10.234	-21.67	-5.459	-14.12	-3.719	-14.76	2.086	28.25
	ny08	-4.851	-7.76	-4.712	-7.39	-1.249	-3.71	2.149	11.79
	ny10	-12.828*	-20.15	-20.348*	-28.57	-5.497*	-15.94	-4.903	-23.26
	ny20	-7.618	-17.55	-8.374	-20.76	-3.921	-15.70	-0.676	-6.49
	ny52	-14.140*	-21.33	-13.072*	-20.74	-9.047*	-22.16	-2.511	-12.38
	ny65	3.328	6.64	-5.048	-9.39	-1.468	-5.34	-1.983	-13.62
	ny68	1.237	2.61	-3.658	-8.05	2.614	10.98	2.523	28.14
	ny98	-4.745	-12.21	-7.361	-18.26	-1.352	-6.41	-0.036	-0.36
	pa29	-9.040*	-13.81	-9.363	-14.58	-2.968	-9.67	0.571	4.19
	pa72	-18.571*	-28.29	-16.681*	-28.55	-6.829	-21.03	-2.438	-19.30
	vt01	-2.208	-4.57	-2.767	-6.02	-0.508	-1.85	3.502	35.89
	vt99	-0.077	-0.20	-6.241	-16.01	1.394	6.15	1.215	11.98
	wi25	-1.358	-5.44	-6.812	-17.04	0.508	1.93	2.006	9.47
	wi28	-3.673	-18.14	-15.340*	-34.53	-4.222	-15.79	-2.571	-10.33
	wi36	-4.040	-21.70	-7.788	-26.38	-1.358	-6.85	1.654	12.28
	wi37	4.781	53.97	-3.385	-12.09	-0.703	-3.26	-0.404	-1.80

* $p<0.05$

Table 7 (continued).

Region	Site	Hydrogen Ion Change (μeq/L)	Hydrogen Ion Percent Change	Sulfate Change (μeq/L)	Sulfate Percent Change	Nitrate Change (μeq/L)	Nitrate Percent Change	Ammonium Change (μeq/L>	Ammonium Percent Change
10	ar16	-0.514	-2.59	-1.823	-6.82	1.030	7.57	0.676	6.71
	ar27	-3.242	-25.50	-3.012	-11.74	0.879	6.48	0.090	0.61
	ia08	3.980	35.01	0.752	2.08	3.624	15.94	14.328*	72.78
	il35	-9.904*	-24.63	-10.929*	-22.81	-1.789	-9.41	4.496	43.94
	il63	-3.115	-7.61	-12.009*	-22.37	-1.489	-7.76	-0.710	-5.12
	in20	-4.280	-9.35	-15.991*	-25.52	-1.462	-5.27	-4.237	-18.63
	ky03	-1.998	-4.40	-5.902	-11.72	2.285	12.45	2.810	26.45
	ky22	-7.247	-18.76	-13.240*	-29.08	-1.801	-9.63	0.768	9.88
	ky35	-6.766	-14.05	-7.581*	-14.45	-0.381	-1.79	1.302	11.93
	ky38	-6.168	-17.93	-7.932	-19.10	-1.942	-10.87	2.675	30.16
	ma01	-13.635	-31.62	-10.006	-21.64	-5.205	-22.75	-0.622	-7.68
	ma13	-20.186*	-35.34	-11.094	-20.83	-1.894	-9.33	0.968	13.82
	md03	-0.112	-0.20	-2.058	-3.72	-0.587	-2.13	3.963	31.51
	mi26	-8.835	-19.07	-17.211*	-27.84	-4.315	-13.97	.-0.493	-2.21
	mn23	-1.206	-13.00	-1.674	-8.11	0.076	0.41	0.057	0.25
	mo03	-9.570*	-34.95	-15.105*	-36.24	0.113	0.59	0.794	5.23
	mo05	-2.723	-9.16	-6.032	-15.94	-0.962	-5.49	1.163	9.38
	ms30	-3.804	-17.72	-6.508*	-24.13	-0.426	-3.36	1.369	18.51
	nc25	-13.007*	-36.99	-13.888*	-36.41	-3.630	-26.15	1.163	17.44
	nj99	-6.070	-13.09	-6.323	-12.84	0.580	2.61	3.210	33.94 ,
	ny99	-15.249	-23.69	-13.750	-23.92	-8.499	-26.87	0.527	5.17
	oh09	-0.071	-0.13	-0.501	-0.85	0.925	3.97	3.916*	30.89
	oh17	-6.717	-11.71	-10.247	-15.25	-2.196	-7.15	2.323	13.14
	oh49	-9.354	-13.13	-9.557	-12.72	-2.156	-7.45	-1.221	-8.25
	oh71	-10.057*	-16.49	-14.432*	-20.09	-4.442	-14.32	-1.725	-8.08
	pal5	-16.451*	-23.04	-16.484*	-24.01	-6.289	-18.62	-0.329	-2.36
	pa42	-5.454	-7.94	-7.642	-11.77	-1.671	-5.04	0.689	4.72
	tnOO	-14.394*	-26.45	-18.666*	-31.72	-2.496	-13.04	0.856	9.44
	tn11	-2.361	-7.01	-6.867	-17.40	0.353	2.43	0.465	5.42
	tn14	1.103	5.23	-0.939	-3.70	3.686	32.83	3.148	47.54
	va13	-7.474	-20.15	-12.748*	-28.03	-0.172	-1.03	1.103	12.20
	va28	-9.004*	-25.69	-11.258*	-29.00	-2.782	-17.93	1.505	16.35
	wi99	1.223	4.12	-4.831	-10.46	0.126	0.47	0.028	0.11
	wv04	-17.644*	-32.87	-21.810*	-39.62	-5.646*	-24.43	-2.024	-19.15
	wv18	-5.319	-8.88	-6.850	-11.05	-1.979	-7.13	-1.679	-12.83
11	al10	3.937	20.83	-3.772	-13.28	0.319	2.75	-0.284	-4.29
	ar02	-0.075	-0.52	-5.161	-19.66	1.203	10.48	1.235	12.08
	ar03	-3.643	-16.28	-2.699	-9.83	-0.444	-3.10	2.461	30.93
	fl03	1.890	9.34	2.463	10.89	3.361*	35.78	1.558	37.53
	fl11	-3.405*	-39.17	1.691	10.80	3.983	67.84	6.146*	273.20
	fl14	-0.594	-3.56	0.966	5.17	0.830	9.20	2.504	79.24
	fl41	-1.275	-8.39	-1.559	-7.24	3.180	31.86	2.385	46.19
	fl99	9.196*	62.09	7.349*	32.49	5.418*	62.40	3.667*	109.52
	ga20	-3.159	-15.10	-4.005	-15.27	1.347	12.43	3.193	54.16
	ga41	-5.515	-19.11	-9.367*	-27.35	-2.788	-20.09	-0.180	-2.43
	gaSO	0.345	2.27	-0.593	-2.92	1.690	18.82	1.978	38.00
	la12	1.129	7.84	-7.695*	-28.76	-0.973	-7.77	-2.667	-22.75
	la30	-4.236	-21.12	-9.545*	-32.41	-3.046	-21.41	-2.544	-21.79
	md13	-11.747	-21.31	-11.873	-21.00	-5.776	-20.90	-1.709	-11.53
	ms10	0.647	3.72	-3.862	-15.13	0.397	3.38	2.652	33.39
	nc03	-9.320*	-28.00	-8.127	-22.50	-2.540	-15.66	2.595	34.79
	nc34	-10.171*	-25.33	-7.860	-17.83	-2.503	-13.28	0.601	4.65
	nc35	-3.703	-14.83	-5.457	-17.32	-1.799	-12.56	2.142	22.43
	nc36	1.555	5.27	4.061	14.00	1.723	11.70	5.655*	104.55
	nc41	-10.043	-30.88	-10.300*	-26.38	-4.742*	-25.82	5.446	48.22
	sc06	-3.056	-11.00	-2.885	-8.88	0.307	2.43	2.984	63.65
	tx21	-4.746	-19.22	-10.306*	-28.65	-0.984	-7.17	2.029	24.87
	tx38	0.403	2.97	-2.221	-8.77	0.984	8.37	1.558	19.55
	vaOO	-9.726	-17.79	-4.957	-9.76	-4.343	-16.34	0.778	6.59
12	ak03	-1.227	-32.32	0.598	16.89	1.834*	178.64	0.167	13.63

* p<0.,05

Table 7 (continued).

Region	Site	Calcium Change (μeq/L)	Calcium Percent Change	Magnesium Change (μeq/L)	Magnesium Percent Change	Potassium Change (μeq/L)	Potassium Percent Change	Sodium Change (μeq/L)	Sodium Percent Change	Chloride Change (μeq/L)	Chloride Percent Change
1	ca45	-1.144*	-49.28	-1.036	-35.20	-0.269*	-45.58	-0.929	-9.72	-3.716	-30.49
	or02	-0.126	-5.11	-1.658	-25.31	0.070	9.89	-6.098	-22.26	-7.873	-24.34
	or10	-0.840*	-41.49	-0.976*	-45.75	-0.030	-9.23	-2.746*	-35.70	-3.746*	-42.09
	or97	-0.379	-13.65	-0.487	-14.19	0.104	18.10	0.233	1.88	-1.126	-7.46
	or98	-0.365	-15.16	-1.129*	-31.98	0.016	2.32	-3.113	-22.46	-3.999	-25.03
	wa14	-0.449	-25.46	-1.772*	-37.93	-0.044	-8.32	-5.633	-29.96	-9.048*	-38.55
	wa19	-0.538	-32.64	-1.214*	-54.42	0.046	17.03	-1.174	-22.23	-2.395	-34.65
	wa21	-1.482*	-51.55	-2.206*	-62.28	-0.069	-13.42	-7.586*	-55.29	-9.500*	-59.66
2	ca42	-2.023	-32.46	-1.148	-28.71	-0.306	-36.42	-2.406	-19.22	-2.337	-18.16
	ca75	-0.786	-18.64	-1.147	-51.26	-0.642	-47.69	-1.483	-31.55	-2.052	-41.85
	ca88	0.055	1.23	0.061	1.95	0.158	19.50	-0.341	-4.40	-0.715	-8.70
	ca98	-5.671*	-51.05	-2.342*	-64.71	-0.397	-33.51	-2.802	-38.63	-3.572*	-47.43
3	coOO	-7.167	-48.12	-1.498*	-55.21	-0.647*	-53.11	-3.813*	-47.29	-1.572*	-40.71
	co19	-1.381	-14.02	-0.927*	-38.24	0.066	9.60	0.081	3.19	0.309	13.34
	co21	-1.954	-19.66	-0.931*	-34.76	-0.148	-18.94	0.415	18.52	-0.123	-5.17
	co97	0.632	10.24	-0.415	-22.03	0.085	27.27	0.941	53.30	0.827*	51.22
	co98	-5.045*	-48.34	-1.611*	-60.46	-0.362*	-53.44	-0.901	-28.91	-0.513	-21.40
	id15	-3.094*	-48.56	-0.905*	-55.66	-0.046	-9.29	-1.047	-26.79	-0.439	-18.14
	mt05	-2.254*	-43.99	-0.612*	-41.23	-0.196	-26.27	-0.122	-5.55	-0.557*	-28.73
	mt07	-2.041	-30.30	-0.745*	-45.43	-0.218	-39.10	-0.431	-18.76	-0.372	-18.43
	nm07	-4.537	-33.18	-1.089*	-46.75	-0.468*	-54.21	-0.765	-25.33	-1.044*	-34.09
	or18	-1.033	-32.22	-0.612*	-51.77	-0.076	-17.55	-0.602	-22.30	-0.564	-25.78
	ut01	2.085	13.28	-0.043	-0.92	-0.294	-30.74	1.026	10.83	-1.042	-7.34
	ut99	-1.320	-11.49	-0.845	-20.00	-0.384	-40.20	-1.790	-38.55	-1.312	-32.01
	uy02	-3.934*	-38.39	-1.454*	-50.52	-0.176*	-40.31	-0.129	-5.63	-1.633*	-51.20
	wy08	-2.080	-18.55	-0.774	-30.70	-0.279	-34.57	0.301	11.49	-0.538	-18.20
	uy98	-3.686	-33.02	-0.734	-29.86	-0.017	-3.06	-0.209	-5.75	-0.560	-14.88
4	id03	-3.415	-28.36	-1.140	-39.06	-0.324	-37.63	-0.429	-9.27	-1.217	-23.96
	idll	-1.782	-19.14	-1.291*	-46.25	-0.055	-6.98	2.137	44.11	-0.199	-5.63
	nv01	6.972	84.01	0.287	10.99	0.057	6.46	0.491	8.55	-0.315	-7.52
	nv05	-19.891*	-61.77	-3.229*	-56.49	-0.272	-27.66	-4.597*	-52.95	-1.224	-24.03
	or09	-0.400	-10.97	-0.641	-39.29	-1.562*	-82.16	-1.861	-40.25	-2.174*	-52.16
5	az06	-4.963	-31.16	-3.891	-45.74	0.042	3.77	-10.144	-40.49	-14.397	-46.64
	tx04	-6.259	-22.10	-0.983	-33.53	-0.335	-30.22	-0.115	-2.41	-0.739	-18.29
	tx22	-0.430	-2.54	-0.500	-17.59	0.141	28.26	-0.471	-11.69	0.214	7.33
6	az03	-0.198	-1.36	-0.939	-18.85	0.057	14.37	0.715	19.12	0.269	7.71
	az99	2.790	37.29	-0.623	-26.28	0.215	40.93	1.266	35.13	0.823	23.95
	co99	-1.935	-10.37	-0.711	-19.67	-0.136	-23.11	0.163	5.40	-0.119	-4.22
	nm08	3.144	19.15	-0.790	-25.03	-0.116	-16.56	-1.484	-28.29	-0.155	-4.71
	rm09	-4.833*	-43.04	-1.252*	-52.00	-0.264*	-41.81	-0.517	-17.52	-1.089*	-33.46
7	co01	-0.205	-1.29	-0.418	-15.61	0.330	32.08	0.181	4.38	0.322	11.03
	co15	-2.996	-24.96	-1.242*	-38.45	-0.283	-38.15	-0.300	-8.81	-0.746	-23.57
	co22	-3.965*	-36.12	-1.326*	-52.14	-0.207	-28.73	-0.759	-19.50	-0.279	-9.91
	mt00	-2.955	-30.22	-0.732	-29.41	-0.067	-12.08	-0.841	-26.02	-0.677*	-26.56
	ok29	-1.322	-8.19	-0.256	-11.18	-0.208	-18.47	0.160	5.84	-0.111	-3.74
	wy06	-1.331	-14.22	-0.649	-28.60	0.072	22.95	0.088	2.42	-0.113	-3.75
	wy99	-5.171	-32.55	-1.771*	-50.58	-0.238*	-33.92	-0.910	-27.98	-0.801	-29.74

* $p<0.05$

Table 7 (continued).

Regfon	Site	Calcium Change (μeq/L)	Calcium Percent Change	Magnesium Change (μeq/L)	Magnesium Percent Change	Potassium Change (μeq/L)	Potassium Percent Change	Sodium Change (μeq/L)	Sodium Percent Change	Chloride Change (μeq/L)	Chloride Percent Change
8	ia23	-3.432	-20.71	-0.664	-24.34	-0.252	-29.40	-0.596	-19.67	-0.527	-15.66
	il11	-3.620*	-32.88	-0.779*	-31.02	-0.113	-22.77	0.586	25.56	-0.146	-3.75
	il18	-1.788	-14.91	-0.688	-17.74	0.133	24.47	0.344	13.19	-0.185	-4.96
	il19	-4.690	-28.81	-2.112	-34.60	-0.097	-13.61	0.318	10.04	-0.331	-6.52
	il78	-3.607	-25.93	-0.912	-30.80	-0.185	-29.21	0.246	9.61	-0.118	-3.59
	in22	1.475	18.22	0.268	13.02	0.478	97.78	0.527	16.94	0.491	10.10
	in34	5.929	37.58	1.533	30.51	-0.050	-8.74	0.185	6.35	0.378	7.50
	in41	-7.782*	-48.72	-1.721*	-41.03	-0.266*	-39.76	-0.750	-21.42	-0.954	-21.12
	ks07	-0.927	-7.76	-0.547	-25.79	-0.126	-18.95	-0.187	-5.35	-0.593	-15.17
	ks31	0.190	1.34	-0.475	-19.81	-0.102	-14.83	-0.146	-4.64	-0.039	-1.25
	ks32	-0.205	-1.58	-0.728	-29.85	-0.182	-15.39	-0.389	-13.58	-0.316	-11.92
	mn27	-6.409*	-36.05	-2.443*	-45.84	-0.399*	-37.05	-0.560	-19.66	-0.583	-18.37
	nd08	-1.391	-11.99	0.418	12.09	0.133	18.61	0.632	30.15	0.397	19.97
	ne15	-3.472	-20.08	-1.023*	-33.50	-0.078	-9.03	-0.054	-1.87	-0.427	-14.49
	okOO	0.060	0.49	-0.872	-31.65	-0.150	-16.69	-1.634	-26.21	-1.887	-30.46
	ok17	-1.335	-10.62	-0.813	-28.40	0.166	19.74	-1.669	-31.44	-1.626	-29.77
	sd99	-5.522	-38.07	-2.235*	-47.92	-0.282	-34.92	-0.452	-15.24	-0.809	-26.52
	tx03	-1.465	-13.33	-0.546	-10.35	-0.243	-18.48	-0.847	-4.27	-3.492	-14.31
	tx10	-1.562	-18.56	-1.337	-28.79	0.257	32.21	-2.540	-16.07	-4.133	-22.07
	tx16	9.455	81.38	-0.081	-3.18	0.084	12.05	1.181	19.26	1.063	17.41
	tx56	-0.092	-0.65	-0.767	-29.18	-0.260	-28.06	-1.325	-20.69	-1.783	-26.85
9	ma08	-0.837	-27.60	-0.565	-27.29	-0.115	-26.39	-0.191	-3.54	-0.056	-0.85
	me00	-1.240	-25.74	-1.350*	-63.18	-0.240*	-49.52	-1.015	-24.10	-0.937	-20.64
	me02	-0.044	-1.90	-0.424	-24.74	0.191	68.39	0.465	9.68	0.493	8.86
	me09	-1.136*	-39.06	-0.513*	-38.54	-0.048	-17.02	-0.346	-11.42	-0.268	-8.05
	me98 -	-0.753	-23.55	-1.761	-29.24	0.163	28.15	-4.860	-21.15	-7.755	-27.70
	mi09	-1.034	-11.60	-0.809	-26.68	0.040	7.96	-0.085	-4.03	-0.443	-14.71
	mi53	-4.627*	-36.14	-1.852*	-38.57	-0.073	-14.03	0.348	14.98	0.249	7.26
	mi98	-2.336	-28.08	-1.122*	-39.13	-0.036	-8.61	-0.220	-10.12	-0.115	-4.16
	mi99	-2.578	-31.82	-1.368*	-48.84	-0.122	-23.34	-0.499	-19.10	-0.373	-14.41
	mn16	-3.006	-30.78	-1.278*	-42.16	-0.204	-27.86	-0.751	-28.66	-0.511	-22.28
	mn18	-3.960*	-44.31	-1.591*	-57.85	-0.315*	-53.18	-0.715*	-33.58	-0.384	-19.44
	nh02	-0.585	-19.91	-0.600*	-37.70	-0.001	-0.45	-0.103	-3.08	-0.279	-6.67
	ny08	-1.783	-24.65	-0.964*	-38.52	-0.088	-22.42	0.071	3.23	-0.089	-2.21
	ny10	-3.627*	-38.21	-0.998*	-37.66	-0.585*	-64.83	-1.063*	-33.20	-2.045*	-37.74
	ny20	-1.714*	-36.18	-0.825*	-50.68	-0.153*	-43.44	-0.281	-13.69	-0.775*	-25.67
	ny52	-1.969	-23.99	-0.723*	-28.33	-0.311*	-42.81	-0.343	-11.32	-1.430*	-27.02
	ny65	-1.657	-31.53	-0.650*	-38.87	-0.055	-18.42	-0.118	-5.96	-0.154	-4.93
	ny68	-0.674	-18.67	-0.635*	-37.13	-0.002	-0.53	0.129	4.69	0.242	6.25
	ny98	-0.915	-21.56	-0.462	-33.10	-0.082	-23.07	0.219	15.11	0.084	4.29
	pa29	-0.867	-14.74	-0.659*	-33.54	0.008	1.86	-0.106	-4.91	-0.181	-4.41
	pa72	-1.457*	-30.38	-0.627	-27.79	-0.112	-20.56	0.491	11.39	-0.017	-0.27
	vt01	-0.779	-14.44	-1.199*	-44.44	-0.155	-27.84	0.191	6.09	-0.180	-4.48
	vt99	-1.251	-28.41	-0.847*	-50.43	0.079	24.13	0.357	22.32	0.239	11.55
	wi25	-4.156*	-34.63	-1.790*	-45.23	-0.175	-25.87	-0.399	-16.40	-0.020	-0.73
	wi28	-6.445*	-45.14	-2.007*	-49.55	-0.441*	-49.72	-0.680	-22.63	-1.281*	-33.44
	wi36	-3.869	-38.85	-1.623*	-52.76	-0.268*	-51.38	-1.046	-40.55	-0.464	-20.16
	Hi37	-6.059*	-45.19	-2.039*	-54.00	-0.473*	-57.03	-1.358*	-42.53	-0.751*	-28.00

* $p<0.05$

Table 7 (continued).

Region	Site	Calcium		Magnesium		Potassium		Sodium		Chloride	
		Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change	Change (µeq/L)	Percent Change
10	ar16	-0.450	-7.35	-0.641	-31.63	-0.074	-9.17	-0.214	-5.16	-0.887	-18.59
	ar27	-0.047	-0.60	0.047	2.70	0.311	57.95	0.812	20.89	0.584	14.34
	ia08	-2.914	-16.11	-0.403	-8.14	0.125	14.44	0.240	11.70	0.032	1.16
	il35	-0.592	-7.78	-0.403	-20.05	-0.045	-8.72	0.190	5.68	0.158	3.64
	il63	-2.681*	-30.39	-0.963*	-41.24	-0.259	-34.76	-0.619	-15.43	-0.745	-13.27
	in20	-4.534*	-39.43	-1.776*	-45.15	-0.257*	-42.34	-1.188*	-34.91	-1.438*	-32.29
	ky03	-1.241	-20.01	-0.717*	-36.83	0.043	9.39	-0.275	-8.34	-0.903	-19.95
	ky22	-6.438*	-55.82	-1.334*	-55.53	-0.199*	-36.49	-0.895*	-31.07	-1.548*	-38.13
	ky35	-1.519	-17.76	-0.920*	-39.03	0.030	4.22	-0.307	-11.38	-0.747	-18.68
	ky38	-2.139	-32.41	-0.730*	-36.42	-0.047	-7.89	-0.527	-13.04	-0.691	-14.45
	ma01	-0.040	-0.76	1.675	11.97	0.049	3.19	11.731	20.66	5.892	8.27
	ma13	1.125	34.21	-0.702	-18.05	0.139	28.37	0.317	2.50	-2.560	-14.71
	md03	-2.194*	-31.50	-1.556*	-49.06	-0.058	-9.55	-2.233	-33.21	-2.617	-27.91
	mi26	-2.271	-22.40	-0.946	-28.13	0.018	3.63	-0.509	-15.79	-1.125*	-24.51
	mn23	-0.473	-5.48	-0.405	-16.07	0.001	0.15	0.106	6.02	0.135	7.38
	mo03	-2.595	-23.00	-0.575	-23.33	-0.464*	-45.64	0.021	0.61	-0.291	-7.75
	mo05	-0.691	-11.92	-0.491	-23.92	0.055	7.88	-1.032	-23.82	-1.221	-24.63
	ms30	-0.703	-17.38	-0.736*	-34.32	-0.368*	-38.82	-0.554	-9.41	-0.809	-12.53
	nc25	-1.787*	-48.11	-0.623	-39.00	-0.087	-16.87	-0.238	-6.08	-0.385	-8.27
	nj99	-1.425	-28.74	-1.553*	-41.87	-0.276	-42.84	-0.649	-7.87	-1.684	-15.23
	ny99	-1.865*	-36.30	-0.434	-15.06	0.150	37.46	2.113	35.67	4.149	46.53
	oh09	0.209	3.13	-0.422	-18.87	0.249*	63.73	0.200	7.39	-0.102	-2.45
	oh17	-3.143	-30.72	-1.263*	-35.87	-0.033	-5.91	0.279	9.74	-0.106	-2.42
	oh49	-1.465	-17.18	-0.922*	-31.45	0.224	36.86	-0.304	-10.62	-0.457	-8.69
	oh71	-1.828	-19.94	-0.785	-26.80	-0.099	-19.98	0.096	3.84	-0.329	-7.77
	pa15	-2.106*	-32.50	-1.055*	-47.42	0.069	15.60	-0.851*	-27.72	-1.488*	-26.90
	pa42	-0.851	-15.36	-0.699*	-33.67	-0.016	-2.66	0.089	3.15	-0.420	-8.18
	tn00	-3.359*	-47.16	-1.603*	-61.57	-0.282*	-41.48	-1.657*	-36.12	-2.792*	-39.99
	tn11	-1.486	-31.69	-1.202*	-60.23	-0.931*	-68.16	-0.403	-14.29	-0.611	-18.23
	tn14	-0.553	-13.10	-0.315	-17.91	-0.094	-16.84	0.103	2.27	-0.526	-9.87
	va13	-1.539	-23.53	-1.020*	-40.59	-0.252	-17.89	-0.058	-1.92	-0.691	-17.62
	va28	-1.137*	-36.44	-0.923*	-55.89	-0.044	-12.75	-0.927	-28.80	-1.401	-32.45
	wi99	-5.524*	-38.53	-1.436*	-32.90	-0.187	-25.70	-0.278	-10.07	-0.561	-14.41
	wv04	-2.919*	-47.64	-1.110*	-58.33	-0.425*	-52.86	-0.757*	-30.05	-1.564*	-37.67
	wv18	-0.653	-8.36	-0.667*	-33.66	-0.136	-21.08	-0.853*	-32.02	-0.970*	-23.21
11	al10	-2.516*	-41.28	-1.069*	-39.41	-0.114	-15.06	-0.543	-7.45	-1.103	-13.28
	ar02	-1.755	-30.65	-0.202	-9.79	-0.307	-26.48	2.086*	42.59	1.508	26.43
	ar03	0.040	0.72	0.006	0.31	0.327*	56.94	0.999	19.38	0.552	9.68
	fl03	-1.710	-29.99	-0.917	-23.84	-0.204	-28.25	-0.771	-5.75	-2.176	-13.63
	fl11	-0.391	-5.89	-1.406	-17.04	0.514	38.22	-0.826	-2.59	-4.118	-10.65
	fl14	-0.258	-7.81	0.010	0.34	-0.036	-6.09	2.000	20.27	1.234	10.78
	fl41	-1.204	-18.19	-0.797	-16.56	-0.246	-24.15	0.597	3.50	-0.779	-3.81
	fl99	-1.226	-18.07	-0.075	-0.82	0.194	17.43	4.217	11.85	2.143	4.99
	ga20	-1.449*	-31.69	-0.371	-12.67	0.515	56.96	0.401	4.60	-0.246	-2.37
	ga41	-2.002*	-46.44	-1.078*	-44.54	-0.298	-32.72	-2.324*	-33.56	-3.161*	-37.93
	ga50	-1.601*	-34.78	-0.617	-20.76	0.319	37.47	-1.426	-15.78	-1.864	-18.23
	la12	-1.519	-27.63	-1.070	-26.46	-0.422*	-44.32	-3.550	-22.79	-5.114	-26.62
	la30	-1.878*	-38.82	-0.938*	-28.53	-0.206	-28.10	-0.979	-8.99	-2.522	-19.22
	md13	-2.133*	-39.30	-1.288*	-34.05	-0.178	-27.52	-2.161	-20.20	-2.631	-19.82
	ms10	-1.186	-25.26	-0.823*	-31.93	-0.225	-24.41	-1.535	-20.06	-2.210*	-25.55
	nc03	-1.438*	-34.98	-1.530*	-39.25	-0.078	-10.40	-3.077	-25.82	-3.982	-28.04
	nc34	-1.111	-27.15	-0.724*	-31.54	-0.181	-16.93	1.079	25.76	0.610	11.01
	nc35	-1.116*	-29.43	-0.230	-7.57	0.006	1.01	2.957	32.20	2.674	24.29
	nc36	-0.748	-20.82	-0.513	-19.40	-0.103	-17.54	0.670	8.29	0.430	4.52
	ne41	-1.338*	-36.38	-1.413*	-44.42	-0.175	-18.80	-3.048	-31.96	-5.139*	-41.97
	sc06	-2.014	-33.91	-0.315	-9.03	1.353	153.48	0.281	2.46	-0.109	-0.81
	tx21	-2.061	-26.47	-0.880	-28.50	-0.130	-13.93	-0.232	-2.81	-1.503	-16.18
	tx38	-0.796	-11.93	-0.544	-17.01	-0.511	-26.20	-0.385	-4.41	-1.051	-10.85
	va00	-1.113	-26.85	-0.892*	-38.91	-0.321*	-40.53	-0.321	-6.85	-0.780	-12.67
12	ak03	1.179	95.80	-0.027	-4.33	0.074	38.15	-0.233	-11.63	0.705	44.27

* $p<0.05$

PRECIPITATION CHEMISTRY TRENDS AT ALL NADP/NTN SITES WITH FIVE YEARS OF CONTINUOUS OPERATION

Table 8. Direction and statistical significance of "deseasonalized" trends in ionic concentrations (μeq/L) in precipitation during the period of activity of each NAOP/NTN montoring site. Sites that were active for less than 5 years were excluded.

		Site Activity		log(H)			log(SO4)			log(NO3)			log(NH4)		
Region	Site	Began	Ended	Year	Month	r2	Year	Month	r2	Year	Month	r2	Year	Month	r2
1	ca45	79/10/09	94/01/04	-0.0236	****	0.339	-0.0001	***	0.336	-0.1087	***	0.269	+0.1858	***	0.244
	or02	80/01/03	94/01/04	-0.7392	***	0.248	-0.0001		0.344	+0.0048		0.215	+0.0020	***	0.316
	or10	80/05/20	94/01/04	+0.1722		0.080	-0.0001	****	0.702	+0.1838	****	0.552	+0.1651	***	0.278
	or97	83/05/03	94/01/04	-0.0404		0.222	-0.0911	**	0.315	+0.0013	****	0.622	+0.0005	****	0.510
	or98	82/07/20	94/01/04	-0.1091	***	0.385	-0.0325	****	0.601	+0.1690	****	0.588	+0.0043	****	0.557
	wa14	80/05/27	94/01/04	-0.4999	**	0.214	-0.0001	**	0.496	+0.0088	***	0.332	+0.7808		0.064
	wa19	84/02/14	94/01/04	-0.0008	****	0.666	-0.0106	****	0.626	+0.2082	****	0.639	+0.0093	****	0.546
	wa21	84/05/01	94/01/04	+0.2398	****	0.617	-0.9890	****	0.691	+0.0429	**	0.433	+0.0509	*	0.351
2	ca42	82/01/19	94/01/04	-0.3491		0.158	-0.2038	***	0.371	-0.8902	****	0.438	-0.8855	****	0.379
	ca68	83/03/22	88/01/12	+0.9221	**	0.620	-0.1102	***	0.719	-0.6164	***	0.702	-0.1441	**	0.616
	ca75	80/07/15	94/01/04	-0.0011		0.302	-0.0241	****	0.605	+0.3583	****	0.523	+0.0188	****	0.483
	ca76	85/07/02	94/01/04	-0.1362	****	0.479	+0.5129	****	0.761	+0.0168	****	0.660	+0.0061	**	0.383
	ca88	78/10/17	94/01/04	-0.0241		0.153	-0.0001	****	0.458	-0.7324	****	0.422	+0.3064	****	0.429
	ca98	83/08/09	94/01/04	-0.2510	**	0.344	-0.2499	****	0.760	-0.0707	****	0.713	+0.6754	****	0.468
	ca99	81/12/15	94/01/04	-0.5497		0.155	-0.7550	****	0.580	+0.1751	****	0.560	+0.1828	***	0.459
3	co00	80/04/29	94/01/04	-0.1968	****	0.401	-0.0001	***	0.508	-0.0054	****	0.467	-0.0631	***	0.377
	co02	84/06/12	94/01/04	+0.9473	*	0.458	-0.9276		0.391	+0.3227		0.473	+0.2521		0.471
	co08	88/01/05	94/01/04	-0.4395	**	0.380	-0.0091	****	0.795	-0.9532		0.232	+0.0398	***	0.622
	co19	80/06/03	94/01/04	-0.0004	****	0.515	-0.0001	****	0.778	+0.8605	****	0.552	+0.2172	****	0.627
	co21	78/10/24	94/01/04	+0.6434	****	0.362	-0.0001	****	0.622	+0.7992	****	0.377	+0.4201	****	0.418
	co92	88/01/19	94/01/04	-0.0476	***	0.680	-0.0579	***	0.736	-0.2447	**	0.654	+0.0643		0.483
	co93	86/10/21	94/01/04	-0.2977		0.115	-0.5923	***	0.638	+0.2788		0.383	+0.0367	**	0.535
	co94	86/11/11	94/01/04	+0.4615	****	0.762	+0.3386	****	0.813	+0.1091	****	0.677	+0.3994	***	0.418
	co96	86/08/05	94/01/04	-0.4168	****	0.787	-0.2778	****	0.768	+0.3794	***	0.686	+0.2807	**	0.551
	co97	84/02/14	94/01/04	+0.6922		0.291	+0.0658	***	0.460	+0.0068	***	0.534	+0.0002	***	0.625
	co98	83/08/23	94/01/04	-0.0617	****	0.614	-0.0001	****	0.732	-0.1505	****	0.580	-0.1559	****	0.601
	id04	82/07/27	91/09/25	-0.2142	***	0.652	-0.0001	****	0.917	-0.0851		0.316	-0.0111		0.429
	id15	84/10/16	94/01/09	+0.6396		0.143	-0.0436	****	0.588	+0.4498	****	0.690	+0.0579	***	0.467
	mt05	80/06/10	94/01/04	-0.0376	****	0.359	-0.0001	****	0.618	-0.7284	****	0.357	+0.5654	***	0.294
	mt07	84/01/31	94/01/04	+0.8961	**	0.247	-0.4240	****	0.485	+0.1445	***	0.334	+0.8248	****	0.399
	nm07	82/06/29	94/01/04	+0.5625	****	0.385	-0.0086	****	0.474	+0.5374	****	0.469	+0.5258	****	0.445
	or18	84/03/13	94/01/04	-0.0320	****	0.551	+0.8403	****	0.750	+0.0047	****	0.599	+0.0013	***	0.481
	ut01	83/12/13	94/01/04	-0.0007	***	0.526	-0.9737		0.143	+0.9913	***	0.444	+0.0124		0.338
	ut08	86/04/01	94/01/04	-0.5295		0.292	+0.0582	**	0.412	+0.0424	***	0.594	+0.0066		0.495
	ut99	85/02/05	94/01/04	-0.6085		0.144	-0.7456	**	0.409	+0.4640	**	0.452	+0.2808	**	0.421
	wy00	86/04/29	94/01/04	-0.0297	***	0.555	-0.9470	***	0.494	+0.1972	***	0.531	+0.0048	***	0.634
	wy02	84/08/28	94/01/04	-0.0349	**	0.322	-0.0027	****	0.680	-0.8828	****	0.478	-0.8552	****	0.590
	uy08	80/06/10	94/01/04	-0.0001	****	0.624	-0.0213	****	0.681	+0.4084	****	0.562	+0.2914	****	0.438
	wy96	86/11/25	92/09/17	-0.7603	**«	0.561 -	-0.1603	****	0.738	+0.2136	****	0.657	+0.1423	****	0.798
	wy98	85/01/08	94/01/04	-0.0102		0.235	-0.0765	****	0.702	+0.8366	****	0.541	+0.1150	***	0.423
4	id03	80/08/29	94/01/04	-0.4947	**	0.264	-0.0403	*	0.280	+0.1767	****	0.493	+0.1126	****	0.496
	id11	83/11/29	94/01/04	-0.0005		0.333	-0.1728	****	0.456	+0.2236	****	0.704	+0.0096	****	0.721
	nv01	84/07/31	94/01/04	-0.0685	****	0.574	-0.6102	***	0.457	+0.0036	****	0.819	+0.0115	****	0.681
	nv03	85/08/13	94/01/04	-0.0631	****	0.778	+0.3046	****	0.696	+0.2367	****	0.693	+0.0767	****	0.696
	nv05	85/01/22	94/01/04	+0.3392	*	0.340	-0.1818	***	0.520	-0.8018	****	0.645	+0.5634	****	0.792
	or09	83/08/30	94/01/04	-0.1412	****	0.460	-0.9170	****	0.518	+0.0769	****	0.483	+0.1351	**	0.343
	or11	80/07/22	93/03/30	-0.9540	*	0.250	-0.0550	**	0.460	+0.5216	****	0.649	+0.0126	**	0.348
	wa24	85/08/27	94/01/04	+0.4382	***»	0.554	-0.7582	***	0.374	+0.0366	***	0.481	+0.7231	*	0.255
5	az06	80/04/22	94/01/04	-0.9686	**	0.225	-0.0005	****	0.584	-0.2310	****	0.576	-0.0537	****	0.648
	nv00	85/01/29	94/01/04	-0.1329		0.437	-0.4279		0.334	-0.1498		0.275	+0.3360	****	0.738
	tx04	80/04/15	94/01/04	+0.9989		0.137	-0.6287		0.144	+0.4847	***	0.246	+0.5846	**	0.218
	tx22	84/06/12	94/01/04	-0.0195	*	0.331	-0.2169	***	0.382	+0.2884	****	0.440	+0.0578	**	0.309
6	az03	81/08/18	94/01/04	-0.0777		0.149	-0.0019	****	0.557	+0.4141	****	0.518	+0.0248	****	0.425
	az99	81/09/01	94/01/04	-0.0001	**	0.462	-0.0009	****	0.564	+0.8806	****	0.643	+0.1561	****	0.518
	co99	81/05/12	94/01/04	-0.0024	****	0.590	-0.0001	****	0.774	-0.9412	****	0.620	+0.4391	****	0.504
	nm0l	85/08/06	94/01/04	-0.0069	****	0.845	-0.1522	*	0.381	+0.5913	****	0.562	+0.0296	*	0.395
	nm08	84/02/07	94/01/04	-0.0090	****	0.506	-0.4922	***	0.433	+0.1041	****	0.502	+0.1065	**	0.375
	nm09	82/02/09	94/01/04	-0.0216	****	0.513	-0.0001	****	0.699	-0.0099	****	0.682	-0.4066	****	0.586
	ut98	85/04/30	94/01/04	+0.2080	***	0.628	+0.2433		0.266	+0.0932	**	0.508	+0.0167	*	0.557

Table 8 (continued).

Region	Site	Site Activity Began	Site Activity Ended	log(H) Year	log(H) Month	log(H) r2	log(SO4) Year	log(SO4) Month	log(SO4) r2	log(NO3) Year	log(NO3) Month	log(NO3) r2	log(NH4) Year	log(NH4) Month	log(NH4) r2
7	co01	83/10/11	94/01/04	-0.4296		0.152	-0.9013	***	0.385	+0.1520		0.123	+0.0163	**	0.353
	co15	79/03/27	94/01/04	-0.1425	****	0.499	-0.0001	****	0.698	+0.7202	****	0.455	+0.2748	****	0.616
	co22	79/05/29	94/01/04	-0.0828	****	0.528	-0.0001	****	0.541	-0.2192		0.109	-0.1341	****	0.439
	mt00	84/07/17	94/01/04	-0.7187		0.080	-0.6820	**	0.285	+0.2903		0.194	+0.0191	****	0.488
	mt13	82/09/21	94/01/18	+0.6034	**	0.332	+0.5591		0.158	+0.6909		0.032	+0.1283		0.293
	mt98	85/08/06	94/01/04	+0.8034		0.247	+0.6399	****	0.686	+0.3227		0.264	+0.0446	****	0.658
	mt99	83/02/01	89/11/28	-0.3667	**	0.747	-0.0590		0.685	-0.1168		0.543	-0.4388	*	0.715
	nd07	81/05/12	94/01/04	-0.7243	***	0.398	-0.0194		0.268	-0.5662		0.100	+0.8574		0.169
	nd11	83/12/06	94/01/04	+0.5658	**	0.410	-0.0231	***	0.510	-0.1246	**	0.477	+0.2474	**	0.401
	nm12	84/11/20	94/01/04	-0.9362	***	0.501	+0.0388	**	0.502	+0.0065	**	0.556	+0.0045	**	0.580
	ok29	85/01/15	94/01/04	-0.4287		0.243	-0.2616		0.188	-0.3664	****	0.744	+0.9422	**	0.373
	sd08	83/10/18	94/01/04	+0.8174		0.241	-0.0593	***	0.483	-0.2095		0.216	-0.4374	**	0.343
	tx02	85/06/25	94/01/04	-0.3776	**	0.431	-0.3244	**	0.328	+0.0064	***	0.572	+0.1712		0.256
	wy06	82/02/02	94/01/04	+0.9425	*	0.248	-0.0243	****	0.532	+0.3980	****	0.498	+0.3412	**	0.348
	wy97	85/05/07	94/01/04	-0.0331		0.411	-0.0210	*	0.485	-0.7914	**	0.459	+0.4590		0.288
	wy99	81/08/18	94/01/04	-0.0938	***	0.273	-0.0451	****	0.400	+0.7391	***	0.296	-0.9477	****	0.363
8	ia23	84/09/18	94/01/04	-0.7132	**	0.257	-0.2868	**	0.309	+0.5057	***	0.356	+0.0034	****	0.550
	il11	79/03/06	94/01/04	-0.1450	****	0.514	-0.0001	****	0.636	-0.0081	****	0.446	-0.6633	****	0.448
	il18	81/06/02	94/01/04	-0.8711		0.045	-0.1053	****	0.344	+0.1131	****	0.322	+0.3158	****	0.326
	il19	80/03/18	94/01/04	-0.0025	***	0.353	-0.0013	****	0.585	-0.1681	****	0.365	+0.3386	****	0.385
	il47	80/04/22	88/11/22	-0.0952	****	0.547	-0.2776	****	0.556	-0.2816	****	0.509	-0.5076	****	0.486
	il78	85/01/15	94/01/04	-0.6380		0.171	-0.0072	***	0.449	-0.5541	****	0.444	+0.3793	***	0.372
	in22	84/10/02	94/01/04	+0.6718		0.112	+0.6073	**	0.326	+0.0210		0.356	+0.0104	***	0.499
	in34	80/07/22	94/01/04	-0.0014	****	0.471	-0.0027	****	0.653	-0.5877	****	0.288	-0.3929	****	0.461
	in41	82/07/20	94/01/04	-0.0440	***	0.366	-0.0323	****	0.604	-0.1950	****	0.397	-0.1161	****	0.542
	ks07	84/04/03	94/01/04	-0.9046		0.167	-0.0776	**	0.314	+0.9034	****	0.389	+0.1227	****	0.470
	ks31	82/08/24	94/01/04	-0.5419		0.109	-0.0959	*	0.197	-0.7892	**	0.190	+0.5060	***	0.282
	ks32	84/04/03	94/01/04	+0.8007	*	0.223	+0.7916		0.187	+0.0565		0.250	+0.0101		0.296
	mn27	79/01/09	94/01/04	-0.4903	****	0.333	-0.0003	****	0.437	-0.0968	****	0.355	-0.2863	****	0.347
	nd08	83/11/01	94/01/04	+0.7409	*	0.250	-0.1658	***	0.411	-0.9884	**	0.283	+0.9746	*	0.306
	ne15	78/08/01	94/01/04	-0.1058		0:059	-0.0006	***	0.334	-0.6529		0.104	-0.1010	****	0.288
	ne99	85/10/01	94/01/04	-0.4644	**	0.325	+0.6768	*	0.276	+0.4974		0.135	+0.0007		0.432
	okOO	83/12/20	94/01/04	-0.6585	***	0.348	-0.0351		0.265	+0.7868	**	0.239	+0.8417	**	0.252
	ok17	83/04/05	94/01/04	+0.7190	**	0.262	-0.0524		0.179	-0.6444	***	0.326	-0.8333	**	0.252
	sd99	83/12/06	94/01/04	-0.1397		0.198	-0.4332	***	0.493	+0.9176	****	0.497	+0.0083	****	0.615
	tx03	84/02/14	94/01/04	+0.3973	***	0.356	-0.4431	**	0.272	-0.9691		0.117	+0.4506	**	0.275
	tx10	84/07/10	94/01/04	+0.3180		0.216	+0.6652		0.144	+0.4928		0.174	+0.7343	**	0.336
	tx16	84/07/03	94/01/04	-0.0275	***	0.406	+0.4206	**	0.338	+0.4985	*	0.281	+0.2477	***	0.399
	tx51	84/06/05	92/05/19	+0.9527		0.258	-0.8673	*	0.330	+0.4389	****	0.582	+0.7333	***	0.457
	tx53	80/04/22	88/09/27	+0.8080	**	0.291	+0.5757	****	0.513	+0.9745		0.167	-0.4188	****	0.507
	tx56	83/09/27	94/01/04	-0.6680		0.110	-0.0432	****	0.420	+0.8870	***	0.334	+0.1090	***	0.385
9	ma08	82/03/16	94/01/03	-0.5713	*	0.210	-0.4923	****	0.396	+0.9788		0.112	+0.2286	****	0.472
	meOO	80/04/22	94/01/04	-0.2532		0.097	-0.0623	****	0.481	+0.2883	**	0.204	+0.8168	****	0.371
	me02	80/10/07	94/01/04	-0.1893	****	0.454	-0.0389	****	0.560	+0.9225	**	0.182	+0.8870	****	0.438
	me09	79/11/27	94/01/04	-0.0947	***	0.254	-0.0012	****	0.577	-0.6962		0.048	-0.4635	****	0.449
	me98	81/11/10	94/01/05	+0.4247	****	0.525	-0.7767	****	0.515	+0.0713	***	0.372	+0.9026	****	0.492
	mi09	79/07/10	94/01/04	-0.0286		0.149	-0.0001	****	0.642	-0.5187	****	0.304	+0.3068	****	0.332
	mi53	78/10/17	94/01/04	-0.0262		0.157	-0.0005	****	0.633	-0.0443	****	0.446	-0.6968	***	0.245
	mi97	85/05/28	94/01/04	-0.5816		0.096	-0.4080		0.115	-0.5250		0.137	+0.4854		0.109
	mi98	84/05/08	94/01/04	-0.0434		0.173	-0.0679	***	0.454	-0.4152	***	0.440	*0.3953	**	0.334
	mi99	83/02/22	94/01/04	-0.6041	*	0.202	-0.0723	****	0.574	+0.9672	****	0.387	+0.3712	***	0.335
	mn16	78/07/11	94/01/04	-0.6396	****	0.410	-0.0001	****	0.467	-0.1591	****	0.517	+0.9601	****	0.279
	mn18	80/11/25	94/01/04	+0.3177		0.081	-0.0001	****	0.630	+0.3728	***	0.303	-0.2403	****	0.473
	nh02	78/08/01	94/01/04	-0.2165	****	0.403	-0.0168	****	0.653	-0.6391		0.025	+0.5718	****	0.471
	ny08	79/04/24	94/01/04	-0.1536	****	0.590	-0.0083	****	0.750	-0.2317	***	0.231	+0.7626	****	0.509
	ny10	80/06/17	94/01/04	-0.0017	****	0.702	-0.0001	****	0.708	-0.1766	***	0.290	-0.2587	***	0.287
	ny12	80/01/08	85/08/06	-0.0166	****	0.819	-0.0285	***	0.752	-0.0640		0.368	-0.1385	**	0.602
	ny20	78/11/07	94/01/04	-0.0909	****	0.351	-0.0005	****	0.741	-0.0915	**	0.211	-0.3890	****	0.546
	ny52	80/06/17	94/01/03	-0.0206	****	0.576	-0.0073	****	0.786	-0.4440	****	0.356	-0.3666	****	0.339
	ny65	80/02/26	94/01/04	+0.5340	****	0.689	-0.4431	****	0.778	-0.8075	****	0.369	+0.7525	****	0.605
	ny68	83/10/17	94/01/04	+0.8618	****	0.425	-0.6232	****	0.544	+0.3021	**	0.305	+0.8418	****	0.497
	ny98	84/07/10	94/01/04	-0.1779	***	0.386	-0.0800	****	0.689	-0.2979	*	0.288	-0.3551	**	0.344
	pa29	78/07/25	94/01/04	-0.0238	****	0.695	-0.0726	****	0.822	-0.1737	****	0.319	+0.4920	****	0.532
	pa72	84/01/03	94/01/05	-0.1778	****	0.446	-0.1366	****	0.563	-0.2627	***	0.341	+0.7055	****	0.510
	vt01	81/05/05	94/01/04	+0.5904	****	0.430	-0.7903	****	0.604	+0.2137		0.150	+0.8882	****	0.498
	vt99	84/06/19	94/01/04	-0.7349		0.180	-0.1518	****	0.639	+0.5170	***	0.411	-0.8372	****	0.509
	wi09	87/01/06	94/01/04	-0.8874	**	0.429	-0.0175	****	0.704	-0.0448	***	0.610	-0.0325	****	0.631
	wi25	85/01/29	94/01/04	-0.7928	**	0.269	-0.1040	****	0.489	+0.8755	****	0.366	+0.6008	**	0.259
	wi28	82/07/06	94/01/04	-0.0012	****	0.427	-0.0001	***	0.478	-0.1037	****	0.440	-0.4351	***	0.328
	wi36	80/01/29	94/01/04	-0.0010		0.263	-0.0001	****	0.630	-0.0202	**	0.279	-0.1881	****	0.318
	wi37	80/06/10	94/01/07	-0.2776	***	0.236	-0.0034	****	0.419	-0.5891	*	0.163	+0.3585	****	0.323

Table 8 (continued).

Region	Site	Site Activity Began	Ended	log(H) Year	Month	r2	log(S04) Year	Month	r2	log(N03) Year	Month	r2	log(NH4) Year	Month	r2
10	al99	84/10/09	94/01/04	-0.7566	**	0.415	-0.2684	*	0.354	+0.9477	****	0.717	+0.2326	***	0.511
	ar16	82/07/20	94/01/04	+0.5061		0.216	-0.3342	**	0.337	+0.5584	****	0.457	-0.9128	****	0.543
	ar27	80/05/20	94/01/04	-0.2775	***	0.248	-0.0002	****	0.420	-0.4964	****	0.569	-0.0391	***	0.277
	ia08	84/08/21	94/01/04	+0.2070	*	0.284	+0.8934	***	0.354	+0.0961	***	0.429	+0.0043	****	0.564
	il35	79/08/07	94/01/04	-0.0653	*	0.167	-0.0001	***	0.367	-0.0088	****	0.440	-0.4465	****	0.433
	il63	79/02/06	94/01/04	-0.1559	***	0.255	-0.0001	****	0.492	-0.0086	****	0.455	-0.0011	****	0.560
	in20	83/09/06	94/01/04	-0.5100	****	0.411	-0.0008	****	0.675	-0.1988	***	0.321	-0.0326	**•*	0.529
	ky03	83/12/06	94/01/04	-0.7310	****	0.716	-0.5029	****	0.714	+0.7058	****	0.569	+0.5873	****	0.617
	ky22	83/09/13	94/01/04	-0.0661	****	0.697	-0.0247	****	0.712	-0.1556	****	0.531	-0.8621	****	0.486
	ky35	83/09/06	94/01/05	-0.2023	****	0.672	-0.0963	****	0.902	-0.2316	***	0.419	+0.7203	****	0.718
	ky38	84/10/09	94/01/04	-0.1537		0.219	-0.1366	***	0.382	+0.7563	****	0.532	+0.2060	****	0.458
	ma0l	81/12/23	94/01/04	+0.7085		0.167	+0.9102		0.074	+0.0635		0.200	+0.1969	*	0.293
	ma13	82/02/09	94/01/05	-0.0305	****	0.459	-0.6152	****	0.468	+0.8710	***	0.296	+0.2107	****	0.490
	md03	84/10/09	94/01/04	+0.8640	****	0.831	-0.8652	****	0.828	-0.6271	****	0.796	+0.0739	****	0.799
	mi26	79/07/03	94/01/04	-0.0149	**	0.303	-0.0001	****	0.600	-0.0043	**	0.313	-0.4609	****	0.446
	mn23	83/10/25	94/01/04	-0.8872	**	0.338	+0.8434	***	0.419	+0.7597	****	0.535	+0.0680		0.267
	mo03	81/10/27	94/01/04	-0.0279	**	0.286	-0.0001		0.336	-0.1244	***	0.326	-0.6772	***	0.335
	no05	81/11/03	94/01/04	+0.7962		0.081	-0.1219		0.162	-0.1781	****	0.400	-0.1042	****	0.532
	ms30	84/07/24	94/01/04	-0.2167	**	0.307	-0.0525	*	0.294	-0.4759	***	0.362	-0.7945	***	0.349
	nc25	78/07/11	94/01/04	-0.1040	****	0.537	-0.0004	****	0.628	-0.4876	****	0.509	+0.8694	****	0.510
	nc45	85/12/03	94/01/05	-0.7096	***	0.820	-0.5643	***	0.799	+0.0949	**	0.727	+0.1606		0.453
	nj99	81/08/11	94/01/04	-0.4017	****	0.504	-0.1305	****	0.569	-0.4688	****	0.422	+0.9237	****	0.495
	ny51	79/07/03	84/10/02	-0.1138	****	0.620	-0.0098	***	0.635	-0.3180	***	0.500	-0.4864	***	0.555
	ny99	83/09/20	94/01/04	-0.8434	****	0.408	-0.7603	****	0.491	-0.5630	***	0.286	+0.5690	****	0.360
	oh09	84/08/21	94/01/04	+0.7648	****	0.519	-0.8308	****	0.630	+0.8521	***	0.393	+0.0682	****	0.499
	oh17	78/10/10	94/01/04	-0.1324	****	0.496	-0.0133	****	0.685	-0.6870	****	0.418	+0.1259	****	0.542
	oh49	78/10/03	94/01/05	-0.1665	****	0.601	-0.0038	****	0.713	-0.1354	****	0.373	+0.5823	****	0.511
	oh71	78/10/03	94/01/04	-0.0613	*••*	0.523	-0.0003	****	0.612	-0.2987	****	0.497	+0.5570	****	0.536
	pa15	83/06/14	94/01/04	-0.0247	****	0.710	-0.1971	****	0.770	-0.1182	****	0.488	+0.8811	****	0.669
	pa42	79/05/01	94/01/04	+0.6482	****	0.734	-0.0886	****	0.802	+0.7775	****	0.417	+0.9290	****	0.605
	tn0O	80/03/18	94/01/04	-0.0739	****	0.401	-0.0001	****	0.544	-0.6165	****	0.410	+0.4826	****	0.384
	tnll	80/08/19	94/01/04	-0.9802	****	0.774	-0.0391	****	0.774	-0.7648	****	0.686	-0.4240	****	0.612
	tn14	84/10/09	94/01/04	+0.3984	**	0.326	-0.9643		0.174	+0.0389	***	0.450	+0.1492	***	0.458
	tn99	84/10/09	90/01/02	-0.5898	**	0.568	-0.3555	**	0.550	-0.8962	***	0.599	-0.3876	*	0.503
	va13	78/08/01	94/01/04	-0.9906	****	0.651	-0.1174	****	0.675	+0.2241	****	0.582	+0.0150	****	0.581
	va28	81/05/19	94/01/03	-0.2073	****	0.729	-0.0096	****	0.826	-0.6536	****	0.519	+0.2127	****	0.649
	wi98	89/08/08	94/01/04	+0.0137	***	0.704	+0.8581		0.194	+0.0112	***	0.747	-0.2587		0.189
	wi99	84/06/12	94/01/04	-0.8619		0.119	-0.0384	***	0.394	-0.8521	**	0.288	-0.6039	*	0.254
	wv04	83/09/13	94/01/06	-0.0073	****	0.679	-0.0001	****	0.787	-0.0741	****	0.450	-0.2258	****	0.395
	wv18	78/07/11	94/01/04	+0.7080	****	0.711	-0.0225	****	0.691	-0.6708	****	0.328	+0.8687	****	0.451
11	al10	83/09/06	94/01/04	+0.1240	***	0.362	-0.2318	****	0.372	+0.9922	****	0.622	-0.1392	***	0.328
	ar02	82/06/01	94/01/04	+0.7074	**	0.266	-0.3578	***	0.330	-0.4242	****	0.572	+0.6215	****	0.399
	ar03	84/01/03	94/01/04	-0.1137	****	0.447	-0.0724	****	0.409	-0.1962	****	0.608	+0.9397	****	0.538
	fl03	78/10/17	94/01/04	+0.0057	****	0.539	-0.1024	**	0.187	+0.0742	****	0.567	-0.5428	****	0.360
	fl11	80/06/24	94/01/04	-0.0222	***	0.332	-0.3188		0.138	+0.3248	*	0.206	+0.2316	**	0.265
	f114	84/03/20	94/01/04	-0.8963	****	0.543	-0.6188	***	0.372	+0.8561	****	0.688	+0.4577		0.224
	f141	83/08/30	94/01/04	+0.2821	****	0.510	-0.9718		0.223	+0.0946	****	0.552	+0.0820	****	0.522
	fl99	83/08/09	94/01/04	+0.0093	****	0.553	+0.0510	*	0.246	+0.0184	****	0.425	+0.0921	****	0.377
	ga20	83/05/03	94/01/04	-0.7244	***	0.331	-0.1485	****	0.397	+0.8659	****	0.459	+0.8026	***	0.354
	ga41	78/10/10	94/01/04	-0.4063	****	0.489	-0.0002	****	0.575	-0.4627	****	0.553	-0.4810	****	0.351
	ga50	83/10/11	94/01/04	+0.8520	****	0.585	-0.4879	****	0.490	+0.4833	****	0.573	+0.2778	****	0.481
	la06	82/11/23	88/01/26	+0.6638		0.442	-0.2569		0.446	-0.5665	*	0.582	-0.1357		0.602
	la12	82/11/23	94/01/04	-0.7234	****	0.702	-0.0852	***	0.332	-0.5861	****	0.630	-0.6009	**	0.273
	la30	83/01/25	94/01/04	+0.5944	****	0.539	-0.1653	**	0.277	-0.2816	****	0.634	-0.2452	****	0.360
	md13	83/03/15	94/01/04	-0.4907	****	0.519	-0.7476	****	0.651	-0.9487	****	0.354	+0.6145	****	0.599
	ms10	84/07/17	94/01/04	+0.7721	****	0.534	-0.1570	****	0.538	+0.1682	****	0.740	+0.3563	***	0.365
	ms14	80/04/24	90/01/02	+0.6531	****	0.400	-0.4785	***	0.406	-0.7671	****	0.669	-0.4527	****	0.624
	ms19	86/11/18	94/01/04	-0.0115	*	0.496	-0.0364		0.325	-0.1949	***	0.608	-0.4361	*	0.406
	nc03	78/11/07	94/01/04	-0.4757	****	0.242	-0.0222	****	0.283	-0.3164	****	0.287	+0.5556	****	0.329
	nc34	78/10/24	94/01/04	-0.0195	****	0.515	-0.0001	****	0.650	-0.0299	****	0.602	-0.7212	****	0.346
	nc35	78/10/31	94/01/04	-0.0258	****	0.385	-0.0014	****	0.395	-0.5381	****	0.383	+0.0022	****	0.440
	nc36	83/10/25	94/01/04	+0.1239	***	0.344	+0.1286	***	0.371	+0.0219	****	0.500	+0.0611	****	0.543
	nc41	78/10/10	94/01/04	-0.3117	****	0.322	-0.0084	****	0.402	-0.2931	****	0.388	+0.1680	****	0.297
	sc06	84/07/24	94/01/04	-0.4975	****	0.545	-0.4971	****	0.623	+0.6528	**	0.398	+0.1059	**	0.452
	sc18	79/04/03	86/06/17	-0.9625	****	0.493	-0.4479	***	0.393	+0.7004	**	0.373	-0.8357	****	0.498
	tx21	82/07/06	94/01/04	-0.5124	****	0.472	-0.0596	****	0.347	-0.0482	****	0.558	-0.4794	****	0.433
	tx38	81/08/25	94/01/04	+0.6969	***	0.328	-0.1659	*	0.261	+0.8996	***	0.293	+0.8819	***	0.312
	va0O	84/10/09	93/12/31	-0.6377	****	0.550	-0.6887	****	0.576	-0.5111	**	0.366	+0.6690	****	0.534
12	ak03	80/06/24	94/01/04	-0.0025	**	0.412	-0.0035	*	0.380	+0.9748		0.190	+0.3536	*	0.204
14	as0l	80/05/27	92/10/13	-0.0595		0.148	-0.0065		0.250	+0.7813	***	0.335	-0.7364		0.112
15	hi0O	80/06/17	93/09/28	+0.0428	****	0.345	+0.0382	****	0.468	-0.7200	***	0.215	-0.3794		0.101

Table 8 (continued).

Region	Site	Site Activity Began	Ended	log(Ca) Year	Month	r2	log(Mg) Year	Month	r2	log(Na) Year	Month	r2	log(Cl) Year	Month	r2
1	ca45	79/10/09	94/01/04	-0.0001	****	0.524	-0.0002	**	0.334	-0.0228	****	0.354	-0.0325	****	0.412
	or02	80/01/03	94/01/04	-0.0001		0.327	-0.0068	****	0.516	-0.0007	****	0.489	-0.0023	****	0.496
	or10	80/05/20	94/01/04	-0.0001	****	0.509	-0.0004		0.234	-0.0244	***	0.267	-0.0249	****	0.338
	or97	83/05/03	94/01/04	-0.0026	****	0.510	-0.1035	****	0.444	-0.9475	****	0.582	-0.3401	****	0.580
	or98	82/07/20	94/01/04	-0.0358	****	0.431	-0.0027	****	0.448	-0.0846	****	0.434	-0.0685	****	0.467
	wa14	80/05/27	94/01/04	-0.0001		0.414	-0.0008	****	0.416	-0.0019	****	0.383	-0.0002	****	0.563
	ua19	84/02/14	94/01/04	-0.0021	**	0.415	-0.0010		0.278	-0.0705	****	0.416	-0.0614	***	0.399
	wa21	84/05/01	94/01/04	-0.0004		0.373	-0.0001	***	0.613	-0.0010	****	0.596	-0.0005	****	0.627
2	ca42	82/01/19	94/01/04	-0.2943	**	0.233	-0.2051	**	0.249	-0.5878	*	0.187	-0.1750	***	0.323
	ca68	83/03/22	88/01/12	-0.8439		0.269	+0.6030		0.310	-0.9533	**	0.548	+0.7262		0.382
	ca75	80/07/15	94/01/04	-0.5235	****	0.395	-0.0317	***	0.344	-0.8290		0.092	-0.1218		0.180
	ca76	85/07/02	94/01/04	+0.7960	****	0.524	-0.3713	****	0.565	+0.9956	****	0.460	+0.6471	****	0.483
	ca88	78/10/17	94/01/04	-0.0516	****	0.363	-0.1678	**	0.210	-0.0162	**	0.244	-0.0076		0.174
	ca98	83/08/09	94/01/04	-0.0835	****	0.496	-0.0051	***	0.441	-0.1354	*	0.283	-0.0685	**	0.319
	ca99	81/12/15	94/01/04	+0.3363	****	0.867	-0.2365	****	0.903	-0.7631	****	0.492	-0.3653	****	0.510
3	co00	80/04/29	94/01/04	-0.0010		0.343	-0.0001		0.561	-0.0001	****	0.622	-0.0001		0.409
	co02	84/06/12	94/01/04	-0.6544		0.307	-0.1977		0.334	-0.2105		0.280	-0.5617		0.314
	co08	88/01/05	94/01/04	-0.0625	***	0.525	-0.2410	**	0.476	-0.1034		0.289	-0.0984		0.347
	co19	80/06/03	94/01/04	-0.0230	****	0.474	-0.0001	***	0.444	-0.3819		0.146	-0.1153	***	0.279
	co21	78/10/24	94/01/04	-0.0044	***	0.313	-0.0001	****	0.428	-0.0001		0.345	-0.0001		0.273
	co92	88/01/19	94/01/04	-0.9582		0.415	-0.6633		0.373	-0.2485		0.254	-0.1984		0.477
	co93	86/10/21	94/01/04	+0.7628	**	0.502	-0.8569	*	0.411	-0.6374		0.247	+0.4087	**	0.430
	co94	86/11/11	94/01/04	+0.9084	**	0.350	-0.8878	***	0.491	-0.6355		0.110	-0.7438	***	0.616
	co96	86/08/05	94/01/04	-0.4811	****	0.853	-0.7494	****	0.885	-0.6747	***	0.590	-0.4772	***	0.655
	co97	84/02/14	94/01/04	+0.7990		0.250	-0.2134		0.390	+0.1740		0.162	+0.0812	**	0.436
	co98	83/08/23	94/01/04	-0.0107	****	0.614	-0.0001	****	0.687	-0.6440		0.102	-0.0200	****	0.606
	id04	82/07/27	91/09/25	-0.2875	*	0.439	-0.0035	*	0.584	+0.5110		0.060	-0.3866		0.141
	id15	84/10/16	94/01/09	-0.1475	***	0.483	-0.0034	****	0.579	-0.7560		0.067	-0.4093		0.220
	mt05	80/06/10	94/01/04	-0.0011	****	0.485	-0.0004		0.304	-0.0038		0.219	-0.0001		0.394
	mt07	84/01/31	94/01/04	-0.0081	**	0.390	-0.0002		0.368	-0.0120		0.200	-0.0560		0.185
	nm07	82/06/29	94/01/04	-0.0642	****	0.517	-0.0003	****	0.499	-0.0002	***	0.400	-0.0001	**	0.424
	or18	84/03/13	94/01/04	-0.0539	****	0.449	-0.0128	***	0.439	-0.2740		0.128	-0.0496		0.179
	ut01	83/12/13	94/01/04	+0.3925		0.132	-0.3933		0.210	+0.8722		0.105	-0.4519		0.166
	ut08	86/04/01	94/01/04	-0.8690	*	0.345	+0.7728		0.263	+0.6436		0.162	+0.1872		0.238
	ut99	85/02/05	94/01/04	-0.9990	****	0.601	-0.3829	****	0.719	-0.0788	**	0.425	-0.2699	***	0.493
	wy00	86/04/29	94/01/04	+0.5448		0.303	-0.5376		0.288	-0.1198	**	0.475	-0.9639		0.140
	wy02	84/08/28	94/01/04	-0.0369	***	0.452	-0.0005	*	0.423	-0.1262		0.149	-0.0002	****	0.553
	wy08	80/06/10	94/01/04	-0.9081	****	0.504	-0.1083	****	0.585	-0.5629		0.217	-0.0018	***	0.506
	wy96	86/11/25	92/09/17	-0.2709	*	0.451	-0.1839	*	0.451	-0.1160		0.329	-0.7663	*	0.398
	wy98	85/01/08	94/01/04	-0.5757	***	0.406	-0.2418	***	0.440	-0.7324		0.193	-0.3225	*	0.273
4	id03	80/08/29	94/01/04	-0.0235	***	0.385	-0.0028	**	0.387	-0.0857		0.200	-0.0133	**	0.376
	id11	83/11/29	94/01/04	-0.6961	**	0.274	-0.0012	**	0.365	+0.5342	*	0.208	-0.2397		0.127
	nv01	84/07/31	94/01/04	+0.7314	**	0.388	+0.6665	**	0.362	-0.5063		0.207	-0.4610	*	0.271
	nv03	85/08/13	94/01/04	+0.2451	**	0.475	+0.8957	****	0.667	-0.8372		0.159	-0.8964	*	0.346
	nv05	85/01/22	94/01/04	-0.0101	***	0.493	-0.0211	**	0.479	-0.0295		0.254	-0.2817		0.129
	or09	83/08/30	94/01/04	-0.8129	**	0.310	-0.0693		0.215	-0.5453		0.212	-0.0003	***	0.523
	or11	80/07/22	93/03/30	-0.6365	***	0.398	-0.2602		0.268	-0.7386	*	0.281	-0.1514	***	0.424
	wa24	85/08/27	94/01/04	+0.1766	***	0.459	-0.8300	**	0.359	+0.7819		0.074	-0.5597		0.156
5	az06	80/04/22	94/01/04	-0.0306	*	0.268	-0.0351		0.197	-0.3068		0.166	-0.5419	***	0.277
	nv00	85/01/29	94/01/04	+0.9086	**	0.481	-0.5434	**	0.470	+0.3729		0.268	-0.5996		0.343
	tx04	80/04/15	94/01/04	-0.9664	**	0.196	-0.0820		0.185	-0.7171		0.148	-0.3210		0.131
	tx22	84/06/12	94/01/04	-0.7811	***	0.364	-0.7188	****	0.462	-0.3536	***	0.400	-0.7287	***	0.409
6	az03	81/08/18	94/01/04	-0.1915	****	0.420	-0.1387	****	0.362	+0.5633	**	0.261	+0.9000	****	0.422
	az99	81/09/01	94/01/04	-0.2781	**	0.273	-0.2267	**	0.271	+0.7948		0.083	-0.6840		0.135
	co99	81/05/12	94/01/04	-0.0714	****	0.376	-0.0232	***	0.321	-0.3606	***	0.303	-0.0391	****	0.466
	nm01	85/08/06	94/01/04	-0.4708		0.139	-0.0393		0.290	-0.2384	**	0.422	-0.0237		0.314
	nm08	84/02/07	94/01/04	+0.2794	****	0.569	-0.3345	****	0.706	+0.2220	****	0.499	+0.7700	****	0.480
	nm09	82/02/09	94/01/04	-0.0002	****	0.618	-0.0001	****	0.667	-0.0001	*	0.436	-0.0001	****	0.586
	ut98	85/04/30	94/01/04	+0.8997	*	0.442	+0.6013	**	0.509	+0.2345		0.383	+0.6854		0.320

Table 8 (continued).

Region	Site	Site Activity Began	Ended	log(Ca) Year	Month	r2	tog(Mg) Year	Month	r2	log(Na) Year	Month	r2	log(Cl) Year	Month	r2
7	co01	83/10/11	94/01/04	-0.3338	**	0.343	-0.0493	***	0.396	-0.9639		0.139	-0.5314		0.106
	co15	79/03/27	94/01/04	-0.0016	****	0.401	-0.0006	**	0.304	-0.0005		0.252	-0.0022	**	0.294
	co22	79/05/29	94/01/04	-0.0001	****	0.575	-0.0001		0.469	-0.0005		0.243	-0.0003		0.265
	mt00	84/07/17	94/01/04	-0.2195	***	0.336	-0.0168	**	0.292	-0.0921		0.146	-0.1187	*	0.265
	mt13	82/09/21	94/01/18	-0.5904		0.180	-0.0721		0.305	-0.1524	****	0.825	-0.1908	**	0.403
	mt98	85/08/06	94/01/04	+0.5639	*	0.329	+0.4363		0.163	-0.4834		0.230	-0.1741		0.153
	mt99	83/02/01	89/11/28	-0.1135		0.441	-0.0267		0.573	-0.1390		0.406	-0.2146		0.669
	nd07	81/05/12	94/01/04	-0.0540		0.284	-0.0084		0.291	-0.1381		0.258	-0.0319		0.231
	nd11	83/12/06	94/01/04	-0.1418	*	0.376	-0.0003	****	0.984	-0.0403	****	0.750	-0.1212	**	0.396
	nm12	84/11/20	94/01/04	+0.5151	***	0.589	-0.0605	***	0.572	+0.1300	**	0.443	-0.0436		0.417
	ok29	85/01/15	94/01/04	-0.5415	***	0.510	-0.5209	***	0.453	+0.6992	**	0.397	-0.7229	***	0.544
	sd08	83/10/18	94/01/04	-0.0107	**	0.467	-0.0003		0.467	-0.1793		0.225	-0.0274		0.229
	tx02	85/06/25	94/01/04	+0.3277	****	0.817	+0.3764	****	0.784	+0.9443	*	0.319	+0.4501	****	0.578
	wy06	82/02/02	94/01/04	-0.0191	**	0.407	-0.0008		0.460	-0.0515	***	0.476	-0.0591		0.203
	wy97	85/05/07	94/01/04	-0.2334	***	0.563	-0.0141	***	0.607	+0.8006	**	0.417	-0.2106	***	0.539
	wy99	81/08/18	94/01/04	-0.1683	***	0.319	-0.0001	***	0.483	-0.1291		0.157	-0.0732		0.200
8	ia23	84/09/18	94/01/04	-0.1932	***	0.373	-0.1835	****	0.518	-0.1472	***	0.410	-0.2049	***	0.391
	il11	79/03/06	94/01/04	-0.0003	****	0.511	-0.0001	****	0.453	-0.1395	***	0.276	-0.0514	**	0.248
	il18	81/06/02	94/01/04	-0.0221	****	0.423	-0.0023	***	0.410	-0.6398	*	0.156	-0.2597	**	0.207
	il19	80/03/18	94/01/04	-0.1177	****	0.370	-0.1558	***	0.296	-0.2287	****	0.383	-0.0590	****	0.551
	il47	80/04/22	88/11/22	-0.0931	****	0.527	-0.0782	*	0.307	-0.7312		0.062	-0.0278		0.226
	il78	85/01/15	94/01/04	-0.1770	****	0.423	-0.0575	****	0.448	+0.6911	**	0.286	-0.5364	**	0.294
	in22	84/10/02	94/01/04	+0.1265	*	0.345	+0.2350		0.267	+0.9189	*	0.256	+0.5365		0.159
	in34	80/07/22	94/01/04	+0.9489	***	0.230	-0.2139	**	0.206	-0.0099	****	0.375	-0.5988	***	0.265
	in41	82/07/20	94/01/04	-0.1045	****	0.545	-0.0340	****	0.518	-0.1542		0.127	-0.0007		0.344
	ks07	84/04/03	94/01/04	-0.1378	**	0.332	-0.0363	*	0.304	-0.5622		0.092	-0.0779		0.195
	ks31	82/08/24	94/01/04	-0.3662	*	0.200	-0.0066	**	0.343	-0.5733		0.115	-0.5966	**	0.229
	ks32	84/04/03	94/01/04	-0.8034	*	0.245	-0.0627		0.174	-0.2788		0.176	-0.1104		0.218
	mn27	79/01/09	94/01/04	-0.0004	**	0.351	-0.0001	*	0.346	-0.0001		0.353	-0.0001		0.377
	nd08	83/11/01	94/01/04	-0.9117		0.138	+0.4553		0.160	+0.2466	*	0.300	+0.8747	*	0.254
	ne15	78/08/01	94/01/04	-0.0030	***	0.343	-0.0003	**	0.350	-0.0001	**	0.429	-0.0001		0.268
	ne99	85/10/01	94/01/04	-0.8634	***	0.454	-0.0613	***	0.512	+0.7703		0.145	-0.5355		0.130
	ok00	83/12/20	94/01/04	-0.0098	**	0.373	-0.0004	**	0.415	-0.0020	**	0.376	-0.0015	***	0.423
	ok17	83/04/05	94/01/04	-0.1589	****	0.432	-0.0409	**	0.377	-0.0866	*	0.286	-0.0116		0.262
	sd99	83/12/06	94/01/04	-0.7177		0.102	-0.0341		0.240	-0.9930	*	0.278	-0.2174	**	0.406
	tx03	84/02/14	94/01/04	-0.3171		0.156	-0.1144		0.182	-0.4560		0.186	-0.1320		0.208
	tx10	84/07/10	94/01/04	-0.1315		0.210	-0.0633		0.192	-0.2586		0.203	-0.1626		0.206
	tx16	84/07/03	94/01/04	+0.0546		0.271	-0.6035		0.230	+0.6673		0.248	+0.6716		0.162
	tx51	84/06/05	92/05/19	-0.2588	***	0.453	-0.0457	***	0.484	+0.9992	***	0.476	-0.4309	***	0.526
	tx53	80/04/22	88/09/27	+0.4924		0.246	-0.2446		0.185	-0.5547		0.184	-0.3450		0.172
	tx56	83/09/27	94/01/04	-0.1878	***	0.345	-0.0054	**	0.351	-0.0538		0.228	-0.0203		0.238
9	ma08	82/03/16	94/01/03	-0.3736	**	0.249	-0.0070	*	0.291	+0.9768	****	0.378	+0.8960	***	0.345
	me00	80/04/22	94/01/04	-0.0007	***	0.387	-0.0001	****	0.569	-0.6936	****	0.574	-0.1935	****	0.580
	me02	80/10/07	94/01/04	-0.0002	****	0.427	-0.0024		0.264	+0.8785	**	0.203	+0.8381	**	0.212
	me09	79/11/27	94/01/04	-0.0001	****	0.522	-0.0001		0.478	-0.0226		0.162	-0.0688	*	0.173
	me98	81/11/10	94/01/05	-0.0046		0.300	-0.0072	****	0.683	-0.0397	****	0.717	-0.0303	****	0.726
	mi09	79/07/10	94/01/04	-0.0149	**	0.311	-0.0004	***	0.387	-0.0015		0.202	-0.0061		0.200
	mi53	78/10/17	94/01/04	-0.0111	*	0.206	-0.0002		0.293	-0.0063		0.160	-0.0067	****	0.573
	mi97	85/05/28	94/01/04	-0.6241		0.124	-0.2367		0.183	+0.5924		0.086	+0.9638		0.016
	mi98	84/05/08	94/01/04	-0.1542	***	0.385	-0.0004	****	0.600	-0.2705	**	0.359	-0.8698	***	0.445
	mi99	83/02/22	94/01/04	-0.0256	***	0.340	-0.0001	**	0.423	-0.0004	****	0.587	-0.0116	****	0.494
	mn16	78/07/11	94/01/04	-0.0001		0.258	-0.0001		0.291	-0.0001		0.341	-0.0001	**	0.397
	mn18	80/11/25	94/01/04	-0.0007	****	0.424	-0.0001	**	0.514	-0.0001	***	0.406	-0.0001	***	0.479
	nh02	78/08/01	94/01/04	-0.0001	****	0.467	-0.0001		0.416	-0.0045		0.202	-0.4710	*	0.135
	ny08	79/04/24	94/01/04	-0.0058	****	0.392	-0.0001	****	0.456	-0.0001		0.337	-0.0010	**	0.244
	ny10	80/06/17	94/01/04	-0.0025	***	0.348	-0.0001	**	0.407	-0.0051	**	0.287	-0.0001	****	0.496
	ny12	80/01/08	85/08/06	-0.0383		0.410	-0.0396		0.376	-0.0255		0.502	-0.1490	*	0.522
	ny20	78/11/07	94/01/04	-0.0001	****	0.611	-0.0001	****	0.668	-0.0001		0.365	-0.0006	*	0.260
	ny52	80/06/17	94/01/03	-0.0381	**	0.255	-0.0001		0.312	-0.0439	****	0.634	-0.0003	****	0.636
	ny65	80/02/26	94/01/04	-0.0002	****	0.425	-0.0001	***	0.411	-0.0089		0.202	-0.0292		0.136
	ny68	83/10/17	94/01/04	-0.2171	****	0.446	-0.0234		0.287	+0.8911	***	0.380	+0.8147	**	0.310
	ny98	84/07/10	94/01/04	-0.1016	***	0.396	-0.0079	*	0.335	+0.8005	***	0.426	-0.5550		0.219
	pa29	78/07/25	94/01/04	-0.0689	****	0.470	-0.0058	****	0.421	-0.0018		0.212	-0.0178	***	0.283
	pa72	84/01/03	94/01/05	-0.0236	***	0.425	-0.0101		0.224	+0.5326	***	0.341	+0.3034	**	0.295
	vt01	81/05/05	94/01/04	-0.0378	***	0.357	-0.0001	**	0.438	-0.9484	****	0.505	-0.6468	***	0.325
	vt99	84/06/19	94/01/04	-0.0277	****	0.518	-0.0001	**	0.535	+0.3118	****	0.501	+0.3652	***	0.432
	wi09	87/01/06	94/01/04	-0.0092	*	0.458	-0.0083	***	0.552	-0.0126	*	0.520	-0.0057	***	0.622
	wi25	85/01/29	94/01/04	-0.0350	***	0.344	-0.0012	****	0.578	-0.1885		0.185	-0.8458	**	0.275
	wi28	82/07/06	94/01/04	-0.0101	***	0.367	-0.0013	***	0.383	-0.0406	****	0.454	-0.0007	****	0.601
	wi36	80/01/29	94/01/04	-0.0017	**	0.340	-0.0013	***	0.345	-0.0057		0.209	-0.0001		0.295
	wi37	80/06/10	94/01/07	-0.0053	*	0.287	-0.0040	***	0.369	-0.0058	***	0.329	-0.0004	*	0.307

Table 8 (continued).

Region	Site	Site Activity Began	Site Activity Ended	log(Ca) Year	log(Ca) Month	log(Ca) r2	log(Mg) Year	log(Mg) Month	log(Mg) r2	tog(Na) Year	tog(Na) Month	tog(Na) r2	log(Cl) Year	log(Cl) Month	log(Cl) r2
10	al99	84/10/09	94/01/04	-0.0773	**	0.465	-0.0092	*	0.465	-0.1693		0.338	-0.0882		0.376
	ar16	82/07/20	94/01/04	-0.1293	****	0.457	-0.0002	**	0.472	-0.2187		0.215	-0.0307	***	0.463
	ar27	80/05/20	94/01/04	-0.0012	****	0.450	-0.0013	***	0.312	-0.7647		0.061	-0.8242		0.024
	ia08	84/08/21	94/01/04	-0.2541	***	0.384	-0.2247	****	0.473	+0.4778	*	0.238	-0.8844	**	0.338
	il35	79/08/07	94/01/04	-0.0001	****	0.511	-0.0001	****	0.442	-0.0593		0.126	-0.2461	**	0.196
	il63	79/02/06	94/01/04	-0.0001	****	0.624	-0.0001	*	0.395	-0.0003	**	0.265	-0.0014	**	0.246
	in20	83/09/06	94/01/04	-0.0014	****	0.688	-0.0001	****	0.657	-0.0111	*	0.315	-0.0066	*	0.333
	ky03	83/12/06	94/01/04	-0.0208	****	0.538	-0.2893		0.126	-0.6727	*	0.203	-0.1724		0.139
	ky22	83/09/13	94/01/04	-0.0001	****	0.547	-0.0001	***	0.630	-0.0276		0.138	-0.0014		0.327
	ky35	83/09/06	94/01/05	-0.0158	****	0.606	-0.0047	***	0.493	-0.1929		0.223	-0.2730		0.232
	ky38	84/10/09	94/01/04	-0.2757	****	0.421	-0.0575	**	0.299	-0.5018		0.120	-0.5304		0.181
	ma01	81/12/23	94/01/04	-0.1382	****	0.659	+0.8881	****	0.726	-0.9019	****	0.781	-0.8005	****	0.798
	ma13	82/02/09	94/01/05	+0.5074	*	0.158	-0.0138	**	0.304	-0.6287	****	0.456	-0.1137	****	0.401
	md03	84/10/09	94/01/04	-0.0057	****	0.660	-0.0005	*	0.410	-0.0814	****	0.515	-0.0989	****	0.496
	mi26	79/07/03	94/01/04	-0.0001	***	0.423	-0.0021	*	0.299	-0.0007		0.231	-0.0039		0.237
	mn23	83/10/25	94/01/04	-0.9129	**	0.325	-0.5231	**	0.347	-0.6038	*	0.258	-0.7585	***	0.438
	mo03	81/10/27	94/01/04	-0.0030	***	0.372	-0.0048	*	0.312	-0.8969		0.071	-0.0437		0.170
	mo05	81/11/03	94/01/04	-0.0014	****	0.468	-0.0001	*	0.413	-0.0005		0.310	-0.0002		0.345
	ms30	84/07/24	94/01/04	-0.0673	****	0.554	-0.0045	***	0.436	-0.5152	**	0.311	-0.3916	***	0.345
	nc25	78/07/11	94/01/04	-0.0001	****	0.550	-0.0001	***	0.384	-0.0001	***	0.421	-0.0681	****	0.349
	nc45	85/12/03	94/01/05	+0.4981	***	0.749	+0.7886		0.285	+0.6496	**	0.679	+0.3478	**	0.719
	nj99	81/08/11	94/01/04	-0.0001	**	0.383	-0.0001	**	0.441	+0.7331	****	0.567	+0.8355	****	0.537
	ny51	79/07/03	84/10/02	-0.0659		0.346	-0.2402		0.331	-0.0333	***	0.560	-0.0678	****	0.628
	ny99	83/09/20	94/01/04	-0.0120	****	0.452	-0.1964	**	0.291	+0.3883	***	0.337	+0.0599	***	0.371
	oh09	84/08/21	94/01/04	+0.7097	****	0.448	-0.3291	****	0.456	-0.9733		0.117	+0.7668		0.140
	oh17	78/10/10	94/01/04	-0.0010	****	0.523	-0.0220	****	0.360	-0.0003		0.244	-0.1243	****	0.307
	oh49	78/10/03	94/01/05	-0.0008	****	0.424	-0.0195	**	0.226	-0.0003		0.220	-0.1489	****	0.318
	oh71	78/10/03	94/01/04	-0.0042	****	0.477	-0.0015	****	0.422	-0.0001		0.246	-0.0009	****	0.337
	pa15	83/06/14	94/01/04	-0.0013	****	0.606	-0.0001	**	0.478	-0.0338	****	0.402	-0.0134		0.226
	pa42	79/05/01	94/01/04	-0.0001	****	0.441	-0.0001		0.365	-0.0001		0.304	-0.0069		0.144
	tn00	80/03/18	94/01/04	-0.0001	****	0.608	-0.0001	****	0.534	-0.0584	****	0.324	-0.0043	***	0.294
	tn11	80/08/19	94/01/04	-0.0001	****	0.538	-0.0001	***	0.545	-0.3528		0.172	-0.2234		0.138
	tn14	84/10/09	94/01/04	-0.9026	***	0.377	-0.0680		0.247	+0.9980	*	0.243	-0.4944		0.216
	tn99	84/10/09	90/01/02	-0.0942	***	0.683	-0.1074	**	0.556	+0.2849	**	0.538	+0.3802	**	0.536
	va13	78/08/01	94/01/04	-0.0753	****	0.374	-0.0867	**	0.216	-0.0001		0.366	-0.0104	*	0.225
	va28	81/05/19	94/01/03	-0.0001	****	0.714	-0.0001		0.550	-0.0732	**	0.333	-0.0550		0.273
	wi98	89/08/08	94/01/04	-0.1468	***	0.710	-0.5379	***	0.708	-0.2319		0.186	-0.0311	*	0.570
	wi99	84/06/12	94/01/04	-0.0092	***	0.467	-0.0051	****	0.649	-0.2198		0.167	-0.0166	***	0.438
	wv04	83/09/13	94/01/06	-0.0001	****	0.605	-0.0001	***	0.666	-0.0021	*	0.330	-0.0006	**	0.425
	wv18	78/07/11	94/01/04	-0.0001	****	0.360	-0.0001	****	0.427	-0.0001		0.334	-0.0058	**	0.221
11	al10	83/09/06	94/01/04	-0.0007	***	0.423	-0.0005	**	0.436	-0.6087	***	0.368	-0.4099	****	0.414
	ar02	82/06/01	94/01/04	-0.0028	****	0.484	-0.0367	**	0.320	+0.3294	***	0.334	+0.9972	***	0.320
	ar03	84/01/03	94/01/04	-0.3463	****	0.499	-0.0689	*	0.266	-0.9164	*	0.195	-0.7755	**	0.233
	fl03	78/10/17	94/01/04	-0.0001	**	0.319	-0.0031	****	0.388	-0.0524	****	0.468	-0.3520	****	0.438
	flll	80/06/24	94/01/04	-0.0019	*	0.310	-0.3006	****	0.601	+0.4858	****	0.640	+0.4188	****	0.680
	fl14	84/03/20	94/01/04	-0.5878	**	0.310	-0.5522		0.193	+0.5399	***	0.360	+0.4168	***	0.357
	fl41	83/08/30	94/01/04	-0.1685	**	0.325	-0.2812	***	0.465	-0.4858	***	0.434	-0.3990	***	0.436
	fl99	83/08/09	94/01/04	-0.3869		0.084	+0.6039	****	0.393	+0.3187	****	0.506	+0.4876	****	0.505
	ga20	83/05/03	94/01/04	-0.0002	****	0.528	-0.2026		0.124	+0.8736	**	0.264	-0.9643	**	0.242
	ga41	78/10/10	94/01/04	-0.0001	****	0.490	-0.0001	***	0.388	-0.0001	***	0.358	-0.0004	****	0.346
	ga50	83/10/11	94/01/04	-0.0160	****	0.573	-0.0551	**	0.332	-0.3656	****	0.466	-0.3147	****	0.451
	la06	82/11/23	88/01/26	-0.3355	**	0.693	-0.0563	**	0.769	-0.0820	**	0.740	-0.2095	**	0.716
	la12	82/11/23	94/01/04	-0.0383	****	0.503	-0.0179	****	0.433	-0.2023	****	0.479	-0.1763	***	0.358
	la30	83/01/25	94/01/04	-0.0047	***	0.397	-0.0008	****	0.521	-0.0463	****	0.583	-0.0090	****	0.665
	md13	83/03/15	94/01/04	-0.0050	****	0.533	-0.0045	**	0.336	-0.2072	****	0.416	-0.2017	****	0.391
	ms10	84/07/17	94/01/04	-0.0599	****	0.612	-0.0090	**	0.361	-0.0187	****	0.510	-0.0021	****	0.609
	ms14	80/04/24	90/01/02	-0.0422	****	0.673	-0.0511		0.233	-0.6798	*	0.231	-0.6315	**	0.250
	ms19	86/11/18	94/01/04	-0.3457	***	0.637	+0.6615	**	0.473	+0.4269	**	0.463	+0.6983	**	0.499
	nc03	78/11/07	94/01/04	-0.0001	****	0.529	-0.0001	****	0.558	-0.0009	****	0.493	-0.0688	****	0.530
	nc34	78/10/24	94/01/04	-0.0001	****	0.539	-0.0001	*	0.321	-0.0007	**	0.262	-0.0071	****	0.314
	nc35	78/10/31	94/01/04	-0.0001	****	0.504	-0.0011	****	0.436	-0.0337	****	0.450	-0.4533	****	0.476
	nc36	83/10/25	94/01/04	-0.0951	****	0.536	-0.0409	****	0.472	-0.6434	****	0.440	-0.5848	****	0.427
	nc41	78/10/10	94/01/04	-0.0001	****	0.525	-0.0010	**	0.281	-0.0004	****	0.378	-0.1367	****	0.401
	sc06	84/07/24	94/01/04	-0.0227	****	0.714	+0.7582	**	0.414	+0.3338	***	0.516	+0.4312	***	0.484
	sc18	79/04/03	86/06/17	-0.7027	**	0.339	-0.9465		0.143	-0.0068		0.270	-0.5457	*	0.269
	tx21	82/07/06	94/01/04	-0.0119	***	0.372	-0.0009	*	0.318	-0.1809		0.179	-0.0833	*	0.213
	tx38	81/08/25	94/01/04	-0.0078	***	0.431	-0.0001		0.418	-0.0786	**	0.266	-0.0525	*	0.265
	va00	84/10/09	93/12/31	-0.0588	***	0.504	-0.0004	**	0.527	-0.5137	****	0.615	-0.3406	****	0.553
12	ak03	80/06/24	94/01/04	-0.1228		0.232	-0.0270		0.226	-0.1586	****	0.453	-0.1347	***	0.339
14	as01	80/05/27	92/10/13	-0.0609		0.136	-0.2352		0.128	-0.3671		0.129	-0.3390		0.116
15	hi00	80/06/17	93/09/28	-0.0001	**	0.351	-0.0001	*	0.366	-0.0329	***	0.303	-0.0141	***	0.317

DISCUSSION

Sulfate Concentration Trends

Regardless of the length of the sampling interval (14, 11, or 9 years), the vast majority of NADP/NTN monitoring sites (100%, 91%, and 83%, respectively) exhibit decreasing sulfate concentration trends (Table 9). The largest percentage and number of sites exhibiting significant ($p<0.05$) decreasing sulfate trends (87%, 45 sites) occur during the longest (1980-1993) summary period. As the period grows shorter, the percentage of sites with significant decreasing sulfate trends drops to 30% (26 sites) from 1983 through 1993 and to 26% (40 sites) from 1985 through 1993. Although 26 sites exhibit increasing trends in the 1985-93 period, only two are statistically significant (Table 9). No increasing trends are evident from 1980 through 1993; eight sites exhibit increasing trends from 1983 through 1993, none of which are significant ($p<0.05$).

Table 9. Trends in sulfate ion concentrations in precipitation in the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	52	(100)	45	(87)	0	(0)	0	(0)
1983-93	86	78	(91)	26	(30)	8	(9)	0	(0)
1985-93	155	129	(83)	40	(26)	26	(17)	2	(1)

*$p<0.05$

On a percentage basis, decreasing sulfate trends occur at well over half the sites in the U.S. for all summary periods (Table 10). Despite this general decreasing pattern in sulfate concentrations, 26 sites exhibit increasing trends in the 1985-93 period, the majority of which are located in the western U.S. Interestingly, the number and percentage of sites with significant sulfate concentration trends in the eastern U.S. drops from 27 (82%) in the 1980-93 period to 8 (17%) in 1983-93, and then increases to 25 (32%) in 1985-93. In contrast, the percentage of sites with significant downward sulfate trends in the western U.S. decreases from 95% in 1980-93 to 45% in 1983-93 to 20% in 1985-93, although the number of sites with significant trends remained relatively constant (Table 10). Sulfate trends in the West have a clearly different pattern than the East, and these differences become more evident during the shorter 11- and 9-year summary periods.

Table 10. Regional trends in sulfate ion concentrations in precipitation east and west of the Mississippi River.

Period	Region	# of Sites	Decreasing Trends: All Sites #	(%)	Decreasing Trends: Significant* #	(%)	Increasing Trends: All Sites #	(%)	Increasing Trends: Significant* #	(%)
1980-93	East	33	33	(100)	27	(82)	0	(0)	0	(0)
	West	19	19	(100)	18	(95)	0	(0)	0	(0)
1983-93	East	46	39	(85)	8	(17)	7	(15)	0	(0)
	West	40	39	(98)	18	(45)	1	(3)	0	(0)
1985-93	East	79	73	(92)	25	(32)	6	(8)	1	(1)
	West	76	56	(74)	15	(20)	20	(26)	1	(1)

*$p<0.05$

Predicted Changes in Sulfate Concentrations

Trend results from each summary period suggest that sulfate concentrations decreased more rapidly during the early 1980s and less rapidly thereafter. This is very evident when mean predicted changes in sulfate concentrations are compared for each period (Table 11). When all sites are considered, sulfate concentrations decreased an average of 11.234 µeq/L since 1980, but only 5.327 µeq/L and 5.360 µeq/L since 1983 and 1985, respectively. At sites exhibiting significant ($p<0.05$) trends, sulfate concentrations decreased 12.327 µeq/L since 1980 and 9.157 µeq/L and 10.607 µeq/L since 1983 and 1985, respectively. Interestingly, mean percentage changes are fairly similar for the sites with significant trends regardless of the length of the summary period. This is not the case when all sites are considered. Although these results suggest that sulfate concentrations have decreased more rapidly during the early 1980s, the results should be interpreted with the understanding that the number of sites included in the analyses varies by summary period and that different sites may be used for the 14-, 11-, and 9-year periods. Such differences can influence the Network mean predicted change in sulfate concentrations as well as the mean predicted change at sites with statistically significant trends. This is also true for each of the other analytes discussed in this report.

On a regional basis, the eastern half of the U.S. experienced, for the most part, larger declines in sulfate concentrations than the western U.S. regardless of the length of the summary period (Table 12). This is particularly evident at sites with significant trends. However, on a percentage basis, the results are reversed with sites in the western region generally experiencing the largest percentage decreases. Larger percentage decreases in the West are the result of lower sulfate concentrations relative to those measured in the eastern portion of the country.

Table 11. Mean predicted changes in sulfate ion concentration in precipitation throughout the United States.

Period	All Sites µeq/L	All Sites (%)	All Sites with Significant ($p<0.05$) Change µeq/L	All Sites with Significant ($p<0.05$) Change (%)
1980-93	-11.234	(-31)	-12.237	(-34)
1983-93	-5.327	(-17)	-9.157	(-32)
1985-93	-5.360	(-14)	-10.607	(-26)

Table 12. Mean predicted change in sulfate concentrations in precipitation east and west of the Mississippi River.

Period	Region	All Sites µeq/L	All Sites (%)	All Sites with Significant ($p<0.05$) Change µeq/L	All Sites with Significant ($p<0.05$) Change (%)
1980-93	East	-12.679	(-25)	-14.408	(-28)
	West	-8.726	(-42)	-8.980	(-43)
1983-93	East	-5.223	(-11)	-11.995	(-25)
	West	-5.445	(-25)	-7.896	(-35)
1985-93	East	-7.790	(-16)	-13.179	(-24)
	West	-2.835	(-11)	-6.427	(-28)

Hydrogen Ion Concentration Trends

Regardless of the length of the summary period (14, 11, or 9 years), hydrogen ion concentrations at the majority of NADP/NTN sites (87%, 73%, and 82%, respectively) are decreasing (Table 13). The largest percentage of sites with significant ($p<0.05$) decreasing hydrogen ion trends (42%, 22 sites) occurs during the 14-year summary period. As the length of the summary period becomes shorter, the percentage of sites with significant decreasing trends drops to 21% (18 sites) and 24% (37 sites), respectively. Although the number of sites with increasing hydrogen ion trends increased from seven to 28 as the summary period length decreased from 14 to 9 years, only one of these increases is statistically significant.

The largest number and percentage of sites with or without statistically significant decreasing trends in hydrogen ion concentrations are located in the eastern portion of the country during the 1980 through 1993 summary period (Table 14). During the two other summary periods, the number and percentage of sites with decreasing trends is more nearly the same between regions. The number of sites with increasing trends has been very consistent between regions regardless of the length of the summary period.

Table 13. Trend in hydrogen ion concentrations in precipitation in the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	45	(87)	22	(42)	7	(13)	0	(0)
1983-93	86	63	(73)	18	(21)	23	(27)	0	(0)
1985-93	155	127	(82)	37	(24)	28	(18)	1	(1)

*p<0.05

Table 14. Regional trends in hydrogen ion concentration in the United States east and west of the Mississippi River.

			Decreasing Trends				Increasing Trends			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	#of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	30	(91)	16	(48)	3	(9)	0	(0)
	West	19	15	(79)	6	(32)	4	(21)	0	(0)
1983-93	East	46	35	(76)	8	(17)	11	(24)	0	(0)
	West	40	28	(70)	10	(25)	12	(30)	0	(0)
1985-93	East	79	65	(82)	18	(23)	14	(18)	1	(1)
	West	76	62	(82)	19	(25)	14	(18)	0	(0)

*p<0.05

Predicted Changes in Hydrogen Ion Concentrations

At sites with significant trends, the average decrease in hydrogen ion concentration since 1980 has been 8.501 µeq/L; since 1983 and 1,985, the average decrease has been 7.145 µeq/L and 7.465 µeq/L (Table 15). Regardless of the length of the summary period, the percentage decrease in hydrogen ion concentrations has been very similar (32% to 36%) and has averaged approximately 33%. On a network wide basis, the average decrease in hydrogen ion concentrations since 1980 has been 5.113 µeq/L (20%), compared to 2.283 µeq/L (12%) from 1983 and 3.619 µeq/L (16%) from 1985.

Table 15. Mean predicted change in hydroge n ion concentrations in precipitation throughout the United States.

Period	All Sites		All Sites with Significant ($p<0.05$) Change	
	µeq/L	(%)	µeq/L	(%)
1980-93	-5.113	(-20)	-8.501	(-32)
1983-93	-2.283	(-12)	-7.145	(-36)
1985-93	-3.619	(-16)	-7.465	(-35)

On a regional basis, hydrogen ion concentration decreases have been approximately 2 to 5 times larger in the East than in the West, regardless of the length of the summary period (Table 16). Percentage decreases have also been very consistent for each summary period, with the mean percentage decrease in the western portion of the U.S. being almost twice as large as in the East. Both patterns are also evident at sites with significant ($p<0.05$) decreasing trends; however, the magnitudes of the mean concentration and percentage changes are much larger, particularly for the 11- and 9-year summary periods, although the differences between regions are not as great.

Table 16. Mean predicted change in hydrogen ion concentrations in precipitation east.and west of the Mississippi River.

Period	Region	All Sites		All Sites with Significant ($p<0.05$) Change	
		µeq/L	(%)	µeq/L	(%)
1980-93	East	-7.226	(-18)	-10.541	(-27)
	West	-1.441	(-24)	-3.059	(-46)
1983-93	East	-2.958	(-8)	-9.815	(-27)
	West	-1.507	(-16)	-5.010	(-42)
1985-93	East	-5.452	(-11)	-11.077	(-22)
	West	-1.714	(-20)	-3.852	(-47)

Coincidence of Decreased SO_4^{2-} and H^+ Concentrations

Regardless of the length of the summary period (14, 11, or 9 years), only 42% to 45% of the sites with significant ($p<0.05$) decreasing sulfate concentration trends exhibit concurrent significant decreasing hydrogen ion concentration trends (Table 17). On a regional basis, a greater number of sites with both significant decreasing sulfate concentrations and decreasing hydrogen ion trends are located in the eastern portion of the U.S. for all summary periods, except for 1983 through 1993. These results suggest that although sulfate concentrations in precipitation are generally decreasing, concurrent changes in either cation concentrations or nitrate and chloride concentrations or a combination of these have offset the effects of sulfate losses resulting in a small net change in free acidity (pH) at many sites. This conclusion has been suggested by Hedin et al (1994) and Lynch et al. (1995) and is based on the assumptions that neither organic acids nor bicarbonates affect hydrogen ion concentrations in precipitation samples collected following NADP/NTN weekly sampling protocols. Although this assumption regarding the importance of organic acids is most likely valid at all NADP/NTN sites, the importance of the bicarbonate cycle and its influence on free acidity cannot be discounted, particularly at those sites where the pH of precipitation frequently exceeds 4.65, the majority of which are located in the western U.S.

Table 17. Coincidence of significant ($p<0.05$) decreasing sulfate and hydrogen ion concentrations in precipitation throughout the United States.

Period	Region	Total # of Sites	# (%) of sites with significant decreasing sulfate ion concentrations	# (%) of these sites with significantly decreasing hydrogen ion concentrations
1980-93	East	33	27 (82)	14 (52)
	West	19	18 (95)	6 (33)
1983-93	East	46	8 (17)	5 (60)
	West	40	18 (45)	6 (33)
1985-93	East	79	25 (32)	12 (48)
	West	76	15 (20)	6 (40)

Nitrate Concentration Trends

For each summary period, fewer sites exhibit decreasing nitrate concentration trends than exhibit decreasing sulfate trends (Tables 9 and 18). This is especially true for the summary periods beginning in 1983 and 1985 when the number of sites exhibiting decreasing nitrate trends is less than the number exhibiting increasing trends. More importantly, decreasing nitrate trends are significant ($p<0.05$) at only a very few sites (7 since 1980, 1 since 1983, and 5 since 1985). In fact, more sites (8 since 1983 and 14 since 1985) exhibit significant increasing nitrate trends than exhibit significant decreasing trends.

The majority (75%) of sites exhibiting decreasing nitrate trends since 1980 are located in the eastern U.S. (Table 19). Six of the seven sites with significant decreasing trends since 1980 are located in the East. The majority (75%) of sites exhibiting increasing nitrate trends since 1980 are located in the western U.S. Although much less dramatic, this pattern is also evident during both the 1983 to 1993 and 1985 to 1993 summary periods. The number of western sites with statistically significant increasing trends increased from 2 since 1980 to 12 since 1985. Several eastern sites also exhibit statistically significant increasing nitrate trends during the 11- and 9-year summary periods.

Table 18. Trends in nitrate concentrations in precipitation in the United States.

Period	# of Sites	Decreasing Trends: All Sites #	(%)	Significant* #	(%)	Increasing Trends: All Sites #	(%)	Significant* #	(%)
1980-93	52	40	(77)	7	(13)	12	(23)	2	(4)
1983-93	86	41	(48)	1	(1)	45	(52)	8	(9)
1985-93	155	72	(46)	5	(3)	83	(54)	14	(9)

*p<0.05

Table 19. Regional trends in nitrate concentrations in the United States east and west of the Mississippi River.

Period	Region	#of Sites	Decreasiing Trends: All Sites #	(%)	Significant* #	(%)	Increasing Trends: All Sites #	(%)	Significant* #	(%)
1980-93	East	33	30	(91)	6	(18)	3	(9)	0	(0)
	West	19	10	(53)	1	(5)	9	(47)	2	(11)
1983-93	East	46	25	(54)	0	(0)	21	(46)	3	(7)
	West	40	16	(40)	1	(3)	24	(60)	5	(13)
1985-93	East	79	50	(63)	4	(5)	29	(37)	2	(3)
	West	76	22	(29)	1	(1)	54	(71)	12	(16)

*p<0.05

Predicted Changes in Nitrate Concentrations

The tendency for nitrate concentrations to exhibit considerable temporal variability is evident in the comparison of µeq/L changes since 1980, 1983, and 1985 (Table 20).. Since 1980, sites with significant nitrate trends (9 sites, 2 with increasing trends) have decreased an average of 3.624 µeq/L compared to an increase of 2.357 µeq/L (9 sites, 8 with increasing trends) and 1.167 µeq/L (19 sites, 14 with increasing trends) since 1983 and 1985, respectively. When all sites are considered (52 sites, 40 with decreasing trends), nitrate concentrations have decreased 1.892 µeq/L since 1980. Since 1983, nitrate concentrations across the network have not changed appreciably because the number of sites exhibiting increasing trends is almost the same as the number with decreasing trends.

On a network wide basis, nitrate concentrations in the East decreased 2.380 µeq/L since 1980 compared to a decrease of 1.045 µeq/L in the western portion of the country; a three-fold difference is evident at sites with statistically significant trends (Table 21). Similar differences are not evident for the 11- and 9-year summary periods indicating that much of the decrease in nitrates occurred as a result of higher concentrations in the early 1980s. Since 1983, nitrate concentrations have exhibited a generally increasing pattern in the West and a decreasing pattern in the East. Although the changes in concentrations are quite small, they are sufficient to offset one another as is evident in Tables 20 and 21. The large 5.285 µeq/L increase in mean nitrate concentrations from 1983 to 1993 at sites in the East with significant ($p<0.05$) trends is very misleading in that the increase is based on only three sites, all of which were positive. The 0.893 µeq/L increase in the West is based on six sites, five of which exhibit increasing trends. These results illustrate the difficulties in regional comparisons that may be influenced by only a few sites or because sites within a region may exhibit different temporal patterns.

Table 20. Mean predicted change in nitrate concentrations in precipitation throughout the United States.

	All Sites		All Sites with Significant (p<0.05) Change	
Period	µeq/L	(%)	µeq/L	(%)
1980-93	-1.892	(-4)	-3.624	(-1)
1983-93	0.146	(9)	2.357	(66)
1985-93	-0.071	(11)	1.167	(68)

Table 21. Mean predicted change in nitrate concentrations in precipitation east and west of the Mississippi River.

		All Sites		All Sites with Significant (p<0.05) Change	
Period	Region	µeq/L	(%)	µeq/L	(%)
1980-93	East	-2.380	(-9)	-4.696	(-22)
	West	-1.045	(6)	-1.479	(42)
1983-93	East	-0.012	(3)	5.285	(40)
	West	0.328	(16)	0.893	(80)
1985-93	East	-1.202	(-2)	-2.692	(2)
	West	1.105	(25)	2.948	(98)

Ammonium Concentration Trends

The percentage of sites with decreasing ammonium concentrations drops from 56% from 1980 through 1993 to 17% from 1985 through 1993 (Table 22). The number of sites with decreasing trends remains relatively constant for all summary periods despite a three-fold increase in the number of NADP/NTN sites from 1980 to 1985. Only three sites have significant ($p<0.05$)

Table 22. Trends in ammonium concentrations in precipitation in the United States

Period	# of Sites	Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
		#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	29	(56)	3	(6)	23	(44)	1	(2)
1983-93	86	22	(26)	0	(0)	64	(74)	10	(12)
1985-93	155	26	(17)	0	(0)	129	(83)	34	(22)

*p<0.05

decreasing trends, all of which occur during the longest summary period. Conversely, the number and percentage of sites with increasing ammonium trends increases substantially as the length of the summary period decreased from 14 years (23 sites, 44%) to 9 years (129 sites, 83%). Likewise, the number and percentage of sites with significant increasing trends rose from one in 1980-93 to 34 (22%) in 1985-93. Clearly, ammonium concentrations have increased throughout the 1980's.

The majority of sites exhibiting decreasing ammonium concentrations are located east of the Mississippi River regardless of the length of the summary period (Table 23). This is especially true for the 1980-1993 and 1985-1993 summary periods. The number of sites with increasing ammonium concentrations are fairly evenly distributed between the eastern and western regions for the 14- and 11-year summary periods. Since 1985, however, the majority of sites with increasing trends are located in the western U.S. This is particularly true for those sites that have statistically significant ($p<0.05$) increasing ammonium trends. Eighty percent of the sites with significant increasing trends since 1983 are located in the West; since 1985, 82% of the significant increasing trends are located in the West (Table 23).

Table 23. Regional trends in ammonium concentrations in precipitation east and west of the Mississipp i River.

Period	Region	#of Sites	Decreasing Trends				Increasing Trends			
			All Sites		Significant*		All Sites		Significant*	
			#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	20	(61)	2	(6)	13	(39)	0	(0)
	West	19	9	(47)	1	(5)	10	(53)	1	(5)
1983-93	East	46	13	(28)	0	(0)	33	(72)	2	(4)
	West	40	9	(23)	0	(0)	31	(78)	8	(20)
1985-93	East	79	21	(27)	0	(0)	58	(73)	6	(8)
	West	76	5	(7)	0	(0)	71	(93)	28	(37)

*p<0.05

Predicted Changes in Ammonium Concentrations

Mean predicted changes in ammonium concentrations for each summary period reinforce the conclusion based on trend analyses that ammonium concentrations are increasing, most obviously since 1983 (Table 24). From 1980 to 1993, ammonium concentrations declined 0.294 µeq/L on average across the country and 2.981 µeq/L at sites with significant trends. From 1983 and from 1985, ammonium concentrations increased on average 1.540 µeq/L and 2.959 µeq/L, respectively, at all sites and 6.879 µeq/L and 7.349 µeq/L, respectively, at sites with significant ($p<0.05$) trends.

Table 24. Mean predicted changes in ammonium concentration in precipitation throughout the United States.

Period	All Sites µeq/L	All Sites (%)	All Sites with Significant ((p<0.05) Change µeq/L	All Sites with Significant ((p<0.05) Change (%)
1980-93	-0.294	(8)	-2.981	(18)
1983-93	1.540	(24)	6.876	(115)
1985-93	2.959	(44)	7.349	(1220

The increasing ammonium concentration pattern since 1983 is evident in both the eastern and western regions of the country, although the magnitude of the increase is greater in the western U.S., especially since 1985 (Table 25). When all NADP/NTN sites are included.in the analysis, ammonium concentrations have increased since 1985 an average of 1.464 µeq/L in the eastern U.S. compared to 4.514 µeq/L in the West. At the 34 sites with significant increasing trends, the average increase in ammonium concentrations since 1985 has been 5.233 µeq/L (117%) and 7.803 µeq/L (123%) for eastern and western regions of the country, respectively.

Table 25. Meani predicted changes in ammonium concentrations in precipitation east and west of the Mississippi River.

Period	Region	All Sites µeq/L	All Sites (%)	All Sites with Significant (p<0.05) Change µeq/L	All Sites with Significant (p<0.05) Change (%)
1980-93	East	-0.208	(1)	-3.827	(-26)
	West	-0.445	(18)	-2.135	(62)
1983-93	East	1.192	(15)	3.822	(108)
	West	1.940	(33)	7.639	(117)
1985-93	East	1.464	(22)	5.233	(117)
	West	4.514	(66)	7.803	(123)

Calcium Concentration Trends

Regardless of the summary period (14,11, or 9 years), the vast majority of NADP/NTN sites exhibit decreasing calcium concentration trends (98%, 95% and 90%, respectively) (Table 26). However, the percentage of sites with significant decreasing (p<0.05) calcium trends drops from 85% (44 sites) during the 1980-93 period to 62% (53 sites) and 28% (43 sites) during the 1983-93 and 1985-1993 summary periods, respectively. Although calcium concentrations are increasing at 15 sites (10%) since 1985, none of the increasing trends is statistically significant.

Table 26. Trends in calcium concentrations in precipitation throughout the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	51	(98)	44	(85)	1	(2)	0	(0)
1983-93	86	82	(95)	53	(62)	4	(5)	0	(0)
1985-93	155	140	(90)	43	(28)	15	(10)	0	(0)

*p<0.05

The pattern of decreasing trends in calcium concentrations is fairly consistent between the eastern and western regions of the country, although there is a slightly lower percentage of western than eastern sites with decreasing calcium, particularly during the 14- and 9-year summary periods (Table 27). Comparison of increasing trend patterns is difficult

Table 27. Regional trends in calcium concentrations in precipitation east and west of the Mississippi River.

			Decreasing Trends				Increasing Trends			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	#of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	33	(100)	30	(91)	0	(0)	0	(0)
	West	19	18	(95)	14	(74)	1	(5)	0	(0)
1983-93	East	46	44	(96)	29	(63)	2	(4)	0	(0)
	West	40	38	(95)	24	(60)	2	(5)	0	(0)
1985-93	East	79	75	(95)	29	(37)	4	(5)	0	(0)
	West	76	65	(86)	14	(18)	11	(14)	0	(0)

*p<0.05

because of the limited number of sites exhibiting increasing calcium concentrations. Nevertheless, most of the increasing trends (11 of the 15 sites) since 1985 are located in the western portion of the U.S. None are statistically significant.

Predicted Changes in Calcium Concentrations

Clearly, calcium concentrations have decreased more rapidly during the early 1980s than in later summary periods (Table 28). From 1980 to 1993, the average overall decrease in calcium has been 4.394 μeq/L, 4.811 μeq/L at sites with significant trends. From 1983 to 1993 and from 1985 to 1993, calcium concentrations have decreased 3.144 μeq/L and 1.822 μeq/L, respectively, at all sites and 3.717 μeq/L and 3.562 μeq/L at sites with significant trends.

Table 28. Mean predicted change in calcium concentrations in precipitation throughout the United States.

	All Sites		All Sites with Significant ($p<0.05$) Change	
Period	μeq/L	(%)	μeq/L	(%)
1980-93	-4.394	(-46)	-4.811	(-50)
1983-93	-3.144	(-34)	-3.717	(-43)
1985-93	-1.822	(-21)	-3.562	(-41)

When all NADP/NTN sites are included in the analysis, the average decrease in calcium concentrations per summary period is fairly consistent (except for 1983 to 1993) between the eastern and western U.S. (Table 29). However, calcium concentrations appear to be declining faster at western sites when only sites with significant decreasing trends are included in the analysis. This is true for all summary periods. Despite the concentration differences between East and West, percent changes have been consistent between regions.

Magnesium Concentration Trends

Trends in magnesium concentrations are almost identical to calcium concentration trends. Regardless of the length of the summary period, almost all NADP/NTN sites exhibit decreasing magnesium concentrations (Table 30), the majority of which are significant ($p<0.05$), particularly from 1980 and 1983 through 1993. Of the few sites with increasing patterns (1 since 1983 and 9 since 1985), none is statistically significant.

Decreasing magnesium concentration trends have been fairly consistent throughout the country regardless of summary period length (Table 31). However, the frequency of sites with significant decreasing trends occurs more often in the East since 1983. Although limited by the number of sites, the distribution of sites with increasing magnesium trends is similar in both regions.

Table 29. Mean predicted change in calcium concentrations in precipitation east and west of the Mississippi River.

		All Sites		All Sites with Significant (p<0.05) Change	
Period	Region	µeq/L	(%)	µeq/L	(%)
1980-93	East	-4.230	(-47)	-4.395	(-49)
	West	-4.678	(-44)	-5.703	(-53)
1983-93	East	-2.513	(-33)	-2.977	(-42)
	West	-3.870	(-35)	-4.612	(-44)
1985-93	East	-1.844	(-25)	-3.061	(-39)
	West	-1.799	(-16)	-4.600	(-45)

Table 30. Trends in magnesium concentrations in precipitation in the United States

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	52	(100)	50	(96)	0	(0)	0	(0)
1983-93	86	85	(99)	78	(91)	1	(1)	0	(0)
1985-93	155	146	(94)	77	(50)	9	(6)	0	(0)

*p0.05

Table 31. Regional trends in magnesium concentrations in precipitation east and west of the Mississipp i River.

			Decreasing Trends				Increasing Trends			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	#of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	33	(100)	32	(97)	0	(0)	0	(0)
	West	19	19	(100)	18	(95)	0	(0)	0	(0)
1983-93	East	46	45	(98)	44	(96)	1	(2)	0	(0)
	West	40	40	(100)	34	(85)	0	(0)	0	(0)
1985-93	East	79	75	(95)	49	(62)	4	(5)	0	(0)
	West	76	71	(93)	28	(37)	5	(7)	0	(0)

*p<0.05

Predicted Changes in Magnesium Concentrations

Like calcium, magnesium concentrations have decreased more rapidly during the early 1980s than later (Table 32). The average decrease in magnesium at all sites since 1980 has been 2.046 µeq/L. Since 1983 and 1985, magnesium concentrations have decreased on average 1.553 µeq/L and 0.913 µeq/L, respectively. The mean percent change has also decreased from 52% since 1980 to 32% since 1985. Given the high number of sites in the NADP/NTN with statistically significant decreasing magnesium concentration trends, it is not surprising that the same patterns are also evident at those sites with significant trends.

Table 32. Mean predicted change in magnesium concentrations in precipitation throughout the United States.

	All Sites		All Sites with Significant (p<0.05) Change	
Period	µeq/L	(%)	µeq/L	(%)
1980-93	-2.046	(-52)	-2.073	(-53)
1983-93	-1.553	(-46)	-1.587	(-48)
1985-93	-0.913	(-32)	-1.233	(-44)

The decrease in magnesium concentrations is fairly consistent throughout the country, although perhaps somewhat greater in the West (Table 33). As might be expected, the largest mean decrease in concentration occurred during the longest summary period, with the western region experiencing about a 0.7 µeq/L larger decrease than sites located east of the Mississippi ~ — River. Decreases in magnesium concentrations were also larger in the West during the shorter summary periods; however, the differences between East and West were considerably smaller. Although slightly higher in the West, mean percent change in magnesium have been very similar regardless of the summary period (Table 33).

Table 33. Mean predicted change in magnesium concentrations in precipitation east and west of the Mississippi River.

		All Sites		All Sites with Significant (p<0.05) Change	
Period	Region	µeq/L	(%)	µeq/L	(%)
1980-93	East	-1.830	(-52)	-1.833	(-53)
	West	-2.423	(-54)	-2.501	(-55)
1983-93	East	-1.388	(-44)	-1.442	(-46)
	West	-1.743	(-47)	-1.775	(-50)
1985-93	East	-0.886	(-33)	-1.128	(-42)
	West	-0.940	(-31)	-1.416	(-47)

Potassium Concentration Trends

Potassium concentrations are generally decreasing nationwide, although the number of sites with decreasing trends declines rapidly as the summary period is shortened from 14 to 9 years (Table 34). The percentage of sites with significant decreasing trends ($p<0.05$) also drops substantially from 1980 (63%) to 1985 (17%). Since 1985, approximately 30% of the sites exhibit increasing potassium trends, although the trends significant ($p<0.05$) at only two sites.

Table 34. Trends in potassium concentrations in precipitation in the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	49	(94)	33	(63)	3	(6)	0	(0)
1983-93	86	78	(91)	45	(52)	8	(9)	0	(0)
1985-93	155	109	(70)	27	(17)	46	(30)	2	(1)

*p<0.05

On a regional comparison (Table 35), the frequency of decreasing potassium trends is fairly consistent for sites located east and west of the Mississippi River, regardless of the length of the summary period. However, there does appear to be a small increase in the number of sites with significant decreasing potassium trends in the eastern compared to the western portion of the country. Sites with increasing potassium concentrations are uniformly distributed between the eastern and western portions of the U.S.

Table 35. Regional trends in potassium concentrations in precipitation east and west of the Mississipp i River.

			Decreasing Trend				Increasing Trend			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	#of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	30	(91)	22	(67)	3	(9)	0	(0)
	West	19	19	(100)	11	(58)	0	(0)	0	(0)
1983-93	East	46	41	(89)	27	(59)	5	(11)	0	(0)
	West	40	37	(93)	18	(45)	3	(8)	0	(0)
1985-93	East	79	57	(72)	15	(19)	22	(28)	1	(1)
	West	76	52	(68)	12	(16)	24	(32)	1	(1)

*p<0.05

Predicted Changes in Potassium Concentrations

For the most part, the mean predicted changes in potassium concentrations across the network and at sites with significant trends have been fairly consistent for all summary periods (Table 36). For both the 14- and 11-year summary periods, potassium concentrations have decreased approximately 0.30 µeq/L (35%) across the network and 0.465 µeq/L (49%) at sites with significant trends. Since 1985 the network wide mean decrease has been considerably smaller. At sites with significant trends, the decrease has also become smaller, although not appreciably so. For each summary period, the predicted mean decrease in potassium concentrations has been greater at western than eastern sites for the network as a whole, as well as at sites with significant trends (Table 37). The differences between western and eastern sites have averaged 0.2 µeq/L or less.

Table 36. Mean predicted changes in potassium concentration in precipitation throughout the United States.

	All Sites		All Sites with Significant ($p<0.05$) Change	
Period	µeq/L	(%)	µeq/L	(%)
1980-93	-0.319	(-37)	-0.427	(-49)
1983-93	-0.295	(-34)	-0.425	(-49)
1985-93	-0.106	(-11)	-0.363	(-41)

Table 37. Mean predicted changes in potassium concentration in precipitation east and west of the Mississippi River.

		All Sites		All Sites with Significant ($p<0.05$) Change	
Period	Region	µeq/L	(%)	µeq/L	(%)
1980-93	East	-0.272	(-35)	-0.377	(-50)
	West	-0.399	(-39)	-0.528	(-48)
1983-93	East	-0.233	(-32)	-0.347	(-47)
	West	-0.365	(-36)	-0.542	(-52)
1985-93	East	-0.070	(-9)	-0.329	(-41)
	West	-0.143	(-13)	-0.405	(-41)

Sodium Concentration Trends

Sodium concentrations are generally decreasing nationwide, although the percentage of sites with decreasing trends declines rapidly from 1980 to 1985 (Table 38). The number of sites with statistically significant decreasing sodium trends also drops rapidly from 1980 (30 sites, 58%) to 1985 (14 sites, 9%). Since 1985, approximately 34% of the sites exhibit increasing sodium trends, although only one site is statistically significant ($p<0.05$). Sites with decreasing sodium trends are more often located west of the Mississippi River, regardless of the summary period (Table 39). Sites with significant sodium trends are most often located in the eastern U.S. Sites with increasing sodium concentrations appear to occur more frequently in eastern than western portions of the country.

Table 38. Trends in sodium concentrations in precipitation in the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%.)	#	(%)	#	(%)	#	(%)
1980-93	52	51	(98)	30	(58)	1	(2)	0	(0)
1983-93	86	74	(86)	24	(28)	12	(14)	0	(0)
1985-93	155	102	(66)	14	(9)	53	(34)	1	(1)

*p<0.05

Table 39. Regional trends in sodium concentration in precipitation east and west of the Mississipp i River.

			Decreasing Trend				Increasing Trend			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	32	(97)	19	(58)	1	(3)	0	(0)
	West	19	19	(100)	11	(58)	0	(0)	0	(0)
1983-93	East	46	38	(83)	9	(20)	8	(17)	0	(0)
	West	40	36	(90)	15	(38)	4	(10)	0	(0)
1985-93	East	79	48	(61)	9	(11)	31	(39)	0	(0)
	West	76	54	(71)	5	(7)	22	(29)	1	(1)

*p<0.05

Predicted Changes in Sodium Concentrations

The network wide average decrease in sodium concentrations since 1980 is estimated at 2.447 µeq/L, a reduction of approximately 32% (Table 40); at the 30 sites with significant ($p<0.05$) trends the reduction averages 3.587 µeq/L (42%). As the length of the summary period becomes shorter, the magnitudes of the mean concentration and percentage decrease drop to 0.533 µeq/L (8%) since 1985. This tendency is also true for sites with significant trends, although the drop is not as large.

Table 40. Mean predicted changes in sodium concentrations in precipitation throughout the United States.

Period	All Sites		All Sites with Significant ($p<0.05$) Change	
	µeq/L	(%)	µeq/L	(%)
1980-93	-2.447	(-32)	-3.587	(-42)
1983-93	-1.379	(-19)	-3.061	(-38)
1985-93	-0.533	(-8)	-1.888	(-32)

Regardless of the length of the summary period, the decrease in sodium concentrations has been considerably greater at western than eastern sites (Table 41). This is true both for the predicted mean concentration at all sites as well as at sites with significant trends. Sodium losses in precipitation are generally 2 to 3 times greater in the West than the East. Since 1985, the mean predicted decrease in sodium has been more than 6 times larger at western than eastern sites.

Table 41. Mean predicted changes in sodium concentration in precipitation east and west of the Mississippi River.

Period	Region	All Sites		All Sites with Significant ($p<0.05$) Change	
		µeq/L	(%)	µeq/L	(%)
1980-93	East	-1.332	(-28)	-1.937	(-38).
	West	-4.384	(-38)	-6.438	(-49)
1983-93	East	-0.849	(-16)	-1.976	(-34)
	West	-1.989	(-23)	-3.712	(-40) .
1985-93	East	-0.149	(-6)	-1.216	(-33)
	West	-0.931	(-10)	-2.895	(-30)

Chloride Concentration Trends

Chloride concentrations are also decreasing nationwide (Table 42). Like sodium, the percentage of sites with decreasing chloride declines from 1980 to 1985, even though the number of sites increases from 50 to 126. Both the number and percentage of sites with significant ($p<0.05$) decreasingchloride trends drops from 35 (67%) from 1980 to 26 (17%) from 1985. Only a few sites exhibit increasing chloride trends during the 14- and 11-year summary period. The largest number (29) and percentage (19%) of sites exhibiting increasing chloride trends occur since 1985, although only one is statistically significant.

Sites with decreasing chloride concentrations appear to be fairly evenly distributed between eastern and western regions of the country regardless of the length of the summary period (Table 43). The largest percentage of sites with significant decreasing trends are located in the western U.S., except for the 1985-1993 summary interval. Increasing chloride trends also appear to be evenly distributed between regions.

Table 42. Trends in chloride concentrations in precipitation in the United States.

		Decreasing Trends				Increasing Trends			
		All Sites		Significant*		All Sites		Significant*	
Period	# of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	52	50	(96)	35	(67)	2	(4)	0	(0)
1983-93	86	80	(93)	32	(37)	6	(7)	0	(0)
1985-93	155	126	(81)	26	(17)	29	(19)	1	(1)

*$p<0.05$

Table 43. Regional trends in chloride concentrations in precipiitation east and west of the Mississippi River.

			Decreasing Trend				Increasing Trend			
			All Sites		Significant*		All Sites		Significant*	
Period	Region	#of Sites	#	(%)	#	(%)	#	(%)	#	(%)
1980-93	East	33	31	(94)	21	(64)	2	(6)	0	(0)
	West	19	19	(100)	14	(74)	0	(0)	0	(0)
1983-93	East	46	43	(93)	12	(26)	3	(7)	0	(0)
	West	40	37	(93)	20	(50)	3	(8)	0	(0)
1985-93	East	79	64	(81)	15	(19)	15	(19)	0	(0)
	West	76	62	(82)	11	(14)	14	(18)	1	(1)

*$p<0.05$

Predicted Changes in Chloride Concentrations

Predicted changes in chloride concentrations follow a pattern that is consistent with sodium concentrations (Table 44). Since 1980, chloride concentrations have decreased approximately 30% (2.453 µeq/L) nationwide; 37% (3.088 µeq/L) at the 35 sites with significant trends. Since 1985, chlorides have decreased on average 1.046 µeq/L (13%) across the country and 2.278 µeq/L at sites with significant trends. The decrease in chloride concentrations in precipitation has been much greater at sites located in the West than sites located east of the Mississippi River for each summary period (Table 45). This regional difference is evident at all sites as well as sites with significant trends.

Table 44. Mean predicted changes in chloride concentration in precipitation in the Untied States

	All Sites		All Sites with Significant (p<0.05) Change	
Period	µeq/L	(%)	µeq/L	(%)
1980-93	-2.453	(-30)	-3.088	(-37)
1983-93	-1.803	(-22)	-3.010	(-37)
1985-93	-1.046	(-13)	-2.278	(-33)

Table 45. Mean predicted changes in chloride concentrations in precipitation east and west of the Mississippi River

		All Sites		All Sites with Significant (p<0.05) Change	
Period	Region	µeq/L	(%)	µeq/L	(%)
1980-93	East	-1.303	(-24)	-1.534	(-30)
	West	-4.449	(-41)	-5.419	(-47)
1983-93	East	-1.265	(-17)	-2.297	(-35)
	West	-2.422	(-28)	-3.437	(-38)
1985-93	East	-0.702	(-11)	-1.848	(-32)
	West	-1.403	(-15)	-2.815	(-34)

SUMMARY

*Sulfate concentrations decreased at 74% or more of the sites east and west of the Mississippi River from the early and mid-1980s to 1993. The downward trends were largest in size and greatest in significance in the earliest part of this period, 1980-1993. In general, sulfate concentrations in 1993 averaged about a third less than in 1980. Decreases in sulfate concentrations exceeded most other ions.

*Hydrogen ion concentrations decreased at 70% or more of the sites east and west of the Mississippi River from the early and middle 1980s to 1993, although the decreases were about 2 to 5 times larger in the East than in the West. Only 42% to 45% of the sites with significant downward sulfate trends also had significant downward hydrogen ion trends. Concurrent changes in other ions offset varying amounts of the sulfate decrease at most sites so that commensurate reductions in hydrogen ion (free acidity) did not occur.

*The two nitrogen species, nitrate and ammonium, exhibit somewhat similar trends both in magnitude and direction. Both ions tend to have concentration decreases in the early 1980s that are strongest in the East and concentration increases later in the period that are strongest in the West. Since one is a cation and the other an anion, the net effect on acidity (pH) is generally to offset one another.

*The base cations (calcium, magnesium, and potassium) have a consistent pattern of decreases at 68% or more of the sites east and west of the Mississippi River from the early and middle 1980s to 1993. These decreases offset decreases in sulfate in varying amounts. In general, calcium decreases were 2 to 3 times larger than the decreases in magnesium which are 3 to 7 times larger than the decreases in potassium.

*Sodium and chloride ion concentrations are generally decreasing throughout most of the country, with the largest decreases occurring west of the Mississippi River. Sodium and chloride concentration decreases are greatest since 1980.

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REFERENCES

Aubertin, G.M., D.S. Bigelow, and B.A. Malo (editors). 1990. **Quality Assurance Plan: NADP/NTN Deposition Monitoring.** National Atmospheric Deposition Program. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Bailey, R.G. 1976. **Ecoregions of the United States.** U.S. Forest Service Intermountain Region, Ogden, UT.

Bailey, R.G. 1980. **Description of the Ecoregions of the United States.** U.S. Dept. Agri. Misc. Publication No. 1391.

Baier, W.G. and T.A. Cohn. 1993. **Trend Analysis of Sulfate, Nitrate, and pH Data Collected at National Atmospheric Deposition/National Trends Network Stations Between 1980 and 1991.** USGS Open File Report 93-56. Reston, VA., 19 pp.

Bigelow, D.S. 1984. **NADP/NTN Instruction Manual: Site Selection and Installation.** National Atmospheric Deposition Program. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Bigelow, D.S. 1986. **Quality Assurance Report. NADP/NTN Deposition Monitoring, Field Operations 1978 through 1983.** National Atmospheric Deposition Program. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Bigelow, D.S. and S.R. Dossett. 1988. **Instruction Manual. NADP/NTN Site Operation.** National Atmospheric Deposition Program. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Bowersox, V.C. 1984. **Data Validation Procedures for Wet Deposition Samples at the Central Analytical Laboratory of the National Atmospheric Deposition Program.** In: Transactions of the APCA/ASQC Specialty Conference on Quality Assurance in Air Pollution Measurements, Boulder, CO. APCA, Pittsburgh, PA.

Cleveland, W.S. 1979. Robust locally weighted regression and smoothing scatterplots. Jour. of the American Statistical Assoc. 74:829-836.

Cleveland, W.S. 1985. **The Elements of Graphing Data.** Wadsworth, Monterey, CA, USA.

Dana, M.T. and R.C. Easter. 1987. Statistical summary and analysis of event precipitation chemistry from the MAP3S network, 1976-1983. Atoms. Environ. 21:113-128.

Hedin, L.O., L. Granat, G.E. Likens, T.A. Buishand, J.N. Galloway, T.J. Butler, and H. Rodhe. 1994. Steep declines in atmospheric base cations in regions of Europe and North America. Nature. 367,351-354.

Hirsch, R.M. and N.E. Peters. 1988. Short-term trends in sulfate deposition at selected bulk precipitation stations in New York. Atmos. Environ. 22, 1175-1178.

Hirsch, R.M., J.R. Slack, and R.A. Smith. 1982. Techniques of trend analysis for monthly water quality data. Water Resour. Res.. 18(1): 107-121.

James, K.O.W. 1993. **Quality Assurance Report. NADP/NTN Deposition Monitoring, Laboratory Operations, Central Analytical Laboratory, January - December 1991.** National Atmospheric Deposition Program. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Kessler, C.J., T.H. Porter, D. Firth, T.W. Sager, and M.W. Hemphill. 1992. Factor analysis of trends in Texas acidic deposition. Atmos. Environ. 26A, 1137-1146.

Lynch, J.A., J.W. Grimm, and V.C. Bowersox. 1995. Trends in precipitation chemistry in the United States: A national perspective, 1980-1992. Atmos. Environ.. 29(11):1231-1246.

National Atmospheric Deposition Program. 1994. **NADP/NTN Annual Data Summary. Precipitation Chemistry in the United States. 1993.** Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO. 465 pp.

National Atmospheric Deposition Program. 1995a. **NADP/NTN Data Base.** Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

National Atmospheric Deposition Program. 1995b. Annual Report of the National Research Support Project 3, January 1 to December 31, 1994. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO.

Nilles, M.A., J.D. Gordon, T.C. Willoughby and L.J. Schroder. 1993. **External Quality Assurance Results for the National Atmospheric Deposition Program/ National Trends Network During 1990.** U.S. Geological Survey, Lakewood, CO. Water-Resources Investigations Report 92-4101.[2]

Oehlert, G.W. 1993. Regional trends in sulfate wet deposition. J. Am. Stat. Assoc. 88, 390-399.

Peden, M.E. 1986. **Methods of Collection and Analysis of Wet Deposition.** Illinois State Water Survey, Champaign, IL. Report No. 381.

Robertson, J.K. and J.W. Wilson. 1985. **Design of the National Trends Network for Monitoring the Chemistry of Atmospheric Precipitation.** U.S. Geological Survey, National Acid Precipitation Assessment Program. Alexandria, VA. U.S. Geological Survey, Circular 964.

Sirois, A. 1993 Temporal variations in sulphate and nitrate concentrations in precipitation in Eastern North America. Atmos. Environ. 27A, 945-963.

Sisterson, D.L., V.C. Bowersox, A.R. Olsen. 1990. Wet deposition of atmospheric pollutants. **In: Deposition Monitoring: Methods and Results,** pp. 6-104, 6-105, 6-145, 6-174, and 6-220. National Acid Precipitation Assessment Program, State of Science and Technology Report 6, Government Printing Office, Washington, DC.

Stensland, G.J., M.E. Peden and V.C. Bowersox. 1983. **NADP Quality Control Procedures for Wet Deposition Sample Collection and Field Measurements.** 76th Annual APCA Meeting, Atlanta, GA. June 1983. Paper No. 83-32.2.

SAS Institute, Inc. 1988. **SAS/STAT User's Guide,** Release 6.03 Edition. Cary, NC. SAS Institute Inc., 1988. 1028 pp.