NADP Proceedings 2001-01

Illinois State Water Survey

NADP 2001

NADP Committee Meeting

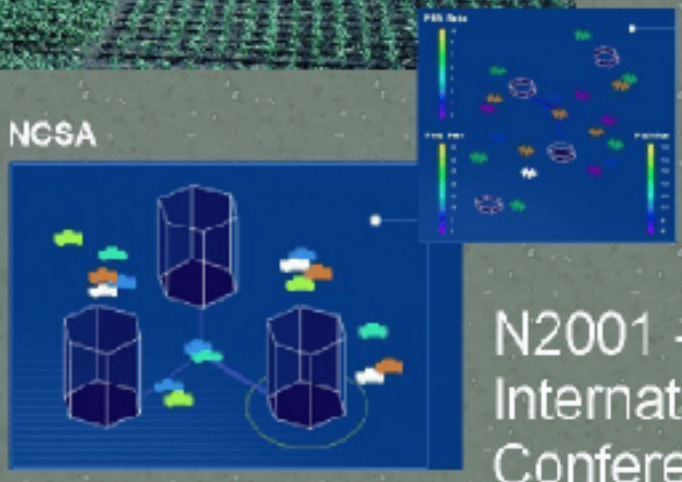
August 27-30, 2001

Champaign, Illinois

Morrow Plots

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

NCSA



N2001 - The Second Annual International Nitrogen Conference

October 14-18, 2001

Potomac, Maryland

In 2000, scientists, students, educators, and others interested in National Atmospheric Deposition Program (NADP) data viewed more than 84,000 maps and made nearly 17,000 on-line data retrievals from the NADP Internet site. These data are used to address important questions about the impact of the wet deposition of nutrients on eutrophication in coastal estuarine environments; the relationship between wet deposition, the health of unmanaged forests, and the depletion of base cations from forest soils; the impact of pollutant emissions changes on precipitation chemistry; and the rate at which precipitation delivers mercury to remote lakes and streams.

NADP was organized in 1977 under the leadership of 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, sites in the NADP precipitation chemistry network first began collecting one-week, wet-only deposition samples analyzed by the Central Analytical Laboratory (CAL) at the Illinois State Water Survey. The network was established to provide data on amounts, temporal trends, and geographic distributions of the atmospheric deposition of acidic chemicals, nutrients, and base cations. NADP was initially organized as SAES North Central Regional Project NC-141, which all four SAES regions endorsed as Interregional Project IR-7 in 1982. A decade later, SAES reclassified IR-7 as National Research Support Project NRSP-3, which it remains.

In October 1981, the federally supported National Acid Precipitation Assessment Program (NAPAP) was established to increase understanding of the causes and effects of acidic precipitation. This program sought to establish a long-term precipitation chemistry network of sampling sites distant from point source influences. Because of its experience in organizing and operating a national-scale network, NADP agreed to coordinate operation of NAPAP's National Trends Network (NTN). To benefit from shared siting criteria, identical operating procedures, and a shared analytical laboratory, NADP and NTN merged with the designation NADP/NTN. Many sampling sites are supported by the U.S. Geological Survey (USGS), NAPAP's lead federal agency for deposition monitoring. Under Title IX of the federal Clean Air Act Amendments of 1990, NAPAP continues. Today there are nearly 230 sites in the network, and the network designation has been shortened to NTN.

In the 1990s, NADP expanded to include two additional networks. The Atmospheric Integrated Research Monitoring Network (AIRMoN), which currently has ten sites, joined NADP in October 1992. AIRMoN sites collect samples daily when precipitation occurs. Samples are refrigerated until analysis at the CAL for the same constituents measured in NTN samples. AIRMoN seeks to identify pollutant source/receptor relationships and the effect of emissions changes on precipitation chemistry, combining measurements with atmospheric models. AIRMoN also evaluates new sample collection and preservation methods. Another NADP network, the Mercury Deposition Network (MDN), currently has nearly 60 sites and joined NADP in 1996. MDN sites collect one-week, wet-only deposition samples that are sent to a laboratory specializing in mercury measurements. Frontier Geosciences, Inc. analyzes all samples for total mercury and some samples for methyl mercury. MDN collects data on the wet deposition of mercury to surface waters, forested watersheds, and other receptors. Forty-one states and nine Canadian provinces have advisories against consuming fish from lakes with high mercury concentrations in fish tissues. MDN data enable researchers to investigate the importance of the atmospheric deposition of mercury as a cause of this problem.

A number of federal agencies support the NADP: U.S. Geological Survey; National Oceanic and Atmospheric Administration; National Park Service; Environmental Protection Agency; U.S. Department of Agriculture - Forest Service; Bureau of Land Management; U.S. Fish & Wildlife Service; Tennessee Valley Authority; and U.S. Department of Agriculture - Cooperative State Research, Education, and Extension Service under Agreement No. 98-COOP-1-5925. Additional support is provided by various other federal agencies, State Agricultural Experiment Stations, state agencies, universities, and public and private research organizations. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author and do not necessarily reflect the view of the U.S. Department of Agriculture or any other sponsor.

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The Illinois State Water Survey is an Affiliated Agency of the University of Illinois and a Division of the Illinois Department of Natural Resources

NADP COMMITTEE MEETING

Proceedings

Champaign, Illinois
August 27-30, 2001

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Prepared by

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August 2001

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NADP COMMITTEE MEETING GENERAL AGENDA

TIME	Monday (8/27)	Tuesday (8/28)	Wednesday (8/29)	Thursday (8/30)
0800	Network Operations Subcommittee Meeting	Network Operations Subcommittee Meeting	Budget Advisory Committee Meeting	Executive Committee Meeting
0830				
0900				
0930				
1000				
1030				
1100				
1130				
1200				
1230				
1300				
1330				
1400		Tours of NCSA Virtual Reality "Cave", Morrow Plots and the Central Analytical Lab		
1430				
1500			Executive Committee Meeting	
1530				
1600				
1630				
1700				
1730		Poster Session and Reception/Social Mixer		
1800				
1830				
1900				
1930				

NADP NETWORK OPERATIONS SUBCOMMITTEE MEETING AGENDA

NADP Network Operations Subcommittee Meeting
Champaign, Illinois
August 27-28, 2001

Monday, August 27, 2001 – Network Operations Subcommittee

Time	Agenda Topic and Presenter(s)
< 0800	Breakfast – on your own – complimentary breakfast available at the hotel
0800	Morning coffee
0815	Introduction and sign-in of attendees; agenda review John Shimshock
0830	ATS External Site Survey/Audit Report – Part I Progress Update and Summary Statistics John Shimshock
0900	ATS External Site Survey / Audit Report – Part II Recommendations to the U.S. EPA to report audit findings to the NOS John Shimshock, Joel Frisch et al.
0915	ATS External Site Survey / Audit Report – Part III Follow-up to the report audit findings and actions to be undertaken and schedule to implement such actions John Shimshock, Joel Frisch, Scott Dossett et al.
1000	30-minute break
1030	Possible new sites with some siting problems Scott Dossett
1100	Changes to NADP/NTN Site Information Worksheet and plans to edit the Site Selection and Installation Manual Scott Dossett
1130	Fish & Wildlife Service "Air Quality" video Kristi Morris
1200	1-hour, 30-minute lunch break
1330	CAL Report Karen Harlin
1430	USGS External QA Report – Part I Includes (i) Blind Audit Program, (ii) Field Blank and Reference Sampler Program, and (iii) Interlaboratory Comparison Program John Gordon
1530	30-minute break
1600	USGS External QA Report – Part II Includes (i) Collocated Sampler Program and (ii) Intersite Comparison Program Natalie Latysh
1700	Adjourn

Tuesday August 28, 2001 – Network Operations Subcommittee

< 0800	Breakfast – on your own – complimentary breakfast available at the hotel
0800	Morning coffee
0815	Introduction and sign-in of attendees; agenda review John Shimshock
0830	Progress update – modernization of sampling hardware and new instrument developer Rick Artz and Van Bowersox
0930	Progress update – experiences with the N-CON precipitation sampler Scott Dossett and Van Bowersox
1000	Progress update – experiences with the Ott-Pluvio rain gauge Van Bowersox and Scott Dossett
1015	30-minute break
1045	Network Equipment Depot (NED) report Scott Dossett
1115	AIRMoN - Ortho-phosphate data Jane Rothert
1130	Late agenda items
1230	Adjourn for 1-hour 15-minute lunch
1345	Field trip - tours of Morrow Plots, NCSA, and the CAL
1730	Poster Session

FIELD TRIP TOURS

Field Trip Tours

I. Morrow Plots

The Morrow Plots, beside the underground Undergraduate Library, are the country's oldest agricultural experiment fields in continuous use. Agriculture professor Manley Miles and first agriculture dean George Morrow began laying out the plots in 1876. Miles first divided the fields into ten plots of 1/2 acre each. Morrow later divided the area further into plots of 1/20 acre. Morrow modeled the plots after agriculture techniques he had observed in Great Britain (Rothamsted in particular) and France. The plots were designated a National Historic Landmark in 1968.

II. National Center for Supercomputing Applications

The CAVE is an integral part of the research activities of the NCSA Visualization and Virtual Environments Group. Its true stereoscopic capabilities, coupled with its uniquely immersive design, enable scientists and researchers to interact with their data in ways never before possible. An atmospheric scientist, for example, can actually "climb inside" of a hurricane and visualize its complex and chaotic elements from any angle or visual perspective.

About the CAVE

Thomas DeFanti and Dan Sandin conceived the idea of the Cave Automatic Virtual Environment (CAVE) in the Spring of 1991. Work at the Electronic Visualization Laboratory (EVL) at the University of Illinois in Chicago, developed the first prototype of the CAVE.

The CAVE developed at EVL ultimately took on the form of a small room, approximately ten feet-wide on each side, with three walls and a floor. Projectors, situated behind the walls, projected computer-generated imagery onto the walls and floor. Two perspective-corrected images were drawn for each frame, one for the right eye and one for the left. Special glasses were worn that ensured that each eye saw only the image drawn for it. This created a stereoscopic effect where the depth information encoded in the virtual scene was restored and conveyed to the eyes of those using it.

There are now several commercial products based on the technology innovated by the CAVE, with CAVE and CAVE-like systems being implemented all over the world. There are many applications which are simply not possible to implement on a two-dimensional viewing surface, such as a computer monitor. Instead, the full immersive and stereoscopic potential of the CAVE are put to use to enable software that could only be dreamed at a decade ago.

How the CAVE Works

The CAVE provides true stereoscopic imagery through the use of four rear-projected screens using an active stereo system. Electrohome CRT projectors are used for the imagery and are bounced off of mylar mirrors so that the CAVE will fit within the constrained space of the room (the projectors require a ten-foot throw distance). Infrared Crystal Eyes active stereo LCD shutter glasses are used in conjunction with the projectors to provide true stereo at an ideal rate of sixty frames per second (thirty frames per second for each eye), however, this frame rate varies greatly with each individual application. All applications are written to use the standard CAVE libraries, with several additional NCSA proprietary extensions available. A twelve-processor Silicon Graphics Onyx 2 Reality Monster powers the CAVE through four Infinite Reality 2 graphics boards (one for each wall). In addition, an eight channel digital sound environment is available to CAVE developers to augment their applications with supplemental auditory information. Wired tracking is provided through either Ascension Technology's Flock of Birds electromagnetic tracking or through the new Isense ultrasonic tracking system.

Why the CAVE Works

When you look at the world, you are seeing it from two different perspectives. The small distance between your eyes means that each eye sees the world from a slightly different angle. Your brain assembles these two images into a single composite image and uses the differences in perspective, along with other cues, to determine the depth of the scene. The CAVE recreates this effect by providing the right and left eyes with slightly different perspectives of the scene that mirror what they would see in real life. This provides the critical depth information that makes everything seem to "come alive" in the CAVE.

The special glasses that you wear in the CAVE are actually shutter glasses that make the right lens become opaque when the image for the left eye is being displayed and vice-versa, so that each eye only sees the image designed for it. The special tracked glasses and CAVE wand are both attached to electromagnetic sensors that allow the computer system to know where within the CAVE each is located and what its orientation is. The computer can use this information to general the proper viewpoint within the scene (so that you can peer around the corner of a building by physically moving your head).

Occlusion and parallax, which are also present in most modern arcade games, are calculated based on the location of the tracked glasses and the current eye being drawn for, providing unparalleled realism.

CAVE Components

Several computers are required to run the CAVE. The primary computer, named Cassatt, controls and coordinates all of the CAVE activities ensuring that the complex pieces of the CAVE work together correctly. Cassatt is a twelve-processor Silicon Graphics Onyx 2 Reality Monster. Another computer, named Satie, is a support computer for Cassatt. Satie is an SGI O2 workstation. It is used by NCSA's researchers to remotely control the operation of their more advanced CAVE applications and to provide additional resources to Cassatt. The CAVE's tracking systems are controlled by two microcomputer workstations. These computers are used to execute the complex software required to continually monitor the position of the special tracked glasses and the CAVE Wand from anywhere in the CAVE.

The CAVE is primarily a graphical system and thus has extremely demanding requirements for its graphics hardware. Sixty different images are displayed every second on each of the CAVE's four walls at very high resolution. The CAVE's graphics system is broken into two parts: the images projected onto the CAVE's walls and the shutter glasses that make the images appear three dimensional.

The images projected onto the walls of the CAVE are provided by the four Electrohome CRT projectors which surround the CAVE. The projectors that create the imagery for the CAVE require ten feet between themselves and the projection screens that make up the walls of the CAVE. NCSA's CAVE is housed in a relatively small room so there is not enough room to allow the projectors to simply be placed ten feet back from the screens. To solve this problem, mirrors are used so that the projectors may be placed at angles to the CAVE walls at the appropriate distance. Mylar mirrors are used since ordinary glass mirrors cannot provide the exceptionally high image quality required by the CAVE.

When you enter the CAVE you must wear special shutter glasses in order to see the images in 3-D. The shutter glasses used in the NCSA CAVE are infrared Crystal Eyes active stereo LCD shutter glasses. Since the CAVE displays different images for the right and left eyes, these glasses ensure that each eye only sees the image designed for it.

In addition to its extraordinary graphics capabilities, the CAVE also provides superb audio facilities. It has an eight channel audio system with state-of-the-art digital audio support that is controlled by an advanced sound mixing board. NCSA's Vanilla Sound Server provides access to these facilities from within a standard CAVE application.

The CAVE has an extremely advanced tracking system that enables it to constantly track the position and orientation of the special tracked glasses and the CAVE Wand. The tracked glasses are identical to the rest of the shutter glasses used in the CAVE except that they have a wire attached to them that is attached to the Tracker Control Unit. The person wearing the tracked glasses controls the viewpoint of the CAVE. They can look around the corner of an object, step behind it, look underneath it, or anything else that they could do in real life. None of the other glasses have this capability. The CAVE Wand is also attached to the Tracker Control Unit via a wire and allows you to walk around (with the joystick in the middle) or interact with the virtual world through the push buttons.

III. Central Analytical Laboratory

Thousands of precipitation samples are collected each year by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) and the NADP/Atmospheric Integrated Research Monitoring Network (AIRMoN), the nation's acid rain monitoring networks. Long-term monitoring networks of this size and importance require careful, accurate laboratory analyses. The NADP/NTN has relied on the Central Analytical Laboratory (CAL) to fulfill its need for site support, high-quality trace analyses, quality assurance, and data management since the program began in 1978.

Overview

The Central Analytical Laboratory provides support services for the National Atmospheric Deposition Program (NADP)/National Trends Network (NTN) and NADP/Atmospheric Integrated Research Monitoring Network (AIRMoN). The CAL is located at the Illinois State Water Survey (ISWS) on the campus of the University of Illinois at Urbana-Champaign. The ISWS has served in this capacity since the NADP/NTN began operations in 1978 and the NADP/AIRMoN began operations in 1992. The CAL provides operations support as follows:

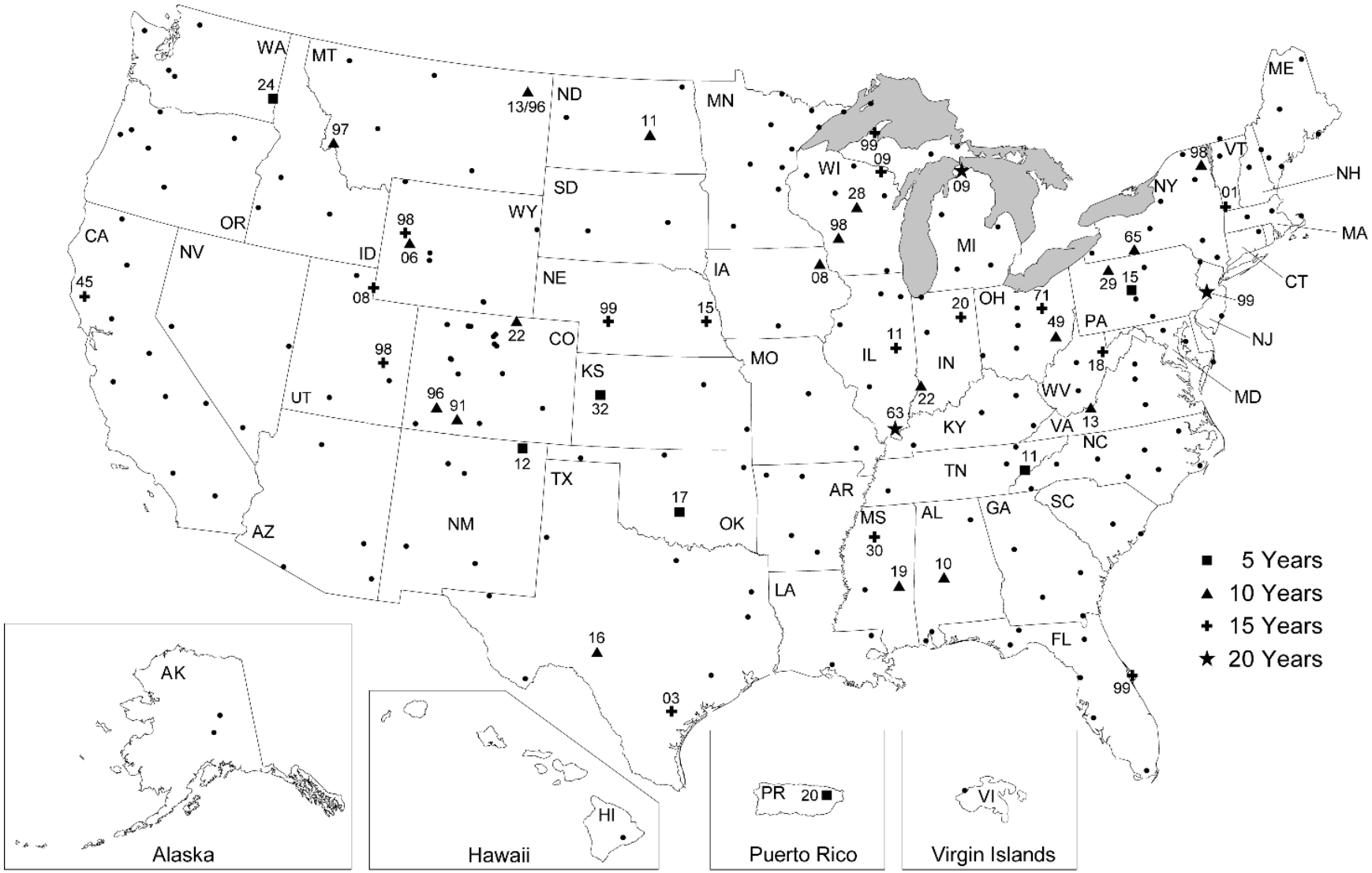
Analytical laboratory services

1. Quality assurance (QA) for field, laboratory, and data management areas
2. Site support, including supplies, site communications, and site operator training
3. Data entry, verification, validation, and reporting

Each month the NTN and AIRMoN submit approximately 1300 precipitation samples to the CAL. When sufficient volume is available, each sample undergoes 11 analyses: nitrate, sulfate, chloride, ammonium, orthophosphate, sodium, potassium, magnesium, calcium, pH, and conductivity. The QA sample requirements (such as internal blanks, control checks, calibration samples, interlaboratory comparison samples, and related samples) add an additional 25 percent sample load to the laboratory. Each month the CAL performs approximately 15,000 analyses for the NADP. Data validation activities require the review of more than 1 million data points each month.

NADP OPERATOR AWARDS

NADP/NTN Site Operator Service Awards - 2001



Site/Sitename	Operator Name	Wet Start	Agency
5 Year Awards			
KS32 – Lake Scott State Park	Curtis Sauer	3/27/84	USGS
NM12 – Capulin Volcano National Monument	Abbie Reaves	11/15/84	EPA/NM ED-ABQ
OK17 – Great Plains Apiary	Kathy McAlister	3/29/83	NOAA-ARL
PA15 – Penn State	Robert Ziegler	6/7/83	NOAA-ARL
PR20 – El Verde	John Bithorn	2/12/85	USFS
TN11 – Great Smoky Mts National Park	Scott Berenyi	8/12/80	NPS
WA24 – Palouse Conservation Farm	Robert Barry	8/20/85	USGS
10 Year Awards			
AL10 – Black Belt Substation	Peggy Seekers	8/31/83	USGS
CO22 – Pawnee	Mark Lindquist	5/22/79	NSF-LTER/CSU
CO91 – Wolf Creek Pass	Todd Pitcher	5/26/92	USFS
CO96 – Molas Pass	Brian Parker	7/29/86	USFS
IA08 – Big Springs Fish Hatchery	Robert Zach	8/14/84	USGS
IN22 – Southwest Purdue Agriculture Center	Angie Thompson	9/25/84	USGS/Purdue Univ
MS19 – Newton	Ron Gilstrap	11/11/86	NOAA-ARL
MT13 – Give Out Morgan (I)	Linda Connor	9/14/82	EPA/Ft Peck Tribes
MT96 – Poplar River	Linda Connor	12/21/99	EPA/Ft Peck Tribes
MT97 – Lost Trail Pass	Chuck Oppegard	9/25/90	USFS
ND11 – Woodworth	Gayle Cook	11/29/83	USGS
NY65 – Jasper	Peter Finlay	2/19/80	USGS
NY98 – Whiteface Mountain	Douglas Wolfe	7/3/84	USGS
OH49 – Caldwell	Mike Franko	9/26/78	USGS
PA29 – Kane Experimental Forest	Donald Dorn	7/18/78	USFS

TX16 – Sonora	Robert Moen	6/26/84	USGS
VA13 – Horton's Station	Stanley Long	7/25/78	TVA
WI28 – Lake Dubay	Barry Benson	6/29/82	Wisconsin DNR
WI98 – Wildcat Mountain	Karen Teed	8/1/89	Wisconsin DNR
WY06 – Pinedale	Sallie Otteman	1/26/82	BLM
15 Year Awards			
CA45 – Hopland	Charles Vaughn	10/3/79	USGS
FL99 – Kennedy Space Center	Lee Maull	8/2/83	Dynamac
IL11 – Bondville	Mike Snider	2/27/79	SAES-U of Illinois
IN20 – Huntington Reservoir	Gary Zeissig	8/22/83	USGS
MI99 – Chassell	David Toczydlowski	2/15/83	NPS-ARD
MS30 – Coffeeville	Hilliard Griffin	7/17/84	TVA
NE15 – Mead	Sheldon Sharp	7/25/78	SAES-U of Nebraska
NE99 – North Platte Agricultural Experiment Station	Jim Goeke	9/24/85	USGS
OH71 – Wooster	Cheryl Capek	9/26/78	USGS
TX03 – Beeville	Domingo Martinez	2/7/84	NOAA-ARL
UT08 – Murphy Ridge	Lee Bodine	3/25/86	BP/Amoco
UT98 – Green River	Nolan Johnson	4/25/85	USGS
VT01 – Bennington	Dan Taylor	4/28/81	USGS
WI09 – Popple River	Cathy McLain	12/30/86	Wisconsin DNR
WV18 – Parsons	John Pearce	7/5/78	USFS
WY98 – Gypsum Creek	Terry Pollard	12/26/84	Exxon Mobile Oil Corp
20 Year Awards			
IL63 – Dixon Springs Agricultural Center	Claris Barger	1/30/79	SAES-U of Illinois
MI09 – Douglas Lake	Robert Vande Kopple	7/3/79	SAES-Michigan State
NJ99 – Washington Crossing	Kathy McCullough	8/4/81	EPA

POSTER SESSION
(IN ALPHABETICAL ORDER BY FIRST AUTHOR)

Optimization and Preparation of Precipitation Analyses

Brigita Demir, Kaye Surratt, and Jane Rothert
Illinois State Water Survey
Champaign, Illinois 61820 USA

The Central Analytical Laboratory (CAL), located at the Illinois State Water Survey, receives approximately 240 samples per week from the National Atmospheric Deposition Program (NADP)/National Trends Network (NTN) and the NADP/Atmospheric Integrated Research Monitoring Network (AIRMoN). Precipitation samples are collected from sites in the United States, Puerto Rico, and the Virgin Islands. The precipitation samples are analyzed by ion chromatography for trace level concentrations of nitrate, sulfate, and chloride. Networks of this size and importance require careful and accurate laboratory analyses.
Two DX-500 ion chromatographs with conductivity detection are used to analyze these samples. The method detection limits are: 0.004 ppm for chloride and 0.008 ppm for nitrate and sulfate. The upper standard concentrations are: 1.500 ppm for chloride and 6.000 ppm for nitrate and sulfate.

To achieve the results required by the NADP, it is essential to optimize ion chromatographic operating conditions, implement stringent sample preparation procedures, and maintain quality assurance practices. This poster will present the methods and procedures used to obtain and maintain high quality results.

NADP Field Equipment Infrastructure Improvements-

Scotty R. Dossett
Illinois State Water Survey
Champaign, Illinois 61820 USA

Examples of current Best Available Technology for rainfall amount and chemistry measurement will be on display. Operating theory of recording raingages and precipitation samplers under consideration for use on the program will be discussed. Equipment available will include: N-Con Systems ADS precipitation collector and the OTT Pluvio and Geonor T200 recording raingages.

The NADP History and Networks

Dossett, S.R. and P. Bedient
Illinois State Water Survey
Champaign, Illinois 61820 USA

A Powerpoint presentation developed for the 2nd Annual National Tribal Forum Series will be used to show the history, sampling strategy and utility of the National Atmospheric Deposition Program.

Programs of the Illinois State Water Survey

Mark E. Peden
Illinois State Water Survey
Office of the Chief
Champaign, Illinois 61820

The Illinois State Water Survey was founded in 1895 as a unit of the University of Illinois Department of Chemistry. Its original mission was to survey the waters of Illinois to trace the spread of waterborne diseases. In its first 15 months of operation, the Water Survey responded to public requests for chemical analyses of 1,787 water samples from 156 towns in 68 Illinois counties. The Water Survey also addressed the health and safety of public water supplies, water softening methods, sewage and wastewater treatment, and the establishment of sanitary standards for drinking water.

Today, the Water Survey is the primary agency in Illinois concerned with water and atmospheric resources. Water Survey research and service programs assess and evaluate the quantity, quality, and use of ground, surface, and atmospheric water resources in Illinois. Much of the Survey's work is facilitated by an extensive database collected and developed over more than a century.

Research and service activities are organized into five scientific groups: Atmospheric Environment Section, Groundwater Section, Watershed Science Section, Analytical Chemistry and Technology Unit, and the National Atmospheric Deposition Program. Each scientific group conducts activities in three interwoven areas according to the needs of the state: research, data collection, and service.

Extensive data collection and research efforts enable the Water Survey to provide numerous services related to water and weather issues in Illinois and the nation. Activities include:

- Workshops and conferences for local and state officials, businesses, and scientists; lectures and seminars for diverse audiences.
- Public information through interviews and news releases for radio, TV, and newspapers statewide.
- Technical reports, public information brochures, and scientific journal articles.
- Meetings with public officials and consultants in the Chicago area about alternative water-supply plans.
- Information on flooding supplied through the Illinois Floodplain Information Repository.
- Water analyses and consultations on public and private water supplies.
- Management strategies to restore lakes for water supply and recreation, and information on lake levels, evaporation, and sedimentation.

Atmospheric Deposition of PAHs, PCBs, and Organochlorine Pesticides to Corpus Christi Bay, Texas

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Air and rain samples were collected at an atmospheric sampling site on Corpus Christi Bay from August 20, 1998 to September 16, 1999. Water samples were periodically collected from Corpus Christi Bay concurrently with air samples for calculation of the gas exchange between air and surface water. Wet deposition, dry deposition and air-water gas exchange rates of PAHs to Corpus Christi Bay were estimated as 182, 68, and -38.4 mg $m^{-2}yr^{-1}$ (negative value indicate loss from surface water to the air), and those of polychlorinated biphenyls (PCBs) were estimated as 3.93, 0.98, and -67.2 mg m^{-2} yr^{-1}. Total input of PAHs and PCBs directly to the surface of Corpus Christi Bay were estimated to be 298 and –87.9 kg yr^{-1}, respectively. The estimation indicates that Corpus Christi Bay is currently acting as a net sink for PAHs and as a net source for PCBs to the atmosphere. Total atmospheric input of PAHs to Corpus Christi Bay is not as large an input compared to input from land runoff and periodic oil spills. The daily and annual gas exchange fluxes of most pesticides appear to be approaching equilibrium between the atmosphere and bay water (flux in is nearly equal to flux out).

Key word index: Polycyclic aromatic hydrocarbons (PAHs), Polychlorinated biphenyls (PCBs), organochlorine pesticides, deposition dry, deposition wet, deposition fluxes, air-water gas exchange, USA, Texas, Corpus Christi Bay.

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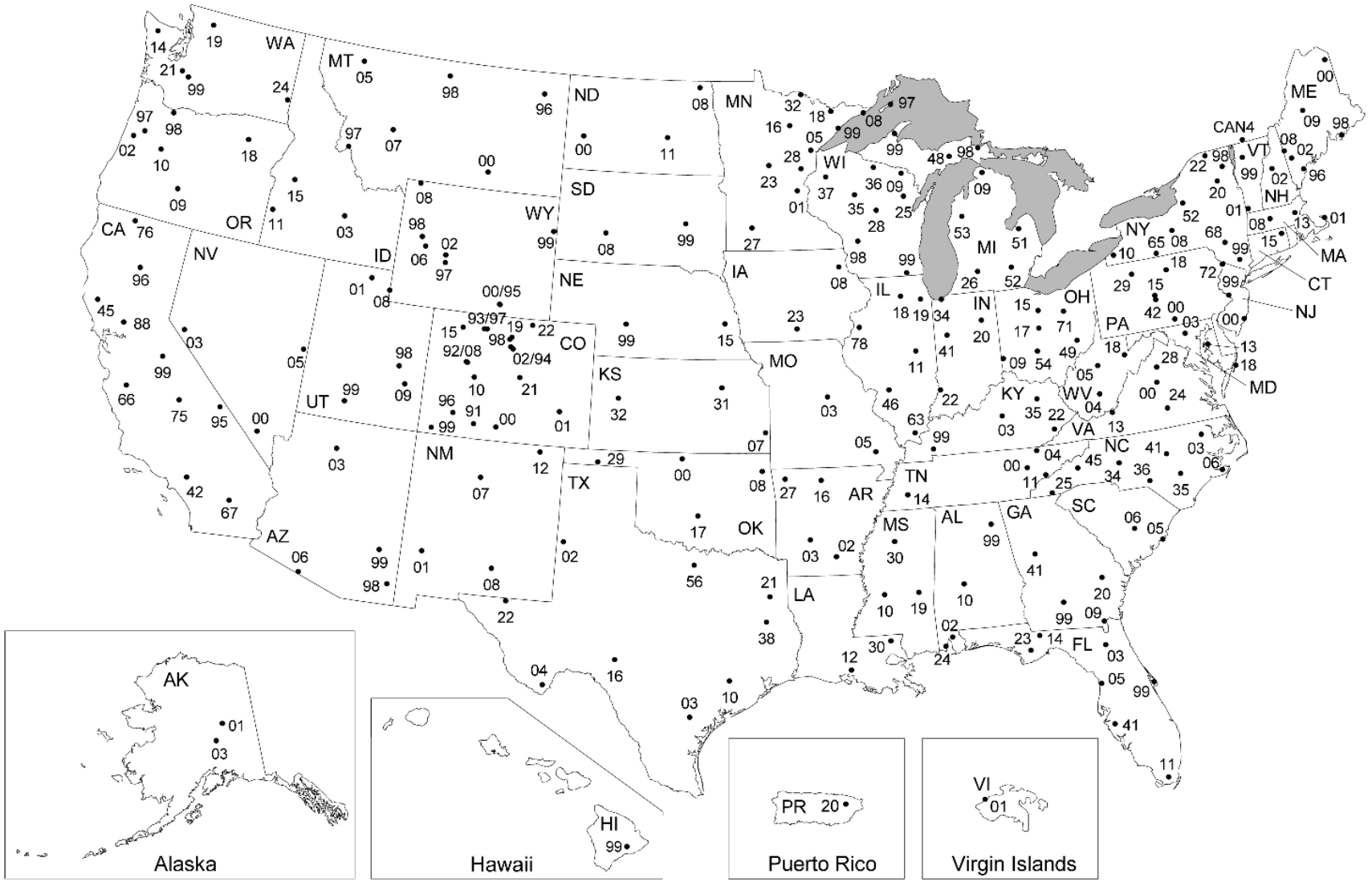
NTN Map and Site Listings

National Atmospheric Deposition Program
National Trends Network



National Atmospheric Deposition Program/National Trends Network Sites
August 1, 2001

State Site Code	Site Name	County	Sponsoring Agency	Start Date
Alabama				
AL02	Delta Elementary	Baldwin	University of Southern Alabama/US EPA	06/01
AL10	Black Belt Ag Substation	Dallas	US Geological Survey	08/83
AL24	Bay Road	Mobile	University of Southern Alabama/US EPA	05/01
AL99	Sand Mountain Ag Experiment Station	DeKalb	Tennessee Valley Authority	10/84
Alaska				
AK01	Caribou - Poker Creek	Fairbanks	USDA Forest Service	12/92
AK03	Denali NP - Mount McKinley	Denali	National Park Service - Air Resources Div	06/80
Arizona				
AZ03	Grand Canyon NP - Hopi Point	Coconino	National Park Service - Air Resources Div	08/81
AZ06	Organ Pipe Cactus NM	Pima	National Park Service - Air Resources Div	04/80
AZ98	Chiricahua	Cochise	US Environmental Protection Agency-CAMD	02/99
AZ99	Oliver Knoll	Graham	US Geological Survey	08/81
Arkansas				
AR02	Warren 2WSW	Bradley	US Geological Survey	05/82
AR03	Caddo Valley	Clark	US Geological Survey	12/83
AR16	Buffalo NR - Buffalo Point	Marion	National Park Service - Air Resources Div	07/82
AR27	Fayetteville	Washington	US Geological Survey	04/80
California				
CA42	Tanbark Flat	Los Angeles	USDA Forest Service	01/82
CA45	Hopland	Mendocino	US Geological Survey	10/79
CA66	Pinnacles NM - Bear Valley	San Benito	National Park Service - Air Resources Div	11/99
CA67	Joshua Tree NP - Black Rock	San Bernardino	National Park Service - Air Resources Div	09/00
CA75	Sequoia NP - Giant Forest	Tular	National Park Service - Air Resources Div	07/80
CA76	Montague	Siskiyou	US Geological Survey	06/85
CA88	Davis	Yolo	US Geological Survey	09/78
CA95	Death Valley NP - Cow Creek	Inyo	National Park Service - Air Resources Div	02/00
CA96	Lassen Volcanic NP - Manzanita Lake	Shasta	National Park Service - Air Resources Div	06/00
*CA99	Yosemite NP - Hodgdon Meadow	Tuolumne	National Park Service - Air Resources Div	12/81
Colorado				
CO00	Alamosa - Weather Service Office	Alamosa	US Geological Survey	04/80
CO01	Las Animas Fish Hatchery	Bent	US Geological Survey	10/83
CO02	Niwot Saddle	Boulder	NSF/INSTAAR-University of Colorado	06/84
CO08	Four Mile Park	Garfield	US Environmental Protection Agency-CAMD	12/87
CO10	Gothic	Gunnison	US Environmental Protection Agency-CAMD	02/99
CO15	Sand Spring	Moffat	Bureau of Land Management	03/79
CO19	Rocky Mountain NP - Beaver Meadows	Larimer	National Park Service - Air Resources Div	05/80
CO21	Manitou	Teller	USDA Forest Service	10/78
CO22	Pawnee	Weld	NSF-LTER/Colorado State University	05/79
CO91	Wolf Creek Pass	Mineral	USDA Forest Service	05/92
CO92	Sunlight Peak	Garfield	US Environmental Protection Agency-CAMD	01/88
CO93	Buffalo Pass - Dry Lake	Routt	USDA Forest Service	10/86
CO94	Sugarloaf	Boulder	US Environmental Protection Agency-CAMD	11/86
CO96	Molas Pass	San Juan	USDA Forest Service	07/86
CO97	Buffalo Pass - Summit Lake	Routt	USDA Forest Service	02/84
CO98	Rocky Mountain NP - Loch Vale	Larimer	USGS/Colorado State University	08/83
CO99	Mesa Verde NP - Chapin Mesa	Montezuma	US Geological Survey	04/81
Connecticut				
CT15	Abington	Windham	US Environmental Protection Agency-CAMD	01/99
Florida				
FL03	Bradford Forest	Bradford	St. John's River Water Management District	10/78
FL05	Chassahowitzka NWR	Citrus	US Fish & Wildlife Serv - Air Quality Branch	08/96
FL11	Everglades NP - Research Center	Dade	National Park Service - Air Resources Div	06/80
FL14	Quincy	Gadsden	US Geological Survey	03/84
FL23	Sumatra	Liberty	US Environmental Protection Agency-CAMD	01/99
FL41	Verna Well Field	Sarasota	US Geological Survey	08/83
FL99	Kennedy Space Center	Brevard	NASA/Dynamac Corporation	08/83

State Site Code	Site Name	County	Sponsoring Agency	Start Date
Georgia				
GA09	Okefenokee NWR	Charlton	US Fish & Wildlife Serv - Air Quality Branch	06/97
GA20	Bellville	Bellville	US Environmental Protection Agency-CAMD	04/83
GA41	Georgia Station	Pike	SAES-University of Georgia	10/78
GA99	Chula	Tift	US Geological Survey	02/94
Hawaii				
HI99	Hawaii Volcanoes NP - Thurston	Hawaii	National Park Service - Air Resources Div	11/00
Idaho				
ID03	Craters of the Moon NM	Butte	National Park Service - Air Resources Div	08/80
ID11	Reynolds Creek	Owyhee	US Geological Survey	11/83
ID15	Smiths Ferry	Valley	US Geological Survey	10/84
Illinois				
IL11	Bondville	Champaign	SAES-University of Illinois	02/79
IL18	Shabbona	DeKalb	SAES-University of Illinois	05/81
IL19	Argonne	DuPage	DOE-Argonne National Laboratory	03/80
IL46	Alhambra	Madison	US Environmental Protection Agency-CAMD	01/99
IL63	Dixon Springs Ag Center	Pope	SAES-University of Illinois	01/79
IL78	Monmouth	Warren	US Geological Survey	01/85
Indiana				
IN20	Huntington Reservoir	Huntington	US Geological Survey	08/83
IN22	Southwest Purdue Ag Center	Knox	US Geological Survey	09/84
IN34	Indiana Dunes NL	Porter	National Park Service - Air Resources Div	07/80
IN41	Purdue University Ag Farm	Tippecanoe	SAES-Purdue University	07/82
Iowa				
IA08	Big Springs Fish Hatchery	Clayton	US Geological Survey	08/84
IA23	McNay Memorial Research Center	Lucas	US Geological Survey	09/84
Kansas				
KS07	Farlington Fish Hatchery	Crawford	US Geological Survey	03/84
KS31	Konza Prairie	Riley	SAES-Kansas State University	08/82
KS32	Lake Scott State Park	Scott	US Geological Survey	03/84
Kentucky				
KY03	Mackville	Washington	US Geological Survey	11/83
KY22	Lilley Cornett Woods	Letcher	NOAA-Air Resources Lab	09/83
KY35	Clark State Fish Hatchery	Rowan	US Geological Survey	08/83
KY99	Mulberry Flats	Trigg	TVA/Murray State University	12/94
Louisiana				
LA12	Iberia Research Station	Iberia	US Geological Survey	11/82
LA30	Southeast Research Station	Washington	US Geological Survey	01/83
Maine				
ME00	Caribou	Aroostook	NOAA-Air Resources Lab	04/80
ME02	Bridgton	Cumberland	EPA/Maine Dept of Env. Protection	09/80
ME08	Gilead	Oxford	US Geological Survey	09/99
ME09	Greenville Station	Piscataquis	SAES-University of Maine	11/79
ME96	Casco Bay - Wolfe's Neck Farm	Cumberland	EPA/University of Southern Maine	01/98
ME98	Acadia NP - McFarland Hill	Hancock	National Park Service - Air Resources Div	11/81
Maryland				
MD03	White Rock Substation	Carroll	Constellation Energy Group	10/84
MD13	Wye	Queen Anne	SAES-University of Maryland	03/83
MD18	Assateague Island NS - Woodcock	Worchester	Maryland Department of Natural Resources	09/00
Massachusetts				
MA01	North Atlantic Coastal Lab	Barnstable	National Park Service - Air Resources Div	12/81
MA08	Quabbin Reservoir	Franklin	NESCAUM	03/82
MA13	East	Middlesex	NESCAUM	02/82

State Site Code	Site Name	County	Sponsoring Agency	Start Date
Michigan				
MI09	Douglas Lake- Univ. Michigan Biological Station	Cheboygan	USDA/Michigan State University	07/79
MI26	Kellogg Biological Station	Kalamazoo	USDA/Michigan State University	06/79
MI48	Seney NWR - Headquarters	Schoolcraft	US Fish & Wildlife Serv - Air Quality Branch	11/00
MI51	Unionville	Tuscola	US Environmental Protection Agency-CAMD	01/99
MI52	Ann Arbor	Washtenaw	US Environmental Protection Agency-CAMD	01/99
MI53	Wellston	Wexford	USDA Forest Service	10/78
MI97	Isle Royale NP - Wallace Lake	Keneenaw	National Park Service - Air Resources Div	05/85
MI98	Raco	Chippewa	US Environmental Protection Agency-CAMD	05/84
MI99	Chassell	Houghton	National Park Service - Air Resources Div	02/83
Minnesota				
MN01	Cedar Creek	Anoka	Minnesota Pollution Control Agncy	12/96
MN05	Fond du Lac	Carlton	EPA/Fond du Lac Reservation	11/96
MN08	Hovland	Cook	Minnesota Pollution Control Agency	12/96
MN16	Marcell Experimental Forest	Itasca	USDA Forest Service	07/78
MN18	Fernberg	Lake	US Environmental Protection Agency-CAMD	11/80
MN23	Camp Ripley	Morrison	US Geological Survey	10/83
MN27	Lamberton	Redwood	Minnesota Pollution Control Agency	01/79
MN28	Grindstone Lake	Pine	Minnesota Pollution Control Agency	12/96
MN32	Voyageurs NP - Sullivan Bay	St. Louis	National Park Service - Air Resources Div	05/00
MN99	Wolf Ridge	Lake	Minnesota Pollution Control Agency	12/96
Mississippi				
MS10	Clinton	Hinds	US Geological Survey	07/84
MS19	Newton	Newton	NOAA-Air Resources Lab	11/86
MS30	Coffeeville	Yalobusha	Tennessee Valley Authority	07/84
Missouri				
MO03	Ashland Wildlife Area	Boone	US Geological Survey	10/81
MO05	University Forest	Butler	US Geological Survey	10/81
Montana				
MT00	Little Big Horn Battlefield	Big Horn	US Geological Survey	07/84
MT05	Glacier NP - Fire Weather Station	Flathead	National Park Service - Air Resources Div	06/80
MT07	Clancy	Jefferson	US Geological Survey	01/84
MT96	Poplar River	Roosevelt	EPA/Ft. Peck Tribes	12/99
MT97	Lost Trail Pass	Ravalli	USDA Forest Service	09/90
MT98	Havre	Hill	US Geological Survey	07/85
Nebraska				
NE15	Mead	Saunders	SAES-University of Nebraska	07/78
NE99	North Platte Ag Station	Lincoln	US Geological Survey	09/85
Nevada				
NV00	Red Rock Canyon	Clark	Bureau of Land Management	01/85
NV03	Smith Valley	Smith	US Geological Survey	08/85
NV05	Great Basin NP - Lehman Caves	White Pine	National Park Service - Air Resources Div	01/85
New Hampshire				
*NH02	Hubbard Brook	Grafton	USDA Forest Service	07/78
New Jersey				
NJ00	Edwin B. Forsythe NWR	Atlantic	US Fish & Wildlife Serv - Air Quality Branch	10/98
NJ99	Washington Crossing	Mercer	US Environmental Protection Agency-CAMD	08/81
New Mexico				
NM01	Gila Cliff Dwellings NM	Catron	EPA/New Mexico Environment Dept.	07/85
NM07	Bandelier NM	Los Alamos	DOE-Los Alamos National Lab	06/82
NM08	Mayhill	Otero	US Geological Survey	01/84
NM12	Capulin Volcano NM	Union	EPA/New Mexico Environment Dept.	11/84

State Site Code	Site Name	County	Sponsoring Agency	Start Date
New York				
NY08	Aurora Research Farm	Cayuga	USDA/Cornell University	04/79
NY10	Chautauqua	Chautauqua	US Geological Survey	06/80
NY20	Huntington Wildlife	Essex	EPA/State Univ of New York-Syracuse	10/78
NY22	St. Regis Mohawk - Fort Covington	Franklin	US Environmental Protection Agency-CAMD	08/99
NY52	Bennett Bridge	Oswego	EPA/State Univ of New York-Oswego	06/80
NY65	Jasper	Steuben	US Geological Survey	02/80
NY68	Biscuit Brook	Ulster	US Geological Survey	10/83
NY98	Whiteface Mountain	Essex	US Geological Survey	07/84
NY99	West Point	Orange	US Geological Survey	09/83
North Carolina				
NC03	Lewiston	Bertie	North Carolina State University	10/78
NC06	Beaufort	Carteret	US Environmental Protection Agency-CAMD	01/99
NC25	Coweeta	Macon	USDA Forest Service	07/78
NC34	Piedmont Research Station	Rowan	North Carolina State University	10/78
NC35	Clinton Crops Research Station	Sampson	North Carolina State University	10/78
NC36	Jordan Creek	Scotland	US Geological Survey	10/83
NC41	Finley Farms	Wake	North Carolina State University	10/78
NC45	Mount Mitchell	Yancey	North Carolina State University	11/85
North Dakota				
ND00	Theodore Roosevelt National Park-Painted Canyon	Billings	National Park Service-Air Resources Division	01/01
ND08	Icelandic State Park	Pembina	US Geological Survey	10/83
ND11	Woodworth	Stutsman	US Geological Survey	11/83
Ohio				
OH09	Oxford	Butler	US Geological Survey	08/84
OH15	Lykens	Crawford	US Environmental Protection Agency-CAMD	01/99
OH17	Delaware	Delaware	USDA Forest Service	10/78
OH49	Caldwell	Noble	US Geological Survey	09/78
OH54	Deer Creek State Park	Pickaway	US Environmental Protection Agency-CAMD	01/99
OH71	Wooster	Wayne	US Geological Survey	09/78
Oklahoma				
OK00	Salt Plains NWR	Alfalfa	US Geological Survey	12/83
OK08	Lake Eucha	Delaware	Oklahoma Conservation Commission	02/00
OK17	Great Plains Apiaries	McClain	NOAA-Air Resources Lab	03/83
OK29	Goodwell Research Station	Texas	US Geological Survey	01/85
Oregon				
OR02	Alsea Guard Ranger Station	Benton	US Environmental Protection Agency-CAMD	12/79
OR09	Silver Lake Ranger Station	Lake	US Geological Survey	08/83
OR10	H J Andrews Experimental Forest	Lane	USDA Forest Service	05/80
OR18	Starkey Experimental Forest	Union	US Geological Survey	03/84
OR97	Hyslop Farm	Benton	US Environmental Protection Agency-CAMD	04/83
OR98	Bull Run	Clackamas	USGS/Portland Water Bureau, OR	07/82
Pennsylvania				
PA00	Arendtsville	Adams	US Environmental Protection Agency-CAMD	01/99
PA15	Penn State	Centre	NOAA-Air Resources Lab	06/83
PA18	Young Woman's Creek	Clinton	US Geological Survey	04/99
PA29	Kane Experimental Forest	Elk	USDA Forest Service	07/78
PA42	Leading Ridge	Huntingdon	SAES-Pennsylvania State University	04/79
PA72	Milford	Pike	USDA Forest Service	12/83
Puerto Rico				
PR20	El Verde	Rio Grande	USDA Forest Service	02/85
South Carolina				
SC05	Cape Romain - NWR	Charleston	US Fish & Wildlife Serv - Air Quality Branch	11/00
SC06	Santee NWR	Clarendon	US Geological Survey	07/84
South Dakota				
SD08	Cottonwood	Jackson	NOAA-Air Resources Lab	10/83
SD99	Huron Well Field	Huron	US Geological Survey	11/83

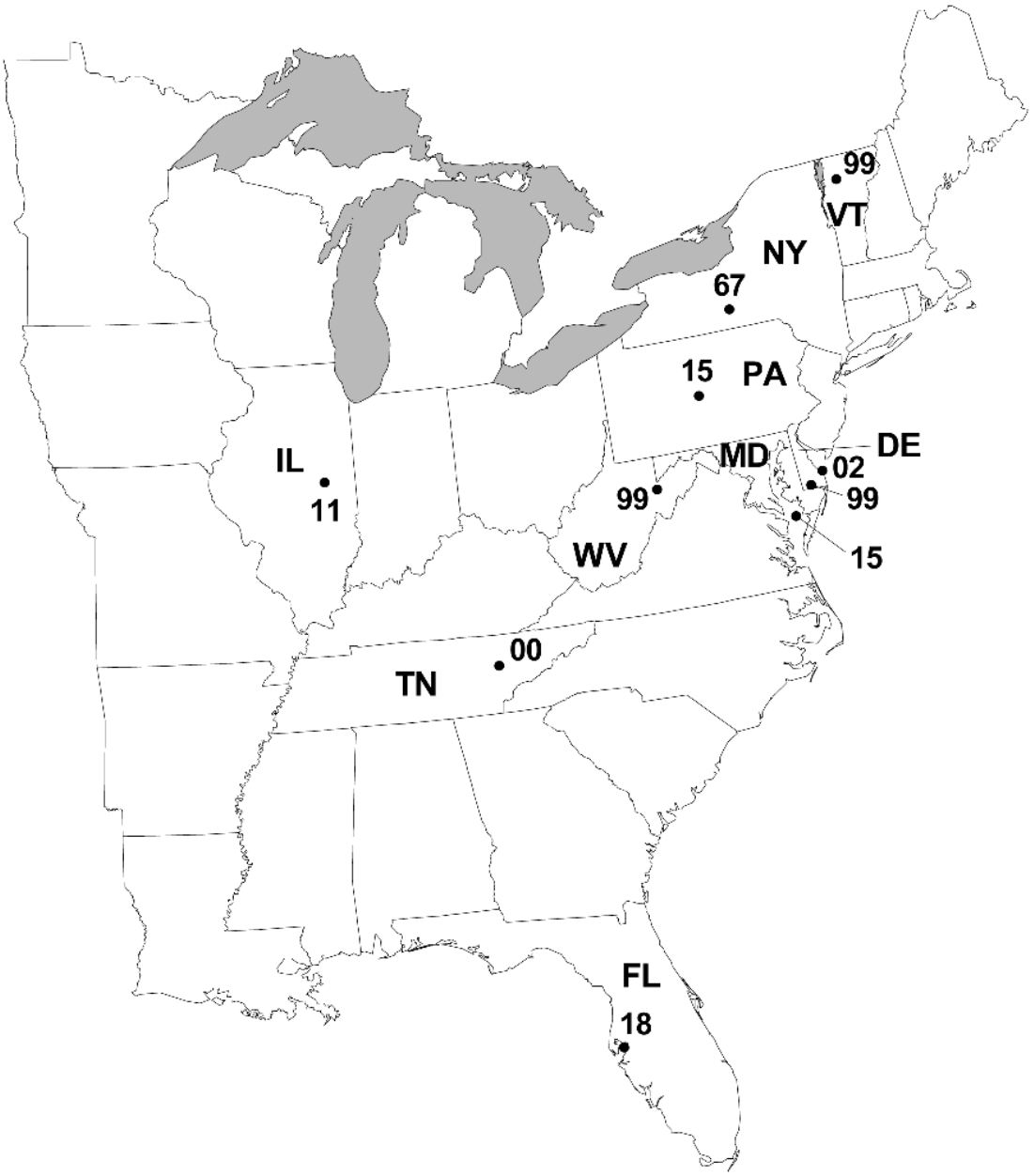
State Site Code	Site Name	County	Sponsoring Agency	Start Date
Tennessee				
TN00	Walker Branch Watershed	Anderson	DOE/Oak Ridge Natl Lab/Lockheed-Martin	03/80
TN04	Speedwell	Claiborne	US Environmental Protection Agency-CAMD	01/99
TN11	Great Smoky Mountain NP - Elkmont	Sevier	National Park Service - Air Resources Div	08/80
TN14	Hatchie NWR	Haywood	Tennessee Valley Authority	10/84
Texas				
TX02	Muleshoe NWR	Bailey	US Geological Survey	06/85
TX03	Beeville	Bee	NOAA-Air Resources Lab	02/84
TX04	Big Bend NP - K-Bar	Brewster	National Park Service - Air Resources Div	04/80
TX10	Attwater Prairie Chicken NWR	Colorado	US Geological Survey	07/84
TX16	Sonora	Edwards	US Geological Survey	06/84
TX21	Longview	Gregg	Texas Natural Resource Conservation Comm	06/82
TX22	Guadalupe Mountains NP-Frijole Ranger	Culberson	US Geological Survey	06/84
TX38	Station	Nacogdoches	Texas Natural Resource Conservation Comm	08/81
TX56	Forest Seed Center LBJ National Grasslands	Wise	US Geological Survey	09/83
Utah				
UT01	Logan	Cache	US Geological Survey	12/83
UT08	Murphy Ridge	Rich	BP Amoco	03/86
UT09	Canyonlands NP - Island in the Sky	San Juan	National Park Service - Air Resources Div	11/97
UT98	Green River	Emery	US Geological Survey	04/85
UT99	Bryce Canyon NP - Repeater Hill	Garfield	National Park Service - Air Resources Div	01/85
Vermont				
VT01	Bennington	Bennington	US Geological Survey	04/81
VT99	Underhill	Chittenden	US Geological Survey	06/84
Virgin Islands				
VI01	Virgin Islands NP - Lind Point	St. John	National Park Service - Air Resources Div	04/98
Virginia				
VA00	Charlottesville	Albemarle	US Geological Survey	10/84
VA13	Horton's Station	Giles	Tennessee Valley Authority	07/78
VA24	Prince Edward	Prince Edward	US Environmental Protection Agency-CAMD	01/99
VA28	Shenandoah NP - Big Meadows	Madison	National Park Service - Air Resources Div	05/81
Washington				
WA14	Olympic NP - Hoh Ranger Station	Jefferson	National Park Service - Air Resources Div	05/80
WA19	North Cascades NP-Marblemount Ranger Station	Skagit	US Geological Survey	02/84
WA21	La Grande	Pierce	US Environmental Protection Agency-CAMD	04/84
WA24	Palouse Conservation Farm	Whitman	US Geological Survey	08/85
WA99	Mount Rainier NP - Tahoma Woods	Pierce	National Park Service - Air Resources Div	10/99
West Virginia				
WV04	Babcock State Park	Fayette	US Geological Survey	09/83
WV05	Cedar Creek State Park	Gilmer	US Environmental Protection Agency-CAMD	01/99
WV18	Parsons	Tucker	USDA Forest Service	07/78
Wisconsin				
WI09	Popple River	Florence	Wisconsin Department of Natural Resources	12/86
WI25	Suring	Oconto	Wisconsin Department of Natural Resources	01/85
WI28	Lake Dubay	Portage	Wisconsin Department of Natural Resources	06/82
WI35	Perkinstown	Taylor	US Environmental Protection Agency-CAMD	01/99
WI36	Trout Lake	Vilas	Wisconsin Department of Natural Resources	01/80
WI37	Spooner	Washburn	Wisconsin Department of Natural Resources	06/80
WI98	Wildcat Mountain	Vernon	Wisconsin Department of Natural Resources	08/89
WI99	Lake Geneva	Walworth	Wisconsin Department of Natural Resources	06/84
Wyoming				
WY00	Snowy Range - West Glacier Lake	Albany	USDA Forest Service	04/86
WY02	Sinks Canyon	Fremont	Bureau of Land Management	08/84
WY06	Pinedale	Sublette	Bureau of Land Management	01/82
WY08	Yellowstone NP - Tower	Park	National Park Service - Air Resources Div	06/80
WY95	Brooklyn Lake	Albany	USDA Forest Service	09/92
WY97	South Pass City	Fremont	SF Phosphates Ltd. - Bridger Teton NF	04/85
WY98	Gypsum Creek	Sublette	Exxon Mobil Corporation	12/84
WY99	Newcastle	Weston	Bureau of Land Management	08/81

State Site Code	Site Name	County	Sponsoring Agency	Start Date
Canada				
CAN4	Sutton	Brome	US Geological Survey	09/86

*Intercomparison sites

AIRMoN Map and Site Listings

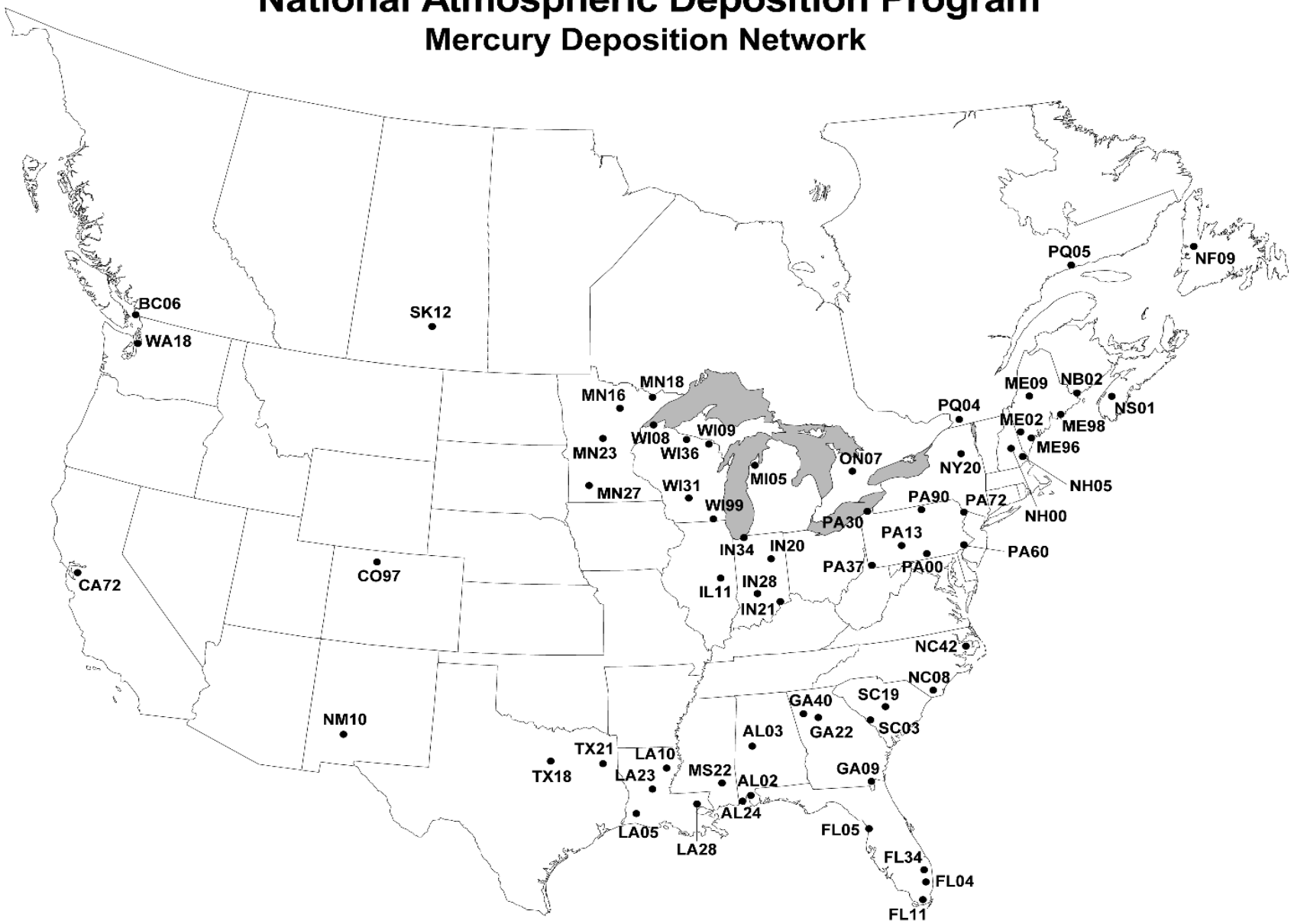
National Atmospheric Deposition Program
Atmospheric Integrated Research Monitoring Network



NADP/Atmospheric Integrated Research Monitoring Network Sites
August 1, 2001

State Site Code	Site Name	County	Sponsoring Agency	Start Date
Delaware				
DE02	Lewes	Sussex	NOAA-Air Resources Laboratory	09/92
Delaware				
DE99	Trap Pond	Sussex	NOAA-Air Resources Laboratory	06/01
Florida				
FL18	Tampa Bay	Hillsborough	FL-Department of Environmental Protection	08/96
Illinois				
IL11	Bondville	Champaign	NOAA-Air Resources Laboratory	10/92
Maryland				
MD15	Smith Island	Somerset	NOAA-Air Resources Laboratory	11/95
New York				
NY67	Cornell University	Thompkins	NOAA-Air Resources Laboratory	09/92
Pennsylvania				
PA15	Penn State	Centre	NOAA-Air Resources Laboratory	10/92
Tennessee				
TN00	Oak Ridge National Lab	Anderson	NOAA-Air Resources Laboratory	09/92
Vermont				
VT99	Underhill	Chittenden	NOAA-Air Resources Laboratory	01/93
West Virginia				
WV99	Canaan Valley Institute	Tucker	NOAA-Air Resources Laboratory	06/00

MDN Map and Site Listings


National Atmospheric Deposition Program
Mercury Deposition Network
BC06
WA18
SK12
CA72
CO97
NM10
TX18
TX21
LA10
LA23
LA05
LA28
MS22
AL02
AL24
AL03
GA09
GA22
GA40
SC19
SC03
NC08
NC42
FL05
FL34
FL04
FL11
IL11
IN28
IN21
IN34
IN20
MI05
WI99
WI31
WI08
WI09
WI36
MN27
MN23
MN16
MN18
ON07
PA30
PA37
PA00
PA13
PA90
PA72
PA60
NH00
NH05
NY20
PQ04
PQ05
NF09
ME09
NB02
NS01
ME02
ME98
ME96

National Atmospheric Deposition Program/Mercury Deposition Network Sites
August 1, 2001

State/Province Site Code	Site Name	County	Sponsoring Agency	Start Date
Alabama				
AL02	Delta Elementary	Baldwin	University of Southern Alabama/ US EPA	06/01
AL03	Centreville	Bibb	Southern Company/Atmos. Research and Analysis, Inc.	06/00
AL24	Bay Road	Mobile	University of Southern Alabama/ US EPA	05/01
California				
CA72	San Jose	Santa Clara	US EPA/San Francisco Estuary Institute	01/00
Colorado				
CO97	Buffalo Pass - Summit Lake	Routt	USDA Forest Service-Rocky Mountain Research Station	09/98
Florida				
FL04	Andytown	Broward	South Florida Water Management Institute	01/98
FL05	Chassahowitzka NWR	Citrus	US Fish and Wildlife Service - Air Quality Branch	07/97
FL11	Everglades NP - Research Center	Dade	South Florida Water Management Institute	12/95*
FL34	ENRP	Palm Beach	South Florida Water Management Institute	07/97
Georgia				
GA09	Okefenokee NWR	Charlton	US Fish and Wildlife Service - Air Quality Branch	07/97
GA22	Atlanta	Fulton	Southern Company/Atmos. Research and Analysis, Inc.	06/01
GA40	Yorkville	Paulding	Southern Company/Atmos. Research and Analysis, Inc.	06/00
Illinois				
IL11	Bondville	Champaign	Illinois State Water Survey	12/95*
Indiana				
IN20	Huntington Reservoir	Huntington	Indiana Department of Env. Management/USGS	10/00
IN21	Clifty Falls State Park	Jefferson	Indiana Department of Env. Management/USGS	01/01
IN28	Bloomington	Monroe	Indiana Department of Env. Management/USGS	12/00
IN34	Indiana Dunes National Lakeshore	Porter	Indiana Department of Env. Management/USGS	10/00
Louisiana				
LA05	Lake Charles	Calcasieu	Louisiana Department of Environmental Quality	10/98
LA10	Chase	Franklin	Louisiana Department of Environmental Quality	10/98
LA23	Alexandria	Rapides	Louisiana Department of Environmental Quality	01/01
LA28	Hammond	Tangipahoa	Louisiana Department of Environmental Quality	10/98
Maine				
ME02	Bridgton	Cumberland	Maine Dept. of Environmental Protection	06/97
ME09	Greenville Station	Piscataquis	Maine Dept. of Environmental Protection	09/96
ME96	Casco Bay - Wolfe's Neck Farm	Cumberland	US EPA/University of Southern Maine	01/98
ME98	Acadia NP - McFarland Hill	Hancock	NPS-Acadia NP & ME Dept of Env. Protection	01/96*
Michigan				
MI05	Sleeping Bear Dunes	Benzie	US EPA-Great Lakes Program Office	Pending
Minnesota				
MN16	Marcell Experimental Forest	Itasca	USDA Forest Service-North Central Research Station	12/95*
MN18	Fernberg	Lake	USDA- FS, Superior NF & MN Pollution Control	01/96*
MN23	Camp Ripley	Morrison	Agency	07/96
MN27	Lamberton	Redwood	Minnesota Pollution Control Agency Minnesota Pollution Control Agency	07/96
Mississippi				
MS22	Oak Grove	Perry	Southern Company/Atmos. Research and Analysis, Inc.	06/00
New Hampshire				
NH00	Laconia	Belknap	State of New Hampshire	05/01
NH05	New Castle	Rockingham	State of New Hampshire	05/01
New Mexico				
NM10	Caballo	Sierra	Bureau of Reclamation/New Mexico State University	05/97
North Carolina				
NC08	Waccamaw State Park	Columbus	North Carolina Dept of Env. & Natural Resources	12/95*
NC42	Pettigrew State Park	Washington	North Carolina Dept of Env. & Natural Resources	12/95*

State/Province Site Code	Site Name	County	Sponsoring Agency	Start Date
New York				
NY20	Huntington Wildlife	Essex	US EPA/State University of New York - Syracuse	12/99
Pennsylvania				
PA00	Arendtsville	Adams	PA Dept of Env. Protection/Penn State University	11/00
PA13	Allegheny Portage Railroad NHS	Cambria	PA Dept of Env. Protection/Penn State University	01/97
PA30	Erie	Erie	PA Dept of Env. Protection/Penn State University	06/00
PA37	Holbrooke	Greene	US Dept of Energy/National Energy Tech. Laboratory	05/99
PA60	Valley Forge	Montgomery	PA Dept of Env. Protection/Penn State University	11/99
PA72	Milford	Pike	PA Dept of Env. Protection/Penn State University	09/00
PA90	Hills Creek State Park	Tioga	PA Dept of Env. Protection/Penn State University	01/97
South Carolina				
SC03	Savannah River	Barnwell	DOE/Westinghouse Savannah River Company	01/01
SC19	Congaree Swamp State Park	Richland	South Carolina Dept of Health & Env. Quality	12/95*
Texas				
TX18	Fort Worth	Tarrant	City of Fort Worth	08/01
TX21	Longview	Gregg	Texas Natural Resource Conservation Commission	12/95*
Washington				
WA18	Seattle - NOAA	King	Frontier Geosciences, Inc	03/96
Wisconsin				
WI08	Brule River	Douglas	Wisconsin Department of Natural Resources	12/95*
WI09	Popple River	Florence	Wisconsin Department of Natural Resources	12/95
WI31	Devil's Lake	Sauk	Wisconsin Department of Natural Resources	01/01
WI36	Trout Lake	Vilas	Wisconsin Department of Natural Resources	12/95*
WI99	Lake Geneva	Walworth	Wisconsin Department of Natural Resources	01/97
CANADA				
British Columbia				
BC06	Reifel Island		Environment Canada - Pacific and Yukon Region	03/00
New Brunswick				
NB02	St. Andrews		Environment Canada - Meteorological Service of Canada	07/96
Newfoundland				
NF09	Newfoundland		Environment Canada - Meteorological Service of Canada	06/00
Nova Scotia				
NS01	Kejimkujik NP		Environment Canada - Meteorological Service of Canada	07/96
Ontario				
ON07	Egbert		Environment Canada - Air Quality Research Branch	03/00
Quebec				
PQ04	Saint Anicet		Environment Canada - Atmos. Environment Branch	04/98
PQ05	Mingan		Environment Canada - Atmos. Environment Branch	04/98
Saskatchewan				
SK12	Regina		Environment Canada - Prairie and Northern Region	08/01

*These dates mark the official start of NADP/MDN operations. Data for a transition network operating in 1995 are available from the NADP web site at http://nadp.sws.uiuc.edu.

NADP COMMITTEE MEETING
PARTICIPANT LIST

National Atmospheric Deposition Program

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ATMOSPHERIC DEPOSITION OF NITROGEN
RICK ARTZ, SESSION CHAIR

PRESENTATION ABSTRACTS
(IN ALPHABETICAL ORDER BY FIRST AUTHOR)

Organic Nitrogen in Precipitation: Real Problem or Sampling Artifact?

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Published observations of organic nitrogen compounds in precipitation go back almost a century. Several different methods have been used to measure both the total and ionic concentrations of N. There is therefore some uncertainty as to whether reported 'organic N' is real, or simply the result of uncertainties in chemical analyses, or inadequate sampling methods. We found that the materials from which the collector was made (polypropylene, steel or glass) had no significant effect on the composition of dissolved organic N. The use of a biocide was found to be very important during sampling and storage of samples before analysis. We set up a network of 7 collectors across the UK, from the Cairngorms to Dorset, all operating to the same protocol, and including a biocide. Samples were analyzed centrally, using proven methods. Over 6 months, organic N contributed about 20% to the total N in UK precipitation but with a large variation across the country. This means that current estimates of wet deposited nitrogen to the UK, which are based only on the ammonium and nitrate concentrations, are too small.

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Annual and Seasonal Trends in Nitrate Concentration in the USA and Their Relationship to Emissions

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Nitrogen deposition, which was once thought to be a beneficial bi-product of air pollution, is now viewed as a major environmental threat, contributing not only to the acidification of terrestrial and aquatic ecosystems, but also to the eutrophication of surface and coastal waters as well. Although progress has been made in reducing sulfate deposition in the USA as a result of the Clean Air Act Amendments of 1990, reductions in nitrogen oxides emissions have been relatively small, regionally specific, and often seasonally dependent. This research will examine annual and seasonal trends in nitrate concentrations and wet deposition in the USA in relationship to regional trends in nitrogen oxides emissions. Precipitation chemistry data from the National Atmospheric Deposition Program and emissions data from the AIRS/DATA databases will be used in this analysis. Where possible, trends in wet deposition will be compared to trends in nitrate concentrations in surface waters draining small, headwater streams.

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Trends in Wet Deposition of Ammonium and Nitrate in the United States, 1985-2000

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In 1998 nearly 27 teragrams of nitrogen oxides and ammonia were emitted to the atmosphere in the United States. Deposition of nitrogen compounds to aquatic and terrestrial ecosystems can account for a significant portion of nitrogen inputs. Trends in wet deposition of oxidized and reduced forms of nitrogen have not followed the well-documented declines in sulfate deposition in the United States. Monthly data from 158 sites in the National Atmospheric Deposition Program/National Trends Network were evaluate for trends over the period 1985-2000 using a parametric model to remove the influence of inter-annual variations in precipitation amount, followed by a non-parametric test for detection of monotonic trends. For ammonium deposition, increases were detected at 61 sites while only 2 sites exhibited declining trends. On a network-wide basis, ammonium deposition increased by 27 percent over the 15-year period of analysis. While the majority of sites did not exhibit any trend in nitrate deposition, a greater number of sites (28) had significant increasing trends versus sites with declining trends (9).

Atmospheric Sources of Aerosol Nitrate and Other Fine Particle Contaminants on the New Jersey Shore

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Fine particles (< 2.5 microns) suspended in the ambient air are complex mixtures of chemical species originating from a wide range of natural and anthropogenic sources. As they are removed from the atmosphere through dry deposition, or as condensation nuclei in precipitation events, these particles contribute pollutants to terrestrial and aquatic ecosystems. Small particles can affect human health and visibility, and have recently become subject to federal regulatory programs for PM-2.5 and Regional Haze. The aerosol nitrate content may be of particular interest along the Northeast coast, as reactions with airborne sea salt and projected future reductions in regional aerosol sulfate levels can both increase the fraction of nitrate present in particle phase. In the current study, 8 years of fine particle measurement data collected at the Brigantine National Wildlife Refuge on the southeast coast of New Jersey are analyzed by a mathematical receptor model called UNMIX. The model acts on variations in multiple chemical species over multiple observations to identify chemical compositions and daily contributions of various sources of influence on the data, which are interpreted as sources of atmospheric emissions. In this case, 11 sources are identified which account for the measured nitrate, sulfate, carbonaceous matter, crustal material, sea salt and fine particle mass.

Nitrogen Deposition to a Mid-latitude Deciduous Forest and Ecosystem Response

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The project described in this presentation seeks to answer questions regarding the role increased nitrogen (N) deposition is playing in enhanced carbon (C) sequestration in temperate mid-latitude forests. We present detailed measurements of N deposition and cycling at an AmeriFlux tower in southern Indiana (MMSF). We describe methods used to determine the atmospheric flux rates which include relaxed eddy accumulation of HNO_3 and fast response NH_3 sensors, document collection of the ecological data and present highlights of sampling conducted to date. The atmospheric measurements indicate an average flux of 4.8 mg-N m-2 dy-1 during the 2000 growing season with approximately 40% coming from dry deposition of NH_3, HNO_3 and particle bound N. Wet deposition and throughfall measurements indicate significant canopy uptake of N (particularly NH_4^+) at the site, leading to a Net Canopy Exchange (NCE) of -8 kg-N ha-1 for the growing season. These data are used in combination with data on the above ground C:N ratio, literfall flux and soil net N mineralization rates to indicate the level of potential perturbation of C sequestration at this site.

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A New Approach to Determine the Total Airborne N-input into the Soil-plant System Using the 15N Isotope Dilution (ITNI): Results for Agricultural Used Areas of Central Germany

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Atmospheric deposition of nitrogen to landscapes raises great concern because of its impact on natural ecosystems with changing vegetation, loss of biodiversity, increasing growth of trees in forest and eutrophication of aquatic systems.[1] The average annual N-emission of Germany into the atmosphere amounts to about 2 mill t N/ha (ammonia/ammonium, NO_x), and assuming a homogeneous distribution over the hole area of Germany an average N-deposition of 45 kg/ha and year can be calculated. N-balances from Long-term field experiments in Central Germany (e.g. Static Fertilization Experiment Bad Lauchstädt) confirmed such high atmospheric N-deposition. Current estimates generally used do account for a deposition of about 30 kg N/ha and year only. These low estimates are derived from measurements using standard methods of wet only and bulk collectors which do not account for the gaseous deposition and direct uptake of atmospheric nitrogen by aerial plant parts. Therefore to measure the real total atmospheric N-input into a soil/plant system (Integrated Total Nitrogen Input - ITNI) a new device was developed using the 15N isotope dilution methodology. A soil/plant system is labeled with [15N]ammonium nitrate and the total input of airborne nitrogen can be calculated from the dilution of this tracer due to nitrogen derived from the atmosphere. During the period 1994-1998 an average annual deposition of 64 ? 12 kg/ha and year was measured with this ITNI system at the research farm Bad Lauchstädt (dry belt of Central Germany). Measurements in 1999/2000 at three other sites in the area of Central Germany revealed deposition rates of about 60 kg/ha and year. These data clearly indicate that the total atmospheric N deposition into the soil/plant system determined by the newly developed ITNI-system significantly exceeds those obtained from standard wet only and bulk collectors. The higher atmospheric N-depositions found match well with those postulated from N balances of long-term agricultural field experiments.

[1] J.W. Erisman et al., Summary of the First Int. Nitrogen Conference, 23.-27. March 1998, Noordwijkerhout, The Netherlands

Deposition of Oxidized Nitrogen in the Eastern United States

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Air quality and selected meteorological parameters have been monitored at rural sites in the United States (US) at the Environmental Protection Agency's (EPA) Clean Air Status and Trends Network (CASTNet) sites. The National Atmospheric Deposition Program(NADP) monitors wet deposition of numerous ions in precipitation. The current study examines air quality and both dry and wet deposition of oxidized nitrogen data from the CASTNet and NADP archives for the ten-year period between 1990 and 1999 at rural sites located in the eastern US. Archived weekly determinations of airborne nitric acid and nitrate concentrations, their dry deposition, and wet nitrate deposition are considered. Geographical regions are defined within the eastern US for examination (e.., Midwest, South, and Northeast). Both the regional (spatial) distribution and the seasonal behavior of concentration and deposition are emphasized. Notice: The US EPA through its Office of Research and Development funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

Comparison of Ammonium in USA Wet Deposition to Ammonia Emission Estimates

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For the USA a substantial database exists for ammonium in precipitation. This paper presents spatial and temporal patterns in the precipitation ammonium record and compares these patterns to those for ammonia emission estimates. We use NADP National Trends Network (NTN) data to examine 5-year average ammonium concentrations in precipitation for two time periods: 1985-89 and 1995-99. For each of the time periods the area of highest ammonium concentration extends from northwestern Texas to North Dakota and eastward through Minnesota and Iowa. To examine changes in these two time periods, we subtract the objectively-analyzed 1985-89 concentrations from the objectively-analyzed 1995-99 concentrations. Ammonium concentrations generally increased over this10-year interval (mean difference: +3.0 [s.d. 2.9] μeq/L or +25.6% [s.d. 23.5%], median difference: +2.5 μeq/L or +22.5%, range: -2.8 μeq/L to +17.6 μeq/L or -24.9% to +121%). We also examine sources of airborne ammonia in the two 5-year periods in an effort to identify potential explanations for the spatial distributions and temporal changes of ammonium concentrations. Among the sources of airborne ammonia that we examine are livestock manure (beef cattle, dairy cows, pigs, laying hens, broiler chickens, and turkeys), fertilizer applications, and automobile exhaust.

Spatial Analysis of Ammonia and Ammonium the UK: Comparison of Model Estimates with Measurements From the National Monitoring Network

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As measures are implemented in Europe to reduce SO_2 and NO_x emissions, attention is falling on the contribution of NH_3 emissions to acidification, nitrogen eutrophication and aerosol formation. In the UK, an atmospheric transport and chemistry model, FRAM, has been developed, with a focus on predicting the patterns of reduced nitrogen (NH_x) concentrations and deposition. At the same time, a national network has been established to measure gaseous NH_3 and aerosol NH_4^+, with sampling at many locations to address questions of regional and local variability, and the extent to which different source categories contribute to concentrations. The paper summarizes the sampling strategy underpinning the national network, including new low cost methods for sampling N_3 and NH_4^+ concentrations (<0.05 - >50 mg m-3). As expected for a pollutant with ground level emissions in the rural environment, the measurements, made at 80 sites, show that NH_3 concentrations vary spatially at a local level. In contrast, NH_4^+ concentrations measured at 50 locations show regional differences, but little local variation. These features are reproduced in FRAME, which provides concentration estimates at a 5 km level. Analysis of the underlying NH_3 emission inventory shows that pig, poultry and sheep emissions may have been underestimated relative to emissions from cattle. The combination of model and measurements is applied to estimate patterns of NH_3 dry deposition to different vegetation types. The combined approach provides the basis to assess NH_x responses across the UK to European emission control policies.

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Nitrogen Deposition in the Lake Tahoe Basin:
Scaling from Leaf to Landscape Using G.I.S.

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As urban areas encroach on forest ecosystems, monitoring atmospheric nitrogen (N) fluxes is becoming increasingly important. A necessary component of any flux estimate is a deposition velocity (m s^-1), which when multiplied by pollutant concentration yields a flux (nmol m^-2 sec^-1). Leaf-scale deposition velocities (Vg) are relatively well characterized for the principal components of nitrogen deposition (i.e., nitric acid, nitrogen dioxide, and ammonia, ammonium nitrate) in semi-arid forests like those in the Lake Tahoe Basin (located on the California-Nevada border). The factors needed to scale those Vg values to the landscape level (cm to km) vary nonlinearly both due to leaf area index in the vertical plane, and heterogeneous canopy distribution in the horizontal plane. Inferential resistance models are commonly used to account for this nonlinear variation, however they assume a homogeneous canopy distribution. A GIS (Geographic Information System) has the ability to map the heterogeneous variability in parameters for such inferential models. This study reports the results of a 'bigleaf' inferential model applied within a GIS framework to address nonlinear scaling issues, and compares the results with less complex N deposition estimates for the Lae Tahoe Basin.

Atmospheric Deposition of Nitrogen
Rick Artz, Session Chair

Poster Abstracts
(In Alphabetical Order by First Author)

Evaluation of the Nitrogen Forms as Macronutrients in Atmospheric Settleable Particles in Maracaibo Lake Strait

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The aim of this study is to determine, the nutrients levels in dustfall over Maracaibo Lake strait. Results on ambient particle fallout measurement, as well as the contribution of $N\text{-}NH_4^+$, $N\text{-}NO_3$-, $N\text{-}NO_2$, $S\text{-}SO_4^{-2}$, and $P–PO_4^{-3}$ (macronutrients), are given for three different monitoring sites, located in the northern and in the southern area of the channel. Samples were collected and analyzed using Standard Methods procedures together with instrumental analysis by high resolution liquid Chromatography. The results showed that settleable particles exhibit the higher deposition at Los Higuitos (site 1) with N-NO2 - > $N\text{-}NH_4^+$ > $N\text{-}NO_3^-$ > S - SO_4^{-2} > P - PO_4^{-3} ; Isla de Pájaros (site 2) $N\text{-}NO_2$ - > $N\text{-}NH_4^+$ > $N\text{-}NO_3^-$ > S - SO_4^{-2} > P - PO_4^{-3} ; San Francisco (site 3) S - SO^{4-2} > $N\text{-}NH_4^+$ > $N\text{-}NO_2^-$ > $N\text{-}NO_3^-$ > P - PO_4^{-3}. Results on atmospheric fallout particles mensurent as well as nutrients levels were higher than those reported in previous studies. The possible sources for the observed atmospheric levels together with the incidence of local conditions are discussed.

Atmospheric Nitrogen Compounds Deposition in Humid Tropic - Cuba

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N mobilized by human and natural activities have caused atmospheric and ecosystem acidification. Acid deposition, and as well as direct effect of gaseous air pollutants is causing widespread damage to terrestrial and aquatic ecosystems. Also, the pollutants are responsible for corrosion of building materials and pieces of art and also have an impact on human health. Emissions of ammonia are also cause of concern regarding the acidification of soils and waters. Actually NH_3 emissions are the same magnitude as NO_x and SO_2 emissions and potentially even more acidifying. In Cuba, main atmospheric nitrogen deposition compounds varies approximately from 12.0 to 65.0 kg N/ha/year in the rural place. The oxidized nitrogen forms being provided more 20% and wet deposition depends on our tropical rain climate features. The NH_3 and ammonium are the most important elements in our tropical conditions. Some of N compounds have some trend to increasing its concentrations.

Isotopes and Pollen: What Can They Tell Us about Land Use History and Nitrogen Source to Wetland Biota?

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Nitrogen isotopes (15N/14N) have been used to elucidate nitrate sources to ecosystems using surface water, ground water, and food web analysis. Previous work has also shown the importance of land use in determining both nitrogen cycling rates and nitrogen isotope ratios of soil, vegetation, and surface waters. This research investigates the use of nitrogen isotopes as indicators of nitrogen source to terrestrial wetlands, over extended temporal and spatial scales. Sediment cores extracted from wetlands throughout the Chesapeake Bay watershed are used to reconstruct changes in sedimentation rates, land cover, and nitrogen source to wetland biota since European settlement (~300 years). The y15N of bulk sedimentary organic matter is used to indicate the relative importance of various nitrogen sources (e.g., human or animal waste, atmospheric deposition). Changes in land use and sedimentation rates are reconstructed using palynology and historical records. Preliminary results show the influence of animal and human waste effluent as a nitrogen source to biota in a Coastal Plain wetland. In the Valley and Ridge province, results from a wetland in central Pennsylvania suggest that an increasing proportion of nitrogen to wetland biota is derived from atmospheric deposition.

Nitrogen Deposition in Latvia

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A wide network of long-running environmental stations covers the territory of Latvia. The network consists of regional GAW/EMEP (Global Atmosphere Watch and Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutant in Europe) stations, ICP-IM (International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems) stations and national stations that are performing deposition and snow cover measurements. Deposition can be divided into dry deposition and wet deposition. Dry and wet nitrogen depositions are measured at the regional GAW/EMEP stations in Rucava and Zoseni. Wet deposition is measured at the ICP-IM background stations in Rucava and Zoseni in open forested area, and at the national stations in 10 towns of Latvia in regions with different anthropogenic impact. An analysis of nitrogen deposition measurement results for 1994-2000 shows that total nitrogen deposition at a background level has decreased by 62% in Rucava and by 39% in Zoseni. In regions under minor anthropogenic impact, wet nitrogen deposition was 2 to 3 times as low as in the regions under anthropogenic impact. The measurement results have been employed in carrying out the ICP-IM, EMEP and ICP-Waters (International Coopeative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes) programmes.

Spatial and Temporal Trends in Total Nitrogen Deposition for the U.S.

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Deposition of biologically active nitrogen species has complex origins and occurs through wet and dry deposition processes. The difficulty in obtaining representative samples from multiple measurement systems over a sustained period has resulted in few studies of total nitrogen deposition for the U.S. Here we used the combined data sets of the Clean Air Status and Trends Network and the National Atmospheric Deposition Program/National Trends Network to estimate the spatial and temporal trends in the total trends of total nitrogen deposition for the U.S. Here we used the combined data sets of the Clean Air Status and Trends Network and the National Atmospheric Deposition Program/National Trends Network to estimate the spatial and temporal trends in total deposition of inorganic nitrogen species over the ten-year period, 1990-99. Although the total amount of nitrogen deposited has remained relatively constant over this period, the magnitude and composition of nitrogen deposition varies markedly by region.

Four NADP Stations Along an Elevational Transect in the Colorado Front Range: Atmospheric Sources of N Deposition

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NADP results have shown that atmospheric deposition of N in wetfall to the Colorado Front Range is now at a critical threshold where irreversible ecosystem damage may occur. Nitrogen deposition to the Front Range is influenced by easterly and westerly weather patterns that can bring air from either the Denver metropolitan area to the east or well mixed tropospheric air to the west. Thus there is potential for a steep depositional gradient, and very different depositional regimes along the Front Range. To help determine source-receptor relationships, we have supplemented two existing NADP sites (Sugarloaf; 2530 m; Niwot Ridge, 3,529 m) with two additional sites at C1 (3032 m) and Soddie (3,400 m). These four sites along North Boulder Creek span an elevation range of 1 kilometer and permit better resolution of storm tracks and N source areas. For this presentation, circulation conditions will be characterized by indices of vorticity, flow force, and vector component of flow direction, at multiple elevations, as well as by synoptic weather type.

Class I Areas at Risk: AIRMoN and Nitrogen Deposition at a High-elevation, Western Site

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Here we report on atmospheric deposition of inorganic nitrogen from the only AIRMoN-type site operated west of the Mississippi River. Our site was not part of the official AIRMoN program but was operated and maintained according to AIRMoN protocols, except for sample analysis. Thirty-two precipitation events were sampled between 1 June and 30 September, 2000, near Telluride Colorado at an elevation of 3,200 m. Inorganic nitrogen deposition at the AIRMoN site of 1.41 kg ha-1 during the study period was 25% to 50% higher than nearby NADP sites. In turn, nitrogen deposition at these NADP sites was similar to high-elevation sites in and near the Colorado Front Range that have been shown to be impacted by atmospheric deposition of inorganic nitrogen in wetfall. Power plant emissions are the likely source of this elevated inorganic nitrogen in wetfall to the San Juan Mountains. PCA analysis shows that solutes that are emitted from power plants were clustered tightly together, including nitrate, ammonium, sulfate, and chloride. Trajectory analysis, including both backward trajectories and forward trajectories, shows that the airmasses that contributed to the precipitation events with high amounts of nitrogen deposition at the AIRMoN site passed directly over or near power plants. Our results suggest that Class I Wilderness Areas in and near the San Juan Mountains are at risk to ecosystem impairment at present rates of atmospheric deposition of inorganic nitrogen in wetfall.

Nitrogen Deposition in Primenet Park Units: a Comparative Analysis

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Wet deposition is being monitored in fourteen National Parks (NPs) as part of the NPS/EPA PRIMENet (Park Research and Intensive Monitoring of Ecosystems Network), including Acadia, Shenandoah, Great Smoky Mountains, Everglades, Virgin Islands, Big Bend, Theodore Roosevelt, Canyonlands, Glacier, Rocky Mountain, Olympic, Denali, Sequoia-Kings Canyon and Hawaii Volcanoes NPs. PRIMENet park sites are part of the National Atmospheric Deposition Program, monitoring weekly concentrations and deposition of inorganic nitrogen species, nitrate and ammonium. A comparison of the 1999 NADP data for these fourteen sites shows a gradient of concentration of inorganic nitrogen (N) from highs in the eastern parks, to lows in Olympic, Virgin Islands and Denali NPs. When we compare N deposition in kg/ha/yr the patterns are somewhat different due to precipitation amount and seasonality. In these Class 1 parks the ecosystem indicators that are most likely to be affected by nitrogen inputs are stream water quality in the upland parks in the East and high-elevation lakes in the West. Soils and surface waters in western mountain parks are also at risk to pulses of N released from melting seasonal snowpacks. A case study comparing an eastern park (Shenandoah) with a western park (Sequoia-Kings) shows the temporal variability of inorganic N concentrations at these two different locations, influenced by different sources of emissions.

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An Evaluation of Alternative Absorbent Coatings and Filter Media for Gas and Aerosol Sampling Using Annular Denuder Systems

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Over the past few years, ambient atmospheric measurements via annular denuder systems have increased in popularity in areas such as eastern North Carolina, where both crop and animal agriculture play prominent roles in the regional economy. Annular denude systems offer the advantage of simultaneously providing data on several trace gases (ammonia and acid gases) and aerosol species. However, recent developments reported in the literature indicate that acidic coatings that have been traditionally used in denuders for ammonia measurements may suffer from certain deficiencies. Furthermore, the customary serial arrangement of multiple membrane filters to capture the aerosol fraction of samples adds to the complexity and expense of long-term measurement programs that deploy multiple samplers. This study details certain options in terms of both coating matrices and filter media. Data collected using different acidic coatings illustrate reported differences in collection efficiency and stability. Ammonia data collected using these different coatings are further compared to a collocated chemiluminescent analyzer to illustrate relative differences in accuracy associated with different coatings. Data from filter media comparisons illustrate options that offer more operational and analytical simplicity, and lower cost while maintaining the integrity of collected aerosol samples and measurement accuracy.

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Nitrogen Compounds Deposition on Urban Ecosystems

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This investigation was carried out to determine air pollution and acid rain impacts in Tehran metropolitan area during the period 1992- 2000. Nitrate ion (NO_3^-) amount as wet deposition in a number of sampling stations of Tehran was over 30kg/ha/yr, and 13 kg/ha/yr for Chitgar Parkland,15 kilometer west of Tehran metropolitan area. Amount of NO_3^- in warm seasons was more than 2 folds comparing with cold seasons. Seasonal sampling of NO_3^- showed that, there was significant difference ($p= 0.01$) between cold and warm seasons. In cold period production of NO_3^- is not parallel with increased consumption of fossil fuels. It means that conditions for photochemical reaction does not occur during winter and cold season. Ammonia (NH_3) is formed as a result of the decomposition of most nitrogenous organic materials, used as fertilizer and as a chemical intermediate. Annual wet deposition of NH_3 was 9 kg/ha/yr. Acidity pH) of precipitation is neutralized by Suspended Particulate Matter (SPM), however many samples of precipitation showed acid rain(pH= 4) in Tehran. The regression equation for independent variable of NO_3^- and dependent variable of acidity(pH) was computed as [$Y= 6.048 + 0.071X$]. Coefficient of determination was 0.34
($r= 0.34$)

Possibility of Tree "Bark Pockets" as Time Capsules for Historical Monitoring of Nitrogen Pollution

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Historical monitoring of environmental pollution, combined with present day monitoring, is essential for assessing pollution levels in the world which have different levels and types of human activity and different environmental histories. Recently, bark enclosed in tree trunks, known as tree bark pockets, has been shown to provide some of the most readily available historical specimens for monitoring air pollution. Bark pockets are common in tree trunks. The phenomenon is well recognized by forestry technicians, saw millers, and dendrologists, because trunks with bark pockets often have problems with lack of strength, discoloration and microbial decomposition of the xylem layer. Bark pockets have not previously been identified as being useful parts of a tree. This study shows the potential values of the bark pockets and bark for monitoring of nitrogen pollution as pollution time capsules.

Characterization of Wet and Dry Deposition in the Down Wind of Industrial Sources in a Dry Tropical Area

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An atmospheric deposition study was conducted in the downwind of Shaktinagar Thermal Power Plant (STPP), Renusagar Thermal Power Plant (RTPP), and Anpara Thermal Power Plant (ATPP), at Singrauli region, U.P., in India to characterize the dry and wet deposition in relation to different pollution loading. During the study period dry and wet depositions and levels of gaseous pollutants (SO_2 and NO_2) have been estimated across the sites. Dry deposition was collected on a fortnight basis and wet deposition on event basis. Depositions were analyzed for pH, conductivity, nitrate, ammonium, and sulphate. Dry deposition rate both collected as clearfall and throughfall varied between 0.36 - 2.65 and 0.50 - 2.91 g m-2 day-1, respectively at control and maximally polluted sites. The pH of dry deposition varied from 5.9 to 7.2 during winter and 6.7 to 7.4 during summer across the sites. In rainy season, the mean pH of clear wet deposition varied from 6.8 to 7.2 and throughfall varied from 6.8 to 7.8. The concentrations of NO_2 and SO_2 pollutants were maximum in winter season. Mean SO_2 concentrations varied from 17 to 70 µg m-3 at control and differently polluted sites during winter season. The variation in NO_2 concentrations did not show a pattern similar to that of SO_2. Maximum NO_2 concentration in winter season was 42 µg m-3 observed near RTPP, whereas in summer maximum was observed near STPP. NO_2 concentration did not show much variation among different sites, suggesting that the sources of NO_2 emission are evenly distributed along the sites. The concentrations of NH_4^+, NO_3^- and SO_4^{2-} ions in dry deposition were found higher in summer as compared to winter season. In dry deposition (clear fall) the concentrations of NH_4^+, NO_3^- and SO_4^{2-} varied from 0.13-1.0, 0.81-2.15 and 0.67-3.76 mg l-1 respectively. In wet deposition (clear fall) the above varied from 0.14-0.74, 0.81-1.82 and 0.67-2.90 mg l-1 respectively. The study clearly showed that the dry deposition was maximum near the power plants. Both dry and wet depositions varied between the sites and season, which suggests significant impact of industrial activities in modifying the atmospheric input.

Month-to-month Variation in Concentration in Precipitation of Nitrate and Ammonium at Sites in the USA

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This paper summarizes the monthly concentration of ammonium and nitrate in precipitation for sites across the 48 contiguous states of the USA. The data are from the National Trends Network (NTN) of the National Atmospheric Deposition Program (NADP). About 200 sites are analyzed, with some of the site data records exceeding 20 years. The fine temporal and spatial coverage by NTN allows for a more comprehensive examination of seasonal concentration patterns than has been possible in the past. Because of the long temporal record the data are grouped and analyzed by month instead of some longer averaging period. Maps of the month at each site of the highest median concentration show considerable variation across the 48 states and between different ion groups. For example ammonium concentrations are highest for eastern sites during months 4, 5, and 6; for central plains sites during months 2, 3 and 4; for southwestern sites during month 6; and for northwestern sites during month 8. Ammonium concentrations will be examined in detail and discussed in relation to the expected variation in potential ammonia emission sources: livestock, fertilizer losses and emission from crops.

Atmospheric Deposition of Nitrogen and Sulphur Compounds in the Czech Republic

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In this paper estimates of dry and wet deposition of nitrogen and sulphur compounds in the Czech Republic for the years 1994 and 1998 are presented. Deposition has been estimated from monitored and modeled concentrations in the atmosphere and in precipitation, where the most important acidifying compounds are sulphur dioxide, nitrogen oxides and ammonia, and their reaction products. Measured atmospheric concentrations of SO_2, NO_x, NH_3 and aerosol particles (SO_4^{2-}, NO_3^- and NH_4^+), along with measured concentrations of SO_4^{2-}, NO_3^- and NH_4^+ in precipitations, weighted by precipitation amounts, were interpolated with a properly used Kriging technique on a 10 x 10 km grid covering the whole Czech Republic. Wet deposition was derived from concentration values for SO_4^{2-}, NO_3^- and NH_4^+ in precipitations and from precipitation amounts. Dry deposition was derived from concentrations of gaseous components and aerosol in the air, and from their deposition velocities. It was estimated that the annual average deposition of SO_x in the Czech Republic decreased from 1384 to 1027 mol H^+ ha-1 a-1 between 1994 and 1998. The annual average NO_y deposition was estimated to be 972 and 919 mol H^+ ha-1 a-1 in 1994 and 1998 respectively. The annual average NH_x deposition was estimated to be 887 mol H^+ ha-1 a-1 and 779 mol H^+ ha-1 a-1 in 1994 and 1998 respectively. Sulphur compounds (SO_x) contributed about 36 %, oxidized nitrogen species (NO_y) 37 %, and reduced nitrogen species (NH_x) 27 % to the total deposition in the Czech Republic in 1998. The wet deposition contributes 42 % to the total deposition in the Czech Republic in 1998.

EFFECTS OF ATMOSPHERIC DEPOSITION OF NITROGEN
KATHY TONNESSEN, SESSION CHAIR

PRESENTATION ABSTRACTS
(IN ALPHABETICAL ORDER BY FIRST AUTHOR)

Effects of N Deposition on Plants and Soil Microorganisms on an Urban to Rural Gradient in Southern California

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Southern California has up to 45 kg/ha/yr N deposition, the highest in the nation. We measured the effects of N deposition on vegetation and soil microorganisms on a gradient from the Riverside area southward 50 km. Most of the atmospheric N that is plant-available is in the form of nitrate, originating from automobile exhaust. Extractable N in soil along the gradient was 87 to 15 µg/g. To test the hypothesis that N is increasing the productivity of exotic annuals, we fertilized plots following a 1993 wildfire in a rural site with 60 kg/ha/yr of ammonium nitrate. Grass productivity increased with N during wet years but not during dry years. Shrub cover increased after the fire but was lower in the fertilized plots by the forth year. The species richness of rbuscular mycorrhizal fungi decreased with elevated soil N along the gradient and in fertilized plots, and large-spored species dropped out. Fatty acid methyl ester soil profiles indicated changes in soil bacteria and fungi that were similar for soils with N deposition or fertilization. Soil microorganisms were consistent indicators of elevated soil N, while there was variability in the plant community along the gradient dependent on other local factors.

The Impacts of Air-borne Nitrogen Pollutants on Diversity: an European Overview

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The effects of increased atmospheric nitrogen inputs, from both NO_y & NH_x on diversity in semi-natural and natural ecosystems of conservational value are reviewed. The severity of their impacts depends on the abiotic conditions in the particular ecosystem. The sensitivity of various vegetation types is presented in detail. Long-term nitrogen enrichment may gradually increased the availability of nitrogen in several of the reviewed vegetation types leading to competitive exclusion of characteristic species by more nitrophilic plants, especially under oligotrophic to mesotrophic soil conditions. Soil acidification is especially important after nitrification of ammonium in weakly buffered environments when acid-resistant plant species became dominant while several endangered plants typical of intermediate pHs disappear. In addition, the related change in the balance between ammonium and nitrate may also affect the performance of several plant species. The susceptibility of plant species to secondary stress factors (pathogens; frost & drought) may be seriously affected by air-borne nitrogen pollutants but the relevant data are absent for most plant communities. It is thus crucial to control emissions of nitrogenous compounds to the atmosphere, in order to reduce or prevent effects on diversity.

Responses of Forests and Streams in Southern Appalachian Mountains to Changes in S, N, and Basecation Deposition

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As part of a comprehensive regional environmental assessment, the Southern Appalachian Mountains Initiative (SAMI) is evaluating the responses of streams and forests in the Southern Appalachian Mountains to changes in future deposition levels of sulfate, nitrate, ammonium, and base cations. The current sensitivity of streams and forests in the Southern Appalachian Mountains to acidification has been characterized using physio-geographic province, stream water acid neutralizing capacity, and forest community type as classification variables. The Model of Acidification of Groundwater in Catchments (MAGIC) and the Nutrient Cycling Model (NuCM) are being used to evaluate the responses of 155 representative streams and 15 forest stands, respectively, to changes in deposition over the period 1995 to 2040. The annual average deposition for 1991-1995 for the 180 sites was characterized using spatially interpolated wet deposition data from the National Atmospheric Deposition Program and factors for dry and cloud deposition derived from the ASTRAP atmospheric transport model. Changes in future wet and dry deposition were projected using the Urban to Regional Multi-scale (URM) atmospheric model and emissions inventories representing SAMI emissions reduction strategies. MAGIC results will be used to interpret regional changes in stream water quality and trout survival. NuCM results will be used to interpret changes in acidification risk for the modeled forest stands.

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Deposition and Effects of Nitrogen Deposition in California Ecosystems

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Atmospheric deposition of nitrogen (N) in California is ecologically significant and highly variable, ranging from about 1 to 45 kg/ha/year. The lowest ambient concentrations and deposition values are found in remote locations of the eastern Sierra Nevada Mountains and the highest in parts of the San Bernardino and San Gabriel Mountains exposed to urban photochemical smog and agricultural emissions. In the Sierra Nevada Mountains, N is deposited mostly in precipitation (rain, snow, and fog) although, especially in the southern part of that range, dry deposition may also provide substantial amounts of N. On the western slopes of the Sierra Nevada, the majority of airborne N is in reduced forms as ammonia (NH_3) and particulate ammonium (NH_4^+) resulting from agricultural activities in the California Central Valley. In southern California, most of the N air pollution is in oxidized forms of nitrogen oxides (NO_x), nitric acid (HNO_3), and particulate nitrate (NO_3^-) resulting from gasoline and diesel fuel combustion and complex photochemical reactions. Consequently, in southern California dry deposition of gases and particles provides most (up to 90%) of the atmospheric N to forests and other ecosystems, with the exception of areas where fog occurrence is frequent. In the mixed conifer forest zone, elevated deposition of N may initially benefit growth of trees and other plants. However, chronic N deposition and ozone (O_3) exposure tend to affect forest health and cause other detrimental effects such as reduction of biomass and carbohydrate levels of roots. In addition to growth disturbances, changes in vegetation composition and contamination of ground and stream water are some of the observed consequences. Other ecosystems have also been affected - in coastal sage ecosystems of southern California, non-native nitrophilous grasses have suppressed native plant species. Long-term, complex interactions of N deposition with other environmental stresses such as elevated O_3 concentrations; drought, insect infestations, fire suppression or intensive land management practices may affect water quality and sustainability of California forests and other ecosystems. Long-term studies of N air chemistry, deposition, cycling, and biological and ecological changes in mixed conifer forests will be conducted on a network of 18 sites along O_3 and N air pollution gradients in the San Bernardino Mountains. The network will encompass 12 sites in which air pollution effects on mixed conifer forest have been studied for nearly 40 years. Similar long-term studies on N deposition and effects are planned for desert, coastal sage and chaparral ecosystems of southern California. These studies will be done in collaboration with researchers of the University of California, Riverside.

Response of Aquatic Ecosystems to Nitrogen Deposition in the Rocky Mountains

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In the Rocky Mountain region of the United States, nitrogen deposition rates are affected by population growth, agricultural activities, and energy development. Regional plus local emissions result in annual atmospheric deposition rates of 3-5 kg N /ha in the Front Range of Colorado, causing symptoms of advanced watershed nitrogen saturation in sensitive alpine/subalpine ecosystems. Research there has provided significant insight into nitrogen sources, cycling, and effects on terrestrial and aquatic ecosystems. Here we examine spatial and temporal patterns of nitrogen deposition and surface-water nitrate concentrations from other parts of Colorado and Wyoming to (1) assess the potential for nitrogen saturation in watersheds with moderate rates of nitrogen deposition; and (2) determine if the aquatic response in other areas is consistent with conceptual models of nitrogen cycling developed for Front Range sites. Early to advanced symptoms of nitrogen saturation were evident in sensitive ecosystems from southeast Colorado to north central Wyoming. As in the Front Range, sensitivity to nitrogen deposition was determined by the presence of steep slopes and sparse soil and vegetation. Future changes in nitrogen deposition or climate are likely to affect biogeochemical cycling in sensitive ecosystems that are scattered over much of the Rocky Mountain region.

Accumulation of Nitrogen in Forest Soils Continues to Cause Episodic Acidification of Streams in Calcium Depleted Watersheds

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In forest soils of geologically sensitive regions of the northeastern United States, atmospheric deposition of sulfur and nitrogen has led to decreased concentrations of exchangeable calcium (and other bases), the form readily available for neutralization of acidic soil water and uptake by roots. Although, leaching of cations by sulfate has decreased over the past three decades as a result of decreasing sulfur emissions, neither emissions of nitrogen nor leaching by nitrate have shown consistent trends. Analysis of northeastern soils suggests that atmospheric deposition has increased the accumulation of nitrogen in the O horizon, and that soils with high organic matter content tend to retain a larger fraction of nitrogen inputs than soils with low organic matter content. Organic rich soils also tend to release higher amounts of nitrate to streams during storms that follow extended dry periods than soils with relatively low organic matter content; a response that results in severe episodic stream acidifiction in calcium depleted watersheds.

Animal Feeding Operations, Ammonia, and Particulate Health Effects

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Nitrogen from livestock can have wide-ranging effects. Federal regulators recently proposed new regulations on livestock producers designed to control nitrogen in surface and ground water. Changes in livestock management practices can affect ammonia emissions, as agricultural operations are the largest source of ammonia emissions in the U.S. These emissions contribute to the formation of fine particulate matter in the atmosphere. Epidemiologists have found an association between particulate matter and adverse health effects, including premature mortality. Management practices that reduce ammonia emissions may decrease adverse health effects, resulting in significant economic benefits. We estimated the impact of a variety of emission controls, including diet optimization, alum, storage tank covers, and the incorporation of manure into the land. To the extent that ammonium nitrate and ammonium sulfate contribute to adverse health effects, ammonia management could have significant health implications. Our results suggest that a 10 percent reduction in livestock ammonia emissions can lead to over $4 billion annually in benefits. Because of the heterogeneous nature of particulate matter, a key question is to what extent the composition and size of particulate matter contribute to adverse effects. Comprehensive cost-benefit analyses of animal waste management practices should consider including these impacts.

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The Impacts of Increasing Atmospheric Nitrogen Deposition on Forest Ecosystems and Watersheds in the Chesapeake Bay Region

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Forests cover about 56% of the total land area of the Chesapeake Bay Watershed. It is important to evaluate the potential effects of long-term atmospheric N deposition on forest productivity, nitrogen retention and water quality. In this study, we applied a process-based forest ecosystem model, PnET-CN, to estimate forest productivity, N leaching losses and forest N retention under a chronic increase of atmospheric N deposition. Wet nitrogen deposition data from 1992 to 1998 were used in this study. The high resolution deposition maps were generated by Penn State University using interpolation algorithms based on concentration data collected at National Atmospheric Deposition Project/ National Trends Network monitoring sites and precipitation from a lager network of sampling sites. The model showed that the average N leaching loss from forested lands is 1.26 kg ha^-1 y^-1 at current N deposition levels, suggesting about 87% retention of N by forest ecosystems. Total dissolved inorganic N exported from the forested watersheds is 25,337 Mg. If N deposition were twice current values, N retention by forests would drop to 76%. Total N leaching loss to streams would then increase four fold. The model simulations also indicated that the N deposition provided additional N availability to trees, increasing the foliage N concentration, which had a positive effect on regional forest productivity. However, it is unclear what is the threshold in which additional nitrogen may degrade forest ecosystem function in terms of reducing net photosynthesis, N use efficiency and forest growth.

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A Mitigation Strategy for Deposition from a New Electricity Generating Facility

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It has been estimated that about a quarter of the total nitrogen load in the Chesapeake Bay may be attributed to atmospheric deposition. Policy coordinating the restoration of the Bay has been developed through a series of Chesapeake Bay Agreements, negotiated and agreed to by the affected jurisdictions. The current Agreement recognizes the contribution from atmospheric deposition and is anticipating that the implementation of the Clean Air Act Amendments of 1990 will provide collateral reductions in deposition. This paper discusses a deposition mitigation strategy developed for new electricity generating facility located close to the Bay. For the majority of the Bay watershed, new major sources are required to offset NO_x emissions, generally at a greater than 1:1 ratio. However, these offsets may not be in the same region, so that local deposition effects are not addressed. An estimate of 2.4 tons per year in incremental deposition in the vicinity of the new facility was made using the CALPUFF model. Nonpoint source loading mitigation studies have shown that vegetative buffers in riparian zones play an important role in intercepting nitrogen before it can run off into the receiving waterway. A forest planting plan that included riparian forest buffer was included as a part of the new facilities permit to construct.

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Mitigation Strategies for N-deposition Sources in South San Jose, Ca: Checkerspot Butterflies, Powerplants, and the Information Superhighway

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Nitrogen deposition from urban smog sources can greatly affect downwind ecosystems. In south San Jose, CA, grasslands on thousands of hectares of nutrient-poor serpentinitic soils are being invaded by nutrient-demanding introduced annual grasses, driven by dry N-deposition loads around 10 kg ha/y. These grass invasions threaten the native biodiversity of the serpentinitic grasslands, including the federally listed threatened Bay checkerspot butterfly. Surprisingly, moderate and well-managed cattle gazing is necessary to combat the grass invasions. Additional NO_x and NH_3 sources planned for the region include a 600 MW natural gas fired powerplant and industrial parks that may eventually draw 20,000 to 50,000 additional cars per day, producing hundreds of tons of NO_x. The US Fish and Wildlife Service and California Energy Commission oversaw the development of a mitigation formula for the powerplant that addressed incremental increases in N-deposition over already stressful background levels. The formula may lead to the dedication of 52 hectares of serpentinitic grassland habitat along with a management endowment for maintaining a suitable grazing regime. Application of the mitigation formula to other projects in the region may lead to several hundred hectares of this unique habitat being protected and managed in perpetuity. "

EFFECTS OF ATMOSPHERIC DEPOSITION OF NITROGEN
KATHY TONNESSEN, SESSION CHAIR

POSTER ABSTRACTS
(IN ALPHABETICAL ORDER BY FIRST AUTHOR)

Effects of Nitrogen Deposition on High Elevation Spruce-Fir and Deciduous Forests Across the Northeastern U.S.

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Concern about the effects of nitrogen deposition on high elevation spruce-fir forests has continued for several decades throughout Europe and the US. Recent studies have suggested that nitrogen deposition may also have negative impacts on forest health in deciduous forests. To test this hypothesis, in 1999, a series of deciduous plots were sampled adjacent to spruce-fir plots originally established in 1987/88 across a nitrogen deposition gradient in the northeastern US. A subset of the spruce-fir plots as also re-sampled. Foliar, forest floor and tree core samples were collected from 70 spruce-fir and 60 deciduous plots at several elevations and aspects to evaluate how these forests respond to nitrogen deposition, and to determine if the ecological state of the previously sampled spruce-fir plots has changed during the past 12 years. Results indicated that forest floor chemistry (C:N ratios, pH and net mineralization and nitrification potential) from deciduous and spruce-fir plots were positively correated at $p < 0.05$. Nitrogen deposition was negatively correlated with forest floor C:N ratios within both forest types. Additionally, spruce-fir forest floor C:N ratios decreased by 10% from 1987 to 1999. These relationships provide useful information about the chronic impacts of nitrogen deposition on spruce-fir and deciduous forests.

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Gross Rates of Internal N Cycle in Acid, High N Deposition Forest Soil: Changes under Long-term N Saturated and Limed Conditions

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The effects of N saturation and liming on the microbial internal N cycling in acid, high N deposition beech forest soils, common in Germany, received little attention. Our study site in Solling, Germany receives ambient N deposition from 35 kg N ha/yr during 1969-1989 to 25 kg N ha/yr beginning the last decade. It is largely unknown whether the internal N cycle and microbial biomass in such system could be improved by liming and would reverse from N saturation (attained by 11/yr N fertilization on top of the ambient N deposition) after 7 years of reduce N input (no fertilizer application and reduced N deposition). Our objectives were: 1) to assess quantitatively the changes of internal N cycling and of microbial biomass under control, N saturation, and lime amelioration, and 2) to determine the factors controlling the differences in internal N cycling from these systems. Gross rates of internal N cycle were measured using 15N pool dilution technique. Our results give insights on the importance of integrating measures of microbial N cycling activity, as sensitive and long-term soil N status indicator, in the development of parameters for assessing N status of forest ecosystems.

Water and Vegetation Sampling to Evaluate Nitrogen Enrichment at Chassahowitzka National Wildlife Refuge 1996-Present

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The U.S. Fish and Wildlife Service (FWS) and Mote Marine Laboratory (MML) have been conducting water and vegetation sampling in the riverine and offshore waters of Chassahowitzka National Wildlife Refuge (NWR) since 1996 to evaluate nutrients and eutrophication related parameters. Chassahowitzka NWR is located on the Gulf of Mexico approximately 100 km north of Tampa, Florida. Portions of the refuge are a nationally designated wilderness and a Class I air quality area. The study was initiated in response to FWS concerns that the Chassahowitzka ecosystem might be experiencing similar increased nitrogen loadings and eutrophication as observed in nearby Tampa Bay. Nitrogen inputs from groundwater discharges to Chassahowitzka have increased; in addition, nitrogen inputs from wet deposition from the atmosphere have increased. The shallow nature of the area provides comparatively little dilution capacity of the region to "buffer" additional nutrient loads. Approximately 20 stations are sampled quarterly for water quality parameters, including nutrients, chlorophyll, and physical parameters. Submerged aquatic vegetation (SAV) is sampled yearly at 30 sites to determine species-specific frequency and abundance. During most sampling periods, water quality has been generally good in Chassahowitzka. However, in 1998, a persistent phytoplankton bloom occurred, apparently stimulated by an increase in offshore nutrients following an unusual discharge event from a nearby watershed river. The severe increases of chlorophyll and reductions in water clarity were coincident with the reduction in abundance or total exclusion of several SAV species from the refuge. Subsequent vegetation samplings have identified recovery of at least some of the species, with others still at depressed levels. FWS is concerned that any increases in nitrogen to the area will further compromise the ecological health and wilderness values of Chassahowitzka NWR.

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The Implications of Ammonia Emissions to Coastal and Estuarine Areas

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Considerable attention continues to focus on nutrient over-enrichment of U.S. coastal and estuarine waters. In recent years, a growing number of people have begun to define the importance of ammonia emissions and subsequent nitrogen deposition on the declining health of these areas. To effectively deal with ammonia emissions, and the attendant effects on air, land and water quality, attention must be focused on strengthening our abilities to identify the primary sources and magnitude of emissions, understand the transport and fate of these emissions, and assess the ecological implications created by those emissions. This poster presentation provides insights into the sources and relative magnitude of ammonia emissions, the nature and distribution of ammonia/ammonium deposition, and the ecological implications. Explicit examples used to support the presentation come from an array of science-based assessments."

Effects of Fertilizers on the Human Health of Sindh, Pakistan

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Lake and canal water were collected and monitored for 06 years for the contents of nitrogen. It was found that the sources of nitrogen were the agricultural fertilizers. Attempts were made to correlate the diseases of human with nitrogen. Various parameters are correlated with each other and with the diseases.

Evaluation of the CALPUFF Model Using NADP/NTN and CASTNet Data

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The Maryland Department of Natural Resources Power Plant Research Program (PPRP) has undertaken efforts to investigate the contribution of atmospheric nitrogen to excess nutrient loading in the Bay. These investigations have focused on the use of the CAMET/CALPUFF modeling system to estimate nitrogen deposition attributable to NO_x emissions from both local Maryland and regional sources onto the surface of the Bay and onto land areas in the Bay watershed. PPRP's work on atmospheric nitrogen deposition has resulted in the development of an approach to using CALMET/CALPUFF that allows for estimates of nitrogen deposition due to sources of NO_x in the Eastern U.S. The work also involves evaluations of the estimates produced by CALPUFF, by comparing model predictions to measured deposition rates and concentrations. PPRP has used NADP/NTN data on nitrogen deposition to perform evaluations of wet deposition rates and has used CASTNet data to perform evaluations of HNO_3 and particulate nitrate concentrations. The proposed paper focuses on the evaluation of model vs. measured deposition and concentrations, presenting comparisons for stations in the eastern U.S. and providing insights into the potential uses of CALMET/CALPUFF for investigating the effect of air pollution emissions control strategies on acidic deposition.

Nitrogen Mobilisation by Human Beings, Pets, Animals, and Livestock, Environmental Impact of Nitrogen Sources

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This paper compares yearly nitrogen mobilization required in a country for the feeding of human populations, pets and livestock (all of which are defined by human activities). Every animal requires protein nutriments. The nitrogen contained in food resources mainly returns to the environment as wastes, sewage and sludge. Hence, every animal will engender environmental impacts. Results of the model for France are proposed as an example. Results obtained are discussed especially in relationship to the ESB disease context. The link between nitrogen sources for the feeding of humans and animals and the environmental impacts is discussed using farm-gate nitrogen balances. Depending on the nitrogen resource used to feed livestock, impacts on environment are found to be quite different. If the nitrogen sources used in feeding are locally produced, the impact should be limited; conversely, if nitrogen sources are imported, the nitrogen balance is degraded. As a consequence, water resource degradation could increase. Results estimate what the effects would be on the nitrogen balance if an entire nation suppressed protein importation for livestock production. Results for France are proposed as an example. The balance obtained is discussed."

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