2014 Scientific Symposium and Fall Meeting

The Global Connection of Air and Water

October 21-24, 2014
Indianapolis, IN

National Atmospheric Deposition Program

Schedule at a Glance

	Tuesday October 21	Wednesday October 22	Thursday October 23	Friday October 24
7:30	Registration	Registration	Registration	
8:00				CLAD Meeting
8:15			Overview	
8:30	Joint Subcommittee Meeting	Welcome and Annual State of NADP	Session 4 (4 speakers)	
8:45				
9:00		Keynote Address Dr. David A. Wolf NASA		
9:15				
9:30				
9:45				
10:00	**Break**	**Break**	**Break**	**Break**
10:15	Subcommittee Meetings (4)	Session 1 (5 speakers)	Session 5 (4 speakers)	Total Deposition Science Committee Meeting
10:30				
10:45				
11:00				
11:15				
11:30				
11:45				
12:00	**Lunch on your own**	**Lunch on your own**	**Lunch on your own/SCUAM Lunch Meeting**	**Lunch on your own**
12:15				
12:30				Total Deposition Science Committee Meeting
1:00				
1:15			Session 5 (4 speakers)	
1:30	Joint Subcommittee meeting	Session 2 (5 speakers)		
1:45				
2:00				
2:15				
2:30				
2:45			**Break**	
3:00			Session 6 (5 speakers)	
3:15		**Break**		Adjourn
3:30	**Break**			
3:45	Executive Committee Meeting	Session 3 (4 speakers)		
4:00				
4:15				
4:30				
4:45			Wrap-up	
5:00				
5:15			**Optional Field Trip**	
5:30		**Break**		
6:00	**Adjourn**			
6:30	Guided Dinner Outings (optional)	Poster Session and Reception		
7:00				
8:00				
9:30				

NADP 2014
Technical Committee Meeting

October 21-24, 2014
Indianapolis, IN

Scientific Symposium Chair
Martin Risch
U.S. Geological Survey

PROCEEDINGS

Prepared by

Lisa A. Volk
NADP Program Office
Illinois State Water Survey
Prairie Research Institute
University of Illinois
2204 Griffith Drive
Champaign, IL 61820

October 2014

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Poster Session (arranged in alphabetical order by first author)

NADP Scientific Symposium Agenda

NADP Annual Meeting and Scientific Symposium
Indianapolis, IN
October 21-24, 2014

Tuesday, October 21, 2014		**Room Location**
Open All Day	Registration Desk	Indianapolis Foyer
8:30 a.m.–10:00 a.m.	Joint Subcommittee Meeting	Indianapolis Ballroom
10:00 a.m.-10:15 a.m.	Break	Indianapolis Foyer
10:15 a.m.–12:10 p.m.	Subcommittee Meetings	
	Network Operations	Indianapolis Ballroom
	Data Management & Analysis	Circle City 3 Room
	Ecological Response and Outreach	Corydon Room
	Critical Loads	Vincennes Room
12:10 p.m.-1:30 p.m.	Lunch on your own	
1:30 p.m. - 3:30 p.m.	Joint Subcommittee Meeting	Indianapolis Ballroom
3:30 p.m. - 3:45 p.m.	Break	Indianapolis Foyer
3:45 p.m. - 6:00 p.m.	Executive Committee Meeting	Corydon Room

Wednesday, October 22, 2014		**Room Location**
Open All Day	Registration/Office	Indianapolis Foyer
8:30 a.m. - 9:00 a.m.	**Welcome, Program Office Report Awards and Announcements**	Indianapolis Ballroom
	Martin Risch: NADP- Vice Chair, Symposium Chair U.S. Geological Survey	
	David Gay: NADP Coordinator	
	Chris Rogers: NADP Chair AMEC E&I	

Wednesday, October 22, 2014		**Room Location**
		Indianapolis Ballroom
9:00 a.m. – 10:00 a.m.	**Keynote Address** **The International Space Program and the Global Connection of Air and Water** Dr. David A. Wolf, NASA	
10:00 a.m. – 10:20 a.m.	Break	
Technical Session 1:	**International Atmospheric Deposition Monitoring and Models** Session Chair: Richard Artz NOAA – Air Resources Laboratory	
10:20 a.m. – 10:50 a.m.	**A Global Assessment of Precipitation Chemistry and Deposition** Robert Vet, Environment Canada	
10:50 a.m. – 11:10 a.m.	**What in the World is the WMO GAW QASAC-Americas and is NADP Contributing to Standardization of Global Precipitation Chemistry Measurements?** Van Bowersox, World Data Centre for Precipitation Chemistry and Quality Assurance/Science Activity Centre – Americas	
11:10 a.m. – 11:30a.m.	**Mercury Monitoring in Taiwan and Southeast Asia** Guey Rong Sheu, National Central University	
11:30 a.m. – 11:50 a.m.	**Total Deposition of Nitrogen and Sulfur in the United States** Gary Lear, U.S. EPA	
11:50 a.m. – 12:10 p.m.	**Increased Air Pollution over the Chesapeake Bay and its Effect on Deposition to the Bay** Dan Goldberg, University of Maryland	
12:10 p.m. – 1:40 p.m.	Lunch on your own	
Technical Session 2:	**Measurements and Models of Wet and Dry Atmospheric Deposition** Session Chair: John Walker USEPA	
1:40 p.m. – 2:00 p.m.	**Estimation of Nitrogen Deposition in Precipitation from Historical Studies, 1955-1984** Amy Ludtke, USGS	

Wednesday, October 22, 2014		**Room Location**
		Indianapolis Ballroom
2:00 p.m.–2:20 p.m.	**Organic Nitrogen in the Snowpack throughout the United States Rocky Mountains** Bret Schichtel, National Park Service	
2:20 p.m.-2:40 p.m.	**Field Performance Evaluation of the Monitor for AeRosols and GAses in Ambient Air (MARGA)** Greg Beachley, US EPA	
2:40 p.m. – 3:00 p.m.	**Improvements to the Characterization of Organic Nitrogen Chemistry and Deposition** Donna Schwede, US EPA	
3:00 p.m. – 3:20 p.m.	**Method Development Estimating Atmospheric Deposition of Various Pollutants** Leiming Zhang, Environment Canada	
3:20 p.m. – 3:40 p.m.	Break	
Technical Session 3:	**Agricultural Emissions and Atmospheric Deposition** Session Chair: Richard Grant Purdue University	
3:40 p.m. – 4:10 p.m.	**National Assessment of Emissions from Livestock Facilities** Al Heber, Purdue University	
4:10 p.m. – 4:30 p.m.	**Using estimates of nitrogen deposition from NADP to assess sources and spatial distribution of stream nitrogen loads in the United States** Anne Hoos, USGS	
4:30 p.m. – 4:50 p.m.	**Quantifying Bi-Directional Ammonia Flux from Managed Cropland by Relaxed Eddy Accumulation** Andrew Nelson, University of Illinois	
4:50 p.m. - 5:10 p.m.	**Measurement of Speciated Nitrogen and Sulfur Fluxes Above a Grass Field** Ian Rumsey, College of Charleston	
5:10 p.m. – 5:35 p.m.	Summary/Wrap-up of Wednesday and Thursday Preview	
5:35 p.m. – 6:30 p.m.	Break	

Wednesday, October 22, 2014		**Room Location**
6:30 p.m. – 9:30 p.m.	**Poster Session and Reception**	Monument Hall
Thursday, October 23, 2014		**Room Location**
Open All Day	Registration/Office	Indianapolis Foyer

Thursday, October 23, 2014		**Room Location**
		Indianapolis Ballroom
8:15 a.m. – 8:30 a.m.	**Opening remarks, announcements and overview of Day 2** Martin Risch, NADP Vice Chair, USGS	
Technical Session 4:	**Mercury Deposition and Ecosystem Effects** Session Chair: David Schmeltz US EPA	
8:30 a.m. – 9:00 a.m.	**Historical and Global Perspectives of Environmental Hg Deposition: Future Science Directions for Effective Monitoring and Research** Dave Krabbenhoft, USGS	
9:00 a.m. – 9:20 a.m.	**Long-Term Trends in Mercury Deposition** Peter Weiss-Penzias, University of California, Santa Cruz	
9:20 a.m. – 9:40 a.m.	**Mercury in fish from 21 national parks in the western U.S. – Inter- and intra-park variation in concentrations and ecological risk** Colleen Flanagan-Pritz, National Park Service	
9:40 a.m. – 10:00 a.m.	**Measurements of Gaseous Oxidized Mercury Dry Deposition Using Passive Samplers at the NAPD Beltsville (MD99) Site** Xinrong Ren, NOAA – Air Resources Laboratory	
10:00 a.m. – 10:20 a.m.	Break	
Technical Session 5:	**Critical Loads of Atmospheric Deposition** Session Chair: Jason Lynch and Jennifer Phelan USEPA and RTI	
10:20 a.m. – 10:50 a.m.	**Critical Loads of Acidity to Recover Acid-impaired Adirondack Lakes** Charles, Driscoll, Syracuse University	

Thursday, October 23, 2014 **Room Location**

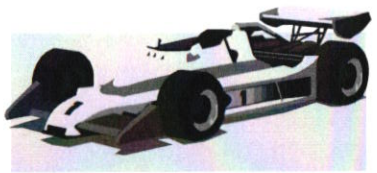
Indianapolis Ballroom

10:50 a.m. – 11:20 a.m.	Critical loads in Europe: overview and latest developments Gert Jan Reinds, Alterra-Wageningen UR
11:20 a.m. – 11:40 a.m.	**Nitrogen Critical Loads in the Pacific Northwest, USA: Current Understanding and Data Gaps** Tonnie Cummings, National Park Service
11:40 a.m. – 12:00 p.m.	**Contribution of Oil and Gas Production to Nitrogen Deposition and Critical Load exceedance in Class 1&2 Areas in the Western US** Tammy Thompson, CIRA, Colorado State University
12:00 p.m. – 1:20 p.m.	Lunch on your own Downtown Food Truck Rally **Or**
12:00 p.m. – 1:20 p.m.	Science Committee for Urban Air Monitoring Lunch Meeting in Circle City 6
Technical Session 5:	**Critical Loads of Mercury and Nitrogen (continued)** Session Chair: Jason Lynch and Jennifer Phelan US EPA and RTI
1:20 p.m. – 1:40 p.m.	**Development and release of the Air Quality Portal for Land Management Planning: The application and use of critical loads for management and policy decisions** Claire O'Dea, USDA Forest Service
1:40 p.m. - 2:00 p.m.	**Comparison of Aerodynamic Resistance Parameterizations and Implications for Dry Deposition Modeling** John Walker, USEPA
2:00 p.m. – 2:20 p.m.	**Characteristics of New CMAQ Deposition Series of 2002 to 2011 for Critical Loads)** Robin Dennis, USEPA
2:20 p.m. – 2:40 p.m.	**A management tool for predicting effects of interactions of climate change and nitrogen deposition on forest health and setting critical loads** Linda Pardo, USDA Forest Service
2:40 p.m. – 2:55 p.m.	**Break**

Thursday, October 23, 2014 **Room Location**

Indianapolis Ballroom

Technical Session 6:	**Urban Air Chemistry and Deposition** Session Chair: Richard Pouyat USDA Forest Service
2:55 p.m. – 3:25 p.m.	**Urban Atmospheric Chemistry and Reactive Nitrogen Deposition** Emily Elliott, University of Pittsburgh
3:25 p.m. - 3:45 p.m.	**The Importance of Small Scale Deposition Gradients in the Urban Landscape** Thomas Whitlow, Cornell University
3:45 p.m. – 4:05 p.m.	**Sourcing Dry N Deposition in Urban Areas and Implications for National N Inventories** Katherine Redling, University of Pittsburgh
4:05 p.m. – 4:25 p.m.	**Controls on Variability of Nitrogen Deposition and Cycling within Urban Ecosystems** Steve Decina, Boston University
4:25 p.m. – 4:45 p.m.	**Chronology of Acid Rain in Mexico City and the Gulf of Mexico** Humberto Bravo and Rodolfo Sosa Echeverria, Universidad Nacional Autónoma de México
4:45 p.m. – 4:50 p.m.	Summary and Wrap-up of Thursday Preview for Thursday night and Friday
4:50 p.m.	Adjourn
5:00 p.m.	Assemble for shuttles to outing
5:30 p.m. – 7:30 p.m.	Optional Field Trip - Indianapolis Motor Speedway



Friday, October 24, 2014		**Room Location**
8:00 a.m. – 10:00 a.m.	Critical Loads Science Committee	Circle City 10
10:00 a.m. – 10:15 a.m.	Break	
10:15 a.m. – 12:00 p.m.	Total Deposition Science Committee Meeting	Corydon Room
12:00 p.m. – 1:00 p.m.	Lunch	
1:00 p.m. – 3:15 p.m.	Total Deposition Science Committee Meeting	Corydon Room
3:15 p.m.	**Adjourn**	

2014 NADP Site Operator Awards

National Atmospheric Deposition Program Operator Awards

5 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
CA45 - NTN	Steven Poor	Hopland	U.S. Geological Survey	10/03/1979
CO01 - NTN	Russell Lewins	Las Animas Fish Hatchery	U.S. Geological Survey	10/04/1983
FL34 - MDN	Deena Ruiz	Everglades Nutrient Removal Project	South Florida Water Management District	07/08/1997
FL97 - MDN	Deena Ruiz	Everglades-Western Broward County	South Florida Water Management District	11/08/2006
ME00 - NTN	Kelly Langley	Caribou	Maine DEP/EPA	04/14/1980
MDN	Kelly Langley	Caribou	Maine DEP/EPA	05/09/2007
ME04 - MDN	Bill Thompson	Carrabassett Valley	Penobscot Indian Nation/EPA	02/17/2009
NY20 - NTN	Charlotte Demers	Huntington Wildlife	NYSERDA	10/31/1978
PA72 - NTN	Rebecca Philpot	Milford	U.S. Forest Service	12/27/1983
TN14 - NTN	Deborah Brewer	Hatchie National Wildlife Refuge	TVA	10/02/1984

10 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
AL99 - NTN	Mack Smith	Sand Mountain Research & Extension Center	TVA	10/02/1984
AR02 - NTN	Stacy Wilson	Warren 2WSW	U.S. Geological Survey	05/25/1982
ID02 - NTN	Marrina Frederick	Priest River Experimental Forest	U.S. Forest Service	12/31/2002
IL11 - MDN	Michael Snider	Bondville	ISWS	01/06/1999
IN21-MDN	Michael Dalgleish	Clifty Falls State Park	Lake Michigan Air Directors Consortium	01/12/2001
LA30- NTN	Jerry Simmons	Southeast Research Station	U.S. Geological Survey	01/18/1983
MD08 - NTN	Mark Castro	Piney Reservoir	Maryland Dept. of Natural Resources	06/29/2004
ME04 - NTN	Bill Thompson	Carrabassett Valley	U.S. EPA - Clean Air Markets	03/12/2002
VA28 - NTN	Liz Garcia	Shenandoah NP - Big Meadows	National Park Service - ARD	05/12/1981
MDN	Liz Garcia	Shenandoah NP - Big Meadows	National Park Service - ARD	10/22/2002
VT99 - MDN	Miriam Pendleton	Underhill	Vermont Monitoring Cooperative	07/27/2004

15 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
FL23 - NTN	Jimmy Bishop	Sumatra	U.S. EPA - Clean Air Markets	01/26/1999
GA99 - NTN	Charles Welsh	Chula	U.S. Geological Survey	02/10/1994
IL46 - NTN	Walter Steiner	Alhambra	U.S. EPA - Clean Air Markets	01/26/1999
IL78 - NTN	Marty Johnson	Monmouth	U.S. Geological Survey	01/08/1985
NC06 - NTN	Nathan Hall	Beaufort	U.S. EPA - Clean Air Markets	01/26/1999
OH54 - NTN	Sally Hammond	Deer Creek State Park	U.S. EPA - Clean Air Markets	01/26/1999
OR97 - NTN	Lynn Conley	Hyslop Farm	U.S. EPA - Clean Air Markets	04/26/1983
PA00 - NTN	Sharon Scamack	Arendtsville	U.S. EPA - Clean Air Markets	01/26/1999
PA18 - NTN	Kevin Horner	Young Woman's Creek	U.S. Geological Survey	04/20/1999
VA24 - NTN	Gene Brooks	Prince Edward	U.S. EPA - Clean Air Markets	01/26/1999

20 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
AR03 - NTN	Harrell Beckwith	Caddo Valley	U.S. Geological Survey	12/30/1983
CA42 - NTN	Mike Oxford	Tanbark Flat	U.S. Forest Service	01/12/1982
PR20 - NTN	John Bithorn	El Verde	U.S. Forest Service	02/12/1985

25 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
AL10 - NTN	Peggy Seekers	Black Belt Research & Extension Center	U.S. Geological Survey	08/31/1983
CO08 - NTN	Wayne Ives	Four Mile Park	U.S. EPA - Clean Air Markets	12/29/1987
CO92 - NTN	Wayne Ives	Sunlight Peak	U.S. EPA - Clean Air Markets	01/13/1988
IN41 - NTN	Kenneth Scheeringa	Agronomy Center for Research and Extension	Purdue University - SAES	07/13/1982
OR18 - NTN	Cheryl Borum	Starkey Experimental Forest	U.S. Geological Survey	03/06/1984
TX02 - NTN	Glenda Copley	Muleshoe National Wildlife Refuge	U.S. Geological Survey	06/18/1985

30 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start
MS10 - NTN	Eddie Morris	Clinton	U.S. Geological Survey	07/10/1984

PREVIOUS YEARS SITE OPERATOR AWARDS

National Atmospheric Deposition Program Missed Operator Awards

5 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start	Year missed
KS32 - MDN	Curtis Sauer	Lake Scott State Park	Kansas Department of Health and Environment	06/10/2008	2013
MD00 - MDN	James Tyler Bell	Smithsonian Envir. Research Center	Smithsonian Environmental Research Center	12/07/2006	2012
MI48 - NTN	Jim Patton	Seney National Wildlife Refuge	USFWS - Air Quality Branch	11/28/2000	2013
MN01- NTN	Jim Krueger	Cedar Creek	Minnesota Pollution Control Agency	12/31/1996	2011
NY43 - MDN	Tom Everts	Rochester	NYSERDA	01/08/2008	2013
NY67 - AMoN	Tom Butler	Ithaca	U.S. EPA - Clean Air Markets	10/30/2007	2013
OH02 - MDN	Gary Conley	Athens Super Site	Lake Michigan Air Directors Consortium	12/28/2004	2013
AMoN	Gary Conley	Athens Super Site	U.S. EPA - Clean Air Markets	10/30/2007	2013
TN11 - NTN	Russell Paulk	Great Smoky Mountains NP - Elkmont	National Park Service - ARD	08/12/1980	2012
MDN	Russell Paulk	Great Smoky Mountains NP - Elkmont	National Park Service - ARD	01/30/2002	2013
TX21 - NTN	Timmy Burris	Longview	Texas Commission on Environmental Quality	06/29/1982	2012
VA13 - NTN	Diane Reaver	Horton's Station	TVA	07/28/1978	2010
WI10 - NTN	Joe Cebe	Potawatomi	Forest County Potawatomi Community/EPA	06/07/2005	2013
MDN	Joe Cebe	Potawatomi	Forest County Potawatomi Community/EPA	06/07/2005	2013
WY08 - NTN	John Klaptosky	Yellowstone NP - Tower Falls	National Park Service - ARD	06/05/1980	2013

10 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start	Year missed
AL03-MDN	Dennis Stripling	Centreville	Atmospheric Research & Analysis, Inc.	06/20/2000	2010
CA50-NTN	Faerthen Felix	Sagehen Creek	U.S. Geological Survey	11/06/2001	2011
CO00 - NTN	Ted Smith	Alamosa	U.S. Geological Survey	04/22/1980	2011
DE02 - AIRMoN	Douglas Dinkle	Lewes	NOAA-ARL	09/29/1992	2013
ME08 - NTN	Kurt Johnson	Gilead	U.S. Geological Survey	09/28/1999	2012
MO46 - MDN	Jean Placher	Mingo National Wildlife Refuge	Missouri DNR/ U.S. EPA	03/26/2002	2012
NY01-NTN	Wes Bentz	Alfred	U.S. Geological Survey	08/07/2004	2012
NY20-MDN	Charlotte Demers	Huntington Wildlife	NYSERDA	12/10/1999	2013
NY99 - NTN	Matthew Munson	West Point	U.S. Geological Survey	09/13/1983	2011
PA00 - MDN	Sharon Scamack	Arendtsville	Pennsylvania State University	11/14/2000	2012
TX56 - NTN	Dale Burks	L.B.J. National Grasslands	U.S. Geological Survey	09/20/1983	2013
WA19 - NTN	Mike Larrabee	North Cascades NP - Marblemount Ranger Station	U.S. Geological Survey	02/07/1984	2012
WI31 - MDN	Alexander Nyhus	Devil's Lake	WI DNR	01/11/2001	2013

15 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start	Year missed
MN27 - NTN	Lee Klossner	Lamberton	Minnesota Pollution Control Agency	01/02/1979	2011
MT00- NTN	Wayne Not Afraid	Little Bighorn Battlefield National Monument	U.S. Geological Survey	07/13/1984	2012

20 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start	Year missed
IL11 - NTN	Michael Snider	Bondville	U.S. EPA - Clean Air Markets	02/27/1979	2006
MT07 - NTN	Kent Dodge	Clancy	U.S. Geological Survey	01/24/1984	2008
MT96-NTN	Linda Weeks Connor	Poplar River	Fort Peck Tribes/EPA	12/21/1999	2012

25 YEAR AWARDS

Site Code	Operator Name	Site Name	Funding Agency	Wet Start	Year missed
IL11 - NTN	Michael Snider	Bondville	U.S. EPA - Clean Air Markets	02/27/1979	2011
MT07 - NTN	Kent Dodge	Clancy	U.S. Geological Survey	01/24/1984	2013

KEYNOTE SPEAKER

DAVID A. WOLF (BSEE, M.D.)
NASA ASTRONAUT (FORMER)

PERSONAL DATA: Born August 23, 1956, in Indianapolis, Indiana. He enjoys sport aerobatic flying, scuba diving, handball, running and water skiing. His parents, Dr. and Mrs. Harry Wolf, reside in Indianapolis.

EDUCATION: Graduated from North Central High School, Indianapolis, Indiana, in 1974; received a Bachelor of Science degree in Electrical Engineering from Purdue University in 1978, and received a Doctor of Medicine degree from Indiana University in 1982. He completed his medical internship in 1983 at Methodist Hospital in Indianapolis, Indiana, and United States Air Force flight surgeon training at Brooks Air Force Base in San Antonio, Texas. Dr. Wolf has completed both U.S. astronaut and Russian cosmonaut training.

SPECIAL HONORS: Recipient of the NASA Exceptional Engineering Achievement Medal, 1990, and was NASA Inventor of the Year, 1992. Dr. Wolf graduated "with distinction" from the honors curriculum in Electrical Engineering at Purdue University and received an Academic Achievement Award upon graduation from Indiana University Medical School (combined research program). Heis a Purdue "Distinguished Engineering Alumnus." He received the Carl R. Ruddell scholarship award for research in medical ultrasonic digital signal and image processing. He is a member of Eta Kappa Knu and Phi Eta Sigma honorary societies. Dr. Wolf has received 15 U.S. patents, published more than 40 technical publications or papers, and received more than 20 Space Act Awards, primarily for 3-D tissue engineering technologies for which he received the Texas State Bar Patent of the Year in 1994. Dr. Wolf has received an additional honorary Doctorate from Indiana University and four Spaceflight Medals.

EXPERIENCE: As a research scientist at the Indianapolis Center for Advanced Research from 1980 to 1983, Dr. Wolf established himself as a pioneer in the development of modern medical ultrasonic image processing techniques. This technology applied pulse compression digital RF pulse echo signal processing to improve image resolution and enable target parameter extraction, techniques now used by most commercial systems. He also developed novel Doppler demodulation techniques, extending the range velocity product limitations inherent to conventional pulsed Doppler systems. He served as a USAF senior flight surgeon in the Air National Guard (1983 to 2004), achieving the rank of Lt. Colonel. He has logged more than 2,000 hours of flight time, including air combat training as a weapons systems officer (F4 Phantom jet), T-38 Talon and competition sport aerobatics (Christen Eagle).

NASA EXPERIENCE: Dr. Wolf served as chief of the Astronaut Office Extravehicular Activity (EVA) Branch for much of the International Space Station (ISS) assembly. He led a team responsible for the development, test and execution of spacewalks from the ISS and space shuttle. This team plays a critical role for ISS assembly, maintenance and repair; requiring innovations to extend EVA capability in the areas of hardware, techniques and human performance. Dr. Wolf has logged 168 days, 12 hours, 56 minutes and 04 seconds in space over four separate missions, including a long-duration mission (128 days) on the Russian MIR space station, which was trained and conducted completely in the Russian language. He has conducted a total of seven spacewalks, using both the American and Russian spacesuits, and has logged 47 hours and 05 minutes of extravehicular activity. He is an active public speaker and is called on to represent NASA in a wide variety of venues to communicate the experience and importance of human space flight.

In 1983, Dr. Wolf joined the Medical Sciences Division, Johnson Space Center, Houston, Texas. He was responsible for the development of the American Flight Echocardiograph, which is used in space for investigating cardiovascular physiology in microgravity. This work required synthesis of spacecraft avionics integration, human physiology and space operations to acquire fundamental cardiovascular data for human space exploration and reveal new Earth-based physiological principles. On completion, he was assigned as Chief Engineer for design of the

Space Station Medical Facility, now operational on orbit. This work pioneered concepts in telemedicine, medical informatics and bioinstrumentation. In 1986, he became Chief Engineer (and, later, Program Manager) of the "Space Bioreactor," a biotechnology-based tissue engineering and cancer research program. This team, under Dr. Wolf's leadership, achieved the development of state of the art tissue engineering systems now widely used for both commercial and research purposes on Earth. Dr. Wolf fostered the successful technology transfer to private industry and to academic laboratory applications. Special skills developed include real-time computer process control, communications, power systems, bioprocessing, fluid dynamics, aerospace physiology and aerospace medicine. In these roles, Dr. Wolf was responsible for technical and multidisciplinary team leadership, a multimillion dollar budget, systems design, safety (electrical and biological) and spacecraft integration. This "on schedule" program is now a core biotechnology research facility on the ISS.

Selected as a NASA astronaut in January 1990, Dr. Wolf became qualified for space flight in July 1991. His technical assignments have included orbiter vehicle processing and testing at Kennedy Space Center (1991 to 1992) and spacecraft communications (CAPCOM, 1994 to 1995) on console for the first and third shuttle-MIR rendezvous and docking. He is a senior EVA (spacewalk) instructor and has qualified with the shuttle robotic manipulator system (robot arm). Dr. Wolf completed cosmonaut training at the Gagarin Cosmonaut Training Center, Star City, Russia. In December 2012, Dr. Wolf retired from NASA. He now works as a private consultant, serves as Extraordinary Scientist in Residence for the Indianapolis Children's Museum (the largest of its kind), and is an active public and motivational speaker.

SPACE FLIGHT EXPERIENCE: STS-58 Columbia (October 16 to November 1, 1993) was a dedicated Spacelab life sciences research mission. The crew conducted neurovestibular, cardiovascular, cardiopulmonary, metabolic, and musculoskeletal research, using microgravity to reveal fundamental human physiology otherwise masked by Earth's gravity. The mission duration was 14 days, 12 minutes and 32 seconds, a record at that time.

NASA-MIR 6 (Sept 25, 1997 to Jan 31, 1998). This sixth mission of the joint shuttle-MIR long-duration space flight program, immediately following "the" fire and collision, and recovering from multiple total power failures, played a core role to establish the international relationships serving the foundation of the current ISS Program. Dr. Wolf performed cosmonaut engineering and scientific duties on the Russian MIR space station, including 9 EVA hours in the Russian ORLAN spacesuit. The mission duration was 128 days. Wolf launched on STS-86 and returned on STS-89.

STS-112 Atlantis (October 7 to October 18, 2002) and STS-127 Endeavor (July 15 to July 31, 2009). These missions were on-orbit heavy ISS assembly missions by EVA and Robotics, including the S1 truss, Japanese Exposed Facility (JEF), P6 battery changeouts and multiple large external equipment installations. The missions provided critical ISS spacecraft communications, thermal control and power management systems. Wolf's primary duties were as lead spacewalker (EV1) and rendezvous navigation specialist. He performed a total of 6 spacewalks: 19 hours and 41 minutes of EVA on STS-112; 18 hours and 24 minutes of EVA on STS-127. STS-112 mission duration was 10 days, 19 hours and 58 minutes; and STS-12 mission duration was 15 days, 16 hours, 44 minutes and 58seconds.

TECHNICAL SESSION 1:
INTERNATIONAL ATMOSPHERIC DEPOSITION MONITORING AND MODELS

Session Chair: Richard Artz,
NOAA – Air Resources Laboratory

A Global Assessment of Precipitation Chemistry and Deposition

Robert Vet[1] , Richard S. Artz, Silvina Carou, Mike Shaw, Chul-Un Ro, Wenche Aas, Alex Baker, Van C. Bowersox, Frank Dentener, Corinne Galy-Lacaux, Amy Hou, Jacobus J. Pienaar, Robert Gillett, M. Christina Forti, Sergey Gromov, Hiroshi Hara, Tamara Khodzher, Natalie M. Mahowald, Slobodan Nickovic, P. S. P. Rao and Neville W. Reid

A Global Assessment of Precipitation Chemistry and Deposition of Sulfur, Nitrogen, Sea Salt, Base Cations, Organic Acids, Acidity and pH, and Phosphorus was recently published as a Special Issue of Atmospheric Environment (Volume 93, August 2014). The Assessment was written under the direction of the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) Scientific Advisory Group for Precipitation Chemistry (SAG-PC) and addressed three major questions: (1) what do measurements and model estimates of precipitation chemistry and wet, dry and total deposition of the above chemical species show globally and regionally? (2) has wet deposition of major ions changed since 2000 (and, where information and data are available, since 1990) and (3) what are the major gaps and uncertainties in our knowledge? To that end, regionally-representative measurements for two 3-year-averaging periods, 2000-2002 and 2005-2007, were compiled worldwide. Data from the 2000-2002 averaging period were combined with 2001 ensemble-mean modeling results from 21 global chemical transport models produced in Phase 1 of the Coordinated Model Studies Activities of the Task Force on Hemispheric Transport of Air Pollution (TF HTAP). The measurement data and modeling results were used to generate global and regional maps of concentrations and deposition. A major product of the assessment was a database of quality assured data gathered from regional and national monitoring networks worldwide, including NADP. The database is available for download from the World Data Centre for Precipitation Chemistry (http://wdcpc.org/). The assessment concludes that global concentrations and deposition of sulfur and nitrogen are reasonably well characterized with levels generally highest near emission sources and more than an order of magnitude lower in areas largely free of anthropogenic influences. In many parts of the world, wet deposition of reduced nitrogen exceeds that of oxidized nitrogen and is increasing. Sulfur and nitrogen concentrations and deposition in North America and Europe have declined significantly, in line with emission reduction policies. Major regions of the world, including South America, the more remote areas of North America, much of Asia, Africa, Oceania, polar regions, and all of the oceans, are inadequately sampled, particularly for phosphorus, organic forms of nitrogen, and weak acids including carbonates and organic acids. Measurement-based inferential estimates of dry deposition are limited to sulfur and some nitrogen species in only a few regions of the world, and methods are highly uncertain. The assessment concludes with recommendations that address major gaps and uncertainties in global ion concentration and deposition measurements.

[1]Environment Canada, robert.vet@ec.gc.ca

What In the World Is the WMO GAW QASAC-Americas and Is NADP Contributing to Standardization of Global Precipitation Chemistry Measurements?

Van Bowersox[1] and Richard Artz[2]

The Quality Assurance/Science Activity Centre – Americas (QA/SAC-Americas, http://qasac-americas.org/) is one of four QA/SACs that operate to ensure data quality and support science activities in the World Meteorological Organization (WMO) Global Atmosphere Watch (GAW) programme. The QA/SAC-Americas, supported by the NOAA Air Resources Laboratory, seeks to support and improve global precipitation chemistry measurements, while other QA/SACs address measurements of gases and aerosols.

WMO is an agency of the United Nations. Its mission is to contribute to the safety, well-being, and economic benefit of people everywhere in matters related to weather, climate, water resources, and environmental issues. Discovery of a seasonal ozone hole, the realization that acid rain was damaging forests and fisheries, and the prospect of rising greenhouse gas concentrations that could effect climate change led WMO in 1989 to establish the GAW Programme with its focus on atmospheric chemistry. GAW looked to national meteorological and hydrological organizations to expand their measurement systems to include measurements of ozone, greenhouse gases, smog-producing NOx and VOCs, aerosols, and precipitation chemistry.

Standard protocols for measuring chemicals in air and precipitation were lacking as was a system for evaluating the accuracy of measurements often at trace levels. Needed was a quality assurance program that could address these shortcomings. Science advisory groups were formed to engage experts in developing standard procedures and quality assurance protocols. These groups set standards for sampling and analytical equipment, calibration, operational methods, and quality control/quality assurance procedures. The primary objective was to ensure that GAW data were of known and adequate quality to describe the spatial and temporal distributions of chemicals in air and precipitation the world over.

The Science Advisory Group for Precipitation Chemistry (SAG-PC) is a panel of scientists with expertise in atmospheric chemistry, especially precipitation scavenging, the sampling and analysis of precipitation, and wet deposition rates and loads. Chaired by Richard Artz of the NOAA Air Resources Laboratory, the SAG-PC organizes and guides the preparation of regional and global assessments (e.g. Vet. et al. http://dx.doi.org/10.1016/j.atmosenv.2013.10.060), prepares guidelines for precipitation chemistry measurements (e.g., *Manual for the GAW Precipitation Chemistry Programme : WMO-GAW Report No. 160*), and seeks to expand precipitation chemistry monitoring in underrepresented regions and provide training for precipitation sampling and analysis. In addition, the SAG-PC provides guidance for the QA/SAC- Americas and the World Data Centre for Precipitation Chemistry (WDCPC, http://wdcpc.org/).

The QA/SAC-Americas seeks to document and improve the quality of precipitation chemistry measurements from around the world. To do this, it conducts semi-annual inter-laboratory comparison studies. Each study consists of three "rain samples" formulated by the NADP CAL. Concentrations are generally in the range of measurements observed at regionally representative sites around the world. Between 80 and 90 laboratories receive samples with typical participation rates of ~90%. Each participant is expected to measure pH, conductivity, sulfate, nitrate, ammonium, chloride, sodium, calcium, magnesium, and potassium. Measurements of fluoride and acidity are optional. Study results are summarized and posted on the QA/SAC web site. The median measurement is taken as the "accepted true value" and non-parametric statistics are computed and presented in graphical (ring diagrams) and tabular forms. Participants are invited to view their results and take corrective actions to improve performance, as needed.

[1]World Data Centre for Precipitation Chemistry and Quality Assurance/Science Activity Centre - Americas, manager@qasac-americas.org

[2]NOAA - Air Resources Laboratory, richard.artz@noaa.gov

Mercury Monitoring in Taiwan and Southeast Asia

Guey-Rong Sheu[1], David Gay[2] and David Schmeltz[3]

East Asia is the largest anthropogenic Hg emission source region globally. Therefore, increasing atmospheric mercury (Hg) measurements have been conducted in East Asia and its downwind regions, such as in China, Japan, Korea, Taiwan, and over the North Pacific Ocean. Nonetheless, speciated measurement data are still limited. Besides, atmospheric Hg data are very rare for the Southeast Asia, a region with many small-scale gold mining and intensive biomass burning activities that could contribute significant amount of Hg to the atmosphere. Systematic monitoring of Hg in the atmosphere and rainwater in Taiwan has been started since 2006. Speciated atmospheric Hg has been measured since April 13, 2006 at the Lulin Atmospheric Background Station (LABS; 120.87°E, 23.47°N, 2862 m a.s.l.) in central Taiwan to collect baseline information of Hg in the free troposphere and to study the trans-boundary transport of Hg from regional and global sources. A nation-wide wet Hg deposition monitoring network, consisting of 11 sampling sites in Taiwan and a remote islet site in subtropical Northwest Pacific Ocean, was established to collect weekly rainwater samples for Hg analysis since late 2008. The purpose of this network is to establish a national database of Hg concentration in precipitation and the associated wet deposition fluxes. Since 2010, our group has collaborated with local scientists via the 7-SEAS research project to study the distribution of atmospheric Hg in northern Thailand and Vietnam during the spring biomass burning season. In 2012, USEPA, Taiwan EPA, NADP, Environment Canada and the National Central University in Taiwan with partners in Southeast Asia launched the Asia Pacific Mercury Monitoring Network (APMMN) for tracking the atmospheric transport and deposition of Hg in the Asia-Pacific region. The initial phase of the APMMN is a cooperative pilot Hg wet deposition monitoring network in Southeast Asia (Thailand, Indonesia, and Vietnam), with technical support from several organizations in Taiwan, Japan, South Korea and the United States. Monitoring will begin in September 2014 and the pilot network will operate for three years

[1]Department of Atmospheric Sciences, National Central University, Taiwan, grsheu@atm.ncu.edu.tw
[2]NADP Program Office
[3]USEPA, Office of Atmospheric Programs

Total Deposition of Nitrogen and Sulfur in the United States

Gary Lear[1] and Donna Schwede[2]

Atmospheric deposition of nitrogen and sulfur causes many deleterious effects on ecosystems including acidification and excess eutrophication. Assessments to support development of strategies to mitigate these effects require spatially and temporally continuous values of nitrogen and sulfur deposition. In the U.S., national monitoring networks exist that provide values of wet and dry deposition at discrete locations. While wet deposition can be interpolated between the monitoring locations, dry deposition cannot. Additionally, monitoring networks do not measure the complete suite of chemicals that contribute to total sulfur and nitrogen deposition. Regional air quality models provide spatially continuous values of deposition of monitored species as well as important unmeasured species. However, air quality modeling values are not generally available for an extended continuous time period. Air quality modeling results may also be biased for some chemical species. We developed a novel approach for estimating dry deposition using data from monitoring networks such as the Clean Air Status and Trends Network (CASTNET), the National Atmospheric Deposition Program (NADP) Ammonia Monitoring Network (AMoN), and the Southeastern Aerosol Research and Characterization (SEARCH) network and modeled data from the Community Multiscale Air Quality (CMAQ) model. These dry deposition values estimates are then combined with wet deposition values from the NADP National Trends Network (NTN) to develop values of total deposition of sulfur and nitrogen. Data developed using this method are made available via the CASTNET website. Future plans include the use of CMAQ 5.0 with the ammonia bidirectional flux module, data from 1-in-3 monitoring networks (e.g., IMPROVE and CSN), and additional evaluations and comparisons with other estimates of total N and S deposition.

[1]Clean Air Markets Division, Office of Atmospheric Programs, U.S. Environmental Protection Agency, lear.gary@epa.gov
[2]Atmospheric Modeling and Analysis Division, National Exposure Research Laboratory, USEPA, schwede.donna@epa.gov

Increased Air Pollution over the Chesapeake Bay and its Effect on Deposition to the Bay

Dan Goldberg[1], Christopher Loughner[2], Maria Tzortziou[3], Tim Canty[4], Tim Vinciguerra[5], Ken Pickering[6], Xinrong Ren[7] and Russell Dickerson[8]

NASA's DISCOVER-AQ air quality campaign observed total reactive nitrogen among other trace gas constituents in the Baltimore-Washington region during the summer of 2011. In conjunction, a NOAA research vessel observed ozone and reactive nitrogen during a 10-day experiment over the Chesapeake Bay. Ozone and reactive nitrogen observations over the bay during the afternoon are often 10% - 20% higher than the closest upwind ground sites. We suggest that a combination of complex boundary layer dynamics, deposition rates, and unaccounted marine emissions are playing an integral role in the regional maximum of ozone and its precursors over the Chesapeake Bay. We use an air quality prediction model to quantify the total deposition of reactive nitrogen. Models show ozone and nitric acid are being trapped in a convergence zone along the bay shore leading to increased deposition to the bay. We will compare this with observations of deposition from the NADP monitoring sites along the Chesapeake Bay.

[1]University of Maryland, dgoldb@atmos.umd.edu
[2]ESSIC/University of Maryland, christopher.p.loughner@nasa.gov
[3]ESSIC/University of Maryland, maria.a.tzortziou@nasa.gov
[4]University of Maryland, tcanty@atmos.umd.edu
[5]University of Maryland, tvin@umd.edu
[6]NASA Goddard, kenneth.e.pickering@nasa.gov
[7]NOAA/University of Maryland, xinrong.ren@noaa.gov
[8]University of Maryland, russ@atmos.umd.edu

TECHNICAL SESSION 2:
MEASUREMENTS AND MODELS OF WET AND DRY ATMOSPHERIC DEPOSITION

Session Chair: John Walker,
U.S. EPA

Estimation of Nitrogen Deposition in Precipitation from Historical Studies, 1955 – 1984

Amy Ludtke[1] and Jo Ann Gronberg[2]

The U.S. Geological Survey's National Water Quality Assessment Program is analyzing long-term changes in nitrogen deposition for surface and ground water studies on a national basis. Atmospheric deposition of nitrogen is one of the key components needed for an inclusive nitrogen trend analysis. The National Atmospheric Deposition Program's (NADP) National Trends Network provides estimates of nitrogen in atmospheric wet deposition beginning in 1978, but there was a need for data predating this time period. The National historical data sources that were coalesced for the nitrogen deposition estimates were: 1) Air Force Cambridge Research Center's study from 1955 – 1956; 2) Public Health Service and the National Center for Atmospheric Research from 1960 - 1966; and 3) National Atmospheric Deposition Program from 1981 – 1984. A fourth study conducted during 1972 - 1982, conducted by the National Oceanic and Atmospheric Administration, U.S. Environmental Agency, and World Meteorological Organization was not included in the analysis, but the data were digitized.

Historical data sets were reconstructed by: digitizing the data; estimating and interpolating latitude and longitude based on the most probable National Weather Service stations for that time; associating the precipitation collection station with the closest National Climatic Data Center precipitation depth; and making appropriate data substitutions for missing precipitation depths or concentration values. Once the nitrogen loads were calculated, inorganic nitrogen wet deposition maps were generated for years 1955-1956, 1962-1965, and 1981-1984. The nitrogen deposition estimates, in kilograms per hectare, are presented as 2,338.383-meter by 2,338.383-meter resolution raster datasets. The units and resolution used are the same as those used in the National Atmospheric Deposition Program National Trends Network raster datasets from 1985 to 2012, for easier comparison between these sources.

As a result of this investigation, all data from the four national studies, as well as a regional USGS study (1966 – 1967), are now available online in tabular datasets. These data sets include precipitation chemistry results (calcium, magnesium, potassium, sodium, ammonium, nitrate, nitrogen, chloride, sulfate, pH, and specific conductance when available), precipitation depth, calculated site-specific precipitation-weighted concentrations, and raster datasets of nitrogen from wet deposition. The USGS has made these data available in appendixes of: *Estimates of inorganic nitrogen wet deposition from precipitation for the conterminous United States, 1955–84*, by Gronberg, J.M., Ludtke, A.S., and Knifong, D.L, 2014, available online: http://pubs.usgs.gov/sir/2014/5067 or http://dx.doi.org/10.3133/sir20145067

[1]USGS, asludtke@usgs.gov
[2]USGS, jmgronbe@usgs.gov

Organic Nitrogen in the Snowpack throughout the United States Rocky Mountains

Bret Schichtel[1], KD Benedict[2], GP Ingersoll[3], Y Desyaterik[4], K Morris[5], WC Malm[6] and JL Collett Jr.[7]

Excess reactive nitrogen (Nr) deposition is occurring in sensitive ecosystems in the Rocky Mountains. In some high alpine lakes in Rocky Mountain National Park and the Greater Yellowstone Area, this deposition has passed critical thresholds and is causing biogeochemical changes. Nr deposition is monitored by the National Atmospheric Deposition Program National Trends Network (NADP/NTN) and Clean Air Status and Trends (CASTNET) network that measure inorganic nitrate and ammonium. Missing Nr components from these networks include organic nitrogen (ON). Special monitoring studies at Rocky Mountain and Grand Teton national parks found significant contributions of wet ON deposition and potentially high concentrations of ON gas associated with biomass burning that could contribute to Nr deposition. However the spatial extent of the ON is not known. Every year the U.S. Geological Survey collects snowpack samples at over 50 sites throughout the United States Rocky Mountains. Similar to the NADP, these samples are analyzed for the inorganic ionic composition, including oxidized and reduced nitrogen compounds. A benefit of the snowpack samples is that they contain contributions from both dry and wet deposition, but the multi-month long sample collection period provides opportunities for chemical and biological processing of the deposited Nr. To better understand the contribution of ON to the Nr deposition, the 2012 and 2013 snowpack samples were also analyzed for total nitrogen from which ON was estimated. It was found that 0-70% of the Nr in the 2012 samples was ON with 21% on average. ON was poorly correlated with inorganic oxidized and reduced N indicating different sources responsible for the ON or possibly different atmospheric/snowpack rates of processing. The ON was correlated with water soluble organic carbon and potassium, indicating potential contributions from biomass burning.

[1]National Park Service, bret_schichtel@nps.gov
[2]Colorado State University, katherine.benedict@colostate.edu
[3]US Geological Survey, gpingers@usgs.gov
[4]Colorado State University, yury.desyaterik@colostate.edu
[5]National Park Service, Kristi_Morris@nps.gov
[6]Colorado State University, wc.malm@colostate.edu
[7]Colorado State University, jeffrey.collett@colostate.edu

Field Performance Evaluation of the Monitor for AeRosols and GAses in ambient air (MARGA)

Greg Beachley[1], Gary Lear[2], Melissa Puchalski[3], Chris Rogers[4] and Kevin Mishoe[5]

The US EPA has measured hourly (semi-continuous) ambient concentrations of soluble gases (SO_2, HNO_3, NH_3) and aerosols (SO_4^{-2}, NO_3^-, NH_4^+) using duplicate Monitor for AeRosols and GAses (MARGA) systems at the Beltsville, MD (BEL116) site during extended sampling periods over the past year. The effort has supplemented long-standing Clean Air Status and Trends Network (CASTNET) filter pack measurements of weekly integrated atmospheric concentrations of those pollutants with short-term concentration variations.

MARGA performance has been previously verified but it is a resource-intensive instrument that requires significant attention for field operation. Performance for all species will be assessed using time integrated sampling methods historically present at CASTNET sites (e.g. filterpack, AMoN samplers) and will be correlated with a pulsed fluorescence SO_2 analyzer to determine the efficacy of verifying overall instrument performance with a single species check.

In addition, MARGA measurements of speciated and total nitrate will be compared with that determined by the filterpack and compared with co-located hourly NOy concentrations to investigate an artifact of higher than expected total nitrate filterpack concentrations during summertime.

Measured ambient NH_3 concentration data will also be compared with historical CMAQ predicted concentration values as a function of season and time as a tool to investigate the efficacy of the model and potentially identify any artifacts or biases that may exist.

[1]Clean Air Markets Division, US EPA, beachley.gregory@epa.gov
[2]Clean Air Markets Division, US EPA
[3]Clean Air Markets Division, US EPA
[4]AMEC Inc., Jacksonville, FL
[5]AMEC Inc., Newberry, FL

Improvements to the characterization of organic nitrogen chemistry and deposition

Donna Schwede[1], Deborah Luecken[2], John Walker[3] and George Pouliot[4]

Excess atmospheric nitrogen deposition can cause significant harmful effects to ecosystems. Organic nitrogen deposition can be an important contributor to the total nitrogen budget, contributing 10-30%, however there are large uncertainties in the chemistry and deposition of these compounds. Organic nitrogen comprises thousands of different types of molecules, with a corresponding large range of physical and chemical properties. For example, the reaction rate of common organic nitrates, which controls the chemical lifetime in the atmosphere, can vary from 15 minutes to 5 days depending on the structure of the compound. Even more dramatically, the Henry's Law constant of different organic nitrogen compounds can vary over 4 orders of magnitude depending on the presence of polar functional groups, affecting its lifetime in the presence of clouds, rain and fog as well as dry deposition. Current chemical mechanisms and deposition modules used in air quality models assign organic nitrates to only one or two "representative" compounds. We modified the Carbon Bond (CB05) chemical mechanism and wet and dry deposition modules in the Community Multiscale Air Quality (CMAQ) model to provide an improved treatment of gaseous organic nitrate chemistry and deposition. To evaluate the model improvements, we compare model results against measured wet deposition values of total, inorganic, and organic nitrogen. Additionally, we examine source regions of air masses to investigate missing sources of organic nitrogen in the model such as amines.

[1]US EPA, schwede.donna@epa.gov
[2]US EPA, luecken.deborah@epa.gov
[3]US EPA, walker.johnt@epa.gov
[4]US EPA, pouliot.george@epa.gov

Method development estimating atmospheric deposition of various pollutants

Leiming Zhang[1]

Quantifying atmospheric deposition of critical pollutants is important in assessing their life time in air and their potential impact on various ecosystems. Recent progresses in Environment Canada on the development of numerical algorithms and frameworks for the estimation of atmospheric deposition of different groups of air pollutants will be discussed. These developments include (1) a new dry deposition algorithm for bulk fine, coarse and giant aerosol particles; (2) a new semi-empirical algorithm for below-cloud scavenging by rain and snow for size-resolved aerosol particles and a further extended algorithm for bulk fine, coarse and giant particles; (3) a modified atmospheric gradient method quantifying dry deposition fluxes of ozone and acidifying pollutants over forest canopies; (4) a bi-directional air-surface flux exchange scheme for elemental gaseous mercury; and (5) a framework mapping atmospheric deposition of polycyclic aromatic compounds in the Athabasca oil sands region.

[1]Environment Canada, leiming.zhang@ec.gc.ca

TECHNICAL SESSION 3:
AGRICULTURAL EMISSIONS AND ATMOSPHERIC DEPOSITION

Session Chair: Richard Grant,
Purdue University

National Assessment of Emissions from livestock facilities

Al Heber, Purdue University

Using estimates of nitrogen deposition from the National Atmospheric Deposition Program to assess sources and spatial distribution of stream nitrogen loads in the United States

Anne Hoos[1] and Stephen D. Preston[2]

The USGS has developed spatially referenced regression (SPARROW) models of nitrogen transport in streams in 2002 for the U.S. These models provide information about the spatial distribution of nitrogen loads and concentrations in streams and loads delivered to receiving water bodies. The models are developed by statistically relating measured stream nitrogen loads with datasets of nitrogen inputs to the watershed in 2002, including National Atmospheric Deposition Program (NADP) wet deposition of total inorganic nitrogen. Export coefficients that relate input quantity to total (inorganic plus organic) nitrogen load in streams are empirically estimated for each nitrogen source. The NADP wet deposition data are used in these models as proxy for the contributions of total (wet plus dry) nitrogen deposition. The export coefficient estimated for atmospheric deposition varies by about 5-fold by region and according to physical watershed properties such as soil permeability and temperature. For the Southeast and Midwest the average export coefficient is 0.5, meaning that for a watershed with wet deposition rate of 400 kilograms per square kilometer per year, 200 kilograms per square kilometer per year is estimated to reach the channel of the nearest stream. The relative contribution of atmospheric deposition to the total mass of nitrogen delivered to the stream varies with the importance of other sources, such as wastewater discharge, agricultural fertilizer and livestock, and urban land, in the stream's watershed. The relative contribution is greatest (more than 60 percent for some river basins) in areas such as New England, the northernmost part of the Midwest, and much of the Southeast, where other sources contribute smaller amounts to loading. Using the NADP wet deposition data in these models as proxy for total deposition assumes that the regional patterns of wet and dry deposition are generally correlated over large areas of the U.S. The USGS recently developed a nitrogen SPARROW model for the eastern U.S. that uses modeled total deposition (wet plus dry) from an air quality model (Community Multi-scale Air Quality Model, or CMAQ) in place of the NADP wet deposition data. The NADP wet deposition data are used, however, to calibrate the CMAQ model. The coupled CMAQ-SPAROW model can account for contributions from the individual source categories of atmospheric nitrogen: emissions to the atmosphere from power plants, other industry, vehicles, livestock, and fertilizer, and background sources. Accounting for individual components of atmospheric nitrogen increases usefulness of the model for management applications.

[1]U.S. Geological Sur vey, abhoos@gmail.com
[2]U.S. Geological Survey, spreston@usgs.gov

Quantifying Bi-Directional Ammonia Flux from Managed Cropland by Relaxed Eddy Accumulation

Andrew Nelson[1], Marcelo S. Vieira-Filho[2], Christopher Lehmann[3], Sotiria Koloutsou-Vakakis[4] and Mark J. Rood[5]

In the atmosphere, gaseous ammonia (NH_3) reacts readily with acidic compounds to form ammonium salts that persist as small (diameter <2.5μm) particulate matter ($PM_{2.5}$). The use of nitrogen-based fertilizers is estimated to contribute >40% of total NH_3 emissions in central Illinois based on the Carnegie Melon University (CMU) model. This research seeks to address the need for enhanced understanding of agricultural ammonia emission pathways by measuring bi-directional flux of gaseous NH_3 over a corn (*Zea mays*) canopy.

A relaxed eddy accumulation (REA) system designed for ammonia flux measurement was deployed in a corn plot at the Energy Biosciences Institute (EBI) at the University of Illinois (UI) and average ammonia flux was measured during four-hour periods in the morning and afternoon for the duration of the 2014 growing season. The REA coefficient (β) was found to be 0.56 ± 0.053, consistent with values presented in the literature. For the duration of the field campaign, the average gaseous ammonia concentration was 4.02 μg/m3 ± 2.15 μg/m^3, with the highest concentrations (up to 8.11 μg/m^3) observed near the time of fertilization. The average ammonia flux was found to vary by over an order of magnitude throughout the season, ranging from -198.44 ng/m^2/s to 973.80 ng/m^2/s, where negative flux indicates deposition. Overall, greater upward fluxes were observed during the 14 day period following fertilization when compared to the rest of the season. This presentation will provide an overview of the experimental setup and field campaign and provide further results and analysis of ammonia flux as measured during this effort.

[1]Department of Civil and Environmental Engineering, University of Illinois, nelson73@illinois.edu

[2]Geofísica e Ciências Atmosféricas da Universidade de São Paulo, vieira.filho@live.com

[3]National Atmospheric Deposition Program, Illinois State Water Survey, clehmann@illinois.edu

[4]Department of Civil and Environmental Engineering, University of Illinois, sotiriak@illinois.edu

[5]Department of Civil and Environmental Engineering, University of Illinois, mrood@illinois.edu

Measurement of speciated nitrogen and sulfur fluxes above a grass field

Ian Rumsey[1] and John T. Walker[2]

Atmospheric deposition of nitrogen and sulfur compounds is a concern due to potential environmental impacts such as ecosystem eutrophication and acidification. The development of models to predict nitrogen and sulfur air-surface exchange fluxes requires observational datasets that capture a range of different conditions including variations in meteorology, surface conditions and atmospheric chemistry. For the development of total nitrogen and sulfur deposition budgets, the simultaneous measurement of multiple species is an additional requirement. New measurement instruments, such as the Monitor for AeRosols and GAses in ambient air (MARGA) 2S, allow the opportunity to conduct long-term multi-species flux measurements. The MARGA 2S is an on-line analyzer that employs dual sample collection boxes and measures water-soluble aerosols and gases at an hourly temporal resolution using ion chromatography. Air-surface exchange fluxes of gases (NH_3, HNO_3, and SO_2) and aerosols (NH_4^+, NO_3^-, and SO_4^{2-}) were calculated by measuring vertical concentration gradients between two different heights using a modified MARGA 2S and by applying the aerodynamic gradient method. The presentation provides a summary of the performance of the MARGA as a gradient system and preliminary measurements of nitrogen and sulfur compound fluxes above a grass field during different seasons in 2012. The air-surface exchange fluxes are evaluated with respect to seasonal and diurnal variations as well as the influence of surface characteristics and meteorological conditions. The total flux uncertainty is determined by calculating the concentration gradient and transfer velocity precision. The relative contribution of individual nitrogen compounds to the total flux of NH_3 + NH_4^+ + HNO_3 + NO_3^- is evaluated with respect to seasonal variations.

[1]College of Charleston, rumseyic@cofc.edu

[2]U.S. Environmental Protection Agency, walker.johnt@epa.gov

TECHNICAL SESSION 4:
MERCURY DEPOSITION AND ECOSYSTEM EFFECTS

Session Chair: David Schmeltz,
U.S. EPA

Historical and Global Perspectives of Environmental Hg Deposition: Future Science Directions for Effective Monitoring and Research

Dave Krabbenhoft, USGS

Long Term Temporal and Spatial Trends in Mercury Deposition

Peter Weiss-Penzias[1], Arnout F.H. ter Schure[2] and David A. Gay.[3]

National inventory data and projections, by both EPRI and U.S. EPA, show that there was an overall ~50% drop in U.S. utility emissions of total mercury (Hg) between 2007 and 2010. Announced plant and unit retirements since 2010 indicate a continuing further reduction in U.S. Hg emissions. Because of uncertainties in speciation changes in the emitted mercury by these electric generating units (EGUs), it is however unclear how much U.S. deposition "should" have changed in this period. The primary question addressed here is therefore "Do the reductions in mercury emissions from EGUs (and other sources) in the United States, driven by MATS and other regulations, translate into observed changes in: a) mercury concentrations in precipitation and/or b) total mercury wet deposition." As such, the NADP's Mercury Deposition (MDN) data is analyzed for temporal and spatial trends. The last time such analyses were presented was with data until 2005[1]. Hence, almost a decade of additional data is available for such spatial and temporal analysis, covering the aforementioned important Hg-emissions' reduction period between 2007 and 2010. Additionally, new MDN sites have been added and some retired since 2005 which potentially affect the trend results. Preliminary results of these analyses are presented and discussed.

[1]Prestbo, E.M., Gay, D. A. 2009. **Wet deposition of mercury in the U.S. and Canada, 1996–2005: Results and analysis of the NADP mercury deposition network (MDN).** *Atmos. Environ.* 43, 4223–4233.

[1]Department of Microbiology and Environmental Toxicology, University of California, Santa Cruz, CA, pweiss@ucsc.edu

[2]Environment Sector, Electric Power Research Institute, Palo Alto, CA, USA, aterschu@epri.com

[3]Illinois State Water Survey, Institute of Natural Resource Sustainability, University of Illinois, 2, dgay@illinois.edu

Mercury in fish from 21 national parks in the western U.S. – Inter- and intra-park variation in concentrations and ecological risk

Colleen Flanagan Pritz[1], Collin Eagles-Smith[2] and James Willacker[3]

National parks, protected areas considered to be relatively pristine and removed from environmental contaminants, contained levels of mercury in some fish that exceeded thresholds for potential impacts to fish, birds, and humans. We measured mercury (Hg) in more than 1,400 fish from 86 remote lakes and rivers – spanning 16 fish species and 21 national parks in 10 western states – and compared Hg concentrations in the fish to an array of health benchmarks. Across all parks, sites, and species, fish Hg concentrations ranged from 9.9 to 1,109 ng/g ww with a mean of 77.7 ng/g ww. Fish Hg levels varied greatly both among and within parks, suggesting that patterns of Hg risk are driven by processes occurring at site specific, local, and global scales. In most parks, Hg concentrations in fish were moderate to low in comparison with similar fish species from other locations in the western U.S. Mercury concentrations were below EPA's fish tissue criterion for safe human consumption in 96 percent of the sport fish sampled. However, the average concentration of Hg in sport fish from two sites in Wrangell-St. Elias and Lake Clark (AK) national parks exceeded EPA's human health criterion. Mercury levels in individual sport fish at some sites from Lassen Volcanic (CA), Mount Rainer (WA), Rocky Mountain (CO), Yellowstone (WY), and Yosemite (CA) national parks also exceeded the human health criterion. Mercury concentrations exceeded the most conservative fish toxicity benchmark at 15% of all sites, and the most sensitive health benchmark for fish-eating birds at 52% of all sites. Exposure to high levels of Hg in humans may cause damage to the brain, kidneys, and the developing fetus. In wildlife, elevated Hg levels can result in reduced foraging efficiency, survival, and reproductive success. Much of the mercury found in these mainly high elevation areas is likely the result of air pollution from outside the parks. Future targeted research and monitoring across park habitats would help identify patterns of Hg distribution across the landscape and facilitate informed management decisions aimed at reducing the ecological risk posed by Hg contamination in sensitive ecosystems protected by the National Park Service.

[1]National Park Service, colleen_flanagan@nps.gov
[2]USGS FRESC, ceagles-smith@usgs.gov
[3]USGS FRESC, jwillacker@usgs.gov

Measurements of Gaseous Oxidized Mercury Dry Deposition Using Passive Samplers at the NAPD Beltsville (MD99) Site

Xinrong Ren[1], Daniel Goldberg[2], Allison Ring[3], Mark Castro[4], Winston Luke[5], Paul Kelley[6], Jason Karlstrom[7] and John Sherwell[8]

Gaseous oxidized mercury (GOM) dry deposition was measured using surrogate surface passive samplers at the NADP Beltsville site (MD99) between August 2013 and February 2014. A total of 13 bi-weekly GOM passive samples were collected and the average GOM dry deposition was 42±14 ng m^{-2} per two weeks. Collocated wet deposition measurements show that the average mercury wet deposition was 207 ng m^{-2} per two weeks. This suggests that the GOM dry deposition accounts for about 18% of the total mercury dry deposition. For comparison, the average GOM dry deposition measured at the NADP Piney Resevior site was 56±23 ng m^{-2} per two weeks, which is about 23% of the total mercury deposition (246 ng m^{-2} per two weeks). Correlation between the measured GOM dry deposition and other collocated measurements, including atmospheric Hg species, trace gases, as well as meteorological parameters will be presented. These limited GOM dry deposition measurements showed that these passive samplers can be useful to investigate spatial/temporal variability of GOM.

[1]UMD/NOAA-ARL, Xinrong.Ren@noaa.gov
[2]UMD-AOSC, dgoldb@atmos.umd.edu
[3]UMD-AOSC, aring@atmos.umd.edu
[4]UMD-CES, mcastro@al.umces.edu
[5]NOAA/ARL, winston.luke@noaa.gov
[6]NOAA/ARL, paul.kelley@noaa.gov
[7]Frontier Global Sciences, JasonKarlstrom@eurofinsUS.com
[8]MD-DNR, jsherwell@dnr.state.md.us

TECHNICAL SESSION 5:
CRITICAL LOADS OF ATMOSPHERIC DEPOSITION

Session Chair: Jason Lynch and Jennifer Phelan, U.S. EPA and RTI

Critical loads of acidity to recover acid-impaired lakes in the Adirondack region of New York

Charles Driscoll[1] and Habibollah Fakhraei

Acidic deposition has impaired the structure and function of acid-sensitive Northern Forest watersheds in the northeastern U.S. In particular many surface waters in the Adirondack region of New York have experienced decreases in pH and acid neutralizing capacity (ANC) due to acidic deposition. In spite of air quality programs over past decades, 128 lakes in the Adirondacks are classified as "impaired" under Section 303(d) of the Clean Water Act in 2010 due to elevated acidity. The biogeochemical model PnET-BGC was developed to improve understanding of the response of forested watershed to effects of air pollution, changing climate and land disturbance. Of particular interest a new algorithm was developed to depict the compensatory response of soil organic acids to decreases in acidic deposition. PnET-BGC was used to relate decreases in atmospheric sulfur and nitrogen deposition to changes in Adirondack lake water chemistry. The model was calibrated and confirmed using observed soil and lake water chemistry data and then applied to calculate maximum atmospheric deposition that the impaired lakes can receive to achieve ANC endpoints. Of the 128 acid-impaired lakes, the analysis suggests that 40 will recover to below an endpoint ANC value of 20 $\mu eq\ L^{-1}$ without any additional emission controls and another 36 could recover with some additional decrease in atmospheric sulfur deposition by 2050. In contrast by 2200, 80 of the impaired lakes are simulated to recover to ANC values above 20 $\mu eq\ L^{-1}$ with no additional emission controls and 9 more would recover with additional decreases in acid deposition. This analysis indicates that under current air quality management programs most impaired Adirondack lakes will recover over the very long term (i.e., centuries), but recovery could be accelerated by additional emission controls. Also it appears that about 30% of the impaired Adirondack lakes (39 out of 128) will not recover regardless of the level of reduction in acid deposition. These lake-watersheds are either naturally acidic or have been acidified by acidic deposition beyond the point of recovery, but could be recovered by other mitigation options such as liming. Our analysis indicated that the enhanced release of naturally occurring organic acids limits the recovery of ANC following decreases in acidic deposition. We also show the use of empirical spatial relationships of biological acidification indicators in critical load calculations.

[1]Department of Civil and Environmental Engineering, Syracuse University, ctdrisco@syr.edu

Critical loads in Europe: overview and latest developments

Gert Jan Reinds[1] and Jean-Paul Hettelingh[2]

As a result of the observed relationship between air pollution and acidification of soils and waters, in 1979 the United Nations Economic Commission for Europe (UNECE) initiated the Convention on Long-range Transboundary Air Pollution (LRTAP). Under this convention a number of working groups were established, to investigate all relevant aspects of air pollution and its effects on ecosystems, crops, human health and materials. The ICP on Modelling and Mapping of Critical Levels and Loads and Air Pollution Effects (ICP M&M) is responsible, inter alia, for the assessment of regional critical loads in Europe. It's major aim is to develop methodologies and databases of critical loads of sulphur and nitrogen that are used in the assessment of cost-effective emission-abatement alternatives in support of European policies to curb air pollution (Gregor et al., 2001). Following the obligations laid down in the 1988 NOx Protocol (that still proposed flat rate reductions), the 1994 Protocol on further abatement of Sulphur was the first protocol based on computations that provided the most cost-effective measures based on ecosystem vulnerability (expressed by critical loads) and emission abatement costs, optimized in an European framework. In 1999 the so-called multi-effect multi-pollutant protocol (also known as the Gothenburg Protocol) was signed that included sulphur (S), nitrogen oxides (NOx), ammonia (NH3) and volatile organic compounds (VOCs).

The emission reduction protocols have been successful: compared to 1980, the emissions in 2010 in Europe of SOx under the Gothenburg protocol should have been reduced by more than 60%, emissions of NOx by about 40% and those of ammonia by 17%.
Next to critical loads for S and N, also methodologies for critical loads for heavy metals have been developed in Europe. In 1994, a first explorative study was carried out commissioned by the Dutch ministry of Housing, Spatial Planning and the Environment covering emissions, deposition and critical loads for heavy metals in Europe (Van den Hout et al, 1999). This was followed in 2005 by a report of the CCE on critical loads for Cd, Pb and Hg in Europe with contributions of various countries that provided national critical load assessments. In 2006 a report was published to support the review of the Heavy Metal protocol under LRTAP (Hettelingh & Sliggers, 2006), that apart from the 'priority' metals also included preliminary critical load assessments for Cu, Zn, As, Cr and Se.

Over the last years, there has been an increased emphasis on dynamic modelling of S and N effects on ecosystems in Europe, to investigate recovery from acidification and eutrophication. Recently, much effort is dedicated to derive critical loads for N, based on biodiversity criteria, thus shifting from abiotic criteria such as a critical N concentration in the soil to criteria like 'habitat quality index', based on functions describing probability occurrence of plants as a function of pH, N and climatic variables (Reinds et al, 2012). This work is partly carried out within the EU FPVII Framework project Eclaire.

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Reinds, G.J. L
[1]Alterra-Wageningen UR, gertjan.reinds@wur.nl|
[2]RIVM-CCE

Nitrogen Critical Loads in the Pacific Northwest, USA: Current Understanding and Data Gaps

Tonnie Cummings[1], Tamara Blett[2], Linda Geiser[3], Rick Graw[4], Jill McMurray[5], Steven Perakis[6], Ellen Porter[7] and Regina Rochefort[8]

The National Park Service (NPS) and U.S. Forest Service (USFS) manage areas in the Pacific Northwest (i.e., the states of Idaho, Oregon, and Washington), that contain significant natural resources and provide many recreational opportunities. The agencies are mandated to protect the air quality and air pollution-sensitive resources on these federal lands. Until recently, very few nitrogen critical loads studies had been conducted in the Pacific Northwest. Because there are several sources of nitrogen in the region, NPS and USFS air quality staff became concerned that lack of nitrogen effects information would inhibit their ability to adequately protect Pacific Northwest park and forest resources. Therefore, the agencies - with scientific input from the U.S. Geological Survey - developed a coordinated approach for accumulating additional nitrogen effects information and using the data in planning and regulatory arenas. As a first step in that process, the agencies recently published a report that summarizes the current state of knowledge about nitrogen deposition, effects, and critical loads in the region. The report's intended audience is NPS and USFS managers in the Pacific Northwest, state and federal regulatory agencies, and research organizations. The report describes: sources and effects of nitrogen deposition, legal mandates for NPS and USFS air quality protection efforts, the concept and use of critical loads and target loads to protect resources, and potential interactions of nitrogen and climate change. The report also summarizes current nitrogen effects studies in the region and prioritizes data needed to improve understanding of how nitrogen affects regional ecological resources.

[1]National Park Service, tonnie_cummings@nps.gov
[2]National Park Service, tamara_blett@nps.gov
[3]U.S. Forest Service, lgeiser@fs.fed.us
[4]U.S. Forest Service, rgraw@fs.fed.us
[5]U.S. Forest Service, jamcmurray@fs.fed.us
[6]U.S. Geological Survey, sperakis@usgs.gov
[7]National Park Service, ellen_porter@nps.gov
[8]National Park Service, regina_rochefort@nps.gov

Contribution of Oil and Gas Production to Nitrogen Deposition and Critical Load exceedance in Class 1&2 Areas in the Western US

Tammy Thompson[1], Michael G. Barna[2] and Bret Schichtel[3]

Nitrogen deposition has become a major concern for protected ecosystems in the Western US. A "critical load" value for an individual pollutant is defined as the amount of that pollutant an ecosystem can absorb before detrimental changes occur to that ecosystem. Researchers have found that many areas in the Western US have surpassed their critical load for nitrogen deposition. Here we utilize the Comprehensive Air quality Model with Extensions (CAMx) with 2008 meteorology and emissions to simulate the nitrogen deposition in the Western US. These model inputs were generated as part of the WESTJUMP modeling study which included a detailed assessment of oil and gas emissions. We compare modeled nitrogen deposition to critical load values for sensitive lichen species, finding that 73% of class 1&2 areas in the Western US have modeled annual nitrogen deposition totals above these conservative critical load values. Oil and gas production in the Western US has increased considerably in the past 5 to 10 years, often in remote areas near class 1&2 sensitive ecosystems. We also quantify the modeled contribution of emissions associated with oil and gas production to nitrogen deposition by comparing a 2008 modeling run without oil and gas emissions to the 2008 basecase modeling run with full emissions. We report the contributions of oil and gas to nitrogen deposition in all class 1&2 areas in the Western US in the context of their critical load values.

[1]CSU CIRA, Tammy.Thompson@colostate.edu
[2]National Park Service, Mike.Barna@colostate.edu
[3]National Park Service, Bret.Schichtel@colostate.edu

Development and release of the Air Quality Portal for Land Management Planning: The application and use of critical loads for management and policy decisions

Claire O'Dea[1] and Cindy Huber[2]

The National Forest Management Act requires every national forest and grassland managed by the Forest Service to develop and maintain a land management plan. The process for plan development and revision, along with the required plan content, is outlined in the Forest Service Planning Rule. The Forest Service released a revised Planning Rule in 2012, which for the first time requires national forests and grasslands to consider air quality when developing plan components. Specifically, Planning Rule directives require an assessment of critical load exceedances. If critical loads have been exceeded, forests and grasslands are required to develop plan components to protect or restore key ecosystem characteristics.

These requirements provided a unique opportunity to standardize the way national forests view and manage air quality, specifically implementing the use of critical loads of air pollution into the land management planning process. The Forest Service developed the Air Quality Portal for Land Management Planning in response to these new requirements. The Air Quality Portal is a decision support system based in large part on the critical loads information calculated and compiled by the NADP Critical Loads of Atmospheric Deposition Science Committee in the National Critical Loads Database.

By creating an easy-to-use resource to guide national forests in considering and treating air quality for land management planning, we ensure a nationally consistent methodology which incorporates the best available science and data and eases the burden on our national forests. The site includes background information on atmospheric deposition and critical loads of air pollution, a standardized air quality assessment process (including guidance on assessing critical loads of air pollution for land management planning), national air quality data, sample forest plan components and assessments, and training materials. A public-facing version of the Air Quality Portal for Land Management Planning should be completed by the fall NADP meeting. The Forest Service would like to present the capability of this new tool to the NADP community in order to demonstrate how we are currently implementing CLAD and TDEP information in land management, and to suggest future collaborative opportunities.

[1]USDA Forest Service, cbodea@fs.fed.us
[2]NADP, clad.focus@gmail.com

Comparison of Aerodynamic Resistance Parameterizations and Implications for Dry Deposition Modeling

John Walker[1], Donna Schwede[2] and Jesse Bash[3]

Nitrogen deposition data used to support the secondary National Ambient Air Quality Standards and critical loads research derives from both measurements and modeling. Data sets with spatial coverage sufficient for regional scale deposition assessments are currently generated from several distinct modeling platforms, which yield substantially different estimates under certain conditions. For the ecological and atmospheric science communities to provide the best science for policy development, differences in these data sets must be reconciled. One source of bias in deposition estimates across data sets is the choice of model formulation for dry deposition. While most dry deposition models employ a similar conceptual framework, the well-known resistance analogy, the details of the models differ. The resistance framework describes the process of dry deposition as consisting of three components in sequence: turbulent transfer from the atmosphere to the receptor surface, diffusion across the laminar boundary layer of air at the receptor surface and uptake by the surface. The resistance to transfer by these processes, referred to as the aerodynamic (R_a), boundary layer (R_b), and canopy (R_c) resistances, respectively, controls the rate at which the gas or particle deposits (i.e., deposition velocity).

For some compounds such as nitric acid (HNO_3), an important contributor to the dry N flux, the deposition process is not influenced by the chemical (e.g., acidity), physical (e.g., morphology), or biological (e.g., stomatal behavior) characteristics of the surface. For such compounds, R_a is the limiting resistance. In many cases, differences in the parameterization of R_a cause large differences in model estimates of dry nitrogen deposition. This study investigates the impact of differences in R_a parameterizations on dry deposition estimates, particularly nitrogen compounds. Parameterizations include those used in the CASTNet multi-layer model (MLM), versions of the Community Multi-scale Air Quality Model (CMAQ) with input from the Weather Research Forecast model (CMAQ-WRF) and 5th generation Mesoscale Model (CMAQ-MM5), and the Big Leaf Model (BLM) of Zhang et al. (2003) used within the Canadian Meteorological Service's "A Unified Regional Air quality Modelling System" (AURAMS), the Canadian Air and Precipitation Monitoring Network (CAPMoN) and the Comprehensive Air Quality Model with Extensions (CAMx). This suite of models represents the most commonly used methods for developing nitrogen deposition budgets across North America.

Parameterizations are compared using a common set of micrometeorological data collected over a grass field (Duke Forest, NC), a mixed hardwood forest (Coweeta, NC), and a coniferous forest (Howland Forest, MA). Differences in parameterizations are analyzed with respect to atmospheric stability and the impact of differences in R_a on dry deposition calculations is illustrated by comparing cumulative seasonal and annual HNO_3 deposition for the three case study sites.

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[1]US EPA, walker.johnt@epa.gov
[2]US EPA, schwede.donna@epa.gov
[3]US EPA, bash.jesse@epa.gov

Characteristics of New CMAQ Deposition Series of 2002 to 2011 for Critical Loads

Robin Dennis[1], Kristen Foley[2] and Jesse Bash[3]

A new CMAQ time series from 2002 to 2011 of annual deposition that incorporates bi-directional ammonia deposition is now available. The 12 km grid simulations have been post processed with a PRISM-based precipitation correction and a bias adjustment based on NADP data for the full CONUS domain. Several analyses of the new annual CMAQ outputs are presented to provide a sense of the deposition series. Temporal trends and inter-annual variability in total precipitation and wet deposition of NO3, NH4 and SO4 across 5 major regions of the country (Northeast, Southeast, Great Lakes, intermountain West, and Pacific) are compared to NADP measurements for raw CMAQ outputs and fully adjusted CMAQ outputs. The regional RMSE error is also presented. Trends of NADP observations and raw CMAQ output are very comparable for the eastern half of the CONUS for NO3, NH4, and SO4 wet deposition. There is an under prediction in raw CMAQ output across the intermountain West that is least for SO4, presumably due to missing emissions. In the West for all three species there is a slightly greater decrease in raw CMAQ output from 2006/2008 onward compared to observations, suggesting something systematic. For the Pacific states there is a slightly greater trend downward in raw CMAQ output than observed for NO3 and SO4 with a significant over-prediction offset for SO4. For the eastern half of the CONUS the adjustments to the wet deposition are small, the order of 10-20% on average, but for the intermountain West the adjustments are significant. These will be illustrated by regional time series and spatial maps of the adjustments. Finally biases in ambient concentrations of total nitrate, SO2 and SO4 will be summarized for the 5 major regions using CASTNet and other ambient data. Inter-annual variability and systematic behavior of the biases will be noted.

[1]US EPA, dennis.robin@epa.gov
[2]US EPA, foley.kristen@epa.gov
[3]US EPA, bash.jesse@epa.gov

A management tool for predicting effects of interactions of climate change and nitrogen deposition on forest health and setting critical loads

Linda Pardo[1], MJ Robin-Abbott[2], JA Pontius[3] and CB O'Dea[4]

Among the challenges to maintaining ecosystem health and sustainability over the long term are climate change, nitrogen (N) deposition, pest outbreaks, and land use change and fragmentation. In this project, we are developing a GIS-based tool to evaluate the impact of multiple stressors (N deposition, climate change, pests) simultaneously for species of management concern on public and private lands. The regional tool that we are developing for the Northeast serves as a pilot project for national-scale implementation. Our approach is to: (1) develop critical loads (CL) for individual species of trees and herbaceous plants; (2) develop a framework to evaluate the effect of landscape characteristics and other abiotic factors on N CLs for species of management concern; (3) assess the interacting effects of climate change and N deposition on forest health and how this will affect the CL; (4) incorporate impacts from insect pests into the forest health and CL assessment. The abiotic modifying factors include elevation, latitude, precipitation, temperature (e.g., min winter T, max summer T), and soil characteristics. The impact of each abiotic modifying factor on the response to N deposition for a given species is determined by the weight of evidence (weak, moderate, or strong) which is based on the certainty associated with the data and response reported. For each location and species/community, an assessment is made about the certainty (likely, possible, unlikely) of the effect on the CL based on the weight of the evidence. The systematic approach we developed, in which the basis for each decision is made explicit, allows users to understand the reliability of the CLs presented.

[1]USDA Forest Service, lpardo@fs.fed.us
[2]EBSER, mjrobina@gmail.com
[3]UVM/USDA Forest Service, jennifer.pontius@uvm.edu
[4]USDA Forest Service, cbodea@fs.fed.us

TECHNICAL SESSION 6:
URBAN AIR CHEMISTRY AND DEPOSITION

Session Chair: Richard Pouyat,
USDA Forest Service

Urban atmospheric chemistry and reactive nitrogen deposition

Emily Elliott[1]

The family of NADP and CASTNET monitoring networks are the foundation for our understanding of atmospheric wet and dry nitrogen (N) deposition to landscapes. As such, empirical deposition measurements from these networks are critical inputs for watershed models, critical loads assessments, and ecosystem studies. Further, data collected from these networks are commonly used to assess emission control policies. However, isotopic, remote sensing, public health and modeling studies indicate a more spatially heterogeneous pattern of reactive N deposition than is currently captured by these networks. In this presentation, we highlight present knowledge regarding rates of urban atmospheric deposition of reactive N, controls on these rates, and key unknowns. We then examine the potential implications of such deposition patterns on ecosystem processes, human health, and water quality using examples from near-road and urban settings.

[1]University of Pittsburgh, eelliott@pitt.edu

The Importance of Small Scale Deposition Gradients in the Urban Landscape

Thomas Whitlow[1], Richard V. Pouyat[2] and Pamela Templer[3]

Monitoring networks for both atmospheric deposition and air quality compliance are deliberately located to avoid local sources. While appropriate for capturing regional trends, this approach misses the fine-grained patterns that are likely to have an overriding impact on deposition fluxes at scales and locations where city dwellers encounter them. Fluxes should necessarily include heavy metals in addition to nitrogen. Near ground sources like vehicles and building surfaces, manufacturing, construction activities and peak power generation facilities are important sources to consider in the context human well-being and biogeochemistry.

This talk has 3 parts. First, we will summarize published information about near road deposition of heavy metals. Second, we will present new data from studies we are conducting at the Brooklyn Grange vegetable farms in New York City that show both vertical and horizontal variation and findings from gradient studies downwind of heavily trafficked streets. Last, we will discuss problems we have encountered and suggest strategies for sample collection that can be incorporated into the present NADP protocol.

[1]Section of Horticulture, School of Integrative Plant Science, Cornell UNiv., thw2@cornell.edu
[2]US Fiorest Service, rpouyat@fs.fed.us
[3]Boston Univ., ptempler@bu.edu

Sourcing dry N deposition in urban areas and implications for national N inventories

Katherine Redling[1] and Emily Elliott[2]

While wet deposition makes up the majority of total reactive nitrogen deposition in the eastern U.S., dry deposition accounts for 20-50%, and thus can be a significant source of reactive nitrogen to ecosystems. While many studies have measured dry N deposition in rural areas, there are few measurements of dry N deposition in urban areas. When combined with national monitoring (e.g., NADP-NTN and CASTNET) sited in rural locations, dry N deposition in urban areas is poorly characterized. However, these measurements are especially important in areas with high traffic volumes because previous studies have shown that dry N deposition deposits close to the source, especially from automobiles. For example, previous research suggests that N deposition observed by NADP-NTN and CASTNET reflects NO_x derived primarily from regionally-transported emissions from stationary sources (e.g., power plant smoke stacks) rather than mobile sources (e.g. automobiles). Furthermore, CASTNET does not measure NO_2; 80% of dry N deposition measured by CASTNET is from HNO_3. However, previous studies have documented that NO_2 is a large component of total dry N deposition, especially near roadways.

This study characterized the amount and sources of dry N deposition (NO_2 and HNO_3) along two urban to rural gradients, one in Baltimore, MD and the other in Pittsburgh, PA, in order to better understand dry N deposition dynamics in urban areas. Passive samplers were deployed at urban, suburban and rural sites for five months to collect NO_2 and HNO_3 for calculation of N fluxes. This method provides a straightforward and inexpensive approach for monitoring N deposition and sources across large spatial gradients for extended time periods.

Results showed that the Pittsburgh gradient urban site had 1.8 times higher N flux than the corresponding rural site and 2.3 times higher N flux than the suburban site. The Maryland gradient urban site had 1.5 times greater total N flux than the rural site. Further, N deposition at urban sampling locations was greater than that measured at nearby CASTNET sites, which may lead to an underestimation of total N deposited in urban areas. 59-71% of the total nitrogen was NO_2, which is not measured by CASTNET. NO_2 flux was strongly correlated with traffic volume at each site, indicating that NO_2 flux may be derived primarily from automobiles and deposits locally. In contrast, HNO_3 flux correlated with stationary source NO_x emissions, indicating that HNO_3 may be transported regionally due to its longer atmospheric lifetime.

[1]University of Pittsburgh Department of Geology & Planetary Science, kmm98@pitt.edu
[2]University of Pittsburgh Department of Geology & Planetary Science, eelliott@pitt.edu

Controls on Variability of Nitrogen Deposition and Cycling within Urban Ecosystems

Steve Decina[1], Dr. Pamela Templer[2] and Dr. Lucy Hutyra[3]

Numerous studies have shown elevated rates of nitrogen deposition in urban areas compared to their rural counterparts. However, we do not have a clear understanding of how rates of nitrogen deposition and cycling vary within a city and as a function of different urban land uses. In this study, we measured rates of nitrogen deposition, internal nitrogen cycling, nitrogen leaching, and soil CO_2 respiration across 15 sites in and around Boston, MA. In order to determine potential drivers of urban nitrogen cycling, these sites range across metrics of urbanness, including traffic density, distance to major highways, and impervious surface area fraction. Preliminary results show variability within urban areas that has not yet been accounted for in previous studies examining only one or two urban sites. The results of this study have the potential to inform our understanding of atmospheric deposition in urban areas and to reveal how particular features of a city may influence atmospheric nitrogen inputs and cycling, which could be instrumental in more accurately constraining regional estimates of deposition and critical loads.

[1]Boston University, sdecina@bu.edu
[2]Boston University, ptempler@bu.edu
[3]Boston University, lrhutyra@bu.edu

Chronology of acid rain in Mexico City and the Gulf of Mexico.

Humberto Bravo A., Rodolfo Sosa E., Ana Luisa Alarcón J., Maria del Carmen Torres B., Pablo Sánchez A., Monica Jaimes P., Elías Granados H.

The first sampling of acid rain in the Mexico City Metropolitan Area (MCMA), dating from 1980. However, from 2003 it has been properly followed by protocols of the US-EPA, as well as a strict quality assurance and quality control program. These surveys are being carried out at 26 stations distributed throughout the MCMA in collaboration with the Federal District Government (GDF) of Mexico City.

The physico-chemical parameters of pH and conductivity are evaluated in the field and in the laboratory, while the concentration of ions (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, SO_4^{2-}, $NO_3^-$and Cl^-) is determined in the laboratory by High Performance Liquid Chromatography (HPLC).

The pH values decrease from North to South in the MCMA, the Southwest area presents the highest levels of acidity. Analyzing the entire study period (2004-2012), is the last year (2012) which presented the phenomenon of acid rain (pH <5.6) throughout all the MCMA.

In relation to the concentrations of sulfate and nitrate, the highest values occur in the Northwest of the metropolitan area, showing the influence of external sources of precursors located at the North; taking into consideration the prevailing wind direction is from North to South. It is important to note that although the sources located in the MCMA have decreased emissions of acid rain precursors (SO_2 and NO_x), this has not been yet accomplished outside, and however, these emissions also influences on the levels of SO_4^{2-}, NO_3^- and acidic pH values into MCMA.

The Gulf of Mexico is a region that exhibits the phenomenon of acid rain, which has been detected since 2003 in four sampling sites installed and operated by the University of Mexico. These four sites were kept running continuously until 2006, remaining today (2014) and considered as a reference site "La Mancha", Veracruz.

For the evaluation of wet atmospheric deposition, the collection is performed daily and is carried out to determine the physico-chemical parameters of pH and conductivity in the field. Later in the laboratory, again makes measuring pH and conductivity, as well as determination of the ion concentrations of ions by HPLC.

In relation to the wet atmospheric deposition found the following ranges of values for the volume weighted average per year during the study period (2003-2013): pH (4.81-5.44); sulfate (15.78-40.10μeq/L); nitrate (3.60-20.85μeq/L). This shows the potential impact on different receptors in the study area, being: agricultural areas, water bodies, buildings that are part of the cultural heritage, industries, among others.

[1]Universidad Nacional Autónoma de México, hbravo@unam.mx

[2]Universidad Nacional Autónoma de México, rodsosa@unam.mx

[3]Universidad Nacional Autónoma de México, pasa@unam.mx

[4]Universidad Nacional Autónoma de México, mcarmen@atmosfera.unam.mx

[5]Universidad Nacional Autónoma de México, anna_larcon@hotmail.com

[6]Universidad Nacional Autónoma de México, mjaimes@sedema.df.gob.mx

[7]Universidad Nacional Autónoma de México, elias78@unam.mx

POSTER SESSIONS

In Alphabetical Order by Author

Spatial Variability in Ozone and CO_2 Flux during the Front Range Air Pollution and Photochemistry Experiment

Berkeley Almand-Hunter[1], Ricardo Piedrahita[2], Aleya Kaushik[3], David Noone[4], John Walker[5] and Michael Hannigan[6]

Air quality problems persist in the Northern Front-Range Metropolitan Area (NFRMA) of Colorado despite efforts to reduce emissions, and summertime ozone concentrations in the NFRMA frequently exceed the NAAQS. Atmospheric modeling in the NFRMA is challenging due to the complex topography of the area, as well as diversity of pollutant sources (urban NOx and VOCs, power plants, industrial complexes, oil and gas, agricultural emissions, biogenic emissions, and wildfires). An improved understanding of the local atmospheric chemistry will enable researchers to advance these atmospheric models, which will subsequently be used to develop and test more effective air quality management strategies. The Front Range Air Pollution and Photochemistry Experiment (FRAPPE) investigates this problem through detailed examination of atmospheric chemistry in the NFRMA, including photochemistry, aerosol and oxidant formation and fate, and meteorological flow patterns. Our project specifically explores the spatial variability in ozone (O_3) concentration and dry deposition within the FRAPPE study area.

One source of uncertainty in atmospheric models is ozone flux, which varies spatially due to local meteorology and variation in ambient concentration and deposition velocity. Model grid cells typically range in size from 10-100 km and 100-500 km, for regional and global models, respectively. With the reduction of sub-grid variability in mind, the monitoring sites used for model inputs are chosen to be representative of the surrounding areas, but accurate representations of an entire grid cell cannot always be achieved. Large spatial variability within a model grid cell can lead to poor estimates of trace-gas flux and concentration. Our research addresses this issue by measuring spatial variability in O_3 flux using low-cost dry-deposition flux chambers.

We are measuring O_3 and CO_2 flux with 5 low-cost flux chambers and one eddy-covariance tower. The eddy-covariance tower is located at the Boulder Atmospheric Observatory in Erie, CO. All 5 chambers are within a 8.3 x 6 km square, with one chamber collocated with the eddy-covariance tower, and the other 4 chambers at distances of 0.33, 1.14, 3.22, and 7.55 km from the tower. The largest distance between any two chambers is 8.5 km. All 5 chambers measure flux onto native grasslands across a range of natural variability in species, leaf-area index, and ecosystem productivity. Preliminary results show that ambient ozone concentrations and fluxes vary between sites. A detailed analysis of the variability in O_3 fluxes and concentrations across measurement sites will be presented.

[1]University of Colorado at Boulder, berkeley.almand@colorado.edu

[2]University of Colorado at Boulder

[3]University of Colorado at Boulder

[4]University of Colorado at Boulder, Oregon State University

[5]US Environmental Protection Agency

[6]University of Colorado at Boulder

Champaign-Urbana Transect Ambient Ammonia Study

Sybil Anderson[1], Marcelo S. Vieira-Filho[2] and Christopher MB Lehmann[3]

Ammonia (NH_3) is a gas readily released into the air from a variety of biological sources, as well as from industrial and combustion processes. As the most prevalent base gas in the atmosphere, it contributes to the formation of atmospheric particulate matter and its deposition increases the alkalinity of sensitive ecosystems. In 2010, an Ammonia Monitoring Network (AMoN) was approved to track long-term trends in ambient NH_3 concentrations. The network currently contains 66 active sites throughout the United States.

Agriculture has been considered to be the primary source of anthropogenic ammonia, and this research project is looking at how ambient ammonia can vary within a local region with different land uses. The Champaign-Urbana region (CU) is a micro-urban area surrounded by cropland, so there are a number of possible sources besides agriculture including: urban centers, interstates, parks, and a major university campus. This research study is looking at a transect of CU, roughly perpendicular to prevailing winds. Radiello® passive samplers were deployed at nine locations for eight 1-week sampling periods along a 15 kilometer transect of CU during the growing season. The aim of the research is to both help determine how representative ammonia concentrations are of a surrounding region and examine the impact of land use on those ambient concentrations.

During spring 2014, when fertilization was prevalent, ambient ammonia concentrations at all sampler sites were between 2.4 $\mu g/m^3$ and 4.7 $\mu g/m^3$ with the cropland-located sampler representing the highest concentration. Once the period of fertilization was over, concentration at all sites were lower and the cropland was no longer the highest concentration. The lowest site observed is in restored prairie land, located within 0.75 km of cropland and other farm activity. It is believed other sources besides agriculture are contributing to the background ambient ammonia concentrations of the CU region.

[1]NADP, Illinois State Water Survey; Prairie Research Institute, University of Illinois, sybilma@illinois.edu

[2]Departamento de Ciências Atmosféricas, Instituto de Astronomia, Geofísica e Ciências Atmosféricas da, vieira.filho@live.com

[3]NADP, Illinois State Water Survey; Prairie Research Institute, University of Illinois, clehmann@illinois.edu

Increasing Spatial and Temporal Resolution of Gaseous Ammonia Emissions from Chemical Fertilizer Usage

Srinidhi Balasubramanian[1], Sotiria Koloutsou-Vakakis[2], Meng Wang[3], Yangcuiyu Xiong[4] and Mark Rood[5]

A method and results for increasing spatial and temporal resolution of NH_3 emissions from chemical fertilizer usage (NH_3-CFU) are presented. Such emissions are used as inputs to chemical transport models (CTMs) to estimate particulate matter concentrations and reactive nitrogen deposition. Typically, emission inputs are obtained from the National Emissions Inventory (NEI). NH_3-CFU are estimated by combining annual fertilizer sales reported at county level with fertilizer-specific emission factors. However, inputs to CTMs are required at finer spatial resolutions and hourly temporal scale. The Sparse Matrix Operator Kernel Emissions (SMOKE) model is used to bridge resolution gaps between NEI and CTMs by use of spatial surrogates and temporal factors, which could be further improved.

Spatial surrogates within SMOKE are developed by estimating the ratio of cropland within 4x4 km^2 grid to net cropland within county area. This approach does not consider crop fertilizer requirements that result in spatial heterogeneity in NH_3 emissions at sub-county resolutions. The Improved Spatial Surrogate (ISS) method was developed to modify the existing spatial surrogate within SMOKE by incorporating annual cropland distribution and crop-specific nitrogen demands. Results for a test domain of 4x4 km^2 grids over Central Illinois indicate large variations in grid based differences in estimates between SMOKE and ISS. Such differences range between -10% - 120% with 58% of the grid cells exhibiting more than ± 10% difference. Applicability of the ISS method is currently being tested by upscaling to (1) 4x4 km^2 over Midwest USA and (2) 12x12 km^2 across continental USA.

Hourly temporal factors in SMOKE are currently estimated by equally disaggregating emissions within each crop season proportionately to the nitrogen applied. This excludes influences of local weather and soil conditions. In this research, the process based DeNitrification DeComposition (DNDC) model was employed to model daily variations in NH_3-CFU within the test domain. For the years 2002-2011, mean NH_3 emissions from DNDC were within ±15% of SMOKE and ISS estimates. Inter-annual temporal patterns were similar in distribution but varied in magnitudes by ±20%. However, individual emission peaks on days post fertilization were 2.5-8 times greater than those estimated by SMOKE.

By providing alternate approaches to bridge spatial and temporal resolution between NEI and CTMs, this study could assist in improving modeling predictions of atmospheric particulate matter and deposition of reactive nitrogen.

[1]University of Illinois at Urbana Champaign, sblsbrm2@illinois.edu

[2]University of Illinois at Urbana Champaign, sotiriak@illinois.edu

[3]University of Illinois at Urbana Champaign, mwang15@illinois.edu

[4]University of Illinois at Urbana Champaign, yxiong9@illinois.edu

[5]University of Illinois at Urbana Champaign, mrood@illinois.edu

Factors Influencing Long-Term Nitrogen Storage In Soils

Andrew Bingham[1]

Nitrogen is one of the most important plant nutrients and often its availability is the limiting factor for primary production. Nitrogen enters an ecosystem from the atmosphere and can be cycled via many different pathways before it is either stored in the soil, returned to the atmosphere or leached into ground water. Recent realizations that most nitrogen stored in soil is in labile, organic forms rather than recalcitrant compounds have led to a re-evaluation of how it is sequestered for extended time periods. The long-term (centuries to millennia) storage of nitrogen in soils is influenced by many interacting factors. Adsorption to mineral particles, physical protection and microbial processing are now thought to be the primary controls governing the transfer of nitrogen to the long-term storage pool. The rate of durable nitrogen storage is an important term in critical loads equations, and better understanding of the factors influencing it will provide more accurate estimates for this term. This new understanding can also have important implications for models of nitrogen cycling as well as policies governing anthropogenic emissions.

[1]National Park Service, drew_bingham@nps.gov

Nitrogen Deposition: Trends and Impacts in the Greater Yellowstone Area

Tamara Blett[1] and Terry Svalberg[2]

Air quality and ecosystem monitoring and research indicate that anthropogenic nitrogen pollution is beginning to alter sensitive ecosystems in the Greater Yellowstone Area (GYA). Some GYA lakes may be at the early stages of eutrophication (nitrate concentrations are at levels where algal species may increase), and some lakes are beginning to acidify (lose acid neutralizing capacity). Lake sediment cores show increasing influences of anthropogenic nitrogen and degraded lichen communities are present in areas of higher nitrogen deposition. Although the ecosystems changes are subtle, an increasing weight of evidence points to declining health in aquatic and terrestrial ecosystems in the GYA. Deposition and ambient air monitors also indicate that nitrogen compounds in air, rain, and snow are increasing in several areas of the GYA. Critical loads indicating thresholds of change for chemical and biological endpoints have been developed to show the levels of nitrogen specifically impacting different ecosystem components in the GYA. Critical loads in the GYA can: (1) Help National Park and National Forest land managers set goals to protect and improve resource conditions and (2) Serve as benchmarks identifying areas and pollutants for which State and Regional Plans to improve air quality would be most effective.

[1]National Park Service, tamara_blett@nps.gov
[2]USDA Forest Service, tsvalberg@fs.fed.us

Atmospheric Mercury Trends in Western Maryland: 1996 – 2013

Mark Castro[1], John Sherwell, Ph.D.[2] and Chris Moore, Ph.D.[3]

The purpose of this study was to compare average annual rates of mercury wet deposition and annual average ambient air concentrations of speciated mercury to changes in power plant mercury emissions. The wet deposition and atmospheric measurements were made at the Piney Creek Reservoir atmospheric monitoring station in western Maryland (MD 08). For total mercury deposition, the annual volume weighted total mercury concentrations decreased from 13 ng L^{-1} in 1996 to 5 ng L^{-1} in the early 2000s, but increased to 9 ng L^{-1} in 2012. From 2005 to 2011, there were no reductions in the average annual ambient air concentrations of GEM. However, the average annual GOM concentrations decreased from 22 pg m^{-3} in 2008 to 9 pg m^{-3} in 2012. Similarly, the average annual $PBM_{2.5}$ concentrations decreased from 7 pg m^{-3} in 2007 to 4 pg m^{-3} in 2012. These downward trends were consistent with reductions in mercury emissions from power plants. For example, power plant mercury emissions in Pennsylvania decreased from 2.75 tons yr^{-1} in 2007 to 1.95 tons yr^{-1} in 2011.

[1]Appalachian Laboratory, mcastro@umces.edu
[2]Maryland Department of Natural Resources, JSHERWELL@dnr.state.md.us
[3]DRI, Reno, Chris.Moore@dri.edu

Mapping atmospheric deposition of nitrogen and sulfur in Rocky Mountain National Park, USA using ion-exchange resin collectors

David Clow[1], Heidi A. Roop[2], Leora Nanus[3], Mark E. Fenn[4] and Graham A. Sexstone[5]

Lakes and streams in Class 1 wilderness areas in the western United States (U.S.) are at risk from atmospheric deposition of nitrogen (N) and sulfur (S), and protection of these resources is mandated under the Federal Clean Air Act and amendments. Assessment of critical loads, which are the maximum exposure to pollution an area can receive without adverse effects on sensitive ecosystems, requires accurate deposition estimates. However, deposition is difficult and expensive to measure in high-elevation wilderness, and spatial patterns in N and S deposition in these areas remain poorly quantified. In this study, ion-exchange resin (IER) collectors were used to measure dissolved inorganic N (DIN) and S deposition during June 2006 – September 2007 at approximately 20 alpine/subalpine sites spanning the Continental Divide in Rocky Mountain National Park. Results indicated good agreement between deposition estimated from IER collectors and commonly used wet+dry methods during summer, but poor agreement during winter. Snowpack sampling was found to be a more accurate way of quantifying DIN and S deposition during winter. Summer DIN deposition was significantly greater on the east side of the park than on the west side (25-50%; $p \leq 0.03$), consistent with transport of pollutants to the park from urban and agricultural areas to the east. Sources of atmospheric nitrate (NO_3^-) were examined using N isotopes. The average $d^{15}N$ of NO_3^- from IER collectors was 3.5‰ greater during winter than during summer ($p<0.001$), indicating a seasonal shift in the relative importance of regional NOx sources, such as coal combustion and vehicular sources of atmospheric NO_3^-. There were no significant differences in $d^{15}N$ of NO_3^- between east and west sides of the park during summer or winter ($p=0.83$), indicating that the two areas may have similar sources of atmospheric NO_3^-. Results from this study indicate that a combination of IER collectors and snowpack sampling can be used to characterize spatial variability in DIN and S deposition in high-elevation wilderness areas. These data can improve our ability to model critical loads by filling gaps in geographic coverage of deposition monitoring/modeling programs and thus may enable policy makers to better protect sensitive natural resources in Class 1 Wilderness areas.

[1]USGS, dwclow@usgs.gov
[2]GNS Science, New Zealand, h.roop@gns.cri.nz
[3]Department of Geography and Environment, San Francisco State University, lnanus@sfsu.edu
[4]US Forest Service, Pacific Southwest Research Station, mfenn@fs.fed.us
[5]United States Geological Survey, Denver, sexstone@usgs.gov

Chemical Speciation Network Spatial and Temporal Trends in Sulfur/Sulfate Ratio

Tracy Dombek[1], Prakash Doraiswamy[2], R.K.M. Jayanty[3] and Eva Hardison[4]

The $PM_{2.5}$ speciation trends network (STN), part of the Chemical Speciation Network (CSN), has been operational since the year 2000. $PM_{2.5}$ samples are collected on Teflon, Nylon and Quartz filters. Teflon filters are used to determine gravimetric mass and analyzed for elemental composition using XRF. Nylon filters are analyzed for ions using ion chromatography, and Quartz filters are analyzed for organic and elemental carbon using thermo-optical analysis. In this work, we compare elemental sulfur concentrations measured on Teflon filters with XRF to sulfate ion concentrations found on Nylon filters. If all of sulfur is present in the form of sulfate, the sulfur to sulfate ratio would be equal to 0.33. Alternatively, three times that ratio will equal 1.0. These ratios were calculated in data from all CSN sites from 2003 through 2013. The data were stratified by year and season for the entire network and for each site to examine spatial and temporal patterns. The sulfur and sulfate data were highly correlated, with the exception of a few outliers. A seasonal pattern in the distribution of the ratio was observed, with higher values during the summer during some years. This suggests that the non-sulfate sulfur may be associated, at least partly, with secondary organo-sulfate compounds. Confirmation of the presence of excess sulfur in water soluble forms was verified by selecting a small set of samples with ratios exceeding our current control limits and reanalyzing these for sulfate with and without an additional oxidation step by ion chromatography.

[1]RTI International, tdombek@rti.org
[2]RTI International, pdoraiswamy@rti.org
[3]RTI International, pdoraiswamy@rti.org
[4]RTI International, pdoraiswamy@rti.org

Preliminary Results from the Weather Research and Forecasting Model over Midwest USA

Kan Fu[1], Srinidhi Balasubramanian[2], Sotiria Koloutsou-Vakakis[3], Michael McFarland[4] and Mark Rood[5]

Excess reactive nitrogen can have detrimental effect for the environment, including eutrophication, greenhouse gas effect, over-fertilization, particulate matter formation and so on. In this study, the Weather Research and Forecasting (WRF) model is used to provide inputs to Chemical Transport Models, which will be used to estimate atmospheric particle matter concentrations and reactive nitrogen deposition over Midwest USA. One-way nesting is used at a spatial resolution of 4 km x 4 km for a nested domain. A separate run with a coarser spatial resolution (12 km x 12 km) was also completed. Such comparison is of interest to investigate how spatial resolution affects the predictions of WRF.

North American Meso-scale Forecast System data from National Oceanic and Atmospheric Administration are used as the lateral and boundary conditions. Surface observation data are incorporated to improve the first guess of model predication using objective analysis. Different physics schemes available in WRF model are tested to identify the best combination for Midwest USA. Finally, the WRF model predications will be compared with weather stations data to check the reliability of the WRF model.

[1]Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Illinois, kanfu2@illinois.edu

[2]Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Illinois, sblsbrm2@illinois.edu

[3]Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Illinois, sotiriak@illinois.edu

[4]Department of Aerospace Engineering, University of Illinois at Urbana-Champaign, Illinois, dmmcf@illinois.edu

[5]Civil and Environmental Engineering, University of Illinois at Urbana-Champaign, Illinois, mrood@illinois.edu

Uncertainties of gaseous oxidized mercury measurements: Ambient air concentration and dry deposition

Jiaoyan Huang[1], Seth Lyman[2] and Mae Gustin[3]

Mercury (Hg) is a toxic air pollutant, and the atmosphere is the primary pathway by which it enters ecosystems. Because of this it is important to understand the chemistry of atmospheric Hg, and processes controlling the deposition and assimilation into ecosystems for assessing risks to human and environmental health. The current sampling method for gaseous oxidized Hg (GOM) (KCl-coated denuder in a Tekran analytical system) has been reported to underestimate concentrations, and the uncertainty associated with the measurement of GOM and particulate bound Hg by this instrument is high. Because of this, estimation of GOM dry deposition in numerical models that use measured GOM concentrations are biased low. In addition, dry deposition measured with surrogate surfaces are typically higher than model values. Different GOM compounds have different chemical and physical properties that influence their atmospheric behavior. In this study, permeation tubes were made using 6 potential GOM compounds which can be separated by thermodesorption from nylon membranes at different temperatures. The ability of the KCl-denuder, cation-exchange membranes (CEM), and nylon membranes to take up these compounds were investigated using a manifold system under different conditions, including zero air, ambient air, and air with water vapor added. Laboratory and field results indicate both membranes have higher GOM collection efficiency than the KCl-coated denuder. In addition, multiple relative humidity tests (RH) using our manifold showed the GOM collection efficiency of Tekran was reduced 20-35% at RH = 25-70%. The membranes were also deployed using an active system at field sites in Nevada and Florida. Overall, the field results showed CEM collected the highest GOM concentration among these three methods, and nylon membranes were influenced by precipitation. Field data showed that different GOM compounds were released at different temperatures from nylon membranes and the results varied with location and time. Dry deposition was comparable to modeled results if the underestimation of GOM by the KCl-coated denuder was considered. GOM collected using our active system, and GOM dry deposition measured by surrogate surfaces indicate different GOM compounds in the atmosphere. This active membrane system can better quantify true GOM concentrations than KCl denuder-based methods and when coupled with ramp heating thermo-desorption through a pyrolyzer into a Tekran 2537 or to a GC-MS, can determine the chemistry of GOM compounds. Also, membrane-based passive samplers can be used for long-term global Hg monitoring.

[1]huangj1311@gmail.com

[2]Bingham Entrepreneurship & Energy Research Center, Utah State University, seth.lyman@usu.edu

[3]Department of Natural Resources and Environmental Sciences, University of Nevada, mgustin@cabnr.unr.edu

CASTNET 'Small Footprint Filter Pack' Only Sites

Selma Isil[1], Kevin Mishoe[2], Justin Knoll[3], Chris Rogers[4] and Ralph Baumgardner[5]

The Clean Air Status and Trends Network (CASTNET) currently features more than 90 sites across the contiguous United States and Alaska. In recent years, CASTNET has taken the approach of expanding by adding new sites that are considered 'small footprint'. These sites do not have traditional CASTNET shelters but instead use small, tower-mounted equipment boxes. Small footprint sites only include a filter pack system for measuring ambient concentrations and ambient temperature measurement for use in converting concentrations to local conditions. The equipment box houses the mass flow controller, pump, cellular modem, and data logger and is mounted at approximate chest height. The tower is a regular 10 meter CASTNET tilt-down tower used at traditional CASTNET sites. The first small footprint sites were installed in 2012 in the northeast, with two sites in the Adirondack Park in New York and one site in northern Vermont. Two additional small footprints sites were added in 2014. One site was installed in northeastern Kansas in February 2014 as part of the Kickapoo Tribe's air monitoring program, and the second site began operations in late summer 2014 at the Red Lake Nation of Minnesota.

An alternative energy, 'off-grid' design for small footprint sites is currently being developed and tested at the AMEC field test site in Gainesville, Florida. This design will use a wind turbine and solar panel for generating electricity, which will be stored in two 12 volt AGM (absorbent glass mat) deep cycle batteries. The batteries will then be used to power the site. The first 'off-grid' site will be installed in late summer 2014 at the Coweeta Hydrologic Laboratory in North Carolina as part of a transect study designed to characterize concentrations in an Appalachian valley. The second site may be located in the northwestern United States and is scheduled to be deployed by the end of 2014. The 'off-grid' design will make it possible to do filter pack sampling in remote locations where electrical access is not possible or would be cost prohibitive.

[1]AMEC, Inc., selma.isil@amec.com
[2]AMEC, kevin.mishoe@amec.com
[3]AMEC, justin.knoll@amec.com
[4]AMEC, christopher.rogers@amec.com
[5]AMEC, Baumgardner.Ralph@epa.gov

Land Cover at National Atmospheric Deposition Sites derived from the National Land Cover Database

Dennis Jackson[1] and Amanda L. Conklin[2]

The National Atmospheric Deposition Program (NADP) coordinates the monitoring of atmospheric deposition at numerous locations across North America. Collectively these individual sites are important components of five unique networks that directly measure atmospheric concentrations and deposition rates at site locations. These observations provide point-source observations on parameters such as acidity content, nutrient levels, and deposition rates of important constituent's such as mercury and ammonia. Regional and other large scale assessments involving atmospheric deposition often utilize land use or land cover as a parameter that controls

This investigation evaluates the Land Cover of active NADP sites located in the continental United States using the 2011 National Land Cover Database (NLCD). The NLCD serves as the definitive Landsat-based, 30-meter resolution, land cover database for the US. NLCD provides spatial reference and descriptive data for characteristics of the land surface such as thematic class (for example, urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. The classification system used by NLCD2011 is modified from the Anderson Land Cover Classification System.

The analysis indicates that 19.8% (88 of 444) of the NADP active sites are located in areas classified as Pasture/Hay, which includes grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. In addition the analysis evaluated land cover at a scale of 500-m for each site. This information is available to support future investigations related to interactions between land cover and deposition.

[1]Savannah River National Laboratory, dennis.jackson@srnl.doe.gov
[2]The Ohio State University

Establish National Atmospheric Deposition Program Sites at Historically Black Colleges & Universities

Dennis Jackson[1], Kathy Carvalho-Knighton[2], Glenn McClendon[3], Godfrey A. Uzochukwu[4], Elijah Johnson[5], Karen Skubal[6] and Dennis G. Jackson[7]

The Savannah River Environmental Sciences Field Station (SRESFS) is a consortium of Historically Black Colleges and Universities (HBCU) that provide hands-on, field oriented experiences for underrepresented students. The US Department of Energy's Office of Environmental Management has provided support to establish and operate NADP National Trends Network (NTN) and Mercury Deposition Network (MDN) sites at two HBCU facilities. The grant provided network approved equipment that is located at North Carolina A&T State University (NCA&T) and Florida Agricultural & Mechanical University (FAMU), both 1890 land grant institutions. Research professors at each institution oversee the local operation through the use of student research interns. Professors and interns operate each station consistent with current NADP protocols to measure local deposition. Through the NADP program office the local deposition results will be incorporated with results from other stations across the United States. This project will introduce HBCU professors and students to techniques of deposition monitoring, contribute to nationwide efforts in environmental monitoring, and provide collaboration opportunities for HBCU faculty with other researchers related to atmospheric deposition.

[1]Savannah River National Laboratory, dennis.jackson@srnl.doe.gov
[2]Savannah River Environmental Sciences Field Station, South Carolina State University, Orangeburg, SC
[3]South Carolina State University, Orangeburg, SC
[4]North Carolina Agricultural and Technical State University, Greensboro, NC
[5]Florida Agricultural & Mechanical University
[6]US Department of Energy
[7]avannah River National Laboratory, dennis.jackson@srnl.doe.gov

Speciated Atmospheric Mercury Measurements: Challenges and Opportunities

Winston Luke[1], Xinrong Ren[2], Paul Kelley[3], Mark Olson[4], Aidan Colton[5], Nash Kobayashi[6] and Ronald Cole[7]

The Tekran mercury speciation system is the only commercially viable instrumentation for the routine measurement of mercury compounds in the atmosphere, and is widely deployed in mercury monitoring networks worldwide. To date, however, many key performance measures of the instrumentation have yet to be adequately addressed or documented. While a number of controlled experiments have been conducted in laboratory settings, issues of potential measurement artifacts, non-quantitative collection efficiencies of GOM species, humidity effects, etc. remain to be explored under field conditions. This presentation will address some issues surrounding the accuracy, reproducibility, and robustness of speciated mercury measurements made with the Tekran analytical instrumentation deployed at three AMNet sites operated by NOAA's Air Resources Laboratory: a coastal location (Grand Bay NERR, MS); an inland site in the Mid-Atlantic region (Beltsville, MD); and a high elevation site in the remote free troposphere (Mauna Loa Observatory, HI).

[1]NOAA/Air Resources Laboratory, Winston.Luke@noaa.gov
[2]NOAA/ARL, Xinrong.Ren@noaa.gov
[3]NOAA/ARL, Paul.Kelley@noaa.gov
[4]NADP/ISWS, mlolson@illinois.edu
[5]NOAA/ESRL, Aidan.Colton@noaa.gov
[6]NOAA/ESRL, Nash.Kobayashi@noaa.gov
[7]Grand Bay NERR, Ronald.Cole@dmr.ms.gov

Recent trends in stream nitrate export in the Colorado Front Range and the role of atmospheric deposition

Alisa Mast[1], David Clow[2], Jill Baron[3] and Greg Wetherbee[4]

Long-term patterns of stream nitrate export and atmospheric N deposition were evaluated over three decades in Loch Vale, a high-elevation watershed in the Colorado Front Range. Flow-normalized concentrations and fluxes were estimated using a regression model, which removes the influence of interannual variability in streamflow to better reveal the underlying patterns of change. Stream N export began increasing in the early 1990s, peaked in the mid-2000s, and has since declined by over 30%. Similarities in the timing and magnitude of N deposition provide evidence the watershed is responding to changes in atmospheric deposition. Other possible explanations including forest disturbance, snow depth, or permafrost melting could not explain stream N export. Our results show that stream nitrate export responds rapidly to reductions in N deposition in high elevation watersheds, similar to patterns observed for reductions in sulfur

[1]U.S. Geological Survey, mamast@usgs.gov
[2]USGS
[3]USGS
[4]USGS

Speciated Reactive Nitrogen Measurements Using Chemiluminescence

Kevin Mishoe[1], Christopher Rogers[2], Melissa Puchalski[3], Greg Beachley[4] and Ralph Baumgardner[5]

The Clean Air Status and Trends Network (CASTNET) has a more than 25-year record of atmospheric nitrogen measurements at rural/remote locations in the United States. The routine nitrogen measurements made at CASTNET sites are nitric acid (HNO_3), nitrate (NO_3), and ammonium (NH_4). CASTNET also provides estimates of dry deposition for these compounds. Many CASTNET sites are located at or near a National Atmospheric Deposition Program (NADP) National Trends Network (NTN) site, which provides measurements of NO_3 and NH_4 in wet deposition. Recent efforts have been made to expand measurements to enable a more complete assessment of contributors to the nitrogen budget. In 2007, CASTNET began participating in the NADP Ammonia Monitoring Network (AMoN), which was initiated to establish a nationwide network of passive ammonia (NH_3) monitors. Recently, CASTNET has also conducted several nitrogen measurement studies to supplement and enhance the filter pack and AMoN samples.

At the coastal site in Beaufort, North Carolina (BFT142), a trace level NO/NO_y system was deployed at the site using a commercially available chemiluminescence analyzer to further characterize reactive oxidized nitrogen. The setup featured a custom modification to use a second molybdenum converter that allowed for the collection of NO_x and, by difference calculation, NO_2. Data analyses from these studies have provided insights into ambient nitrogen levels in coastal North Carolina and helped identify sampling artifacts from this dual converter system.

As a follow on to the Beaufort reactive oxidized nitrogen study, an experimental total reactive nitrogen sampling system has been developed to further analyze the components of the reactive nitrogen sample. The total reactive nitrogen system, deployed at the Beltsville, MD (BEL116) CASTNET site, consists of four converter boxes: a TN_x stainless steel converter, two traditional molybdenum converters (one at 10m for NO_y and a second at the analyzer for NO_x), and an LED-based photolytic NO_x converter. Calculated parameters include NH_x, NO_2 from the molybdenum converter, and NO_2 (true) from the photolytic converter. A solenoid sampling system diverts flow through the various converter boxes to allow for the detection of these species using a single analyzer. This approach reduces the expenses of inter-unit calibration and problematic biases or analytical drifts. Once data have been collected and validated, data comparisons will be made between the total reactive nitrogen sampler, CASTNET filter pack measurements, AMoN, and the MARGA.

[1]AMEC Environment & Infrastructure, Inc., kevin.mishoe@amec.com
[2]AMEC, christopher.rogers@amec.com
[3]USEPA, puchalski.melissa@epa.gov
[4]USEPA, beachley.gregory@epa.gov
[5]USEPA, baumgardner.ralph@epa.gov

Linking abiotic to biotic: servicewide baseline data for mercury in national parks

Sarah Nelson[1], Collin Eagles-Smith[2], James Willacker[3], Colleen Flanagan Pritz[4], David P. Krabbenhoft[5] and Celia Y. Chen[6]

In partnership with over 40 national parks across the U.S., we are developing the use of dragonfly nymphs as bio-sentinels for mercury (Hg) in aquatic foodwebs. To validate the use of these sentinels, and gain a better understanding of the connection between biotic and abiotic pools of Hg, this project also includes collection of landcover/landscape data, surface water chemistry including Hg and Hg-relevant chemistry (pH, sulfate, dissolved organic carbon (DOC)), and most recently, sediment Hg. Because of the wide geographic scope of the research, the project also provides a nationwide snapshot of Hg in these diverse media, primarily in undeveloped watersheds. In preliminary data from 23 parks sampled in 2013 total Hg (THg) in water ranged over two orders of magnitude (0.16-28 ng/L; median=2.2 ng/L), and pH ranged from 5.5-9.2 (mean=7.7). In dragonfly nymphs, THg concentrations averaged 154 ± 124 (mean ± SD) ppb, dw. THg in surface water was weakly correlated with THg in dragonfly nymphs (Pearson's R=0.38). Sites with the greatest THg concentrations were located in New England as well as western sites that could be influenced by global Hg sources as well as regional to local influences such as volcanic activity, wildfires, and urbanization. Whereas dragonfly and water THg concentrations were generally greater in the eastern compared to the western U.S. in 2012, based on data from a smaller set of 12 pilot parks, the addition of parks that provide better coverage of western states has changed the geographic pattern of Hg in water and biota. Site-to-site variability within a park was high; one park included a site with the greatest concentrations of THg in dragonflies and fourth-highest concentration of THg in water, but also a site where dragonfly THg fell in the lowest quartile of all the data. Our ongoing research is examining the factors that influence water and dragonfly Hg, as well as sample collection across a broader set of parks (47 in 2014), and evaluation of temporal trends in dragonfly and water Hg within a project year.

[1]University of Maine, sarah.j.nelson@maine.edu
[2]USGS-FRESC, ceagles-smith@usgs.gov
[3]USGS-FRESC, jwillacker@usgs.gov
[4]National Park Service-ARD, colleen_flanagan@nps.gov
[5]USGS-Mercury Research Laboratory, dpkrabbe@usgs.gov
[6]Department of Biological Sciences, Dartmouth College, celia.y.chen@dartmouth.edu

Tekran Mercury Speciation intercomparison at Horicon Marsh, Wisconsin

Mark Olson[1] and David Grande[2]

In August 2013 the National Atmospheric Deposition Program (NADP) Atmospheric Mercury Network (AMNet) teamed with the Wisconsin Department of Natural Resources to initiate a study to compare the new Tekran 2537X to the 2537B. The 2537B is the system in use within AMNet at the WI07 site. The 2537X was loaned from Tekran to NADP while the 1130 and 1135 components were donated by the Florida Department of Environmental Protection (FDEP). Several aspects of the speciation system were evaluated including precision and accuracy estimates, differences in glassware collection efficiency, evaluation of glassware cleaning protocols, to name a few. In August 2014 a third speciation system was added to the study. The 2537B was donated by FDEP with the 1130 and 1135 coming from the New York State Department of Environmental Conservation.

Results from the 2 system study show the 2537X and 2537B have Gaseous Elemental Mercury (GEM) differences of 1.3% or 0.02 ng/m3 producing over 85% of combined valid data. Gaseous Oxidized Mercury (GOM) and Particulate Bound Mercury (PBM) differences are higher and quite variable although few results above the expected Method Detection Limit have been seen. The results from the GEM precision and accuracy studies will be presented along with preliminary results from the three instrument study and suggested modifications to glassware cleaning procedures.

[1]NADP Program Office, mlolson@illinois.edu
[2]Wisconsin Dept. of Natural Resources

National Atmospheric Deposition Programs Atmospheric Mercury Network (AMNet): Dry Deposition of Mercury

Mark Olson[1] and David Gay[2]

The NADP Atmospheric Mercury Network (AMNet) is a collaborative effort involving many federal, state, and tribal agencies, academic researchers, and industry partners across North America and the South Pacific. AMNet officially began operation in January 2009, and now has over 110 site years of observations for Gaseous Elemental Mercury (GEM), Gaseous Oxidized Mercury (GOM), and Particulate-bound Mercury ($PBM_{2.5}$). The NADP's role is to organize individual monitoring groups into a homogeneous monitoring effort, implement consistent standard operating procedures and provide final quality assured data. The end result is a data base of comparable atmospheric mercury speciation measurements coordinated by the AMNet Site Liaison. The AMNet mercury data provided on the NADP web site is available for use by scientists, modelers, government agencies and educators. In collaboration with Environment Canada, AMNet will estimate short-term rates of dry deposition of the three mercury fractions. This data, in combination with wet deposition rates from associated Mercury Deposition Network (MDN) sites, can be used to approximate "total" mercury deposition (wet plus dry) at individual locations.

[1]NADP Program Office, mlolson@illinois.edu
[2]NADP Program Office, dgay@illinois.edu

Monitoring air quality and nutrient deposition in the Forest Service Class I Wilderness areas

Pamela Padgett[1]

Poor air quality and deposition of pollution compounds have serious detrimental effects on native ecosystems. Air pollution and deposition are known to contribute to invasion of weedy exotic plant species, decline in native shrub populations, and poor growth in many tree species. Class I wilderness areas are one of the few landscapes where land managers have some control over factors influencing air quality. Through the Clean Air Act, land managers have the responsibility for "Prevention of Significant Deterioration" of natural resources by new pollution sources. However, determination of significant deterioration requires monitoring data, especially information on the existing condition and current air quality parameters within the wilderness boundaries.

The National Atmospheric Deposition Program (NADP) has coordinated wet deposition monitoring for more than 35 years. NADP is the "go-to" resource for measurements of the acid and nutrient content in the nation's rain. With over 250 locations in rural and remote locations across the country, data from the NADP networks is widely used by researchers, land managers, and policy makers to understand the effects of air pollution on native ecosystems and natural resources, and to establish goals for emission restrictions. Many of the NADP sites were established and are operated by the Forest Service, National Parks Service, Bureau of Land Management, Fish and Wildlife, among other state and federal land managers. The Forest Service frequently relies on NADP data for natural resource assessments. The question arose: Which specific monitoring locations were most appropriate for assessing air quality and deposition at a specific Class I Wilderness area?

A GIS-based study was conducted to identify the proximity of NADP monitoring stations to each of the 88 Class I areas managed by the Forest Service. The results demonstrated that 17 Class I areas have adequate monitoring within the recommended 20km distance from the boundary. An additional 36 Class I areas have data available from NADP stations between 20km to 50km from the boundaries, but because most wilderness areas are located in mountains with complex terrain, monitoring data from locations greater that 20km may not reflect the conditions within the wilderness boundaries. The results of this study highlighted a serious lack of deposition data for most Class I wilderness areas managed by the Forest Service.

[1]USDA Forest Service, ppadgett1460@gmail.com

A new uncertainty framework for critical loads in the US

Linda Pardo[1], MJ Robin-Abbott[2], CM Clark[3], LH Geiser[4], JA Lynch[5], CB O'Dea[6], DC Baldwin[7], KJ Horn[8], EAH Smithwick[9] and RQ Thomas[10]

In order to make critical loads most useful to policy makers and resource managers, it is essential to quantify the uncertainty associated with the critical load. In the past, a rating system developed in Europe which uses a 3 point scale: ##-reliable, #fairly reliable, (#) expert judgment was most often used for critical loads in the US. The new system that we have developed uses a 5 point scale to allow finer nuances in reliability of the critical loads. The factors that affect the certainty of the critical load include the number of sites, the number of samples, the representativeness of sites to the region being evaluated, and the strength or clarity of the response on which the critical load is based. We have created two tables detailing the criteria that define each of the rating levels from the most uncertain (1) to the most robust (5). Different combinations of criteria can lead to the same rating (for example, a large sample size with a moderately strong response could be in the same category as a strong response with a moderate sample size). The first table is for heterogeneous data, that is, data from many different studies that are combined for the purpose of estimating a critical load; the second table is for large datasets of homogeneous data (e.g., FIA data). This uncertainty framework is being incorporated into several national-scale critical loads projects and should improve the ability to compare critical loads and better understand their implications.

[1]USDA Forest Service, lpardo@fs.fed.us
[2]EBSER, mjrobina@gmail.com
[3]USEPA, Clark.Christopher@epa.gov
[4]USDA Forest Service, lgeiser@fs.fed.us
[5]USEPA, lynch.jason@epa.gov
[6]USDA Forest Service, cbodea@fs.fed.us
[7]Penn State University, dcb5006@psu.edu
[8]Virginia Tech, kjhorn@vt.edu
[9]Penn State University, smithwick@psu.edu
[10]Virginia Tech, rqthomas@vt.edu

Variations in Background NH_3 Concentrations in Agricultural Regions within the United States

Austin M. Pearson*, Richard H. Grant, Derrick W. Snyder, and Shawn Johnson

The variation in background ammonia (NH_3) concentrations in agricultural regions is of increasing interest due to the difficulty in determining agriculture-specific NH_3 emissions. Understanding these variations will increase the accuracy of emissions estimates from agricultural lands throughout the United States. In this study, integrated two week samples of atmospheric NH_3 concentrations were obtained from the Ammonia Monitoring Network (AMoN) and measurements of diurnal NH_3 concentrations by a Tunable Diode Laser (TDL) were conducted in June 2014 at the Purdue Agronomy Center for Research and Education (ACRE) to determine the annual and diurnal variability in NH_3 background concentrations. Passive NH_3 concentration measurements and landscape analyses for AMoN sites CO13, IL11, IN99, KS98, MI96, MN18, NY67, OH02, OH27, OK99, SC05, TX43, and WI07, were conducted to determine the influence of the number of farms (sources) near a site on NH_3 concentrations. Drier climates tended to have higher background NH_3 concentrations than wetter climates (Fig. 1): higher background NH_3 concentrations can be explained by the reaction in the soil $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$. In wetter climates, NH_3 will gain a hydrogen proton to become NH_4^+ and is not detected by NH_3 instruments. Background TDL NH_3 concentrations and the time of day was studied to determine diurnal cycles of NH_3. Maximum and minimum concentrations for each day ranged from 45 to 90 ppb. Diurnal NH_3 concentrations tended to display temperature dependence: higher NH_3 concentrations corresponded with higher temperatures (Fig. 2). Further analysis of diurnal and annual cycles of background NH_3 dependence on temperature and soil moisture will be discussed.

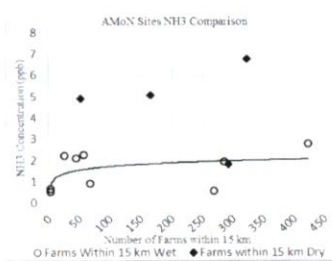

Fig. 1

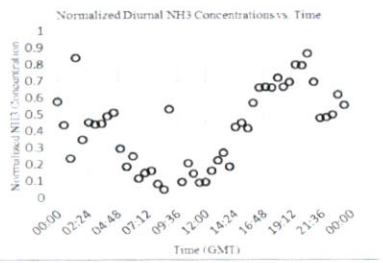

Fig. 2

Purdue Applied Meteorology Laboratory, Department of Agronomy, Purdue University, 915 W. State Street; West Lafayette, IN 47905; 765-494-8048; pearsona@purdue.edu
*PRESENTING AUTHOR

A preliminary design for an urban network in NADP

Richard Pouyat[1], Thomas Whitlow[2] and Pamela Templer[3]

Urban landscapes and their environments typically exhibit higher concentrations and depositional fluxes of atmospheric particles and chemicals than rural environments. Most atmospheric pollutants originate from the combustion of fossil fuels, industrial emissions, and wear products from vehicles, all of which are associated with cities. These include nitrogen oxides, sulfur oxides, heavy metals, and numerous organic chemicals. In addition, urban landscapes have unique source-sink relationships of pollutants at various scales, which make it difficult to predict their spatial-temporal depositional and accumulation patterns and thus the potential for human exposure and ecosystem impacts. A newly formed ad-hoc Subcommittee on Urban Atmospheric Monitoring (SCUAM) was formed to address the monitoring and assessment of urban atmospheric environments. We are in the early stages of designing an urban network by initiating a pilot in three cities: Bronx or Brooklyn, NY; Boston, MA; and a suburban site in Maryland.

The urban network will consist of existing NADP networks, in particular the National Trends Network (NTN), Mercury Deposition Network (MDN), and the Ammonia Monitoring Network (AMON). We hope to expand the mercury analysis to include heavy metals. To expand on the number of observations and to quantify the spatial and temporal heterogeneity of urban atmospheric environments, we will utilize passive and through-fall samplers. Preliminary data collected from the Bronx and Boston sites will be presented to address questions related to the effect of tree canopies on fine particulates and gaseous pollutants; the amount of mostly wet deposition that occurs; and finally the spatial and temporal patterns of "hot moments and spots" that happen in urban landscapes

[1]U.S. Forest Service, rpouyat@fs.fed.us
[2]Cornell University, thw2@cornell.edu
[3]Boston University, ptempler@bu.edu

Building Tribal Partnerships with Low Cost Small-footprint Ambient Monitoring Sites

Melissa Puchalski[1], Amber Reano[2], Christopher Rogers[3], Kevin Mishoe[4], Kemp Howell[5] and Gary Lear[6]

CASTNET was established in 1991 to assess trends in ambient air quality and deposition of acidic pollutants due to emission reduction programs. CASTNET currently has more than 90 monitoring stations across the US and Canada. While CASTNET is managed by federal agencies (US EPA, National Park Service and Bureau of Land Management) there are more than 50 partners that are invaluable to the day-to-day operation of the network. These partnerships include universities, Native American tribes, and state agencies that provide site operator support, land, and their expertise in air monitoring research.

CASTNET has maintained three long-term tribal partnerships. In eastern Oklahoma the Cherokee Nation operates a CASTNET filter pack and ozone analyzer at their NCore station. This site has been operating as a CASTNET site since 2002. The Alabama-Coushatta tribe has operated a CASTNET site in eastern Texas since 2004, while the Santee Sioux in northern Nebraska have been operating a CASTNET site since 2006.

In 2012, CASTNET developed a small-footprint, low power monitoring site that does not require a temperature-controlled shelter. The small footprint site consists of a 10-m tower, a typical CASTNET filter pack with an enclosure located on the tower that includes a pump, MFC and telemetry. Since the development of the small-footprint site CASTNET has increased the number of monitoring sites by offering this low impact, low-cost setup for measuring weekly sulfur and nitrogen species. Two tribal partners, Kickapoo Nation located in Northeast Kansas and Red Lake Nation located in northern Minnesota joined CASTNET in 2013/2014 with the deployment of the small-footprint site.

EPA will continue their outreach efforts to existing tribal partners. Efforts will be expanded to other interested tribes in 2014. CASTNET will develop tools for viewing data, reports on air quality and deposition fluxes in tribal regions, and training documents and Frequently Asked Questions for tribal air monitoring groups.

[1]US EPA, puchalski.melissa@epa.gov
[2]Brown University, ambreano@gmail.com
[3]AMEC, christopher.rogers@amec.com
[4]AMEC, kevin.mishoe@amec.com
[5]AMEC, kemp.howell@amec.com
[6]US EPA, lear.gary@epa.gov

Laboratory and Field Measurements of the Suppression of Ammonia Volatilization from Surface Applied Urea Using A New Urease Inhibitor Formulation

Wayne Robarge[1], Chenxi Zhang[2] and Thomas Rufty[3]

Ammonia loss from commercial fertilizers can impact the formation of atmospheric aerosols, as well as contribute to nitrogen (N) deposition in terrestrial and aquatic ecosystems. Urea is the predominant form of N fertilizer used worldwide due to its high N content (46.6% N) and low cost. Once in contact with soil or vegetation, urea is hydrolyzed to ammonium via the activity of naturally occurring urease enzymes. Losses of N from surface applied urea as ammonia can exceed 30%. To address this issue, various physical and chemical mechanisms have been incorporated into granular urea. The most common chemical mechanism is incorporation of an urease inhibitor such as *N*-(*n*-butyl) thiophosphoric triamide (NBPT). In this study, we investigated ammonia volatilization from surface applied urea using a new urease inhibitor formulation (LIMUS® from BASF, The Chemical Company) as compared to commercially available granular urea. Laboratory experiments were conducted with a customized growth chamber system designed to continuously measure ammonia volatilization. With day/night soil surface temperatures of 10/21^{0}C, urea or LIMUS®-treated granules were surface applied (+/- crop residues) to columns filled with a Midwestern US soil (Drummer silty clay loam). Temporal patterns in ammonia volatilization were followed for at least 10d. Field experiments were conducted on a plot of translocated Drummer silty clay loam to a research site just south of Raleigh, NC. Ammonia volatilization of applied urea granules was monitored using acid-coated foam in covered-PVC cylinders, or annular denuder technology using flow-through PVC chambers. Daily exchanges of acid-coated denuder tubes enhanced the sensitivity of ammonia volatilization measurements for the treated-urea granules. Ammonia-loss from commercial urea granules ranged from 6 - ~ 35%, depending on ambient temperature. This loss typically occurred within the first 5-10 days under field conditions. Incorporation of the urease-inhibitor product minimized the loss of N via volatilization (< 5%) for up to 20+ days in the absence of a rainfall event. Visual observations confirmed that on bare soil, treated or untreated urea granules quickly "dissolve" and move into the soil. The accompanying urease-inhibitor formulation moves with the urea continuing to provide protection against reaction with naturally occurring urease enzymes. In the presence of crop residues, the urease inhibitor was also very efficient. Use of the new urease inhibitor formulation is an effective way to reduce N losses as ammonia when urea-containing fertilizers are surface applied to agricultural crops.

[1]NC State University, wayne_robarge@ncsu.edu

[2]NC State University, czhang4@ncsu.edu

[3]NC State University, tom_rufty@ncsu.edu

The effect of abiotic modifying factors on critical loads of N: species specific tables

Molly J. Robin-Abbott[1], Linda H. Pardo[2], Claire B. O'Dea[3] and Jennifer A. Pontius[4]

Forest health is affected by multiple factors, including climate change, nitrogen deposition, insect pests, and forest pathogens. We are developing a GIS-based tool to evaluate the impact of multiple stressors on forest health and critical loads of nitrogen (N). In the first phase of this project, we have created a framework to evaluate the effects of abiotic modifying factors on species specific critical loads of N. Tree species of management concern were identified by resource managers in VT and NH: American beech, American chestnut, quaking and bigtooth aspen, balsam fir, paper and yellow birch, butternut, eastern hemlock, red, white, and chestnut oak, red and pitch pine, red and black spruce, sugar maple, and white cedar. Ranges for critical loads of N were determined based on empirical responses to N deposition as reported in the literature. For each species, we have created a table of abiotic modifying factors that influence the response of trees to N deposition, including elevation, aspect, precipitation, average January and July temperature, and soil characteristics. For each factor, we identify thresholds that affect the species' response to N deposition. These tables will be used in concert with GIS data to generate site and species specific critical loads of N, and can also be used to generate critical loads of N under various climate change scenarios.

[1]EBSER, USFS, mrobinabbott02@fs.fed.us

[2]US Forest Service, lpardo@fs.fed.us

[3]US Forest Service, cbodea@fs.fed.us

[4]US Forest Service, University of Vermont, japontiu@uvm.edu

CASTNET's NO_y Monitoring Network

Christopher Rogers[1], Melissa Puchalski[2], Kevin Mishoe[3] and Greg Beachley[4]

For more than 25 years, Environmental Protection Agency's (EPA) Clean Air Status and Trends Network (CASTNET) has collected ambient measurements of nitric acid, nitrate, and ammonium concentrations using a filter pack. As of August 2014, 92 CASTNET sites continue to make these measurements. CASTNET also produces estimates of the dry deposition of these compounds. CASTNET estimates wet deposition of ammonium and nitrate using interpolated measurements from the National Atmospheric Deposition Program's (NADP) National Trends Network (NTN) and the Parameter-elevation Relationships on Independent Slopes Model (PRISM). However, key contributors to the nitrogen budget have been missing from CASTNET. Two of these components are ammonia (NH_3) and total reactive nitrogen (NO_y). Missing NH_3 measurements have been addressed by CASTNET's participation in NADP's Ammonia Monitoring Network (AMoN), which started in 2007. To develop a data set of NO_y measurements, EPA has established an NO_ymonitoring network stretching from the east coast to the mountain west, which now features six EPA CASTNET sites. In addition, NPS, a primary sponsor of CASTNET, conducts NO_y measurements at several of their CASTNET sites.

NO_y is defined as NO_x [nitrogen oxide + nitrogen dioxide] plus NO_z [nitric acid, nitrous acid, PAN, other organic nitrates, and nitrite]. Typical concentrations at the six EPA-sponsored CASTNET sites measuring NO_y range from an average of 0.6 parts per billion (ppb) at Huntington Wildlife Forest, NY and 0.7 ppb at Pinedale, WY to 4.5 ppb at Bondville, IL to 10.2 ppb at Beltsville, MD. Comparisons with total nitrate measured by the CASTNET filter pack show similar temporal patterns with total nitrate typically around half of the NO_y concentration. CASTNET NO_y data from select sites are used as part of the NCore program and provide information to atmospheric modelers, policy makers, and scientists studying environmental impacts.

[1]AMEC Environment & Infrastructure, Inc., christopher.rogers@amec.com
[2]USEPA, puchalski.melissa@epa.gove
[3]AMEC Environment & Infrastructure, kevin.mishoe@amec.com
[4]USEPA, beachley.gregory@epa.gov

The Asia-Pacific Mercury Monitoring Network (APMMN): Regional cooperation to track the atmospheric transport and deposition of mercury

David Schmeltz[1], David Gay[2], Guey-Rong Sheu[3], Shuenn-Chin Chang[4], Kohji Marumoto[5], Esrom Hamonangan[6], Hathairatana Garivait[7], Hung-Po Hsu[8], Nguyen Van Thuy[9], Mark Olson[10], Young-Hee Kim[11], Winston Luke[12] and Sandy Steffan[13]

Globally, Asia is the largest source region for atmospheric mercury due to immense coal combustion, industrial emissions, and biomass burning activities. In UNEP's most recent global mercury assessment, Asian sources account for more than half of the anthropogenic mercury emitted globally. In addition to being a major contributor of global mercury emissions, Asia receives significant mercury deposition from upwind local, regional and long distance sources. Despite the magnitude and extent of Asian mercury emissions, few long-term measurements have been made in the Asia-Pacific region and accessible datasets are very limited. A documented database of high quality measurements is needed for development of environmental baselines and future assessments of the Minamata Convention, improving atmospheric models, characterizing mercury transport and deposition, and determining tempo-spatial mercury changes.

Here we report on recent progress to establish a consistent network of monitoring stations for tracking the atmospheric transport and deposition of mercury in the Asia-Pacific region. In 2012, USEPA, Taiwan EPA, NADP and the National Central University in Taiwan with partners in Southeast Asia launched the Asia Pacific Mercury Monitoring Network (APMMN). Agency scientists from eight countries are cooperating to share information, data, tools, and technologies to expand coordinated mercury monitoring capacity, develop baseline mercury data useful to regional and global modelers, cultivate a common understanding of policy-relevant mercury scientific topics, and provide training and support to scientists from under-monitored regions.

The initial phase of the APMMN is a cooperative pilot mercury wet deposition monitoring network in Southeast Asia (Thailand, Indonesia, and Vietnam), with technical support from several organizations in Taiwan, Japan, South Korea and the United States. The pilot network is designed to monitor the wet deposition of mercury using SOPs developed based on NADP/MDN adapted to Southeast Asian conditions. Monitoring will begin in September 2014; and the pilot network will operate for three years. Future plans include participation from other countries and more stations throughout Asia, inclusion of atmospheric mercury monitoring (gaseous and particulate), and development of longer-term continuous measurements.

[1]USEPA, Office of Atmospheric Programs, schmeltz.david@epa.gov
[2]NADP Program Office
[3]National Central University, Department of Atmospheric Sciences, Taiwan
[4]Environmental Protection Administration, Taiwan
[5]National Institute for Minamata Disease, Japan
[6]Indonesia Ministry of Environment
[8]Environmental Protection Administration, Taiwan
[9]Vietnam Environment Administration
[10]NADP Program Office
[11]Korea Ministry of Environment
[12]NOAA Air Resources Laoratory,
[13]Environment Canada,

INTEGRATING PLANT RESPONSES TO SOIL CHEMISTRY AT A CONTINENTAL-SCALE

Erica Smithwick[1], Doug Baldwin[2], Kevin Horn[3], Linda Pardo[4] and R. Quinn Thomas[5]

Forecasting key response thresholds to nitrogen deposition is limited by a lack of synthesis of plant responses to soil chemistry across spatial scales and research approaches. To develop our best understanding of N deposition impact on tree growth and survival, our project analyzes over 100 plot- level studies that explicitly include data on plant function and soil chemistry in response to N inputs in the U.S. and Canada. Plant measures included tissue chemistry, growth, health, survival, and stress indicators. Measures of soil chemistry included soil solution and exchangeable nutrients and metals available to plants. Threshold responses to soil solution or exchangeable chemistry were identified by species, ecosystem types, N deposition, and other modifying factors (soil type, elevation, latitude) where available. Random forests, bivariate relationships, and general linear models with bootstrapping were used to relate plant and soil relationships and associated uncertainty. Preliminary results show strong geographic bias across ecoregions. Across all studies, soil base cations, soil P, and soil pH were the most important variables in predicting aboveground plant biomass. Other plant functional and stress relationships showed non-linear behavior with significant variation across ecoregions and studies. Our overall goal is to identify thresholds that will directly inform critical load estimates used in management and policy.

[1]The Pennsylvania State University, smithwick@psu.edu

[2]The Pennsylvania State University, dcb5006@psu.edu

[3]Virginia Tech University, kjhorn@vt.edu

[4]USDA Forest Service, lpardo@fs.fed.us

[5]Virginia Tech University, rqthomas@vt.edu

Wet Deposition of Carbon Aerosols: Lessons Learned from a Field Study

Alexander Torres[1], Tami C. Bond[2] and Christopher M.B. Lehmann[3]

Carbon aerosol is a major fraction of the fine particulate matter in the atmosphere, contributing to air quality degradation and affecting climate change. Carbon aerosols are classified in two main fractions, organic carbon (OC) and elemental carbon (EC). Combustion of fossil fuels and biomass are the main sources of directly emitted carbon aerosols. In addition, OC can be produced in the atmosphere from the condensation of volatile organic compounds (VOCs). The dominant removal pathway of carbon aerosol from the atmosphere is wet deposition. The wet removal of OC is expected to vary seasonally, due to the variation of secondary organic aerosol (SOA) and its variation with temperature and emissions sources. The wet removal of EC is limited by its hydrophobic character; EC needs to undergo an "aging" process before removal by precipitation.

The concentration of OC and EC in precipitation was monitored from 2011 to 2013 at Bondville, IL. OC in precipitation was fractionated into soluble (DOC) and insoluble (WIOC) material. The concentration of carbonaceous aerosol in precipitation was complemented with the concentration of ions measured by the National Atmospheric Deposition Program (NADP) and the concentration of aerosol species in air measured by the Interagency Monitoring of Protected Visual Environments (IMPROVE). Results indicated that 95% of the total OC in precipitation was dissolved. The concentration of DOC was 1.9 times higher than the total molar concentration of sulfate, nitrate, and ammonium. DOC was positively correlated (R^2=0.54) with the deficit of measured anions in precipitation, suggesting that measured DOC is predominantly represented by organic acids. DOC was positively correlated with all ions in precipitation but not with EC, indicating that non-combustion sources are mostly contributing to the DOC fraction. WIOC was positively correlated with all ions and carbon fractions in precipitation. EC in precipitation was only correlated with ammonium, sulfate, and WIOC.

The WIOC/EC ratio in precipitation was 14.6, about four times higher than the OC/EC ratio in air (3.8), suggesting than EC is poorly removed by precipitation as compared with OC. However, the DOC/EC ratio in precipitation was 470, two orders of magnitude higher than the ratio in air which can be caused by the scavenging of VOCs. The scavenging ratio (SR), defined as the ratio of the concentration in rain to that in air, was used as an indicator of the effectiveness of the wet removal process. The SR was found to vary seasonally and by constituent.

[1]University of Illinois, torresn1@illinois.edu

[2]University of Illinois, yark@illinois.edu

[3]National Atmospheric Deposition Program, clehmann@illinois.edu

Atmospheric Ammonia Diurnal Variation in an Urban Environment: Case Study Results for São Paulo, Brazil

Marcelo Vieira-Filho[1], Marcelo S. Vieira-Filho[2], Sybil Anderson[3], Christopher Lehmann[4] and Adalgiza Fornaro[5]

Ammonia (NH3) is the main alkaline compound in the atmosphere, playing an important role in to neutralizing anthropogenic acidic emissions. Gaseous ammonia fosters undesirable consequences in aquatic and terrestrial ecosystems, including eutrophication. Agricultural activities have been considered as main ammonia emissions source, principally from NH3-based fertilizer applications and animal husbandry. The incorporation of three-way catalytic converter technology in vehicles running with petrol has significantly increased non-agricultural ammonia emissions, especially in urban areas. Recent estimates indicate an increase of more than 200 times in vehicular nitrogen emissions in the form of ammonia since 1995. Considering the São Paulo, Brazil city vehicle fleet as a case study, this research aims to characterize the temporal patterns associated with urban ammonia. The environmental agency of São Paulo (CETESB) reports that from the total vehicle fleet of over 7 million vehicles, 46% of vehicles since 1999 are equipped with three-way catalysts.

This study evaluated ammonia concentration variability at a street with heavy traffic in a São Paulo summer season from November 9 to December 17, 2013. Ammonia concentrations were measured by a Picarro G2103 continuous monitor (3s time resolution). The hourly NH3 concentrations showed a relationship with traffic, presenting maximum values between 8 a.m. to 10 a.m. During the monitoring period, lower NH3 concentrations were observed on weekends, mainly on Sundays. The average ammonia values were 11 ppb (8 μg m-3), reaching maximum values of 30 ppb (22 μg m-3). These concentrations were higher than some agricultural areas, and comparable to the levels in urban areas of Europe and USA.

[1]Departamento de Ciências Atmosféricas, Instituto de Astronomia, Geofísica e Ciências Atmosféricas da, marcelov@illinois.edu

[2]Departamento de Ciências Atmosféricas, Instituto de Astronomia, Geofísica e Ciências Atmosféricas da, vieira.filho@live.com

[3]National Atmospheric Deposition Program, Illinois State Water Survey; Prairie Research Institute, Un, sybilma@illinois.edu

[4]National Atmospheric Deposition Program, Illinois State Water Survey; Prairie Research Institute, Un, clehmann@illinois.edu

[5]Departamento de Ciências Atmosféricas, Instituto de Astronomia, Geofísica e Ciências Atmosféricas da

Determination of Total Dissolved Nitrogen (TDN) in AIRMoN Wet Deposition Samples

Annette Wells[1], Lee Green[2], Nina Gartman[3], Katie Blaydes[4], Sybil Anderson[5], Christopher Lehmann[6] and John Walker[7]

There is a need to better quantify the wet deposition of nitrogen species not measured routinely by the NADP's NTN and AIRMoN, including concentrations of nitrite ion and organic nitrogen. The Central Analytical Laboratory (CAL) measured nitrite ion and organic nitrogen in Atmospheric Integrated Research Monitoring Network (AIRMoN) samples collected in February – August, 2014. These nitrogen fractions were measured in addition to the existing nitrogen measurements which include ammonium and nitrate ions. This special study was part of a wider initiative sponsored by the U.S. EPA's National Risk Management Research Laboratory to better quantify total dissolved nitrogen (TDN) in wet deposition samples. For the study period, the fraction of nitrite ion as total nitrogen ranged from 0 – 6.6%, with a median of 0.52%. The fraction of organic nitrogen ranged from 0 - 60%, with a median of 2.6%. This poster presents an overview of the TDN quantification study, including an evaluation of quality assurance and quality control.

[1]NADP/CAL, acwells7@illinois.edu

[2]NADP/CAL, leegreen@illinois.edu

[3]NADP/CAL, ngartman@illinois.edu

[4]NADP/CAL, kblaydes@illinois.edu

[5]NADP/CAL, sybilma@illinois.edu

[6]NADP/CAL, clehmann@illinois.edu

[7]NADP/CAL, walker.john@epa.gov

Proposal for a Tritium Wet-Deposition Network for the National Atmospheric Deposition Program

Gregory Wetherbee[1], Dennis Jackson[2], Christopher M.B. Lehmann[3] and Andrew Hunt[4]

The commercial nuclear power industry instituted a program to protect groundwater from radionuclides released from nuclear plants in the United States (EPRI, 2008). A component of this program includes evaluation of background radionuclide concentrations in the surrounding environment and the atmospheric deposition of plant-related radionuclides. The industry subsequently issued a review of methods and tools (EPRI, 2009) and specific guidance for estimating atmospheric deposition of tritium (^{3}H) at nuclear power plants (EPRI, 2010). These methods are used to: estimate ^{3}H source terms, such as nuclear power plant operations, predict resulting deposition of ^{3}H using meteorological models, and evaluate resulting groundwater impacts using hydrogeological models.

Enhancement of radionuclide monitoring is proposed by the National Atmospheric Deposition Program (NADP) / National Trends Network (NTN) and U.S. Geological Survey (USGS). A pilot network consisting of existing NADP/NTN sites is proposed to collect monthly composited precipitation samples for ^{3}H analysis. The network will further NADP by expanding its scope to include estimation of ^{3}H deposition in a specified geographical area; representing a significant increase in NADP capability. The ^{3}H concentration and deposition data will be made freely available through web-based data dissemination, including an annual ^{3}H deposition map for the Southeastern USA, data permitting.

Under this proposal, the pilot network will be used to test new protocols for ^{3}H deposition monitoring. For example, after the NADP Central Analytical Laboratory processes the weekly NTN samples into precipitation-depth weighted monthly composite samples, they will be analyzed for helium-3 (^{3}He) by gas mass spectrometry (GMS) at the USGS Noble Gas Laboratory in Denver, Colorado. Since ^{3}H decays to ^{3}He by electron capture with beta particle emission, the GMS analytical technique measures ^{3}He to infer ^{3}H and is capable of detection limits of 0.1 picocuries per liter (pCi/L). GMS is commonly used to measure ^{3}H activities for estimation of groundwater age (McMahon et al., 2013), and has been used recently to monitor ^{3}H released from the Fukushima Dai-Ichi nuclear power plant in Japan (Povinec et al., 2013). Samples collected at NADP NTN Site SC03, located at the Savannah River Site in South Carolina, were analyzed for ^{3}H by GMS, but data were not available for this abstract.

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[1]USGS, wetherbe@usgs.gov

[2]Savannah River National Laboratory, dennis.jackson@srnl.doe.gov

[3]Univ. Illinois, Prairie Res. Inst., Central Analytical Laboratory, clehmann@uiuc.edu

[4]USGS Noble Gas Laboratory, ahunt@usgs.gov

NTN Map and Site Listings

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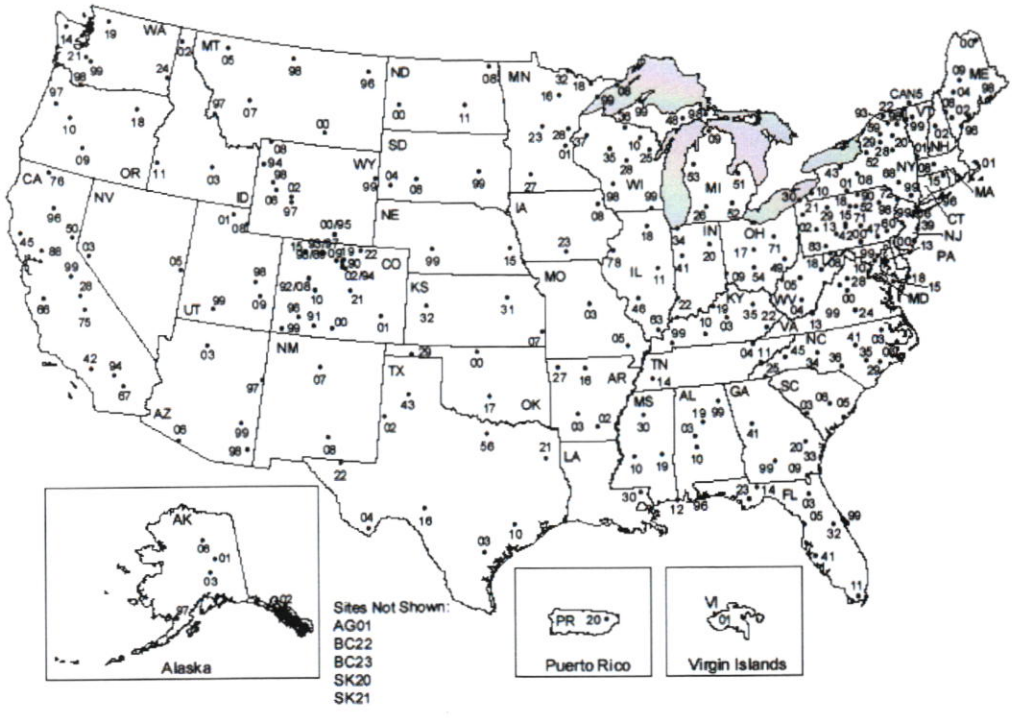
National Atmospheric Deposition Program
National Trends Network



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National Atmospheric Deposition Program/National Trends Network Sites July 31, 2014				
State/Province Site Code	**Site Name**	**Collocation**	**Sponsoring Agency**	**Start Date**
Alabama				
AL03	Centerville	MDN	Atmospheric Research & Analysis, Inc.	02/11
AL10	Black Belt Research & Extension Center		US Geological Survey	08/83
AL19	Birmingham	AMNet/MDN	Atmospheric Research & Analysis, Inc.	12/12
AL99	Sand Mountain Research & Extension Center	AMoN	Tennessee Valley Authority	10/84
Alaska				
AK01	Poker Creek		USDA Forest Service	12/92
AK02	Juneau		USDA Forest Service	06/04
AK03	Denali NP - Mount McKinley	AMNet	National Park Service - Air Resources Division	06/80
AK06	Gates of the Arctic NP - Bettles	MDN	US Bureau of Land Management	11/08
AK97	Katmai National Park - King Salmon		National Park Service - Air Resources Division	11/09
Argentina				
AG01	Laurenti-MAR		NOAA-Air Resources Lab	10/11
Arizona				
AZ03	Grand Canyon NP - Hopi Point		National Park Service - Air Resources Division	08/81
AZ06	Organ Pipe Cactus NM		National Park Service - Air Resources Division	04/80
AZ97	Petrified Forest NP-Rainbow Forest		National Park Service - Air Resources Division	12/02
AZ98	Chiricahua	AMoN	US Environmental Protection Agency-CAM	02/99
AZ99	Oliver Knoll		US Geological Survey	08/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Arkansas				
AR02	Warren 2WSW		US Geological Survey	05/82
AR03	Caddo Valley	AMoN	US Geological Survey	12/83
AR16	Buffalo NR - Buffalo Point		National Park Service - Air Resources Division	07/82
AR27	Fayetteville		US Geological Survey	05/80
California				
CA28	Kings River Experimental Watershed		USDA Forest Service	04/07
CA42	Tanbark Flat		USDA Forest Service	01/82
CA45	Hopland		US Geological Survey	10/79
CA50	Sagehen Creek		US Geological Survey	11/01
CA66	Pinnacles NM - Bear Valley		National Park Service - Air Resources Division	11/99
CA67	Joshua Tree NP - Black Rock	AMoN	National Park Service - Air Resources Division	09/00
CA75	Sequoia NP - Giant Forest	MDN	National Park Service - Air Resources Division	07/80
CA76	Montague		US Geological Survey	06/85
CA88	Davis		US Geological Survey	09/78
CA94	Converse Flats	MDN	USDA Forest Service	05/06
CA96	Lassen Volcanic NP - Manzanita Lake		National Park Service - Air Resources Division	06/00
CA99	Yosemite NP - Hodgdon Meadow		National Park Service - Air Resources Division	12/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Colorado				
CO00	Alamosa		US Geological Survey	04/80
CO01	Las Animas Fish Hatchery		US Geological Survey	10/83
CO02	Niwot Saddle		NSF-Institute of Arctic & Alpine Research/University of CO	06/84
CO08	Four Mile Park		US Environmental Protection Agency-CAM	12/87
CO09	Kawaneechee Meadow		Grand County Water Information Network	07/12
CO10	Gothic	AMoN	US Environmental Protection Agency-CAM	02/99
CO15	Sand Spring		US Bureau of Land Management	03/79
CO19	Rocky Mountain NP - Beaver Meadows		National Park Service - Air Resources Division	05/80
CO21	Manitou		USDA Forest Service	10/78
CO22	Pawnee		Colorado Department of Public Health & Environment	05/79
CO89	Rocky Mountain NP - Loch Vale		National Park Service - Air Resources Division	09/09
CO90	Niwot Ridge-Southeast		NSF-Institute of Arctic & Alpine Research/University of CO	01/06
CO91	Wolf Creek Pass		USDA Forest Service	05/92
CO92	Sunlight Peak		US Environmental Protection Agency-CAM	01/88
CO93	Buffalo Pass - Dry Lake		USDA Forest Service	10/86
CO94	Sugarloaf		US Environmental Protection Agency-CAM	11/86
CO96	Molas Pass	MDN	USDA Forest Service	07/86
CO97	Buffalo Pass - Summit Lake	MDN	USDA Forest Service	02/84
CO98	Rocky Mountain NP - Loch Vale	AMoN	USGS/Colorado State University	08/83
CO99	Mesa Verde NP - Chapin Mesa	MDN	US Geological Survey	04/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Connecticut				
CT15	Abington	AMoN	US Environmental Protection Agency-CAM	01/99
Florida				
FL03	Bradford Forest		US Environmental Protection Agency-CAM	10/78
FL05	Chassahowitzka NWR	MDN	US Fish & Wildlife Service - Air Quality Branch	08/96
FL11	Everglades NP - Research Center	MDN/AMoN	National Park Service - Air Resources Division	06/80
FL14	Quincy		US Geological Survey	03/84
FL23	Sumatra		US Environmental Protection Agency-CAM	01/99
FL32	Orlando		Seminole County Public Works Department	12/05
FL41	Verna Well Field		US Geological Survey	08/83
FL96	Pensacola	AMNet/MDN	Atmospheric Research & Analysis, Inc.	01/13
FL99	Kennedy Space Center		NASA/Innovative Health Applications, LLC	08/83
Georgia				
GA09	Okefenokee NWR	MDN	US Fish & Wildlife Service - Air Quality Branch	06/97
GA20	Bellville		US Environmental Protection Agency-CAM	04/83
GA33	Sapelo Island	MDN	NSF/UGA, & GA Dept. of Natural Resources	11/02
GA41	Georgia Station	AMoN	Atmospheric Research & Analysis, Inc.	10/78
GA99	Chula		US Geological Survey	02/94
Idaho				
ID02	Priest River Experimental Forest		USDA Forest Service	12/02
ID03	Craters of the Moon NM	AMoN	National Park Service - Air Resources Division	08/80
ID11	Reynolds Creek		US Geological Survey	11/83

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Illinois				
IL11	Bondville	AIRMoN/ MDN/AMoN	US Environmental Protection Agency-CAM	02/79
IL18	Shabbona		SAES-University of Illinois	05/81
IL46	Alhambra	AMoN	US Environmental Protection Agency-CAM	01/99
IL63	Dixon Springs Agricultural Center	MDN	SAES-University of Illinois	01/79
IL78	Monmouth		US Geological Survey	01/85
Indiana				
IN20	Roush Lake		US Geological Survey	08/83
IN22	Southwest Purdue Agriculture Center	MDN	US Geological Survey	09/84
IN34	Indiana Dunes NL	MDN	National Park Service - Air Resources Division	07/80
IN41	Agronomy Center for Research and Extension		SAES-Purdue University	07/82
Iowa				
IA08	Big Springs Fish Hatchery		US Geological Survey	08/84
IA23	McNay Memorial Research Center		US Geological Survey	09/84
Kansas				
KS07	Farlington Fish Hatchery		US Geological Survey	03/84
KS31	Konza Prairie	AMoN	SAES-Kansas State University	08/82
KS32	Lake Scott State Park	MDN	US Geological Survey	03/84

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Kentucky				
KY03	Mackville	AMoN	US Geological Survey	11/83
KY10	Mammoth Cave NP-Houchin Meadow	MDN	National Park Service - Air Resources Division	08/02
KY19	Seneca Park		US Geological Survey	10/03
KY22	Lilley Cornett Woods		US Geological Survey	09/83
KY35	Clark State Fish Hatchery		US Geological Survey	08/83
KY99	Mulberry Flats		TVA/Murray State University	12/94
Louisiana				
LA12	Iberia Research Station		US Geological Survey	11/82
LA30	Southeast Research Station		US Geological Survey	01/83
Maine				
ME00	Caribou	MDN	EPA/Maine Dept. of Environmental Protection	04/80
ME02	Bridgton	MDN	EPA/Maine Dept. of Environmental Protection	09/80
ME04	Carrabassett Valley	MDN	US Environmental Protection Agency - CAM	03/02
ME08	Gilead		US Geological Survey	09/99
ME09	Greenville Station	MDN	EPA/Maine Dept. of Environmental Protection	11/79
ME94	Indian Township		US Environmental Protection Agency - CAM	10/13
ME96	Casco Bay - Wolfe's Neck Farm	MDN	EPA/Maine Dept. of Environmental Protection	01/98
ME98	Acadia NP - McFarland Hill	MDN	National Park Service - Air Resources Division	11/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Maryland				
MD08	Piney Reservoir	MDN/AMNet/ AMoN	Maryland Department of Natural Resources	06/04
MD13	Wye		SAES-University of Maryland	03/83
MD15	Smith Island		NOAA-Air Resources Lab	06/04
MD18	Assateague Island NS - Woodcock		Maryland Department of Natural Resources	09/00
MD99	Beltsville	MDN/AMNet AMoN	Maryland Department of Natural Resources	06/04
Massachusetts				
MA01	North Atlantic Coastal Lab	MDN	National Park Service - Air Resources Division	12/81
MA08	Quabbin Reservoir		Northeast States for Coordinated Air Use Management	03/82
MA14	Nantucket		Nantucket Land Council	03/14
Michigan				
MI09	Douglas Lake	MDN	SAES-Michigan State University	07/79
MI26	Kellogg Biological Station	MDN	SAES-Michigan State University	06/79
MI48	Seney NWR - Headquarters	MDN	US Fish & Wildlife Service - Air Quality Branch	11/00
MI51	Unionville		US Environmental Protection Agency-CAM	01/99
MI52	Ann Arbor	MDN	US Environmental Protection Agency-CAM	01/99
MI53	Wellston		USDA Forest Service	10/78
MI98	Raco		US Environmental Protection Agency-CAM	05/84
MI99	Chassell		USDA Forest Service	02/83

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Minnesota				
MN01	Cedar Creek		Minnesota Pollution Control Agency	12/96
MN08	Hovland		Minnesota Pollution Control Agency	12/96
MN16	Marcell Experimental Forest	MDN	USDA Forest Service	07/78
MN18	Fernberg	MDN/AMoN	US Environmental Protection Agency-CAM	11/80
MN23	Camp Ripley	MDN	US Geological Survey	10/83
MN27	Lamberton	MDN	Minnesota Pollution Control Agency	01/79
MN28	Grindstone Lake		Minnesota Pollution Control Agency	12/96
MN32	Voyageurs NP - Sullivan Bay		National Park Service - Air Resources Division	05/00
MN99	Wolf Ridge		Minnesota Pollution Control Agency	12/96
Mississippi				
MS10	Clinton		US Geological Survey	07/84
MS12	Grand Bay NERR	MDN/AMNet	NOAA-Air Resources Lab	03/10
MS19	Newton		NOAA-Air Resources Lab	11/86
MS30	Coffeeville		Tennessee Valley Authority	07/84
Missouri				
MO03	Ashland Wildlife Area	MDN	US Geological Survey	10/81
MO05	University Forest		US Geological Survey	10/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Montana				
MT00	Little Bighorn Battlefield NM		US Geological Survey	07/84
MT05	Glacier NP - Fire Weather Station	MDN	National Park Service - Air Resources Division	06/80
MT07	Clancy		US Geological Survey	01/84
MT96	Poplar River		EPA/Fort Peck Tribes	12/99
MT97	Lost Trail Pass		USDA Forest Service	09/90
MT98	Havre - Northern Agricultural Research Center		US Geological Survey	07/85
Nebraska				
NE15	Mead	MDN	SAES-University of Nebraska	07/78
NE99	North Platte Agricultural Experiment Station		US Geological Survey	09/85
Nevada				
NV03	Smith Valley		US Geological Survey	08/85
NV05	Great Basin NP - Lehman Caves		National Park Service - Air Resources Division	01/85
New Hampshire				
NH02	Hubbard Brook	AMoN	USDA Forest Service	07/78
New Jersey				
NJ00	Edwin B Forsythe NWR		US Fish & Wildlife Service - Air Quality Branch	10/98
NJ39	Cattus Island County Park		US Environmental Protection Agency - CAM	12/12
NJ99	Washington Crossing		US Environmental Protection Agency - CAM	08/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
New Mexico				
NM07	Bandelier NM		National Park Service-Air Resources Division	06/82
NM08	Mayhill		US Geological Survey	01/84
New York				
NY01	Alfred		US Geological Survey	08/04
NY06	Bronx	AMNet/MDN	NYSERDA	01/13
NY08	Aurora Research Farm		USDA/Cornell University	04/79
NY10	Chautauqua		US Geological Survey	06/80
NY20	Huntington Wildlife	MDN/AMNet/ AMoN	NYSERDA	10/78
NY22	Akwesasne Mohawk - Fort Covington		US Environmental Protection Agency - CAM	08/99
NY28	Piseco Lake		NYSERDA	12/12
NY29	Moss Lake		US Geological Survey	07/03
NY43	Rochester	MDN	NYSERDA	04/13
NY52	Bennett Bridge		US Environmental Protection Agency-CAM	06/80
NY59	Wanakena		NYSERDA	01/13
NY68	Biscuit Brook	MDN	US Geological Survey	10/83
NY92	Amherst		NYSERDA	10/13
NY93	Paul Smith's		NYSERDA	01/13
NY96	Cedar Beach, Southold	MDN/AMoN	EPA/Suffolk Dept. of Health Service-Peconic Estuary Program	11/03
NY98	Whiteface Mountain	AMoN	US Geological Survey	07/84
NY99	West Point		US Geological Survey	09/83

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
North Carolina				
NC03	Lewiston		North Carolina State University	10/78
NC06	Beaufort	AMoN	US Environmental Protection Agency-CAM	01/99
NC25	Coweeta	AMoN	USDA Forest Service	07/78
NC29	Hofmann Forest		North Carolina State University	07/02
NC34	Piedmont Research Station		North Carolina State University	10/78
NC35	Clinton Crops Research Station		North Carolina State University	10/78
NC36	Jordan Creek		US Geological Survey	10/83
NC41	Finley Farms		North Carolina State University	10/78
NC45	Mount Mitchell		US Environmental Protection Agency-CAM/NCSU	11/85
North Dakota				
ND00	Theodore Roosevelt NP-Painted Canyon		National Park Service-Air Resources Division	01/01
ND08	Icelandic State Park		US Geological Survey	10/83
ND11	Woodworth		US Geological Survey	11/83
Ohio				
OH09	Oxford		US Geological Survey	08/84
OH17	Delaware		USDA Forest Service	10/78
OH49	Caldwell		US Geological Survey	09/78
OH54	Deer Creek State Park	AMoN	US Environmental Protection Agency-CAM	01/99
OH71	Wooster		US Geological Survey	09/78

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Oklahoma				
OK00	Salt Plains NWR		US Geological Survey	12/83
OK17	Kessler Farm Field Laboratory		NOAA-Air Resources Lab	03/83
OK29	Goodwell Research Station		US Geological Survey	01/85
Oregon				
OR09	Silver Lake Ranger Station		US Geological Survey	08/83
OR10	H J Andrews Experimental Forest		USDA Forest Service	05/80
OR18	Starkey Experimental Forest		US Geological Survey	03/84
OR97	Hyslop Farm		US Environmental Protection Agency-CAM	04/83
Pennsylvania				
PA00	Arendtsville	MDN/AMoN	US Environmental Protection Agency-CAM	01/99
PA02	Crooked Creek Lake		PA Dept. of Env. Protection/Penn State University	07/11
PA13	Allegheny Portage Railroad National Historic Sit	MDN	PA Dept. of Env. Protection/Penn State University	07/11
PA15	Penn State	AIRMoN	NOAA-Air Resources Lab/PA Game Commission	06/83
PA18	Young Woman's Creek	MDN	US Geological Survey	04/99
PA21	Goddard State Park	MDN	PA Dept. of Env. Protection/Penn State University	07/11
PA29	Kane Experimental Forest	MDN/AMoN	USDA Forest Service	07/78
PA30	Erie	MDN	PA Dept. of Env. Protection/Penn State University	07/11
PA42	Leading Ridge	MDN	PA Dept. of Env. Protection/Penn State University/SAES	04/79
PA47	Millersville	MDN	PA Dept. of Env. Protection/Penn State University	11/02
PA52	Little Pine State Park	MDN	PA Dept. of Env. Protection/Penn State University	07/11
PA60	Valley Forge	MDN	PA Dept. of Env. Protection/Penn State University	07/11

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
PA71	Little Buffalo State Park		PA Dept. of Env. Protection/Penn State University	07/11
PA72	Milford	MDN	USDA Forest Service	12/83
PA83	Laurel Hill State Park		PA Dept. of Env. Protection/Penn State University	07/11
PA90	Hills Creek State Park	MDN	PA Dept. of Env. Protection/Penn State University	07/11
PA98	Frances Slocum State Park		PA Dept. of Env. Protection/Penn State University	07/11
Puerto Rico				
PR20	El Verde	MDN/AMoN	USDA Forest Service	02/85
South Carolina				
SC03	Savannah River	MDN	Savannah River Nuclear Solution, LLC	12/11
SC05	Cape Romain NWR	MDN/AMoN	US Fish & Wildlife Service - Air Quality Branch	11/00
SC06	Santee NWR		US Geological Survey	07/84
South Dakota				
SD04	Wind Cave National Park-Elk Mountain		National Park Service - Air Resources Division	11/02
SD08	Cottonwood		US Geological Survey	10/83
SD99	Huron Well Field		US Geological Survey	11/83
Tennessee				
TN04	Speedwell		US Environmental Protection Agency-CAM	01/99
TN11	Great Smoky Mountain NP - Elkmont	MDN	National Park Service - Air Resources Division	08/80
TN14	Hatchie NWR		Tennessee Valley Authority	10/84
Texas				
TX02	Muleshoe NWR		US Geological Survey	06/85
TX03	Beeville		US Geological Survey	02/84

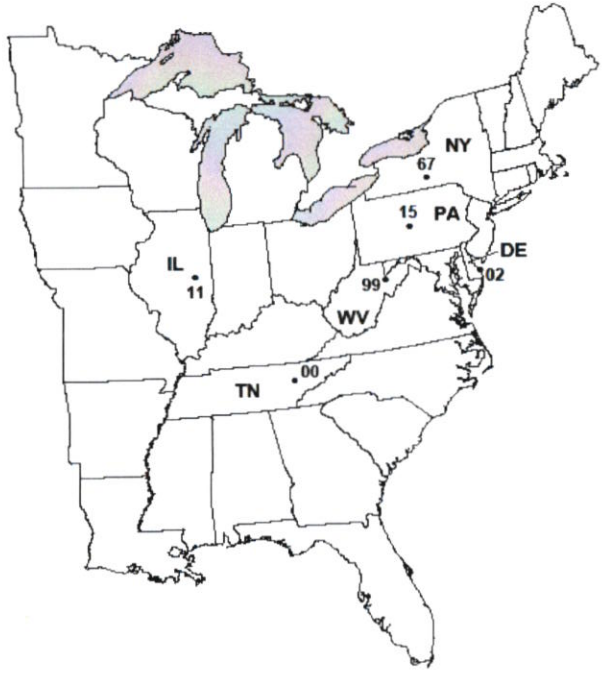
State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
TX04	Big Bend NP - K-Bar		National Park Service - Air Resources Division	04/80
TX10	Attwater Prairie Chicken NWR		US Geological Survey	07/84
TX16	Sonora		US Geological Survey	06/84
TX21	Longview	MDN	Texas Commission on Environmental Quality	06/82
TX22	Guadalupe Mountains NP-Frijole Ranger Stn		US Geological Survey	06/84
TX43	Cañónceta	AMoN	Texas A&M University/Texas Agrilife Research	07/07
TX56	LBJ National Grasslands		US Geological Survey	09/83
Utah				
UT01	Logan	AMoN	US Geological Survey	12/83
UT09	Canyonlands NP - Island in the Sky	AMoN	National Park Service - Air Resources Division	11/97
UT98	Green River		US Geological Survey	04/85
UT99	Bryce Canyon NP - Repeater Hill		National Park Service - Air Resources Division	01/85
Vermont				
VT01	Bennington		US Geological Survey	04/81
VT99	Underhill	AMNet MDN/AMoN	US Geological Survey	06/84
Virgin Islands				
VI01	Virgin Islands NP - Lind Point		National Park Service - Air Resources Division	04/98
Virginia				
VA00	Charlottesville		US Geological Survey	10/84
VA13	Horton's Station		Tennessee Valley Authority	07/78
VA24	Prince Edward	AMoN	US Environmental Protection Agency-CAM	01/99
VA28	Shenandoah NP - Big Meadows	MDN	National Park Service - Air Resources Division	05/81

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
VA99	Natural Bridge Station		USDA Forest Service - Air Program	07/02
Washington				
WA14	Olympic NP - Hoh Ranger Station		National Park Service - Air Resources Division	05/80
WA19	North Cascades NP-Marblemount Ranger Stn		US Geological Survey	02/84
WA21	La Grande		US Environmental Protection Agency-CAM	04/84
WA24	Palouse Conservation Farm		US Geological Survey	08/85
WA98	Columbia River Gorge		USDA Forest Service - Pacific Northwest Region	05/02
WA99	Mount Rainier NP - Tahoma Woods	AMoN	National Park Service - Air Resources Division	10/99
West Virginia				
WV04	Babcock State Park		US Geological Survey	09/83
WV05	Cedar Creek State Park		US Environmental Protection Agency-CAM	01/99
WV18	Parsons	AMoN	USDA Forest Service	07/78
Wisconsin				
WI08	Brule River	MDN	Wisconsin Department of Natural Resources	04/14
WI10	Potawatomi	MDN	EPA/Forest County Potawatomi Community	06/05
WI31	Devil's Lake	MDN	Wisconsin Department of Natural Resources	01/14
WI35	Perkinstown	AMoN	US Environmental Protection Agency-CAM	01/99
WI36	Trout Lake	MDN	Wisconsin Department of Natural Resources	01/80
WI37	Spooner		USDA Forest Service	06/80

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Wyoming				
WY00	Snowy Range		USDA Forest Service	04/86
WY02	Sinks Canyon		Bureau of Land Management	08/84
WY06	Pinedale		Bureau of Land Management	01/82
WY08	Yellowstone NP - Tower Falls	MDN	National Park Service - Air Resources Division	06/80
WY94	Grand Tetons National Park	AMoN	State of Wyoming DEQ	09/11
WY95	Brooklyn Lake	AMoN	USDA Forest Service	09/92
WY97	South Pass City		USDA Forest Service/Bridger Teton NF	04/85
WY98	Gypsum Creek		USDA Forest Service/Bridger Teton NF	12/84
WY99	Newcastle		Bureau of Land Management	08/81
Canada				
BC22	Haul Road Station		Rio Tinto	09/12
BC23	Lakelse Lake		Rio Tinto	03/13
BC24	Port Edward		Prince Rupert Port Authority	01/14
CAN5	Frelighsburg		US Geological Survey	10/01
SK20	Cactus Lake		Saskatchewan Ministry of Environment	02/12
SK21	Hudson Bay		Saskatchewan Ministry of Environment	04/12

AIRMoN Map and Site Listings

National Atmospheric Deposition Program
Atmospheric Integrated Research Monitoring Network



National Atmospheric Deposition Program/Atmospheric Integrated Research Monitoring Network Sites

July 31, 2014

State Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Delaware				
DE02	Lewes		NOAA-Air Resources Laboratory	09/92
Illinois				
IL11	Bondville	MDN/NTN/AMoN	NOAA-Air Resources Laboratory	10/92
New York				
NY67	Cornell University	AMoN	NOAA-Air Resources Laboratory	09/92
Pennsylvania				
PA15	Penn State	NTN	NOAA-Air Resources Laboratory	10/92
Tennessee				
TN00	Walker Branch Watershed		NOAA-Air Resources Laboratory	09/92
West Virginia				
WV99	Canaan Valley Institute		NOAA-Air Resources Laboratory	06/00

AMoN Map and Site Listings

National Atmospheric Deposition Program
Ammonia Monitoring Network

National Atmospheric Deposition Program/Ammonia Monitoring Network Sites

July 31, 2014

State/Province Site Code		Site Name	Collocation	Sponsoring Agency	Start Date
Alabama					
	AL99	Sand Mountain Research & Ext. Center	NTN	US Environmental Protection Agency - CAM	03/11
Arizona					
	AZ98	Chiricahua	NTN	National Park Service - Air Resources Division	03/11
Arkansas					
	AR03	Caddo Valley	NTN	US Environmental Protection Agency - CAM	03/11
California					
	CA44	Yosemite NP- Turtleback Dome		National Park Service - Air Resources Division	03/11
	CA67	Joshua Tree NP - Black Rock	NTN	National Park Service - Air Resources Division	03/11
	CA83	Sequoia NP-Ash Mountain		National Park Service - Air Resources Division	03/11
Colorado					
	CO10	Gothic	NTN	US Environmental Protection Agency - CAM	09/12
	CO13	Fort Collins		US Environmental Protection Agency - CAM	11/07
	CO88	Rocky Mountain NP- Longs Peak		National Park Service - Air Resources Division	05/11
	CO98	Rocky Mountain NP - Loch Vale	NTN	National Park Service - Air Resources Division	05/11
Connecticut					
	CT15	Abington	NTN	US Environmental Protection Agency - CAM	03/11
Florida					
	FL11	Everglades NP - Research Center	NTN/MDN	National Park Service - Air Resources Division	03/11
	FL19	Indian River		US Environmental Protection Agency - CAM	04/11

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Georgia				
GA40	Yorkville	AMNet/MDN	Atmospheric Research & Analysis	12/11
GA41	Georgia Station	NTN	US Environmental Protection Agency - CAM	06/11
Idaho				
ID03	Craters of the Moon NM	NTN	National Park Service - Air Resources Division	06/10
Illinois				
IL11	Bondville	AIRMoN/MDN/ NTN	US Environmental Protection Agency - CAM	10/07
IL37	Stockton		US Environmental Protection Agency - CAM	04/11
IL46	Alhambra	NTN	US Environmental Protection Agency - CAM	03/11
Indiana				
IN99	Indianapolis		US Environmental Protection Agency - CAM	10/07
Kansas				
KS03	Reserve	MDN	Sac and Fox Nation of Missouri	10/11
KS31	Konza Prairie	NTN	US Environmental Protection Agency - CAM	03/11
Kentucky				
KY03	Mackville	NTN	US Environmental Protection Agency - CAM	03/11
KY98	Cadiz		US Environmental Protection Agency - CAM	03/11

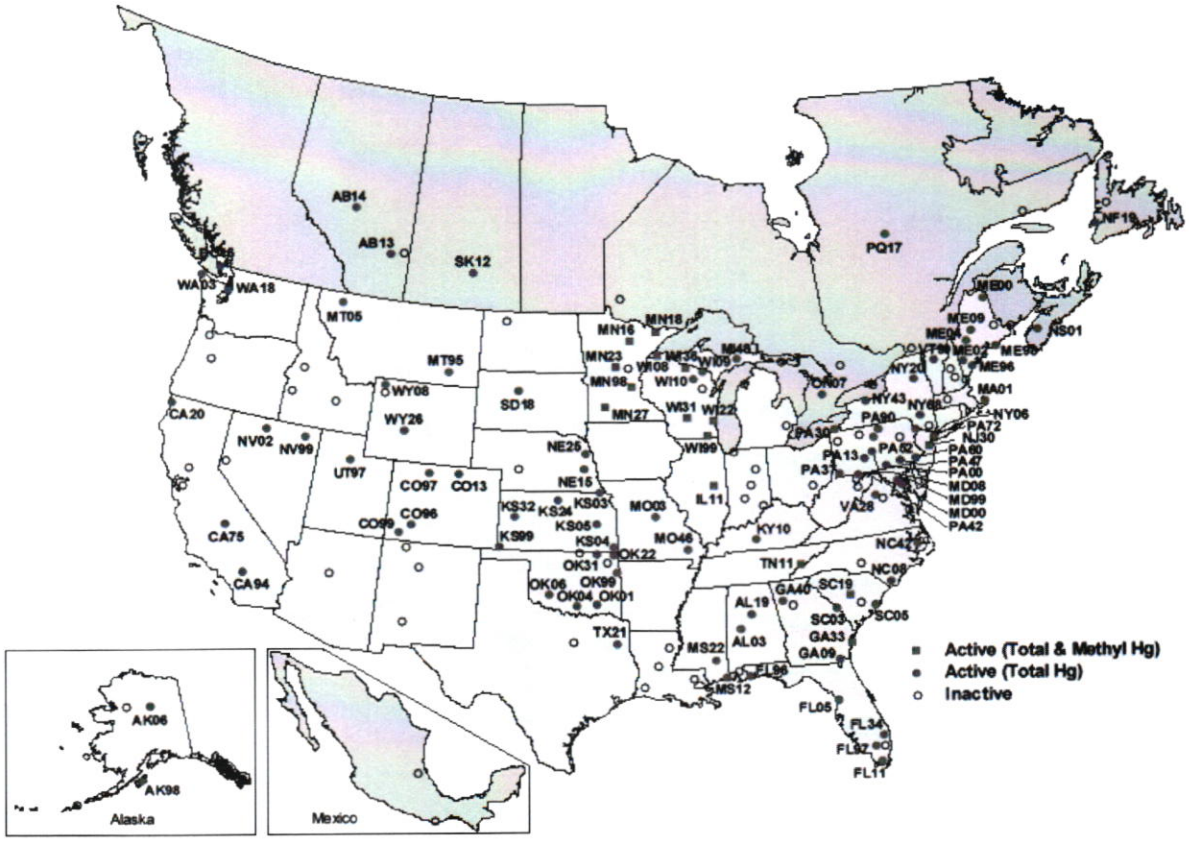
State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Maryland				
MD08	Piney Reservoir	MDN/AMNet/ NTN	State of MD/ Department of Natural Resources	08/10
MD99	Beltsville	MDN/AMNet/ NTN/AMoN	State of MD/ Department of Natural Resources	08/10
Michigan				
MI96	Detroit		US Environmental Protection Agency - CAM	10/07
Minnesota				
MN18	Fernberg	NTN/MDN	US Environmental Protection Agency - CAM	10/07
Nebraska				
NE98	Santee	MDN	US Environmental Protection Agency - CAM	04/11
New Hampshire				
NH02	Hubbard Brook	NTN	US Environmental Protection Agency - CAM	06/12
New Jersey				
NJ98	Washington Crossing CASTNET		US Environmental Protection Agency - CAM	03/11
New Mexico				
NM98	Navajo Lake		US Environmental Protection Agency - CAM	01/08
NM99	Farmington		US Environmental Protection Agency - CAM	01/08

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
New York				
NY16	Cary Institute		Cary Institute Of Ecosystem Studies	10/09
NY20	Huntington Wildlife	MDN/AMNet/ NTN	US Environmental Protection Agency - CAM	06/12
NY67	Ithaca	AIRMoN	US Environmental Protection Agency - CAM	10/07
NY94	Nick's Lake		US Environmental Protection Agency - CAM	11/12
NY98	Whiteface Mountain	NTN	US Environmental Protection Agency - CAM	11/12
North Carolina				
NC06	Beaufort	NTN	US Environmental Protection Agency - CAM	04/10
NC25	Coweeta	NTN	US Environmental Protection Agency - CAM	05/11
NC26	Candor	MDN	US Environmental Protection Agency - CAM	04/11
NC30	Duke Forest		US Environmental Protection Agency - CAM	06/08
Ohio				
OH02	Athens Super Site	AMNet/MDN	US Environmental Protection Agency - CAM	10/07
OH27	Cincinnati		US Environmental Protection Agency - CAM	10/07
OH54	Deer Creek State Park	NTN	US Environmental Protection Agency - CAM	03/11
Oklahoma				
OK99	Stilwell	MDN	US Environmental Protection Agency - CAM	10/07
Pennsylvania				
PA00	Arendtsville	NTN/MDN	US Environmental Protection Agency - CAM	10/09
PA29	Kane Experimental Forest	NTN/MDN	US Environmental Protection Agency - CAM	03/11

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Puerto Rico				
PR20	El Verde	MDN/NTN	U.S. Forest Service	03/14
South Carolina				
SC05	Cape Romain NWR	NTN/MDN	US Environmental Protection Agency - CAM	10/07
Tennessee				
TN01	Great Smoky Mountains NP- Look Rock		National Park Service - Air Resources Division	03/11
Texas				
TX43	Cañónceta	NTN	US Environmental Protection Agency - CAM	10/07
Utah				
UT01	Logan	NTN	State of Utah	11/11
UT09	Canyonlands National Park-Island in the Sky	NTN	State of Utah	05/14
UT97	Salt Lake City	MDN/AMNet	State of Utah	11/11
Vermont				
VT99	Underhill	AMNet/MDN/ NTN	US Environmental Protection Agency - CAM	11/12
Virginia				
VA24	Prince Edward	NTN	US Environmental Protection Agency - CAM	03/11
Washington				
WA99	Mount Rainier NP - Tahoma Woods	NTN	National Park Service - Air Resources Division	03/11
West Virginia				
WV18	Parsons	NTN	US Environmental Protection Agency - CAM	06/11

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Wisconsin				
WI07	Horicon Marsh	AMNet/MDN	US Environmental Protection Agency - CAM	10/07
WI35	Perkinstown	NTN	US Environmental Protection Agency - CAM	03/11
Wyoming				
WY94	Grand Tetons National Park	NTN	National Park Service - Air Resources Division	09/11
WY95	Brooklyn Lake	NTN	US Environmental Protection Agency - CAM	06/12
Canada				
NS01	Kejimkujik National Park	MDN/AMNet	Environment Canada	10/13
ON25	Bonner Lake		Environment Canada	10/13
ON26	Longwoods		Environment Canada	10/13

MDN Map and Site Listings



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National Atmospheric Deposition Program/Mercury Deposition Network Sites

July 31, 2014

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Alabama				
AL03	Centreville	NTN	Atmospheric Research and Analysis, Inc.	06/00
AL19	Birmingham	AMNet/NTN	Atmospheric Research and Analysis, Inc.	12/10
Alaska				
AK04	Nome		State of Alaska Department of Environmental Conservatio	09/13
AK06	Gates of the Arctic NP - Bettles	NTN	US Bureau of Land Management	11/08
AK98	Kodiak		State of Alaska Department of Environmental Conservatio	09/07
California				
CA20	Yurok Tribe-Requa		Electric Power Research Institute	08/06
CA75	Sequoia NP-Giant Forest	NTN	National Park Service - Air Resources Division	07/03
CA94	Converse Flats	NTN	USDA Forest Service	04/06
Colorado				
CO96	Molas Pass	NTN	US Bureau of Land Management	06/09
CO97	Buffalo Pass - Summit Lake	NTN	USDA Forest Service	09/98
CO99	Mesa Verde NP-Chapin Mesa	NTN	National Park Service - Air Resources Division	12/01

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State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Florida				
FL05	Chassahowitzka NWR	NTN	US Fish & Wildlife Service - Chassahowitzka NWR	07/97
FL11	Everglades NP - Research Center	NTN/AMoN	South Florida Water Management District	03/96
FL34	Everglades Nutrient Removal Project		South Florida Water Management District	07/97
FL96	Pensacola	AMNet/NTN	Atmospheric Research and Analysis, Inc.	12/10
FL97	Everglades - Western Broward County		South Florida Water Management District	11/06
Georgia				
GA09	Okefenokee NWR	NTN	US Fish & Wildlife Service - Air Quality Branch	07/97
GA33	Sapelo Island	NTN	Georgia Department of Natural Resources /Sapelo Island NERR	09/07
GA40	Yorkville	AMNet/AMoN	Atmospheric Research and Analysis, Inc.	06/00
Illinois				
IL11	Bondville	AIRMoN/NTN/ AMoN	Illinois State Water Survey/NADP	01/99
IL63	Dixon Springs Agriculture Center	NTN	Lake Michigan Air Directors Consortium - LADCO	12/13
Indiana				
IN21	Clifty Falls State Park		Lake Michigan Air Directors Consortium - LADCO	01/01
IN22	Southwest Purdue Agricultural Center	NTN	Lake Michigan Air Directors Consortium - LADCO	12/13
IN34	Indiana Dunes National Lakeshore	NTN	Lake Michigan Air Directors Consortium - LADCO	10/00

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Kansas				
KS03	Reserve	AMoN	Kansas Department of Health and Environment	01/08
KS04	West Mineral		Kansas Department of Health and Environment	10/08
KS05	Coffey County Lake		Kansas Department of Health and Environment	12/08
KS24	Glen Elder State Park		Kansas Department of Health and Environment	05/08
KS32	Lake Scott State Park	NTN	Kansas Department of Health and Environment	06/08
KS99	Cimarron National Grassland		Kansas Department of Health and Environment	12/08
Kentucky				
KY10	Mammoth Cave NP-Houchin Meadow	NTN	National Park Service - Air Resources Division	08/02
Maine				
ME00	Caribou	NTN	University of Maine	05/07
ME02	Bridgton	NTN	Maine Department of Environmental Protection/EPA	06/97
ME04	Carrabassett Valley	NTN	Penobscot Indian Nation/EPA	02/09
ME09	Greenville Station	NTN	Maine Department of Environmental Protection/EPA	09/96
ME96	Casco Bay - Wolfe's Neck Farm	NTN	Maine Department of Environmental Protection/EPA	01/98
ME98	Acadia NP - McFarland Hill	NTN	Maine Dept. of Environmental Protection/NPS-Acadia NP	03/96
Maryland				
MD00	Smithsonian Environmental Res Ctr		MD DNR/Smithsonian Environmental Research Center	12/06
MD08	Piney Reservoir	NTN /AMNet/ AMoN	MD DNR/University of Maryland-Appalachian Lab	06/04
MD99	Beltsville	NTN /AMNet/ AMoN	MD DNR/University of Maryland-Appalachian Lab	06/04

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Massachusetts				
MA01	North Atlantic Coastal Lab	NTN	NPS - Cape Cod National Seashore	07/03
Michigan				
MI09	Douglas Lake	NTN	Lake Michigan Air Directors Consortium - LADCO	12/13
MI26	Kellogg Biological Station	NTN	Lake Michigan Air Directors Consortium - LADCO	12/13
MI48	Seney NWR - Headquarters	NTN	US Fish & Wildlife Service-Air Quality Branch	11/03
MI52	Ann Arbor	NTN	Lake Michigan Air Directors Consortium - LADCO	12/13
Minnesota				
MN06	Leech Lake		Leech Lake Band of Ojibwe	07/14
MN16	Marcell Experimental Forest	NTN	USDA Forest Service-North Central Research Station & Minnesota Pollution Control Agency	02/96
MN18	Fernberg	NTN/AMoN	Minnesota Pollution Control Agency	03/96
MN23	Camp Ripley	NTN	Minnesota Pollution Control Agency	07/96
MN27	Lamberton	NTN	Minnesota Pollution Control Agency	07/96
MN98	Blaine		Minnesota Pollution Control Agency	02/08
Mississippi				
MS12	Grand Bay NERR	NTN /AMNet	NOAA - Air Resources Lab	03/10
MS22	Oak Grove		Atmospheric Research and Analysis, Inc.	06/00
Missouri				
MO03	Ashland Wildlife Area	NTN	Missouri Department of Natural Resources /EPA	07/10
MO46	Mingo NWR		Missouri Department of Natural Resources /EPA	03/02

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Montana				
MT05	Glacier NP - Fire Weather Station	NTN	National Park Service - Air Resources Division	10/03
MT95	Badger Peak		Northern Cheyenne Tribe	11/10
Nebraska				
NE15	Mead	NTN	Nebraska Department of Environmental Quality	06/07
NE25	Winnebago		Winnebago Tribe of Nebraska	11/09
NE98	Santee	AMoN	Santee Sioux Nation of Nebraska/EPA	10/13
Nevada				
NV02	Lesperance Ranch		Nevada Dept. of Conservation & Natural Resources/Eurofins Frontier Global Sciences, Inc.	01/03
NV99	Gibb's Ranch		Nevada Dept. of Conservation & Natural Resources/Eurofins Frontier Global Sciences, Inc.	02/03
New Jersey				
NJ30	New Brunswick	AMNet	US Geological Survey	01/06
New York				
NY06	Bronx	AMNet/NTN	New York State Department of Env. Conservation	01/08
NY20	Huntington Wildlife	NTN/AMNet/ AMoN	NYSERDA	12/99
NY43	Rochester	NTN	NYSERDA	01/08
NY68	Biscuit Brook	NTN	NYSERDA	03/04
NY96	Cedar Beach, Southhold	NTN	NYSERDA	09/13

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
North Carolina				
NC08	Waccamaw State Park		North Carolina Dept. of Environment & Natural Resource	02/96
NC26	Candor	AMoN	North Carolina Dept. of Environment & Natural Resource	11/05
Ohio				
OH02	Athens Super Site	AMNet/AMoN	Lake Michigan Air Directors Consortium - LADCO	12/04
OH52	South Bass Island	AMNet	Lake Michigan Air Directors Consortium - LADCO	05/14
Oklahoma				
OK01	McGee Creek		Oklahoma Department of Environmental Quality	10/06
OK04	Lake Murray		Oklahoma Department of Environmental Quality	10/07
OK06	Wichita Mountains NWR		Oklahoma Department of Environmental Quality	11/07
OK31	Copan		Oklahoma Department of Environmental Quality	10/06
OK99	Stilwell	AMNet/AMoN	Cherokee Nation/EPA	04/03
Pennsylvania				
PA00	Arendtsville	NTN/AMoN	PA Dept. of Env Protection/Penn State University	11/00
PA13	Allegheny Portage Railroad NHS	NTN	PA Dept. of Env Protection/Penn State University	01/97
PA18	Young Woman's Creek	NTN	PA Dept. of Env Protection/Penn State University	10/13
PA21	Goddard State Park	NTN	PA Dept. of Env Protection/Penn State University	03/10
PA29	Kane Experimental Forest	NTN/AMoN	PA Dept. of Env Protection/Penn State University	06/10
PA30	Erie	NTN	PA Dept. of Env Protection/Penn State University	06/00
PA37	Waynesburg		Electrical Power Research Institute	05/99
PA42	Leading Ridge	NTN	PA Dept. of Env Protection/Penn State University	03/10

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
PA47	Millersville	NTN	PA Dept. of Env Protection/Penn State University	11/02
PA52	Little Pine State Park	NTN	PA Dept. of Env Protection/Penn State University	07/07
PA60	Valley Forge	NTN	PA Dept. of Env Protection/Penn State University	11/99
PA72	Milford	NTN	PA Dept. of Env Protection/Penn State University	09/00
PA90	Hills Creek State Park	NTN	PA Dept. of Env Protection/Penn State University	01/97
South Carolina				
SC03	Savannah River	NTN	Savannah River Nuclear Solutions, LLC	01/01
SC05	Cape Romaine NWR	NTN/AMoN	US Fish & Wildlife Service - Air Quality Branch	03/04
SC19	Congaree Swamp		South Carolina Dept. of Health & Environmental Control	03/96
South Dakota				
SD18	Eagle Butte		Cheyenne River Sioux Tribe/EPA	03/07
Tennessee				
TN11	Great Smoky Mountains NP-Elkmont	NTN	National Park Service - Air Resources Division	01/02
Texas				
TX21	Longview	NTN	Texas Commission on Environmental Quality	03/96
Utah				
UT97	Salt Lake City	AMNet/AMoN	Utah Department of Environmental Quality	05/07
Vermont				
VT99	Underhill	NTN/AMNet/AMoN	Vermont Monitoring Cooperative	07/04

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Virginia				
VA28	Shenandoah NP-Big Meadows	NTN	National Park Service - Air Resources Division	10/02
Washington				
WA03	Makah National Fish Hatchery		Eurofins Frontier Global Sciences	03/07
WA18	Seattle - NOAA		Illinois State Water Survey & Frontier Global Sciences Inc.	03/96
Wisconsin				
WI07	Horicon Marsh	AMoN	Lake Michigan Air Directors Consortium - LADCO	07/14
WI08	Brule River		Wisconsin Department of Natural Resources	03/96
WI10	Potawatomi	NTN	Forest County Potawatomi Community/EPA	06/05
WI31	Devils Lake		Wisconsin Department of Natural Resources	01/01
WI36	Trout Lake	NTN	Wisconsin Department of Natural Resources	03/96
WI99	Lake Geneva	NTN	Lake Michigan Air Directors Consortium - LADCO	01/97
Wyoming				
WY08	Yellowstone NP-Tower Falls	NTN	Wyoming Department of Environmental Quality	10/04
WY26	Roundtop Mountain		State of Wyoming - DEQ	12/11

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
CANADA				
Alberta				
AB13	Henry Kroeger		ATCO Power Sheerness GS	09/04
AB14	Genesee		Jacques Whitford Stantec Axys Ltd.	07/06
British Columbia				
BC16	Saturna Island		Environment Canada	09/09
Newfoundland				
NF19	Stephenville		Environment Canada	2/10
Nova Scotia				
NS01	Kejimkujik NP	AMNet/AMoN	Environment Canada	07/96
Ontario				
ON07	Egbert		Environment Canada	03/00
Quebec				
PQ17	Chapais		Environment Canada	11/09
Saskatchewan				
SK12	Bratt's Lake BSRN		Environment Canada	05/01

AMNet Map and Site Listings

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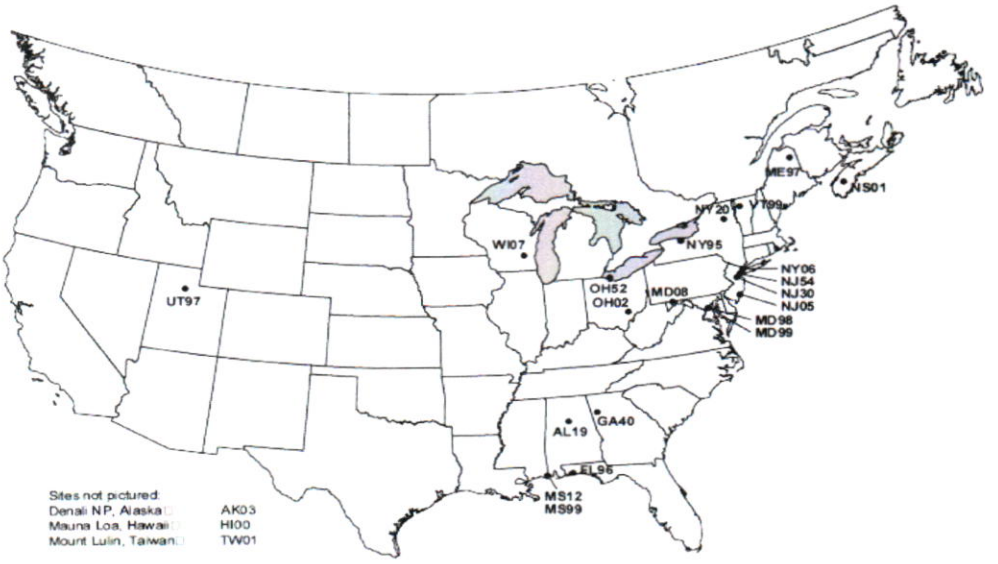
National Atmospheric Deposition Program
Atmospheric Mercury Network



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National Atmospheric Deposition Program/Atmospheric Mercury Network Sites

July 31, 2014

State/Province Site Code		Site Name	Collocation	Sponsoring Agency	Start Date
Alabama					
	AL19	Birmingham	MDN/NTN	Atmospheric Research & Analysis, Inc.	12/10
Alaska					
	AK03	Denali National Park	NTN	National Park Service - Air Resources Division	03/14
Florida					
	FL96	Pensacola	MDN/NTN	Atmospheric Research & Analysis, Inc.	12/10
Georgia					
	GA40	Yorkville	MDN/AMoN	Atmospheric Research & Analysis, Inc.	12/10
Hawaii					
	HI00	Mauna Loa		National Oceanic & Atmospheric Administration	01/12
Maine					
	ME97	Presque Isle		Aroostook Band of Micmacs	12/13

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Maryland				
MD08	Piney Reservoir	MDN/NTN/AMoN	State of Maryland	01/08
MD98	Beltsville II		NOAA/US Environmental Protection Agency-CAMD	01/07
MD99	Beltsville	MDN/NTN/AMoN	NOAA/US Environmental Protection Agency-CAMD	11/06
Mississippi				
MS12	Grand Bay NERR	MDN/NTN	National Oceanic & Atmospheric Administration	09/06
MS99	Grand Bay NERR II		National Oceanic & Atmospheric Administration	10/07
New Jersey				
NJ05	Brigantine		State of New Jersey	06/09
New York				
NY06	New York City	MDN/NTN	State of New York	08/08
NY20	Huntington Wildlife Forest	MDN/NTN/AMoN	NYSERDA	11/07
NY95	Rochester B		NYSERDA	09/08
Ohio				
OH02	Athens Super Site	AMoN/MDN	Lake Michigan Air Directors Consortium	01/07
OH52	South Bass Island	MDN	Lake Michigan Air Directors Consortium	12/11
Utah				
UT97	Salt Lake City	MDN/AMoN	State of Utah	11/08

State/Province Site Code	Site Name	Collocation	Sponsoring Agency	Start Date
Vermont				
VT99	Underhill	MDN/NTN/AMoN	Vermont Monitoring Cooperative	01/14
Wisconsin				
WI07	Horicon Marsh	MDN/AMoN	Lake Michigan Air Directors Consortium	01/11
Canada				
NS01	Kejimkujik NP	MDN/AMoN	Environment Canada	01/09
Taiwan				
TW01	Mt. Lunil		Taiwan EPA	01/12

Proceedings Notes

The National Atmospheric Deposition Program (NADP) was established in 1977 under State Agricultural Experiment Station (SAES) leadership 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 for analysis at the Illinois State Water Survey's Central Analytical Laboratory (CAL), located at the University of Illinois, Urbana-Champaign. The network was established to provide data on amounts, temporal trends, and geographic distributions of the atmospheric deposition of acids, nutrients, and base cations by precipitation.

Initially, the NADP was organized as SAES North Central Regional Project NC-141, which all four SAES regions further endorsed in 1982 as Interregional Project IR-7. A decade later, IR-7 was reclassified as National Research Support Project No. 3 (NRSP-3), which it remains. NRSP projects are multistate activities that support research on topics of concern to more than one state or region of the country. Multistate projects involve the SAES in partnership with the USDA National Institute of Food and Agriculture and other universities, institutions, and agencies.

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, the NADP agreed to coordinate operation of NAPAP's National Trends Network (NTN). To benefit from identical siting criteria and operating procedures and a shared analytical laboratory, NADP and NTN merged with the designation NADP/NTN. This merger brought substantial new federal agency participation into the program. Many NADP/NTN sites were supported by the USGS, NAPAP's lead federal agency for deposition monitoring.

In October 1992, the Atmospheric Integrated Research Monitoring Network (AIRMoN) joined the NADP. AIRMoN sites collect samples daily when precipitation occurs. In January 1996, the NADP established the Mercury Deposition Network (MDN), the third network in the organization. The MDN was formed to provide data on the wet deposition of mercury to surface waters, forested watersheds, and other receptors. In October 2009, the Atmospheric Mercury Network (AMNet) joined the NADP as the fourth network. AMNet measures the concentration of atmospheric mercury. In October 2010, the Ammonia Monitoring Network (AMoN) joined the NADP, measuring atmospheric ammonia concentrations using passive monitors.

SAES project NRSP-3 was renewed in 2014 and it continues to offer a unique opportunity for cooperation among scientists from land-grant and other universities, government agencies, and non-governmental organizations. It provides a framework for leveraging the resources of nearly 100 different sponsoring agencies to address contemporary and emerging issues of national importance.

NADP Program Office
Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495

NADP Home page: http://nadp.isws.illinois.edu
Phone: 217/333-7871