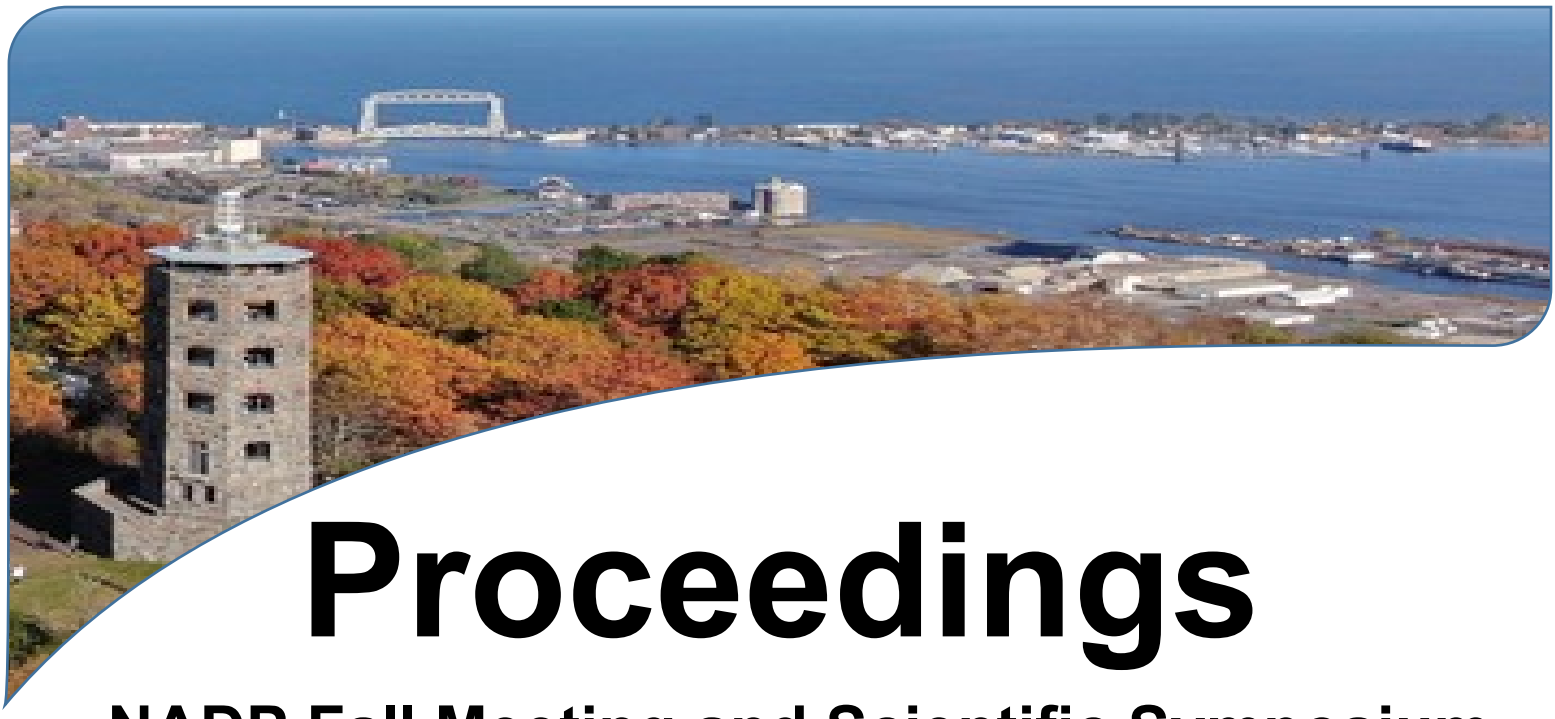

Proceedings

NADP Fall Meeting and Scientific Symposium

Protecting the Health of Communities and Ecosystems in a Changing Climate

November 4-8, 2024

Duluth, MN

Version: 11-20-2024

National Atmospheric Deposition Program

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Table of Contents

Contents

Meeting Information and Acknowledgements

Locations

November 4-7 Fall Meeting and Scientific Symposium will be held at the **Inn on Lake Superior** (350 Canal Park Dr, Duluth, MN).

Acknowledgements

The NADP Program Office would like to thank the following people for their support of and contributions to the 2024 Fall Meeting and Scientific Symposium:

Melissa Puchalski, Scientific Symposium Chair
Kate Knuth, Keynote Speaker
NADP Executive Committee
Ellis C. Cowling Student Travel Award Committee (Beck Dalton, Chris Rogers, Greg Beachley, and Cari Furiness)

In addition, we thank everyone who submitted abstracts and for sharing their research. The use of NADP data by researchers and policymakers is what has made NADP successful for the past 46+ years and will continue to do so for many years to come.

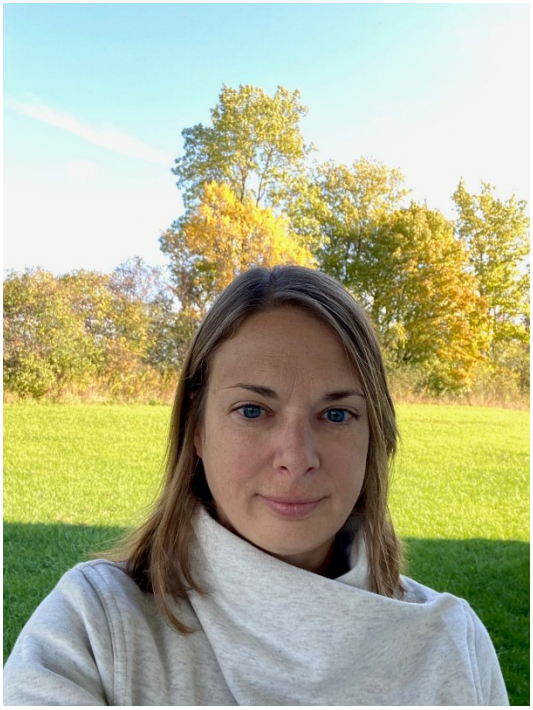
Land Acknowledgement

We acknowledge that we are gathered on the ancestral lands of the Anishinaabe people, including the Ojibwe and Dakota nations. This region, rich in natural resources and cultural significance, has been home to Indigenous communities for thousands of years.

As we convene in Duluth, we recognize the enduring relationship that these communities have with the land, water, and air, and we honor their contributions to environmental stewardship. We commit to fostering respectful relationships with the Native nations and Indigenous peoples that have called this land home by supporting efforts toward reconciliation and justice.

Let us take a moment to reflect on our responsibility to protect the environment and advocate for the sovereignty of the people who have cared for this land long before us.

Message from the NADP Scientific Symposium Chair



When I joined EPA in 2007, I did not envision becoming part of an extensive monitoring family. At that point I had been tasked with assessing how changes in stationary source emissions impacted air quality and deposition trends over time, so I sat down in my "new" chair (likely purchased around the time I was born) and got to work. I didn't realize then that the data used for our progress reports were collected by 100s of individuals across the country every week.

Now, years later I can fully appreciate the amount of work it takes to maintain and expand this incredible program. The last forty-six years of precipitation chemistry data from NADP have been used to characterize environmental changes due to shifts in local, regional, and even global emissions. The addition of ambient ammonia and mercury measurements in the early 2000s has helped answer new questions about particle formation and ecological impacts of air pollution, but there is more to do. I have been humbled by the opportunities to meet the site operators, park and national forest supervisors, program managers, and laboratory staff that are responsible for collectively making sure that NADP continues to provide the highest quality, long-term data record.

I hope this year's symposium theme, "Protecting the Health of Communities and Ecosystems in a Changing Climate", will help foster new research collaborations that link NADP's data experts with climate and health scientists to help answer today's multi-layered environmental problems. There are new tools, better models, and faster technology, but we need to continue to use our reliable, ground-based measurements as goal posts. This NADP community is well positioned to leverage the wealth of information already collected to summarize how short- and long-term climate impacts have resulted in environmental changes that challenge our ability to protect human and ecological health. I am excited to hear about your research, that will undoubtedly help the public advocate for cleaner air, water, and the environment.

Melissa Puchalski, Environmental Protection Agency
Vice-Chair of the Executive Committee

Keynote Address

Showing up for people, the earth, and our shared climate in a time of transformation

Kate Knuth, PhD
Climate Director, Minnesota Pollution Control Agency
Wednesday November 6, 2024, 8:45 AM

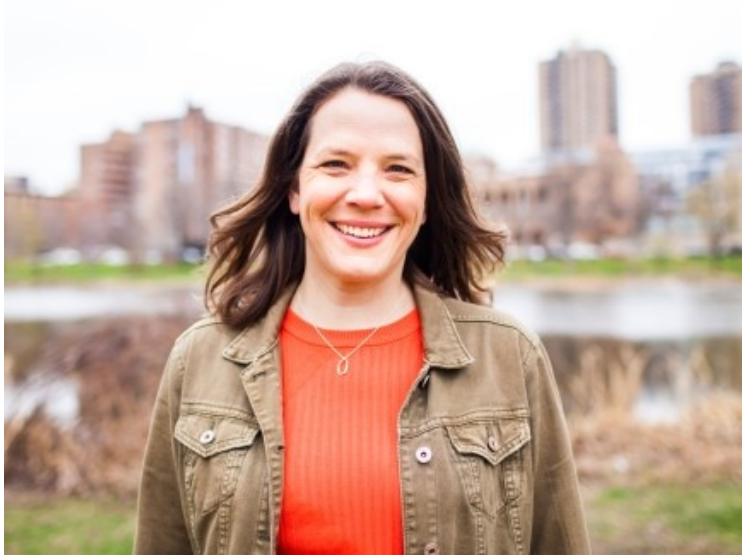


Photo credit: MPCA (https://www.pca.state.mn.us)

Kate serves as the Climate Director for the Minnesota Pollution Control Agency (MPCA). With a deep commitment to addressing climate change, Knuth leverages her extensive background in public service, academic research, and community engagement to this role. As Climate Director for MPCA, Knuth plays a pivotal role in shaping and implementing the state's Climate Action Framework. She works to strengthen partnerships across government agencies, support local climate resilience efforts, and develop policies that align with Minnesota's commitment to achieving a carbon-neutral, resilient, and equitable future.

Knuth previously served as the Minneapolis Chief Resilience Officer and ran the Boreas Leadership Program at the University of Minnesota's Institute on the Environment. She served three terms in the Minnesota House of Representatives. As a legislator, she chief-authored the Global Warming Solutions Act and Toxic Free Kids Act.

Knuth earned a Ph.D. in Conservation Sciences from the University of Minnesota, a M.Sc. in Biodiversity Conservation and Management from the University of Oxford, and a B.A. in biology and philosophy from the University of Chicago. She was a Fulbright Fellow in Norway. Knuth's academic research and writing addresses questions of how to drive deliberate transformations to a more just, sustainable future. She was also a contributor the best-selling anthology *All We Can Save: Truth, Courage, and Solutions for the Climate Crisis*.

Agenda

Note all times are in CST

Technical and Science Committee Meetings

Monday, November 4, 2024

08:00 – 09:30	Joint Session (Part 1) Room Northern Lights 1
09:30 – 10:00	Break and New to NADP Orientation – Welcome session for students and first-time attendees to NADP Fall Meeting Room Atrium/Northern Lights 1
10:00 – 12:00	Critical Loads of Atmospheric Deposition (CLAD) Meeting Room Northern Lights 2
10:00 – 11:30	Aeroallergen Science Monitoring Committee (AMSC) Meeting Room Northern Lights 1
11:30 – 12:30	PFAS Panel Room Northern Lights 1
12:00 - 13:30 12:30 – 14:00	Lunch (On your own)
13:30 – 17:00	CLAD Working Groups Room Northern Lights 2
14:00 – 17:30	Network Operations Subcommittee (NOS) Meeting Room Northern Lights 1

Tuesday, November 5, 2024

08:00 – 09:00	Education and Outreach Subcommittee (EOS) Meeting Room Northern Lights 1
09:00 – 12:00	Total Deposition Science Committee (TDep) Meeting Room Northern Lights 2
09:00 – 12:00	Mercury in the Environment and Links to Deposition (MELD) Meeting Room Northern Lights 1
12:00 – 13:30	Lunch (On your own)

13:30 – 15:15	Joint Session (Part 2) Room Northern Lights 1
15:30 – 18:00	Executive Committee Meeting Room Northern Lights 2

Scientific Symposium

Indicates a student presentation Virtual: pre-recorded

Wednesday, November 6, 2024

08:00 – 08:15 Welcome and logistics
Room Northern Lights Ballroom

Opening of Symposium, Melissa Puchalski, U.S. Environmental Protection Agency
Welcome, Jamie Schauer, Director, Wisconsin State Laboratory of Hygiene

08:15 – 08:45 State of the NADP Address, David Gay, Coordinator

08:45 – 09:30 Keynote Address: Dr. Kate Knuth, Climate Director, Minnesota Pollution Control Agency

09:30 – 09:40 Introductory remarks and cultural history of the Duluth area, Trent Wickman, USDA Forest Service

09:40 – 10:00 Break

Session 1: Protecting the Great Lakes region and coastal ecosystems from air pollution
Co-Chairs: Trent Wickman, USDA-FS and Alex Frie, UMN

10:00 - 10:20 Trent Wickman (USDA Forest Service) - *Partnerships in Monitoring - The Northwoods Lake Monitoring Project*

10:20 - 10:40 Alissia Milani (Environmental Chemistry and Technology Program, UW-Madison) - *Analysis of PFAS in Wet Deposition near Lake Superior*

10:40 - 11:00 Daniel Ruaño (St. Lawrence University) - *Trends in Nitrate, Ammonium, and Total Nitrogen Deposition in the Lake Erie Basin: A 20-Year Analysis*

11:00 - 11:20 Marta Venier (Indiana University) - *The Ins and outs of per- and polyfluoroalkyl substances in the Great Lakes: the role of atmospheric deposition*

11:20 - 11:40 Samantha McClung (University of Minnesota Duluth) - *Atmospheric Deposition of PFAS: Connecting Wet Deposited PFAS to Observations in Lake Sediments*

11:40 - 12:00 Daniel Persaud (Department of Chemistry, York University, Toronto, ON, Canada) - *The occurrence of Perfluoroalkyl Substances (PFAS) in Newfoundland and Labrador, Canada*

12:00 – 13:30 Lunch Break (on your own)

Session 2: New tools to communicate air quality and atmospheric deposition results
Co-Chairs: Beck Dalton, U.S. EPA and Noel Deyette, U.S. Geological Survey

13:30 - 13:50 Desneiges (Deni) Murray (University of New Hampshire) - *Incorporating organic nitrogen into wet deposition estimates pushes sensitive and resilient ecosystems over critical load thresholds.*

13:50 - 14:10 Lin Wu (SUNY-ESF) - *Simulating Atmospheric Mercury in the Northern Hemisphere Using a Hemispheric Version of CMAQ-newHg-Br v2*

14:10 - 14:30 Karen Elizabeth Martínez Ozejo (Agency for Environmental Assessment and Enforcement - OEFA) - *Influence of the Ventilation Index on Sulfur Dioxide Deposition in a Mining-Metallurgical Area and Its Effect on Coastal Hill Vegetation, Lima-Peru*

14:30 - 14:50 Yongqiang Liu (USDA Forest Service) - *Improve Estimates of Atmospheric Smoke Deposition*

14:50 - 15:10 Linda Pardo (USDA Forest Service) - *New Tools for Critical Loads and Air Pollution Effects*

15:10 – 15:30 Break

Session 3: Health and environmental changes driven by shifts to cleaner energy
Co-Chairs: Sara Lance (U of Albany) and Marilyn Wurth (NYS DEC)

15:30 - 15:50 Charles Driscoll (Syracuse University) - *Long-term trends in the chemistry of Adirondack NY lakes in response to decreases in acidic deposition*

15:50 - 16:10 Christopher Clark (U.S. EPA) - *Winners and losers from climate change: An analysis of climate thresholds for tree growth and survival for ~150 species across the contiguous U.S.*

16:10 - 16:30 Linghui Meng (Syracuse University) - *Projections of effects of climate change and urbanization on the carbon, nitrogen, and water dynamics in Northeastern Forest ecosystems*

16:30 - 16:50 Randy Tangang (University of Albany) - *Long-term exposure to ultrafine particles and neurodegenerative disorder-related mortality*

16:50 – 17:10 Randy Kolka (USDA Forest Service) - *Influence of Climate Change on Peatland Mercury Cycling*

18:30 – 20:30 **Poster Session** – Atrium, Inn on Lake Superior

Thursday November 7, 2024

Session 4: Linking shifts in air quality, atmospheric deposition, and critical loads to climate-driven events
Co-Chairs: Jason O'Brien (ECCC) and Jeremy Ash (USDA Forest Service)

08:40 - 09:00		Todd McDonnell (E&S Environmental) - *Forest Vegetation Response to Changes in Air Pollution and Climate*
09:00 - 09:20		Umesh Chandra Kulshrestha (Jawaharlal Nehru University New Delhi) - *Identifying Hot Spots of Air Pollution Through Precipitation Chemistry Measurements in South Asia*
09:20 - 09:40		Sam Simkin (NEON) - *Leveraging NEON data for multi-response critical loads of atmospheric deposition of nitrogen*
09:40 - 10:00		Saurabh Dhakad (Jawaharlal Nehru University) - *Assessing SO42-/Ca and Cl/ NO3- ratios in Atmospheric Dust in North India: Implications for soil acidification*
10:00 - 10:20		Nathaniel Topie (WSP USA Environment & Infrastructure Inc.) - *Water Soluble Organic Nitrogen Characterization Study*
10:20 - 10:40		Amy Luo (University of Tennessee, Knoxville) - *Ozone-induced foliar injury in Great Smoky Mountains National Park: a case study in longitudinal citizen science data*
10:40 – 11:00		Break

Session 5: Sustaining long-term monitoring programs
Co-Chairs: Rick Haeuber (WSLH Visiting Researcher) and Kristi Morris (NPS)

11:00 - 11:20		Brian Izbicki (USDA Forest Service) - *A review of USDA Forest Service sites in the National Atmospheric Deposition Program: motivations for and challenges to site operation*
11:20 - 11:40		Jeff Collett (Colorado State University) - *Spatial and Temporal Trends in Ammonia in Northeast Colorado*
11:40 -12:00		Sarah J. Nelson (Appalachian Mountain Club) - *The Northeast Snow Survey (NESS) Feasibility Study: Engaging interest-holders to design a coordinated, automated snowpack monitoring network for the East*
12:00 - 12:20		Dustin Bronson (USDA Forest Service - Northern Research Station) - *Effect of ozone exposure on 12 herbaceous plants common to the Great Lakes region*
12:20 – 13:45		Lunch Break (on your own)

Session 6: Characterizing cultural and environmental impacts of air pollution to Tribal lands
Co-Chairs: James Parson (Choctaw Tribe of OK) and David Schmeltz (U.S. EPA)

13:45 – 14:00	Brandy Toft (Leech Lake Band of Ojibwe) - *Perspectives from the Environmental Director for the Leech Lake Band of Ojibwe*
14:00 - 14:20	James Parsons (Choctaw Nation of Oklahoma) - *Intro to TAMS and Tribal participation issues in NADP programs*
14:20 - 14:40	Tim Sharac (U.S. EPA) - *Building Federal-Tribal Partnerships: EPA's Rural and Tribal Air Quality Monitoring Program*

Session 7: Measuring emerging and toxic pollutants
Co-Chairs: John Offenberg (U.S. EPA) and Summer Streets (MPCA)

14:40 - 15:00	Irina Nistorescu (York University) - *Measurement of Gas-Phase Perfluoroalkyl Carboxylic Acids (PFCAs) Using Passive Air Samplers*
15:00 - 15:20	Chung-Yen Li (National Central University) - *Developing of a statistical model to explore the influencing mechanisms on atmospheric mercury concentration in Taiwan*
15:20 - 15:40	Hosein Foroutan (Virginia Tech) - *Atmospheric Deposition of Microplastics in South Central Appalachia, United States*
15:40 – 16:00	Break
16:00 - 16:20	Rodolfo Sosa Echeverría (Universidad Nacional Autónoma de México) - *The importance of assessing Mercury in ambient air in Mexico City*
16:20 - 16:40	Michael Tate (U.S. Geological Survey) - *Assessing Atmospheric Mercury Sources using Stable Isotope Methods*
16:40 - 17:00	John Offenberg (U.S. EPA) - *Measuring short-chain per- and polyfluoroalkyl substances in Central New Jersey air using chemical ionization mass spectrometry*
17:00	Symposium Closing Remarks – Melissa Puchalski, U.S. EPA

Ellis B. Cowling Student Travel Award


Professor Ellis B. Cowling inspects one of 125 field monitoring sites used to detect acid rain.

The NADP Scientific Symposium has consistently welcomed undergraduate and graduate students to present their research through oral or poster presentations. Students benefit from discounted registration and are eligible for awards recognizing the best student presentations.

In 2024, the NADP Program Office, in collaboration with the Education and Outreach Subcommittee (EOS), introduced the Ellis B. Cowling Student Travel Award to help offset meeting attendance costs, including registration and lodging.

Funded by the NADP Foundation, established at the University of Wisconsin-Madison in 2019, this award provides honoraria to support student travel to the National Atmospheric Deposition Program Fall Meetings and Scientific Symposia.

For more information on Dr. Ellis Cowling, visit: https://nadp.slh.wisc.edu/news/in-memoriam-ellis-b-cowling-1932-2021/ .

This year's recipients are:

- Allyson Girard — Texas A&M University - Corpus Christi (Poster)
- Conner Guidry — Texas A&M Corpus Christi (Poster)
- Chung-Yen Li — National Central University, Taiwan (Session 7)
- Abril Lunar — Texas A&M University - Corpus Christi (Poster)
- Amy Luo — University of Tennessee, Knoxville (Session 4)
- Alissia Milani — University of Wisconsin – Madison (Session 1)
- Lin Wu — SUNY-ESF (Session 2)

2024 NADP Site Operator Awards

30 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
AR03	Harrell Beckwith	Caddo Valley	U.S. Geological Survey	NTN, AMoN	1994

25 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
FL23	Jimmy Bishop	Sumatra	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	1999
NC06	Nathan Hall	Beaufort	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	1999
PA18	Kevin Horner	Young Woman's Creek	U.S. Geological Survey	NTN	1999
VA24	Gene Brooks	Prince Edward	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	1999

20 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
AL99	Mack Smith	Sand Mountain Research & Extension Center	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	2004
MD08	Mark Castro	Piney Reservoir	Maryland Department of Natural Resources	MDN,NTN, AMoN, AMNet	2004
NJ30/ NJ39	Joshua Ray	New Brunswick/ Cattus Island County Park	New Jersey Department of Environmental Protection / WSP USA-U.S. Environmental Protection Agency	MDN, AMNet/ NTN	2004
VA28	Liz Garcia	Shenandoah National Park-Big Meadows	National Park Service	MDN, NTN	2004

15 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
BC16	Geri Crooks	Saturna Island	Environment and Climate Change Canada	MDN	2009
IA08	Gary Siegwarth	Big Springs Fish Hatchery	U.S. Geological Survey	NTN	2009
ME09	Fred Currie	Greenville Station	Maine Department of Environmental Protection	NTN, MDN	2009
NJ54	Jason Standowski	Elizabeth Lab	New Jersey Department of Environmental Protection	AMNet	2009
NY16	Vicky Kelly	Cary Institute	Cary Institute	AMoN	2009
WI35	Fred Emstrom	Perkinstown	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	2009

10 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
KS24	Lisa Silsby	Glen Elder State Park	Kansas Department of Health and Environment	MDN	2014
KY19	Doug Zettwoch	Cannons Lane	U.S. Geological Survey	NTN	2014
NC45	Robin Dreyer	Mt. Mitchell	U.S. Geological Survey	NTN	2014
NF19	Roseann Russell	Stephenville	Environment and Climate Change Canada	MDN	2014
NJ99	Andrew Rdesinski	Washington Crossing	WSP USA-U.S. Environmental Protection Agency	NTN	2014
OH17	Timothy Fox	Delaware	U.S. Forest Service	NTN	2014
OH52	Justin Chaffin	South Bass Island	Lake Michigan Air Directors Consortium	MDN, AMNet, MLN	2014
SD99	Jessie Rigge	Huron Well Field	U.S. Geological Survey	NTN	2014
SK20	Gerry Scheck	Cactus Lake	Saskatchewan Ministry of Environment	NTN	2014
WI37	Phil Holman	Spooner	USDA Forest Service	NTN	2014

5 Year Awards

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
AB36	Tyler Tracksell	Wapasu	Wood Buffalo Environmental Association	NTN	2019
AK96	Amanda Young	Toolik Field Station	University of Alaska Fairbanks	MDN, NTN	2019
AL10	Tracy Deavours	Black Belt Research & Extension Center	U.S. Geological Survey	NTN	2019
AZ06	Ami Pate	Organ Pipe Cactus National Monument	National Park Service	NTN	2019
CA42	Bonni Corcoran	Tanbark Flat	USDA Forest Service	NTN	2019
CO91	Daryl Kohut	Wolf Creek Pass	USDA Forest Service	NTN	2019
CT15	Nancy McMerriman	Abington	WSP USA-U.S. Environmental Protection Agency	NTN, AMoN	2019
FL11	Adam Thime	Everglades National Park-Research Center	National Park Service	MDN, NTN, AMoN	2019
MA14	RJ Turcotte	Nantucket	Nantucket Land Council, Inc.	NTN	2019
MI52	Mary Lynam	Ann Arbor	Lake Michigan Air Directors Consortium	MDN, MLN	2019
MN06	Carma Huesby	Leech Lake	Leech Lake Band of Ojibwe	MDN	2019
MO03	Drew Anderson	Ashland Wildlife Area	U.S. Geological Survey	NTN	2019
NC26	Stephen Allen	Candor	North Carolina Department of Environment and Natural Resources, Division of Air Quality	MDN	2019
ND00	Blake McCann	Theodore Roosevelt National Park-Painted Canyon	National Park Service	NTN	2019
NE15	Andy Suyker	Mead	University of Nebraska-Lincoln/Nebraska Department of Environment and Energy	MDN, NTN	2019
NY92	Daniel Freeman	Amherst	New York State Energy Research & Development Authority	NTN	2019
OK04	Nick Hardersen	Lake Murray	Oklahoma Department of Environmental Quality	MDN	2019
PA00	Carl Shaver	Arendtsville	WSP USA-U.S. Environmental Protection Agency	AMON	2019

Site Code	Operator Name	Site Name	Funding Agency	Networks	Start
TN00	Calvin Weaver	UT Forest Research Station	National Oceanic and Atmospheric Administration	NTN	2019
TX56	Kevin Wood	L.B.J. National Grasslands	U.S. Geological Survey	NTN	2019
WA03	Courtney Winck	Makah National Fish Hatchery	Makah Tribe	MDN	2019

Abstracts

Session 1: Protecting the Great Lakes region and coastal ecosystems from air pollution

Partnerships in Monitoring - The Northwoods Lake Monitoring Project

Trent Wickman[1, *], Jesse Anderson[2], Katie Hein[3], Sarah Holden[4], and Allison Gamble[2]

To sustain our nation's lakes, we need to know their current health and the impacts of various stressors. The northern half of Minnesota, Wisconsin and Michigan, or the Northwoods, is home to 50% of the natural lakes in the U.S. The clean, clear lakes are what make it a great place to live and draw visitors from all over the world. These lakes are an amazing natural and economic resource—their value can't be calculated.

Stressors that have been identified for the Northwoods are: climate change, excessive algae growth, nutrient loading and color. This project monitored 250 randomly-selected lakes across the Northwoods as an intensification of the EPA National Lake Assessment (NLA) in 2022. The goal was to compare them to each other to understand patterns and stressors within the Northwoods but then to also compare them to the larger, nationwide survey of lakes within the NLA lakes nearby and around the country.

To accomplish this huge task, we organized and jointly sampled these lakes with the help of partners from:

- 5 national forests
- 3 states' regulatory agencies
- 1 county soil and water conservation district
- EPA national and regional staff
- 2 National Park Service units
- 8 tribal bands and authorities
- 5 universities
- Cooperation of numerous lakeshore owners that allowed our crews to access the lakes

The benefits of all this information will enable management of lake resources to produce the greatest good for the public, who highly value them. This effort will also establish a baseline in time for comparison purposes. Preliminary results from the project will be presented.

[1] USDA Forest Service, Duluth, MN
[2] Minnesota Pollution Control Agency, Duluth, MN
[3] University of Wisconsin - Trout Lake Station, WI
[4] Michigan Department of Environment, Great Lakes, and Energy, East Lansing, MI

* Corresponding Author: trent.wickman@usda.gov

Analysis of PFAS in Wet Deposition near Lake Superior

Alissia M. Milani[1, *], Kaitlyn J. Gruber[2], Martin Shafer[3], and Christina K. Remucal[1, 4]

Historic and ongoing per- and polyfluoroalkyl substances (PFAS) contamination in Lake Superior is of great concern. Wet deposition (rain and snow) is a significant source of PFAS to Lake Superior due to the limited number of PFAS point sources in the region, large lake surface area, and relatively small watershed. However, these atmospheric inputs are poorly characterized and constrained. Being the furthest upstream and having a hydraulic residence time of 173 years, PFAS concentrations in Lake Superior will likely affect downstream rivers and the lower Laurentian Great Lakes for decades to come. With many PFAS species being persistent and toxic, understanding sources of PFAS and mitigating contamination is critical. From 2022 to 2023, wet deposition samples were collected on a weekly basis from nine National Trend Network sites around Lake Superior through collaboration with the National Atmospheric Deposition Program (NADP). The wet deposition samples were analyzed for 36 PFAS compounds in five major classes by liquid chromatography-tandem mass spectrometry. The distribution of PFAS classes varied between sites, potentially indicating a regional impact on the concentration of PFAS species in wet deposition. Perfluorocarboxylic acids (PFCAs) were the most frequently detected and most abundant class of PFAS quantified. The high abundance of PFCAs is consistent with previous wet deposition studies and may partially result from atmospheric transformation of volatile precursor PFAS. This wet deposition study will compliment Lake Superior tributary and sediment core datasets to provide a comprehensive analysis of PFAS source contributions to Lake Superior.

[1] Environmental Chemistry and Technology Program, University of Wisconsin – Madison, Madison, WI
[2] Department of Chemistry , University of Wisconsin – Madison, Madison, WI
[3] Wisconsin State Laboratory of Hygiene, University of Wisconsin – Madison, Madison, WI
[4] Department of Civil and Environmental Engineering, University of Wisconsin – Madison, Madison, WI

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Trends in Nitrate, Ammonium, and Total Nitrogen Deposition in the Lake Erie Basin: A 20-Year Analysis

Daniel Ruaño[1, *], and Marina Astitha[2]

This study examines changes in nitrogen deposition in the Lake Erie basin since 2000, focusing on five monitoring sites of the National Atmospheric Deposition Program (NADP): Chautauqua (NY10) and Kane Experimental Forest (PA29) in the east, Wooster (OH71) and Roush Lake (IN20) in the west, and Kellogg Biological Station (MI26) in the northwest.

Quantitative analysis revealed consistent decrease in nitrate (NO_3^-) levels across all monitoring sites. The average reduction in nitrate deposition was 33% over the study period, with western sites showing slightly higher reductions compared to the eastern sites. Specifically, the western sites of Wooster (OH71) and Roush (IN20) exhibited decreases of 37% and 35%, respectively, while eastern sites of Chautauqua (NY10) and Kane (PA29) showed reductions of 30% and 31%.

Ammonium (NH_4^+) levels, in contrast, showed cyclic fluctuations with peaks occurring approximately every 7-10 years over the study period. At Kane (PA29), ammonium levels fluctuated by Å}15% around the mean value. Wooster (OH71) showed similar fluctuations of Å}13%, while Kellogg (MI26) exhibited the highest variability at Å}18%.

Total nitrogen deposition, combining both nitrate and ammonium, followed a decreasing trend similar to nitrate. The average reduction in total nitrogen deposition was approximately 30% across the monitoring sites. Chautauqua (NY10) exhibited a 28% reduction, Kane (PA29) 29%, Wooster (OH71) 33%, Roush (IN20) 32%, and Kellogg (MI26) 32%.

Spatial analysis evidenced regional differences in nitrogen deposition trends. The western sites (OH71, IN20) showed higher reductions in nitrate deposition (36% on average) compared to the eastern sites (NY10, PA29) (30.5% on average). This east-west disparity may be due to differences in local emission sources, prevailing wind patterns, or variations in the implementation of nitrogen reduction measures. The northwestern site, MI26, showed nitrate reductions (32%) intermediate between western and eastern sites, suggesting a potential gradient in deposition changes across the Lake Erie basin.

Observed reductions in nitrogen deposition, particularly nitrate, suggest the effectiveness of regulatory measures aimed at reducing nitrogen oxide emissions. However, persistent cyclic fluctuations in ammonium deposition highlight the need for continued monitoring and management of agricultural nutrient runoff.

These findings have significant ecological implications for Lake Erie, potentially helping to mitigate eutrophication and reduce frequency and intensity of harmful algal blooms. The study underscores the importance of NADP's comprehensive, long-term monitoring. These valuable insights could inform adaptive management strategies for the Lake Erie basin, balancing economic activities with ecosystem health in the face of ongoing climate change and land-use pressures.

[1] Department of Geology, St. Lawrence University, Canton, NY
[2] Department of Civil and Environmental Engineering, University of Connecticut, Storrs, CT

Supported by NSF-REU award 2051074: Transforming the Nation's Aging Infrastructure by Advancing Radical Solutions

* Corresponding Author: dgruan22@stlawu.edu

The Ins and Outs of Per- and Polyfluoroalkyl Substances in the Great Lakes: The Role of Atmospheric Deposition

Chunjie Xia[1], Staci L. Capozzi[1], Kevin A. Romanak[1], Daniel C. Lehman[1], Alice Dove[2], Violeta Richardson[2], Tracie Greenberg[2], Daryl McGoldrick[2], and **Marta Venier**[1, *]

Like for other legacy compounds, such as polychlorinated biphenyls (PCBs), atmospheric deposition could be a significant environmental pathway for delivering PFAS in the environment. PFAS are washed out from the atmosphere by wet and dry deposition and the gas absorption process, of which precipitation is generally considered the dominant mechanism. To date, the mass transfer flow of PFAS via atmospheric deposition to the Great Lakes was not well addressed.

In this study, precipitation (n=207) and air (n = 60) from five sites and water samples (n = 87) from all five Great Lakes were collected in 2021-2023 and analyzed for 41 per- and polyfluoroalkyl substances (PFAS) as part of the Integrated Atmospheric Deposition Network (IADN). These measurements were combined with other available data to estimate the mass budget for 4 representative compounds, PFBA, PFBS, PFOS, and PFOA for the basin. The Σ_{41}PFAS concentrations in precipitation across the five sites ranged between 2.4 and 4.5 ng/L. The median Σ_{41}PFAS concentration in lake water was highest in Lake Ontario (11 ng/L) and lowest in Lake Superior (1.3 ng/ L). The median Σ_{41}PFAS concentration in air samples was highest in Cleveland at 403 pg/m^3 and lowest at Sleeping Bear Dunes at 150 pg/m^3. The net mass transfer flows were generally negative for Lakes Superior, Michigan, and Huron and positive for Lakes Erie and Ontario, indicating that the three most northern lakes are accumulating PFAS and the other two eliminating PFAS. Atmospheric deposition is an important source of PFAS, particularly for Lake Superior.

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Atmospheric Deposition of PFAS: Connecting Wet Deposited PFAS to Observations in Lake Sediments

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Per- and polyfluoroalkyl substances (PFAS) are a large family of persistent contaminants with diverse and poorly characterized sources. Our understanding of their environmental cycling is improving, but is still quite limited. The presence of PFAS in environmental media (e.g., sediments, surface water, ice) found in remote areas emphasizes the significant gaps in our understanding of their sources, fate, and transport. In particular, the importance of atmospheric transport, transformation, and deposition of PFAS as a pathway into surface hydrologic systems is poorly understood. To investigate the magnitude, seasonal differences, and profile (fingerprint) of PFAS characteristic of atmospheric deposition, wet deposition (rain and snow) samples were collected from a suite of National Atmospheric Deposition - National Trends Network (NADP-NTN) precipitation monitoring sites around the upper Great Lakes, and analyzed for 33 PFAS compounds. To investigate the role of atmospheric deposition as a source of PFAS to terrestrial and aquatic ecosystems in the western Great Lakes region, a sediment core from Loaine lake, a remote Minnesota seepage lake with primarily atmospheric inputs was age-dated and analyzed for 37 PFAS. The wet deposition and seepage lake datasets have similar profiles of PFAS, with over 70% of observed PFAS mass being perfluorocarboxylic acids, but the annual PFAS precipitation fluxes were an order of magnitude larger than PFAS sediment accumulation rates. This suggests that in this seepage lake, only a small fraction of precipitation deposited PFAS are accumulated in sediments. The lake sediment core and wet deposition datasets will also be compared to sediment PFAS concentrations measured in the Great Lake sediments by the US Environmental Protection Agency Great Lakes Sediment Surveillance Program (US EPA GLSSP). These preliminary data sets are just one component of a larger effort to constrain PFAS wet deposition across the Great Lakes.

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The occurrence of Perfluoroalkyl Substances (PFAS) in Newfoundland and Labrador, Canada

Daniel Persaud[1, *], Trevor C. VandenBoer[1], Kate E. Edwards[2], Susan E. Ziegler[3], Christine Spencer[4], Amila O. De Silva[4], and Cora J. Young[1]

Perfluoroalkyl substances (PFASs) describe a class of extremely persistent and bioaccumulative compounds that are distributed ubiquitously in the environment. These compounds can be formed from the atmospheric oxidation of volatile precursor compounds or exist in their anionic form, where they can be subsequently removed by wet or dry deposition processes. In the current study, large-volume precipitation samples were collected across four (4) locations across a latitudinal transect in Newfoundland and Labrador, Canada (NL-BELT). The sampling sites were experimental forests within the watersheds of Grand Codroy (47.893° N, 59.174° W), Humber River (49.070° N, 57.643° W), Salmon River (51.256° N, 56.138° W), and Eagle River (53.550° N, 56.987° W). The sample collection was done monthly from October 2013 to August 2016, using an open polyvinylchloride (PVC) pipe or high-density polyethylene (HDPE) total deposition samplers and custom-built HDPE automated deposition samplers. Samples were concentrated using solid-phase extraction (SPE) and analyzed by liquid chromatography-tandem mass spectrometry.

Perfluoroalkylcarboxylic acids (PFCAs) and Perfluoroalkylsulfonic acids (PFSAs) were detected consistently in precipitation samples. The concentration of PFCAs ranged from <LOD to 9851 pg L^{-1}, with the short-chain compound PFBA showing the highest concentration and a detection frequency of 82%. PFOA (C8) was detected in all samples with a mean concentration of 729 pg L^{-1} across the sampling sites. The other PFCAs (C6 – C11) were detected in <74% of samples. The PFSA concentrations were generally lower than the corresponding PFCA with an average concentration of 400 pg L^{-1} across the sampling sites. Concentrations (pg L^{-1}) were converted to annual flux (ng m^{-2} a^{-1}). The average PFCA flux was 500 ng m^{-2} a^{-1}, while the PFSA flux across the sampling sites was 13 ng m^{-2} a^{-1}.

Our results from homologue correlations, molar concentration ratios and model comparisons suggest that most PFCAs are formed through oxidation of precursor compounds. A trend of increasing influence of precursor oxidation as latitude increases was observed. Air mass trajectory analysis suggests a continental input as winds predominantly move from east to west. Correlations with major ions suggest multiple sources, including marine aerosols. This is one of the first studies that explicitly estimates the contribution of dry deposition to overall PFAA deposition. We found that dry deposition of gases and particles can be the dominant deposition pathway for select PFAAs. These observations highlight the complex mechanisms responsible for the transport and deposition of PFAAs along the remote NL-BELT.

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Session 2: New tools to communicate air quality and atmospheric deposition results

Incorporating organic nitrogen into wet deposition estimates pushes sensitive and resilient ecosystems over critical load thresholds

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Dissolved organic nitrogen (DON) in wet deposition is often overlooked in monitoring programs and foundational theories of ecosystem biogeochemical cycles. However, where DON is monitored, concentrations have increased over time showing distinct phenology that aligns with the growing season in the northern hemisphere. Concentrations of DON in wet deposition are at magnitudes that raise questions about the role it plays in terrestrial and aquatic biogeochemical cycles, particularly its contribution to an ecosystem's exceedance of critical loads of nitrogen (CL-N). Currently, exceedance calculations do not consider DON wet deposition due to limited monitoring. This study re-analyzed 284 archived wet deposition samples from 17 NADP NTN sites (2017–2018) to estimate DON's contribution to total N deposition. Samples were re-analyzed for NO_3 and NH_4 and validated for stability. DON was then calculated by subtracting NO_3 and NH_4 from total dissolved N (TDN). The relative abundance was weighted by precipitation depth to create an annual DON scalar, ranging from +1.3% to 15.5%, that was applied to TDep wet deposition within the level 3 Ecoregion where the sample was collected.

Comparing TDep Total N and TDep Total N + DON maps against two CL datasets revealed a 0.4-0.6% increase in area exceeding CL-N for sensitive lichen richness and a 7.4-8.8% increase for herbaceous species richness. The CL-N for sensitive lichen richness had increases in area of exceedance in 17 to 18 Class I areas, while the CL-N for herbaceous species richness had an increase in 6 to 8 Class I areas using 2017 and 2018 data, respectively. These findings suggest that while the relative contribution of wet deposition DON to TDep is small, when considered as an additional input of N it can push ecosystems over CL thresholds, posing risks to ecosystem health. Importantly, this analysis likely underestimates the annual contribution of DON to total N deposition due to incomplete spatial and temporal coverage of our DON data. Nonetheless, this study provides a foundational understanding for the degree to which DON loads should be considered in monitoring programs moving forward.

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Simulating Atmospheric Mercury in the Northern Hemisphere Using a Hemispheric Version of CMAQ-newHg-Br v2

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With the Minamata Convention on Mercury coming into effect in 2017, all parties are required to periodically evaluate the effectiveness of its implementation using available scientific, environmental, technical, financial, and economic data. The hemispheric version of CMAQ-newHg-Br v2 (H-CMAQ-newHg-Br), which incorporates a theory-based gas-particle partitioning scheme for gaseous oxidized mercury (GOM) and the most up-to-date mercury redox chemical mechanism (Wu et al., 2024), is a potential modeling tool for this task. In the present study, H-CMAQ-newHg-Br was developed from extending the regional model to a hemispheric domain and was applied to simulate atmospheric mercury cycling in the Northern Hemisphere for the year of 2019. The model was evaluated through comparison of simulated and observed concentrations of gaseous elemental mercury (GEM) and particulate bound mercury (PBM) and deposition fluxes of total mercury at monitoring locations worldwide as well as intercomparison with the Danish Eulerian Hemispheric Model (DEHM) and global chemical transport models. The advantages, uncertainties, and applications of H-CMAQ-newHg-Br will be discussed. Our results demonstrate that hemispheric H-CMAQ-newHg-Br would be a promising tool for evaluating the effectiveness of the Minamata Convention.

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Influence of the Ventilation Index on Sulfur Dioxide Deposition in a Mining-Metallurgical Area and Its Effect on Coastal Hill Vegetation, Lima-Peru

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The ventilation index is a critical tool for understanding the dispersion of gases in the atmosphere. Its dynamics are particularly important in industrial settings, as it helps identify environmental components that are most likely to be impacted. The Agency for Environmental Assessment and Eforcement (OEFA) of Peru conducted a study in a coastal industrial area, where a metal refinery operates, aiming to assess the effects of SO2 emissions on air quality and Tillandsia species in the vicinity of the industrial activity.

To achieve this, SO2 levels were measured using automated ultraviolet fluorescence equipment, and meteorological parameters were recorded at five locations, both upwind and downwind of the industrial activity, over a period of approximately 20 days. Additionally, sulfur content in the plant tissue of Tillandsia (Tillandsia purpurea and Tillandsia sp.) was analyzed using the ICP-MS method in 19 composite samples, covering an area of up to 5 m^2.

The results of the ventilation index indicate that during nighttime and early morning hours, atmospheric conditions in the study area are conducive to the accumulation of SO2 produced by anthropogenic activities. This is evidenced by hourly SO2 concentrations reaching up to 3014.1 $\mu g/m^3$, associated with low ventilation index values that favored the accumulation of SO2 in the area. Furthermore, a statistically significant difference was observed in the sulfur concentrations in plant tissue, with higher concentrations in samples collected downwind, reaching a maximum sulfur concentration of 16138 mg/kg, compared to 3939 mg/kg found upwind.

Low ventilation index values lead to the accumulation of SO2 concentrations in the first few meters above the ground near the source location downwind. The environmental effects on the Tillandsia community included increased species mortality and elevated sulfur concentrations, as these desert plants derive their nutrients from the atmosphere, making them particularly vulnerable to atmospheric changes.

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Improve Estimates of Atmospheric Smoke Deposition

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Wildfires in the United States have increased dramatically in recent decades and the trend is likely to continue this century under the anthropogenic climate change. This highlights the urgent need to improve estimates of atmospheric smoke deposition for better assessing the smoke impacts on air quality, ecosystems, and human health. While great efforts in developing necessary tools have been made, monitoring and modeling smoke deposition still faces many big challenges, which limits our capacity to provide timing and quality estimates of smoke deposition and contributes to uncertainties in estimating total deposition. In this presentation we propose a research to address these challenges through applying satellite products and field measurement data to improving TDep Measurement-Model Fusion (TDep MMF) method used to provide total deposition maps. The research efforts include improving smoke aerosol schemes and specifications in the EPA's Community Multiscale Air Quality (CMAQ) model, evaluating the roles of smoke feedback in reducing uncertainties in smoke deposition modeling, simulating smoke transport and deposition of historical wildland fires, incorporating the smoke deposition estimates into the existing TDep MMF, and assessing the air quality and human health impacts of smoke deposition. The expanded NADP TDep tool is expected to help better communicate smoke and total air quality and atmospheric deposition results.

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New Tools for Critical Loads and Air Pollution Effects

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The Critical Loads (CL) Hub was developed in order provide guidance about where to find CL-related information. The CL Hub includes background information on CLs, CL tools and reports, data on CL and deposition, EPA Air quality documents, and detailed guidance on using CLs in resource management. As estimates of CLs have proliferated, it has become more difficult for potential users to identify which resource will be most useful to them. In addition, because of the complexity of some of the tools that have been developed, it can be difficult for users to learn how to access the specific information that they need. The CL Hub includes a "guidance panel" to the right of the active tool window; this panel provides step-by-step instructions for how to use each of the websites included in the CL Hub.

We will highlight several of the tools included in the CL Hub: (1) the Watershed Condition Framework (USFS), (2) Air Quality Conditions and Trends (NPS, USFS. FWS), and (3) **C**ritical **L**oad **A**ssessment by **S**ite (CLAS) tool. *The Watershed Condition Framework (WCF) is a comprehensive approach for implementing integrated restoration on priority national forest and grassland watersheds.* Air Quality Conditions and Trends *provides unit-specific air quality data, conditions, and trends for ozone, particulate matter, visibility, nitrogen, and sulfur. CLAS is a CL and exceedance mapping tool that facilitates assessment of risk to forest and aquatic ecosystems for resource managers and policy makers. CLAS includes CL and exceedance information for epiphytic lichens, sensitive lakes and streams, and trees. The CL Hub can be accessed at nadp.slh.wisc.edu/cl-hub/; CLAS can be accessed at https://clas.cira.colostate.edu/.* These tools, developed by CLAD WG-3 *support science-based decision-making for resource management.*

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Session 3: Health and environmental changes driven by shifts to cleaner energy

Long-term trends in the chemistry of Adirondack NY lakes in response to decreases in acidic deposition

Charles T. Driscoll[1, *], Kimberley Driscoll[1], Jason Lynch[2], Scott Riley[2], Gregory Beachley[2], and Richard Haeuber[2]

The Adirondack region of New York has experienced among the most severe impacts of acidic deposition in North America, including acidification of soil and surface waters with effects on forest vegetation and aquatic biota. We report the results on long-term changes in atmospheric deposition, using data from the National Trends Network at Huntington Forest (NY20) and Total Deposition Measurement Model Fusion (TDep MMF) estimated for the Adirondack region, and lake chemistry from the Adirondack Long-term Monitoring (ALTM) program. The Adirondack region has experienced decreases in acid deposition over the past decades, including marked decreases in sulfate and nitrate deposition and minor decreases in ammonium. Current levels of sulfate deposition measured in the Adirondacks are comparable to values reported for remote regions relatively unimpacted by human emissions. Consistent with decreases in atmospheric sulfate and nitrate deposition have been significant decreases in concentrations of sulfate and nitrate in ALTM lakes. Of the 48 ALTM lakes not been treated by liming, 48 have shown significant decreases in concentrations of sulfate with a mean rate of change of -2.5 µeq/L-yr and 43 have experienced significant decreases in nitrate at a rate of - 0.4 µeq/L-yr since 1992. Long-term measurements of nitrate also reveal a marked decrease in the amplitude of seasonal variation in concentrations. Changes in these inputs have influenced the acid-base status of lakes. We report two metrics of trends in the acid-base chemistry of ALTM lakes: measured values of acid neutralizing capacity (ANC) and theoretical ANC calculated as the sum of base cations less the sum of strong acid anions. While both metrics reveal widespread long-term increases in ANC (44 lakes with significant increases), increases in theoretical values of ANC exceed measured values. This discrepancy appears due to marked increases in naturally occurring organic acids that have occurred over the measurement interval, as evidenced by significant increases in dissolved organic acid concentrations in 39 lakes at a mean rate of +9.6 µmol C/L-yr, which have altered the recovery of Adirondack lakes from acid deposition.

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Winners and losers from climate change: An analysis of climate thresholds for tree growth and survival for ~150 species across the contiguous U.S.

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Changes in temperature and precipitation are already influencing U.S. forests and that will continue in the future even as we mitigate climate change. Using spatial gradients in mean annual temperature (MAT) and mean annual precipitation (MAP), we used simulated annealing to estimate critical thresholds for changes in the growth and survival of roughly 150 tree species across the conterminous U.S. (CONUS). We found that growth of nearly one third of tree species assessed (44 spp.) decreased with any increase in MAT (42-49 species), whereas fewer responded negatively to projected regional trends in MAP (<20 species each in the east and west). Hypothetical increases in temperature (+1°C, +2°C) increased average growth in the east and Pacific Northwest and decreases it in parts of the Rockies and Southeast, while survival generally decreased. Average growth and survival generally decreased with wetter conditions (-25%) in the east and with drier conditions (-25%) in the west. Beyond these averages, there were species that benefitted and those that were harmed nearly everywhere across the CONUS. We identified only eight species out of ~150 assessed that were resilient (no negative effect on growth and survival) to increases in temperature, and 24 species in the east and seven 7 in the west displaying resilience to regional trends in precipitation (increases in the east and decreases in the west). We also identified "tipping points" where several species shifted from positive to negative relationships. Average confidence in the relationships was generally high, though there were species and metrics with low confidence especially for survival. These findings have significant implications for the future national forest carbon sink and for conservation efforts in the face of climate change.

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Projections of effects of climate change and urbanization on the carbon, nitrogen, and water dynamics in Northeastern Forest ecosystems

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Human activities have profoundly impacted the structure and function of forest ecosystems in the northeastern U.S., particularly through urbanization, which not only directly reduces forest area but also indirectly affects forest function by altering the atmospheric environment and air quality due to local urban heating effects, increased emissions of CO_2 and nitrogen oxides, and ozone concentrations. Critical questions are: how do urbanization, climate change, and changes in air quality interact to influence the functioning of forest ecosystems and how will changes in these environmental drivers affect forests of the Northeast in the future. To address these questions, we investigated changes in temperature and air quality along the urban-to-rural gradient and examines their interactive effects on the carbon, nitrogen, and water dynamics of northeastern forest ecosystems. We utilized the percentage of impervious surface area as a metric of urbanization and analyzed the relationships between environmental variables and urbanization along the gradient from across southern New England. These relationships were applied in the development of future climate and air quality scenarios for New England, based on the RCP8.5 climate scenario, an aggressive decarbonization air quality scenario (CES40B), and the New England Landscape Futures (NELF) scenarios. We applied the PnET-CN-daily model under these constructed scenarios to project potential changes in carbon, nitrogen, and water dynamics for the New England region over the period 2020 to 2050 and assess the interactions of climate change and urbanization on the function of northeastern forest ecosystems. Forecasts suggest that New England will continue to function as a carbon sink, however, complexities arise from land-cover changes that affect carbon sequestration, particularly southern New England states. Rapid urbanization will result in carbon loss, especially in soil pools. Furthermore, climate change will accelerate soil decomposition rates, intensifying soil carbon loss. While the role of CO_2 in forest responses is significant, due to nutrient limitations the difference in plant carbon storage between the RCP8.5 scenarios and a constant climate scenario is less than previous studies have anticipated.

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Long-term exposure to ultrafine particles and neurodegenerative disorder-related mortality

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Background: Ultrafine particles (UFP) emerged as a particularly concerning air pollutant due to their potential adverse health effects, especially on neurodegenerative diseases. However, the health effects of UFPs are not yet fully understood, partly due to limited monitoring and studies. This study aims to explore the association between long-term UFP exposure and neurodegenerative disorders mortality, considering social demographic disparities, seasonal patterns, and the modifying effects of meteorological factors and other critical air pollutants (i.e., O3, NH3, SO2, summer temperature, winter temperature, and relative humidity).

Methods: We used a Difference-in-Difference design at the county subdivision level in New York State (NYS) from 2013 to 2019, with exposure data on UFPs, other pollutants, and meteorological factors simulated using GEOS-Chem-APM at 17*17 miles refined resolution. Mortality data on neurological disorders was obtained from Vital Records for Upstate NY and NYC.

Results: Neurodegenerative disorder-related mortality and its subtypes (i.e., Alzheimer, Dementia, and Parkinson) generally increased over the period from 2013 to 2019 in NYS, with a significant association between UFP exposure and excess risk of neurodegenerative disease-related mortality (ERIQR=6.49), particularly Alzheimer's (ERIQR=20.93). Females, Hispanics, non-Hispanic whites, older adults (>=65 yrd), and individuals living in urban or suburban areas showed a significant excess risk from UFP exposure (ERIQR ranged from 8.27 to 49.21). The UFP-mortality association was significant during winter (ERIQR=8.74), but not in other seasons. The modification effects of meteorological factors and other air pollutants on UFP- mortality associations were not statistically significant.

Conclusions: These findings indicate a long-term association between UFP exposure and Neurodegenerative disorder-related mortality, particularly Alzheimer's, with higher risks observed among specific demographic groups. However, Meteorological factors or other air pollutants did not modify the associations.

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Influence of Climate Change on Peatland Mercury Cycling

Randy Kolka[1, *]

Few manipulative studies have investigated how the drivers of climate change such as warming, elevated carbon dioxide, and changes in precipitation regimes are predicted to influence peatland mercury cycling and subsequent bioaccumulation in downstream communities. Three studies have manipulated conditions to simulate climate change and measured mercury including The Spruce and Peatland Responses Under Changing Environments (SPRUCE) experiment in northern Minnesota, the BRACE (Biological Response to A Changing Environment) experiment in central Ontario, and the PEATCOSM experiment in northern Michigan. A synthesis of results indicates that warming increases both total mercury (THg) and methylmercury (MeHg) concentrations in peatland porewater with decreasing THg:MeHg ratios. Extreme hydrological events, either drought or heavy precipitation, also tends to lead to similar responses of increased water and soil THg, MeHg, and THg:MeHg ratios in the zone of water table fluctuations. Similarly, sedge treatments at PEATCOSM led to higher water and soil MeHg. Also, there is evidence that elevated carbon dioxide (eCO_2) increases MeHg pore water concentrations at SPRUCE likely associated increases with ecosystem primary productivity. That evidence is in line with recent research analyzing the long-term streamflow and MeHg concentration record for our reference peatland watershed at the Marcell Experimental Forest. That data indicates that MeHg in stream water has decreased over time due to improved air quality but could increase with increasing air temperatures because of increases in decomposition rates associated with higher watershed-level productivity.

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Poster Session

Using iNaturalist Observations to Evaluate the Extrapolation of Herbaceous Critical Load Models

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Herb species critical loads (CLs) for Nitrogen (N) and Sulfur (S) take into account local climate and soil conditions, but the surveys used to develop these CLs were unequally distributed across the continental US (Clark et al 2019). A separate project developed an environmental hull for each herb species CL: i.e., the niche of soil, climate, and deposition conditions similar to those in which each herb occurred (Clark et al unpublished), but since the models were created with limited data it is unknown if the input data covers a species range. Our project tests the accuracy of hulls and the extent of CL exceedances using species occurrence data from iNaturalist, a community science platform of species observations. We used iNaturalist data for 12 common herbaceous species with CLs in national parks and compared their location to each species' hull.

There were more than 150,000 verified research-grade observations from iNaturalist for our 12 species of interest. Observations per species ranged from 1,088 to 20,164. Seven species had over half of their points within the environmental hull. 10 species had 80% of their points within 1 standard deviation of the hull. The conditions of *Pteridium aquilinum*'s range were most aligned with the hull values and *Bouteloua curtipendula*'s conditions were the furthest from the hull range. These comparisons provide relative confidence in which species CLs can be broadly applied across the continental US (CONUS) and which CLs should be restricted in their spatial application.

We used the 2019-2021 TDep total N and total S to determine exceedances of critical loads for all species locations. There were similar rates of exceedance of N CLs and S CLs across the original survey locations and across the iNaturalist locations. Using verified citizen science observations in combination with environmental hulls allows us to better evaluate how representative the hulls are to a species' actual CONUS range. These points also give more information to land managers and policy makers about how broadly the CLs should be applied and the number of species in exceedance of their critical load.

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Exploring the Increasing Trend of Organic Carbon in the Atmospheric Aqueous Phase in the Northeast U.S.

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Organic carbon (OC) is a highly diverse class of compounds that represents a small but critical fraction of the atmosphere's chemical composition. Volatile organic compounds (VOCs), when combined with nitrogen oxides (NO_x), can produce tropospheric ozone (O_3), a regulated air pollutant. OC also represents a large and growing fraction of aerosol mass, either through direct emissions from sources like fossil combustion and biomass burning, or through secondary chemistry by the oxidation and subsequent reduction of vapor pressure of VOCs leading to condensational growth. Clouds droplets and precipitation can contain additional OC due to the dissolution of soluble organic gases to the aqueous phase.

OC has abundantly been found in aqueous samples of clouds, fog, and precipitation, exposing these compounds to unique aqueous chemical reactions and wet deposition. However, the concentrations and controlling factors of atmospheric aqueous organic carbon remain highly unconstrained. Cloud water measurements at Whiteface Mountain in the Adirondack Mountains in upstate New York have revealed an increasing trend of Total Organic Carbon (TOC), with annual median concentrations doubling in 14 years, possibly signalling a growing trend in atmospheric OC. However, the causes and potential consequences of this trend remain unclear. Another question that has yet to be explored is if this trend in OC extends beyond WFM. To answer this question, this work explores the trends of WFM cloud water and 4 additional long-term cloud water and wet deposition datasets that have measured TOC or dissolved OC (DOC) throughout the Northeast US. These sites include Mt Washington, NH, Hubbard Brook NH, Thompson Farm NH, and Sleepers River Vermont. This work will also discuss potential hypotheses driving this increasing trend including increased biomass burning influence and increased biogenic emissions in the region.

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Assessment of a Novel Method for Determination of Total Nitrogen and Total Phosphorus in Precipitation Collected using a Modified NADP-NTN Wet-Deposition Collector

Katie Blaydes[1], **Kat McKinnon**[1, *], and Martin Shafer[1]

The National Atmospheric Deposition Program (NADP) currently measures inorganic species of nitrogen and reactive species of phosphorus in wet deposition samples collected within the National Trends Network (NTN). However, new evidence indicates that precipitation can contain both inorganic and organic forms of nitrogen and phosphorus and that the contribution of organic species of nitrogen to total nitrogen (TN: org-N + inorg-N) can be significant (20-40%). These studies have been limited in scale and scope and much uncertainty remains about the contribution of organic nitrogen species to total nitrogen deposition, and the uncertainty in organic phosphorus (org-P) contributions to total phosphorus (TP) deposition is even greater.

The two major inorganic nitrogen species, ammonium (NH_4^+) and nitrate (NO_3^-) along with an inorganic form of phosphorus, orthophosphate (PO_4^{3-}) are collected and analyzed by the NADP from samples collected using the standard NADP-NTN wet-deposition samplers. For collection of total nitrogen (TN) and total phosphorus (TP), NADP developed the SNiPiT (Sampler for Nitrogen and Phosphorus in Total), that attaches to NADP's existing NCON collector, and incorporates a collection bottle, pre-charged with sulfuric acid (H_2SO_4) which stabilizes the org-N and org-P species for quantitative TN and TP determinations.

Previously, NADP investigated the performance of the SNiPiT sampler and determination of total nitrogen and total phosphorus method using a potassium persulfate digestion (HACH chemistries: 10-107-04-4-C and 10-115-01-4-C). This method utilizes an autoclave digestion wherein all forms of nitrogen and phosphorus are converted into nitrate and orthophosphate, respectively, thus allowing for spectrophotometric determination of TN and TP using NADP's dual-channel Flow Injection Analyzer (FIA).

This investigation revealed that low-volume precipitation samples were being over-acidified at the collection step, causing an interference with color development in the FIA methods. Follow-up studies confirmed a positive correlation between low volume samples (samples < 50 mL) and a negative bias in sample results. In winter of 2023, a base-titration step with sodium hydroxide (NaOH) was investigated to compensate for the over-acidification interference. While viable for TN, the NaOH addition proved unsuccessful for TP, resulting in large false positives extending far beyond the calibration range. Ultra-pure NaOH and potassium hydroxide (KOH) were also investigated, but yielded similar results. In spring of 2024, we investigated whether reducing the concentration of the H_2SO_4 preservative by 50% would eliminate the TP bias. The test resulted in less sample volume required for TN analysis (≥ 20 mL), but a minimum of 100-200 mL of sample volume were needed to prevent negatively biased TP results.

Our presentation will provide a detailed overview of the outcomes from these method evaluations, and will focus on assessing the accuracy and precision of the preservation techniques. In addition, we will summarize efforts utilizing alternate analytical methods.

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Evaluation of Updated NTN Preliminary Data Review Process

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NADP has been updating NTN Preliminary Data Review procedures from a one-by-one sample review to a more streamlined approach, focusing on only samples meeting criteria that indicate they could need edits. As the new approach to NTN Data Review has begun to be used, there has been a need for comparisons to ensure data quality is maintained. We have been monitoring several general dataset conditions including sample condition (notes) code frequencies, sample validity rates, and chemistry value distributions to this end. Comparisons of these parameters in datasets reviewed in the new process to 10-year historic data has overall shown no major discrepancies in data quality.

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Measuring PFAS in Air

Liz O'Gorman[1,*], Jared Kunick[1], and Iris Bloede[1]

The Wisconsin State Laboratory of Hygiene PFAS Research Center is one of the few groups in the country addressing the atmospheric cycling of per- and polyfluoroalkyl substances (PFAS). Our studies have contributed to the growing evidence of widespread and significant dispersal of PFAS across the globe via transport and transformation in the atmosphere, and we've documented that precipitation of PFAS can represent the major depositional pathway to many environments. Advancing our understanding of PFAS depositional pathways requires information on PFAS in vapor and aerosol phases in the atmosphere – key information that is currently lacking, especially in the US. To this end, we have conducted a novel study, pairing weekly integrated precipitation collection (and PFAS characterization) with an intensive air sampling campaign – collecting PFAS from both aerosol and vapor atmospheric pools. An important parallel goal of this study is to validate the air-sampling methods for a very large suite of PFAS – helping to promulgate a robust approach for PFAS quantification in air that can be applied by researchers world-wide.

For this study, the WSLH partnered with the Wisconsin Department of Natural Resources to collect air (and precipitation) samples at two locations in WI, one urban and one rural. We deployed triplicate co-located high-volume air samplers at each location and collected over 40 samples from each over a period of over a year. Sampling periods ranged from 24 to 96 hours at air flow rates of 130 and 230 liters per minute. Processing nearly 1000 m^3 of air is required due to the low ambient concentrations of PFAS in the air (<1-20 pg/m^3). The high-volume samplers were configured with glass-fiber filters to collect aerosol-associated PFAS and glass cartridges, containing polyurethane foam (PUF) and cross-linked polyvinyl styrene (XAD) resin, to collect vapor-phase PFAS. A new method was developed to extract the PFAS from the PUF/XAD, that utilizes a shaker table and significantly less organic solvent than the traditional Soxhlet method. To assess PFAS analyte recovery during field collection and laboratory processing, the cartridges are spiked with over 20 isotopically-labeled PFAS surrogates, before deployment. Our current liquid chromatography, tandem mass spectrometry (LC/MS/MS) method targets 33 PFAS compounds with the intent of eventually transitioning to the analytes in EPA method 1633 (41 PFAS compounds), supplemented with several additional air-relevant PFAS species, especially the fluorotelomer alcohols. In the presentation, we will present preliminary method performance data along with new information on PFAS levels in the atmosphere.

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Are Sensitive Trees Species Protected from Ground-level Ozone Given a Changing Power Sector and Implementation of NO_X Emission reduction Programs for the Power and Other Sectors Over the Past Two Decades?

Jason Lynch[1, *], Kristopher Novak[2], Jeff Herrick[2], Melissa Puchalski[1], George Bowker[1], and Dakota Delong-Maxey[1]

Ground-level ozone is one of many air pollutants that can alter a plant's health and ability to reproduce and can make the plant more susceptible to disease, harsh weather, and other environmental stressors. These impacts can lead to changes in the biological community, both in the diversity of species and in the health and growth of individual species. Emissions of NO_x and other ozone forming air pollutants have decreased over the past two decade due to a changing power sector and the implementation of NOX emission reduction programs for the power and other sectors. However, it is unclear whether changes in emissions are continuing to improve tree health and forest communities as changing weather may offset continued declines in ozone concentrations. We evaluated biomass loss for 10 common tree species in the eastern U.S. that have a higher sensitivity to ozone (black cherry, yellow poplar, American sycamore, chestnut oak, quaking aspen, sweet gun, sugar maple, eastern white pine, Virginia pine, and red maple) before and after changes in NO_X emissions and ozone concentrations on reducing biomass loss of these tree species. This analysis reflects new underlying tree abundance data from the U.S. Forest Service, updated tree-biomass functions published by Lee et.al. 2022, which utilize a new approach that better reflects tree abundance and biomass loss estimates due to ozone exposure. Of these 10 tree species examined, four are less sensitive to ozone exposure (sugar maple, Virginia pine, eastern white pine, chestnut oak) and six are more sensitive (black cherry, yellow poplar, American sycamore, quaking aspen, sweet gum, red maple). This analysis focused on modeled relative percent biomass loss of >5 and >10 percent, which are ecologically important indicators for tree and ecosystem health. Tree biomass loss due to ozone exposure declined sharply as air quality improved between 2000–2002 and 2020–2022. The amount of forest area impacted by ozone exposure with >10 percent biomass loss (most impact) decreased by 88 percent while areas with >5 percent biomass loss declined by 40 percent for all tree species across the eastern U.S. Individually each of the 10 tree species showed decreases in total forest area with ecologically important biomass loss of >5 percent between 2000–2002 and 2020–2022 in the eastern U.S. The four least sensitive tree species are not expected to experience biomass loss above 5 percent due to ozone exposure for the current period. Among the six more sensitive trees, black cherry, yellow poplar, and American sycamore are the only tree species expected to experience ecologically important biomass loss of >5 percent for the current ozone exposure with only black cherry having areas with the more severe level of >10 percent biomass loss.

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CASTNET's Emerging Role in PM Measurement

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Climate change has increased the frequency and severity of wildfires in recent years. These fires produce a mix of gases and particles that impact air quality, leading to human and ecological health risk. At EPA's Clean Air Status & Trends Network (CASTNET) Georgia Station (GAS153) monitoring site, an analysis of black and brown carbon (BC & BrC) and particulate matter (PM) measurements provided information on CASTNET's role in supporting the monitoring of PM and PM speciation during wildfires. The Georgia site provides a location to observe the impact of smoke due to the incidence of prescribed burns in the area. To facilitate this analysis, different brands of low-cost optical PM sensors (LCOS) are co-located with a reference PM monitor (1400a Thermo scientific TEOM) and a 7 wavelengths Aethalometer (AE33) at GAS153 during a short-term monitoring intensive conducted in first quarter of 2024. The TEOM data provide a reference measurement to evaluate the performance of the LCOS. The aethalometer provides comparative measurements for the optical transmissometer analyses of BC on the Teflon filter within the CASTNET 3-stage filter pack, which were made using a SootScan Model OT21. The analysis of these measurements examines trends between PM and BC measurements. This study builds on recommendations from the Science Advisory Board and pushes the modernization of CASTNET forward through its exploration of PM composition and low-cost particulate matter sensor data.

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EPA One Health Approach to Mercury Contamination

Katie Davis[1, *]

Visual image depicting the Environmental Protection Agency's One Health approach to control, reduce and eliminate mercury with the goal to protect human health and the environment. One Health is a collaborative, multisectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment. As mercury cycles through the environment impacting air, land and water, various EPA programs intervene at different steps to reduce mercury pollution and exposure to mercury. The purpose of the poster is to depict visually the EPA policies, regulations and interventions that minimize the impacts of mercury on the environment and human health and to highlight the need for a collaborative and holistic One Health approach. EPA addresses mercury in the environment by regulating air emissions, enforcing drinking water standards, cleaning up Superfund sites and creating fish guidelines to protect children and pregnant people. Long-term monitoring of air, water, soil, and fish tissue are crucial to understand the risk to human health and the environment. EPA has long recognized the interdependent links between people, animals, and their shared environments. This poster is a product from the EPA One Health Coordination Team.

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Source Apportionment of $PM_{2.5}$ Nitrate using Isotope Techniques Coupled with AERONET Optical Properties

Conner Guidry[1, 2, *], J. David Felix[1, 2], and Abril Garcia Lunar[1, 2]

Air quality degradation is a global concern, particularly in densely populated regions where anthropogenic emissions are concentrated, necessitating measures to safeguard public health. Urban areas face significant challenges from particulate matter (PM) pollutants including detrimental effects on human health and contribution to acid rain and nutrient loading. The first step to mitigating PM emissions is to determine their source origin. This project aims to use isotopic techniques coupled with remote sensing data to apportion the NOx emission sources (i.e., industrial, biomass burning, soil biogenic, vehicles, lightning) contributing $PM_{2.5}$ nitrate in a semi-arid coastal urban airshed (Corpus Christi, TX, USA which is nearing $PM_{2.5}$ nonattainment of 9.0 $\mu g/m^3$). This will be complemented using aerosol optical properties coupled with reference clusters to apportion sources of aerosol contributions (i.e., maritime, biomass burning, industrial/urban, dust, mixed). To accomplish this, biweekly $PM_{2.5}$ samples will be collected on quartz fiber filters using a URG-3000-ABC medium-volume sampler. Filter eluents will be analyzed for nitrate isotopic composition ($\delta^{15}N$, $\delta^{18}O$, $\delta^{17}O$), and delta values will be employed in Bayesian isotope mixing models to determine emission source apportionment and investigate oxidative pathways. Our group participates in NASA's AERONET network, and the associated Cimel Sun Photometer will provide aerosol optical properties to apportion aerosol types. Results will be disseminated to state environmental agencies and regional air quality groups to aid in creating informed emission mitigation strategies for urban coastal regions.

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CASTNET Ozone Monitoring Program

Christopher M. Rogers[1], Timothy Sharac[2], Melissa Puchalski[2], **Selma Isil**[3,*], Marcus Stewart[3], and Kevin P. Mishoe[3]

The Clean Air Status and Trends Network (CASTNET) is a long-term monitoring network designed to measure acidic pollutants and ambient ozone (O_3) concentrations in rural areas in the United States and Canada. CASTNET is managed collaboratively by the Environmental Protection Agency – Clean Air and Power Division (EPA), the National Park Service – Air Resources Division (NPS), the Bureau of Land Management – Wyoming State Office (BLM-WSO), and Alberta's Ministry of Environment and Protected Areas. Numerous other participants provide site operator support and grant land access including Native American tribes, other federal agencies, States, private landowners, and universities.

Each CASTNET monitor measures ambient O_3 concentrations for the entire year. CASTNET O_3 data are submitted to the AIRNow Tech website for near-real time reporting (www.airnowtech.org) and to EPA's Air Quality System (AQS) database (https://aqs.epa.gov/aqs). Annual performance evaluations (PE) and results from the National Performance Audit Program (NPAP) are also submitted to AQS routinely.

Eighty CASTNET sites currently report hourly O_3 concentrations. Seventy-seven of the O_3 monitors at CASTNET sites meet the requirements of Title 40 of the Code of Federal Regulations (CFR) Part 58 and are used to determine compliance with the O_3 National Ambient Air Quality Standard (NAAQS). Two monitors are co-located sites and are submitted to AQS as QA/non-regulatory data, and one monitor is at the Duke Forest, NC research site and measures concentrations above the forest canopy. CASTNET provides a unique dataset to serve rural populations where state or local operated O_3 monitors are not required. During the recent Science Advisory Board (SAB) review panel, CASTNET ozone data were highlighted for their utility in evaluating atmospheric chemical transport models and in ground truthing satellite estimates. Preliminary analysis of the fourth highest daily maximum rolling 8-hour averages for 2023 indicate that 18 CASTNET sites had values greater than 70 ppb.

CASTNET is currently starting to evaluate options for the replacement of its aging ozone analyzers and site transfer standards. In conjunction with NPS and Environment and Climate Change Canada (ECCC), EPA will review various commercially available Federal Reference Method (FRM) or Federal Equivalent Method (FEM) equipment during 2024 to determine how to proceed.

Ozone data and additional information about the CASTNET monitoring program can be found on the CASTNET webpage at https://www.epa.gov/castnet.

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Individual effects and interactions between ultrafine particles and extreme temperatures on hospital admissions of high burden diseases

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Background: Research on the health effects of ultrafine particles (UFPs) is limited, especially considering its individual and interaction with extreme temperatures. This study investigates the risks of UFPs number concentrations and extreme temperatures on hospitalizations for high-burden diseases (HBDs) in New York State (NYS).

Methods: We defined HBDs including ischemic heart diseases, diabetes, stroke, kidney diseases, and depression from NYS Hospital Discharge Data, 2013-2018. Daily temperature and pollutants were obtained from chemical transport model with aerosol microphysical simulation with 17×17 miles resolution. UFPs were measured using interquartile range (IQR) increase; extreme heat was defined as temperature >= 90th percentile in summer; and extreme cold as temperature <=10th percentile in winter. Conditional logistic regression with a case-crossover study design were applied while controlling for criteria pollutants, relative humidity, and time-varying variables.

Results: Among 1,308,518 cases in NYS, significant risk ratios (RR) were observed for UFPs (RR_{IQR}: 1.009 to 1.012) and extreme cold (RR: 1.009 to 1.053), but no effect was found for extreme heat. UFPs affected all HBD subtypes except kidney diseases, with the highest RR for diabetes (1.026, 95% CI: 1.011, 1.041). Extreme cold impacted all subtypes, with the highest RR for depression (1.063, 95% CI: 1.035, 1.092). Females, Blacks, non-Hispanics, older adults and those with Medicare or Medicaid were more susceptible to UFPs, while whites, non-Hispanics, older adults, and Medicare recipients were more vulnerable to extreme cold. The adverse effect of UFPs was higher in winter and fall. Elevated UFP concentrations and extreme cold temperatures were associated with longer hospital stays and higher total charges.

Conclusion: We observe short-term associations between exposure to elevated UFPs concentrations or extreme cold and hospitalizations, length of stay, and total charges for HBDs in NYS. These effects varied by sociodemographic groups and seasons, with UFPs having stronger impacts during winter and extreme cold.

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Clean Air Status and Trends Network (CASTNET) Seasonal Temperature Trend Analysis

Jayde Alderman[1, *], Christopher Rogers[2], and Marcus Stewart[1]

EPA's Clean Air Status and Trends Network (CASTNET) is a long-term atmospheric monitoring program with approximately 90 sites located throughout the United States with two sites located in Canada. Since its inception in 1986 as the National Dry Deposition Network, CASTNET has featured quality assured measurements of ambient temperature predominately at a 9-meter probe height. To examine statistical trends in the data record, hourly temperature data were retrieved from 50 CASTNET sites and split into six regions across the United States: Northeast, Southeast, Midwest, Southwest, Rocky Mountain, and Pacific. The data ranges from 1990 to 2021 for sites in the eastern United States, and 1995 to 2021 for western sites. Linear regression of the annual temperatures over time was used to illustrate the rate of change in temperature for each region and season. Prior to the analysis, missing data were replaced using linear interpolation, and outliers were identified and removed.

The results illustrate an increasing trend for spring, summer, and fall for all regions, a decreasing trend for winter in the Pacific, Rocky Mountain and Midwest regions, and an increasing trend for winter in the Southwest, Southeast and Northeast regions. Improved analysis and additional years of data are required to enhance future temperature trend observations. It is recommended that seasonal trend analysis is done on data sets spanning more than thirty years for small geographical regions and a geo-spatial statistical approach be considered for interpolation of missing data before calculating annual averages.

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Differences Nitrogen Dioxide Deposition Modeled from TROPOMI, Pandora Spectrometer Instruments, and in-situ FEM Networks Across Texas Watersheds

Abril G. Lunar[1, 2, *], J. David Felix[1, 2], and Conner Guidry[1, 2]

Nitrogen dioxide (NO2) dry deposition into the environment can lead to eutrophication, soil acidification, algal blooms, and hypoxia. Across watersheds—marine and terrestrial—wet deposition of Nr is well documented while dry deposition is under characterized. To have an accurate representation of the total nitrogen budget and its relationship to critical load exceedance, it is essential to have an accurate representation of dry deposition specific to each watershed. Here we model NO2 dry deposition in terrestrial and marine watersheds (i.e., Galveston Bay, Corpus Christi Bay, Trinity River, and San Antonio River watersheds) using in situ federal equivalent networks by Texas Commission for Environmental Quality (TCEQ) and U.S EPA, ground-level remote sensing from Pandonia Global Network, as well as data from TROPOMI. This allows us to compare the accuracy of both satellite-borne and ground-based remote sensing to a more robust network. Data from the Galveston watershed FEM data has shown that in the Galveston area 6.09x106 kg of N is deposited into the environment in the year 2023. This NO2 loading estimate is a missing component in previous models in the region and represents an 18% underestimate which highlights the need for a more well-rounded approach to air pollution mitigation. The comparison between the TROPOMI—with a higher spatial resolution—in contrast of the FEM network has shown that there could be biases in the outskirts of the watershed. In areas where there is a high density of FEM monitors, like is the case of Houston, there is good agreement (p=0.003) between the conversion of tropospheric column density and FEM ambient concentration. This is especially true with concentrations lower than 14 ppb (R =0.9995). Combining the spatiotemporal advantages of these networks combined gives a more complete understanding of deposition trends across Texas. However, increasing the accuracy of remote sensing-based deposition models would offer a lower cost and larger coverage network in the future.

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National Atmospheric Deposition Program Data Quality is Resilient to a Changing Climate

Gregory A. Wetherbee[1], **Noel Deyette**[2,*], and Ryan McCammon[3]

The U.S. Geological Survey (USGS) has provided an independent quality assurance project to the National Atmospheric Deposition Program (NADP) for over 44 years. Since 1997, USGS has operated a Field Audit Program (Program) to evaluate contamination and stability of dissolved chemical constituents in NADP National Trends Network (NTN) samples. The Program prepares synthetic precipitation solutions that replicate precipitation-level concentrations of major cations and anions and ammonium using chemical reagents, and the samples are shipped to the NTN site operators for processing in the field. After a week without precipitation (dry week), site operators pour 75 percent of their Field-Audit samples into a sample-collection container that was deployed to the field during the dry week, and a lid is used to seal the container for a 24-hour residence time. After the residence time, the sample is processed and containerized for shipment and analysis. The samples are shipped to the NADP Analytical Laboratory (NAL) for chemical analysis. The resulting concentrations from the set of two samples are analyzed to determine positive or negative percent differences. A positive difference represents assumed contamination, and a negative difference implies loss of dissolved ions, which may occur by adsorption to the container walls, degradation by bacteria, and(or) other chemical transformations such as oxidation or degassing.

Evaluation of Program data (1997 – 2023) indicate no trends in NADP/NTN sample contamination or stability attributable to changes in climate despite prolonged drought in the southwestern U.S. and increasing record high temperatures in many places nationwide. Other factors which could affect sample integrity include upgrading approximately 40 percent of the NTN to more sensitive collectors (~2010 - 2012), changing laboratories (2017), and the transition from unlined to plastic-lined collector buckets (2019). While these changing protocols have shifted trends in measured concentrations, they have not resulted in detectable variations in contamination or stability.

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Measuring low-level PFAS with combustion ion chromatography

Iris Bloede[1, *], Emily Sellers[1], Jared Kunick[1], and Liz O'Gorman[1]

Per- and polyfluoroalkyl substances (PFAS) have existed for over 70 years, being used in the manufacturing of everything from non-stick cookware to firefighting foams to dental floss. With its continued prevalence in the market and hard-to-degrade nature, PFAS is almost unavoidable and can be found in most environmental matrices, including air, water, and soil. This has led to an increased need in research regarding the concentration of PFAS in the environment to provide insight into current and legacy levels of contamination and to establish monitoring to detect fluctuations in such levels. Equally important is measuring trace amounts of PFAS in the environment as recent years have led to the discovery that even low levels of exposure can negatively impact human health and easily accumulate in the environment and the body.
The PFAS Research Center at the Wisconsin State Lab of Hygiene is one of the only groups in the nation that can detect low levels of PFAS in environmental samples using non-targeted combustion ion chromatography (CIC). Combustion ion chromatography retains the specificity and sensitivity of traditional ion chromatography while allowing for the testing of all types of combustible samples. In CIC, samples undergo pyrohydrolysis at a temperature of 1050 degrees C in a combustion oven, where total organic fluorine in the sample will become gaseous HF. The HF is transferred to the absorber module where it is brought into solution for matrix elimination, and then this solution is injected into the IC system for analysis.

In order to conduct low-level work, we use a combination of pre-analytic SPE to concentration our samples 1000-fold, a preconcentration column within the CIC instrument to further concentrate samples, and repeated check standards within a run to capture any corrections to be made post-analysis. This allows us to report accurate and precise data for projects such as precipitation, groundwater, and surface water monitoring that may have total organic fluorine concentrations in the low parts per billion. In addition to low-level work, we have also handled a wide range of investigative work with projects that include AFFF, well-drilling foams, impinger samples, septage, and leachates that range from being in the very high parts per million to having no trace of total organic fluorine at all.

In this presentation, we will be going over the CIC instrumentation and methods used at the PFAS Research Center, improvements we have made along the way, and data from select projects.

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Investigating Nitrogen Cycling in New Mexico Alpine and Subalpine Ecosystems Using Stable Isotope Techniques

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Alpine and subalpine ecosystems are nitrogen-limited environments that are highly sensitive to subtle perturbations in reactive nitrogen (Nr) availability. The demonstrated effects of excessive Nr in these environments include shifts in species composition with overall losses in biodiversity, surface water and soil acidification, and additional changes in soil chemistry (e.g., base cation leaching, accumulation of toxic soluble metals). Atmospheric deposition of nitrate (NO3-) and ammonium (NH4+) has been implicated as an important mechanism of Nr transport to remote alpine watersheds, with winter wet and dry deposition accumulation in the snowpack acting as a reservoir of Nr that is subsequently supplied to surface waters upon snowmelt during the growing season. In this study, NO3- stable isotopic data (δ15N, δ18O, Δ17O) will be used to investigate the sources of nitrate in montane lakes, transient and permanent streams, and lower elevation catchments in the Sangre de Cristo Mountains of New Mexico (USA), the southernmost subrange of the Rocky Mountains in North America. In addition to the use of δ15N and δ18O data for partitioning sources of nitrate (e.g., soil NH4+ nitrification, fossil fuel combustion, biomass burning), Δ17O offers unique insight to the post-depositional fate of NO3-. NO3- in the atmosphere primarily derives from the oxidation of nitrogen oxides (i.e., NOx) by ozone (O3), which is enriched in 17O and imparts a largely positive Δ17O value to the resulting NO3- formed via NOx oxidation. The typical Δ17O for NO3- formed in the atmosphere (20-35‰) is easily distinguishable from NO3- formed via nitrification (Δ17O = 0‰) and remains unaltered following deposition and subsequent processing in the environment. NH4+ and dissolved organic nitrogen (DON) stable isotopic data (δ15N) will also be obtained to further constrain the composition of Nr in this system and its origin. Snow, lake and riverine surface water, and soil samples were collected in June and September 2024 to capture the Nr dynamics near the beginning and end of the region's growing season, respectively. NO3-, NH4+, and DON concentrations and isotopic data will be used to infer the processes regulating Nr availability throughout this previously uncharacterized watershed. The results of this study will offer further insight to the extent of nitrogen deposition in alpine and subalpine ecosystems and the fate of atmospheric Nr in these environments, with possible implications for developing protective and mitigative strategies to combat excessive Nr emissions near sensitive montane ecosystems.

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Session 4: Linking shifts in air quality, atmospheric deposition, and critical loads to climate-driven events

Forest Vegetation Response to Changes in Air Pollution and Climate

Todd McDonnell[1, *], Christopher Clark[2], and Michael Bell[3]

Forest vegetation species depend on a host of environmental conditions in ways that are unique for a given species; and vegetation can be adversely affected by air pollution (e.g., N and S deposition and ozone concentrations) and climate-related variables. Previous efforts have been made to statistically relate tree growth and survival to a limited set of these drivers. Additional potential drivers and statistical methods are currently under consideration. The occurrence probability of forest understory and other herbaceous vegetation species has also been evaluated across 165 National Parks using statistical models. This presentation will highlight progress towards consideration of an expanded set of explanatory variables for modeling species-level tree growth and survival to include additional drivers based on a hierarchical Bayesian technique for model parameterization. Additionally, model results related to forest understory and vegetation response to changes in N deposition and air temperature for a broad set of National Parks will be presented.

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Identifying Hot Spots of Air Pollution Through Precipitation Chemistry Measurements in South Asia

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Emissions from rapidly increasing industrial and urban activities are the major cause of air pollution. Recently, nitrogen air pollution and its influence on precipitation chemistry, human health and environment have been the subjects of concerns of researchers. Ammonium aerosols, which mostly exist in fine mode, are scavenged by rain affecting air quality, rain chemistry, as well as soils, vegetation and buildings following their wet deposition onto surfaces. This study has been a part of UKRI GCRF South Asian Nitrogen Hub and reports pH and rain chemistry at a number of sites across South Asia, viz. DTG, Peradeniya (Sri Lanka), MAP (Maldives), KU, Dhulikhel (Nepal), BSMRAU, Dhaka (Bangladesh) and BRRI, Rangpur (Bangladesh), SC, Kanglung (Bhutan) and NCSCM, Chennai, LP Lakshadweep, DEI Agra, ARIES Nainital, IIT Roorkee, IMD New Delhi (India). The samples of rainwater were collected on event basis during 2022-23 using a manual wet collector. Samples were preserved with thymol for avoiding any biological decay. Chemical analysis for ionic components was carried out by using an ion chromatograph. Data selection and analysis were performed by using standard QA/QC practices. pH showed a large variation ranging from 2.94 at BSMRAU Dhaka to 9.40 at IMD New Delhi indicating a wide range of sources of influence in the region. Similarly, a large variation was noticed for Cl^-, NO_3^-, nss-SO_4^{2-}, NH_4^+, Na^+, nss K^+, nss Ca^{2+} and nss Mg^{2+}. Detailed results will be discussed during the conference.

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Leveraging NEON data for multi-response critical loads of atmospheric deposition of nitrogen

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The National Ecological Observatory Network (NEON) collects a large suite of co-located ecological data using standard methodology and anticipates operating for 30 years. One of the strengths of NEON data is that diverse ecological data are collected from the same 47 terrestrial sites and 34 aquatic sites. Here, we examine a subset of NEON data products from terrestrial sites which can be leveraged to provide multi-response critical loads of atmospheric deposition: namely soil C:N, available soil nitrogen, soil microbe biomass (by PLFA), aboveground herbaceous plant productivity, and root biomass and chemistry.

The NEON terrestrial sites span a nitrogen (N) deposition gradient of 2.0 to 10.9 kg/ha/yr. The increase in N deposition across the spatial gradient of sites had a significant negative correlation with soil C:N ratio in the mineral horizon, a positive correlation with fine root mass in the 1-2 mm size class, and a negative correlation with fine root percent nitrogen in the 1-2 mm and 2-10 mm size classes. Available soil nitrogen, soil microbial biomass (total lipids from PLFA analysis), and above-ground herbaceous productivity (of N-fixers and summed across all functional groups) were not correlated with nitrogen deposition.

Using an existing gradient of atmospheric deposition and data from the first 7 years of NEON sampling, we identified emergent spatial patterns in soil chemistry, root biomass, and root chemistry. Other responses such as microbial community composition and aquatic chemistry could also be examined using these and other NEON datasets, and by examining the impact of climatic gradients that also exist across NEON sites. With additional work, it may be possible to derive critical loads from a suite of these response surfaces.

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Assessing SO_4^{2-}/Ca and Cl/ NO_3^- ratios in Atmospheric Dust in North India: Implications for soil acidification

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The deposition of atmospheric dust is a critical factor influencing air quality, soil composition, and ecosystem health. This study examines the atmospheric dust flux and the chemical composition of dustfall across diverse North India environments, focusing on urban and rural settings. The findings revealed significant variability in atmospheric dust deposition, with rural site recording the highest average dust flux. Urban sites displayed considerable fluctuations. These variations highlighted the influence of regional industrial activities, soil erosion, agricultural practices, and climatic conditions on dust deposition rates. Chemical analysis of the dustfall samples further revealed critical insights into the sources and potential environmental impacts of dust deposition. The SO_4^{2-}/Ca ratio suggested significant contributions from both industrial emissions and soil dust, indicating mixed sources of sulfates in the atmosphere. The SO_4^{2-}/NO_3^- ratio provided an evidence of secondary aerosol formation processes, pointing to the conversion of gaseous precursors into particulate matter. Additionally, the Cl/ NO_3^- ratio reflected the influence of non-marine contribution of Cl^-. These ratios have important implications for understanding the composition of atmospheric aerosols and their impact on environmental and public health in North India. The study underscores the need for continuous monitoring of dust deposition and its chemical composition to develop targeted strategies for mitigating the adverse effects of dust pollution, particularly in urban and industrialized regions.

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Water Soluble Organic Nitrogen Characterization Study

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Organic forms of nitrogen (N) are an important component of atmospheric deposition but are not routinely measured. As summarized by Jickells et al. (2013), global datasets of precipitation chemistry indicate that water soluble organic nitrogen (WSON) contributes ~25% of the total N in wet deposition, on average. In the U.S, various studies show that annual averages of WSON range from <5% to ~30%. Generally, measurements of WSON in precipitation and aerosol are limited in North America, precluding development of a complete picture of the spatial and temporal patterns of the contribution of WSON to total nitrogen in wet and dry deposition at regional to continental scales.

The Clean Air Status and Trends Network (CASTNET) is EPA's long-term, rural monitoring network of approximately 90 stations that measure changes in air quality and assesses atmospheric deposition over broad geographic regions of the U.S. (https://www.epa.gov/castnet). CASTNET provides weekly concentrations of inorganic nitrogen species, but to this point has lacked the ability to report the total organic fraction.

A pilot study was conducted in 2020 to investigate the feasibility of quantifying water soluble total nitrogen and WSON on CASTNET Teflon filters, including assessment of potential effects from routine shipping, storage and handling of the filters. Bulk WSON in PM is calculated by measuring the concentration of WSTN and then subtracting the concentrations of the measured inorganic components (NH_4^+, NO_2^-, and NO_3^-). A 27 site one-year study was conducted from November 2022 to November 2023 to assess seasonal and spatial patterns as well as to estimate the contribution and correlation of WSON to the total nitrogen deposition budget. Preliminary interpretation of data has been performed, and seasonality as well as impacts from extreme events such as forest fires can be identified. Averaged across all the sites, preliminary data show that WSON is about 15% of total N, with increases in late-spring and summer months, although results can differ at individual sites. Leveraging the existing sites and sampling media to capture the WSON fraction could offer a more complete assessment of shifts in aerosol chemistry and source impacts on air quality.

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Ozone-induced foliar injury in Great Smoky Mountains National Park: a case study in longitudinal citizen science data

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Citizen science projects are a powerful tool for monitoring long-term ecological trends. Great Smoky Mountains National Park has tracked ecosystem health throughout the park for decades. Staff, visiting students, and volunteers have monitored ozone-related damage to plants in a high-elevation biomonitoring garden at Purchase Knob since 2003. Yellow crownbeard (*Verbesina occidentalis*)—an ozone-sensitive species native to the southeastern United States—is the primary bioindicator species in the biomonitoring garden. Ozone-induced foliar injury on yellow crownbeard appears as purple stippling on the top surface of leaves. Ozone levels have been steadily decreasing at Purchase Knob since 2003, but foliar injury peaked in 2012 and has been improving since then. We also found that weather mediates the effect of ozone levels on yellow crownbeard; yellow crownbeard is more susceptible to ozone-related foliar injury in warm and humid weather, likely due to the increased stomatal conductance of ozone in these conditions. The marked reduction in ozone-related injury in the park over the last decade may highlight a success in recent air pollution regulatory efforts.

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Session 5: Sustaining long-term monitoring programs

A review of USDA Forest Service sites in the National Atmospheric Deposition Program: motivations for and challenges to site operation

Brian Izbicki[1, *], Aaron Piña[1], and Linda Geiser[2]

The USDA Forest Service (FS) is an active partner in the National Atmospheric Deposition Program, maintaining 35 air quality monitoring sites, primarily within the National Trends Network. Individual administrative units within the FS operate and maintain sites, whereas sample analysis and shipping is funded by the agency's Research and Development office at FS headquarters. Concerns about the vulnerability of site operation and maintenance during continuing agency wide staff shortages and constrained budgets, prompted an agency-wide review of the motivations and challenges faced by our operators and their supervisors. The review was implemented as standardized interviews with staff at 34 sites on Forest Service lands. We found that operators and their supervisors are motivated by a sophisticated understanding of the value of long-term air quality data, and personal commitments to providing high quality data. Key challenges reported included limited funds for equipment maintenance and funding, competing time commitments, and physically demanding travel, particularly during adverse winter conditions. Operators welcomed increased direction from the FS Washington Office and NADP Program Office. This review highlights the important contributions of operators and managers to land stewardship. Their insights can help guide and prioritize actions to maintain the agency's long-term commitment to the NADP and may be helpful to other NADP participants facing similar challenges.

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Spatial and Temporal Trends in Ammonia in Northeast Colorado

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Upslope flow from northeastern Colorado is an important mechanism for transporting air pollutants from active urban and agricultural regions into Rocky Mountain National Park (RMNP). This includes both oxidized and reduced forms of nitrogen, including nitric acid and ammonia (NH_3). NH_3 emissions in the region come primarily from animal feeding operations and fertilized cropland; however, urban/traffic emissions and wildfires can also be contributors at certain times and locations. Excess reactive nitrogen (N_r) deposition in RMNP is a historical problem with well documented impacts on the ecosystem. While increased regulation of NO_x emissions has resulted in decreasing deposition of nitrate in RMNP, NH_3 remains an unregulated pollutant with only voluntary efforts to reduce its emissions. The fraction of RMNP Nr wet deposition comprised by NH_4^+ has, consequently, been increasing.

In order to better understand NH_3 sources, spatial patterns and long-term trends in NE Colorado, a combination of surface passive sampler NH_3 measurements and NH_3 total column retrievals from the Infrared Atmospheric Sounding Interferometer (IASI) will be used. We focus on urban, rural, and agricultural regions. A strong seasonal cycle was observed at all measurement sites. The NH_3 mixing ratio from passive measurements was strongly correlated with the number of nearby confined animal feedlot operations, further documenting the importance of that emission source category. Ground-level passive NH_3 measurements exhibit a strong correlation with monthly gridded IASI satellite retrievals. Using satellite retrievals, we find an increasing NH_3 trend of approximately 3% per year in agricultural and urban sub-regions. The absolute trend observed in the agricultural areas is more than double that observed in the Denver metro region, suggesting a larger increase in agricultural than urban emissions. In the Denver metro area, only a small fraction of the increase in gaseous NH_3 could be attributed to reductions in particle sulfate. Elevated NH_3 from wildfire smoke was observed in the satellite record in August 2020, a period of active wildfire activity in northern Colorado, but was less apparent in surface measurements, likely due to lofting of the smoke plume.

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The Northeast Snow Survey (NESS) Feasibility Study: Engaging interest-holders to design a coordinated, automated snowpack monitoring network for the East

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Winter is the fastest warming season east of the Mississippi River, with hotspots of winter warming (greater than +2.5ºC since 1970) concentrated in the northeastern United States. Over the past century, the region has lost 2-3 weeks of sustained winter conditions across both low elevations and some montane areas. Importantly for atmospheric deposition estimation, shifts in snow vs. rain can affect deposition of important analytes such as mercury and nitrogen. Further, most snow measurements in the Northeast are from low-elevation weather stations in populated areas, resulting in gaps of snowpack and weather observations across elevational gradients and in remote areas, with fewer than 5% of all manual and automated stations at higher elevation (>823 m). Due to the challenges of collecting snow in NADP/MDN collectors, particularly in mountainous terrain, winter deposition via snow can be over- or under-estimated. In the western U.S., the NRCS Snow Telemetry (SNOTEL) network monitors snowpack, weather, and other climate elements at over 900 automated stations and provides critical data for hydrological monitoring and water resource management that can enhance context for NADP measurements. In the Eastern U.S., the Northeast Snow Survey (NESS) Feasibility Study is informed by Federal, State, Tribal, and NGO interest-holder engagement to develop priorities for snowpack and weather monitoring and will design a proposed station network and supporting operations that could similarly help refine deposition estimates. For example, interest holders identified a need for snowpack depth and water equivalent measurements along elevational gradients, to fill spatial gaps and better quantify mountain snowpack. Since stations operate year-round, they could potentially help quantify both liquid and solid precipitation across the Northeast and aid in modeling and validation studies of atmospheric deposition. The multi-institution leadership team working in collaboration with USDA-NRCS is also identifying current data resources and gaps to inform network planning through a data survey to collate snowpack and weather data in the region. We will use a systems engineering approach to refine objectives, map our network design. By including input from interest holders in the feasibility study, NESS aims to develop plans for a sustainable network that supports a range of objectives from flood forecasting and resource management to furthering modeling and scientific studies.

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Effect of ozone exposure on 12 herbaceous plants common to the Great Lakes region

Dustin Bronson[1,*] and Natalene Cummings[2]

The USFS Northern Research Station and Forest County Potawatomi Tribe co-developed a study to test the effects of ozone on twelve herbaceous plant species that hold cultural importance to the tribe. Three different trials at a W_{126} of 7.0 ppm-hr, one trial at a W_{126} of 10.0 ppm-hr, and one trial at a W_{126} of 15.0 ppm-hr was conducted. Net photosynthesis was measured each week throughout the trial. After each trial, all plants were harvested, separated into aboveground or belowground plant tissue, then dried and weighed for biomass. Overall, our results show that the species measured are tolerant of ozone up to concentrations that comprise a W_{126} of 15.0 ppm-hr.

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Session 6: Characterizing cultural and environmental impacts of air pollution to Tribal lands

Intro to TAMS and Tribal participation issues in NADP programs

James Parsons[1, *] and Chris Lee[2]

This presentation offers an overview of the Tribal Air Monitoring Support (TAMS) Center and the Tribal Authority Rule. It will explain the various projects the Choctaw Nation of Oklahoma is currently working on. Additionally, the presentation will address challenges that small tribal organizations face in participating in National Air Deposition Program (NADP) projects, including limited funding, capacity constraints, and technical barriers.

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Building Federal-Tribal Partnerships: EPA's Rural and Tribal Air Quality Monitoring Program

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The Clean Air Status and Trends Network (CASTNET) is a robust, long-term air quality monitoring program with sites operating throughout the United States and Canada. CASTNET sites, located primarily in rural communities, measure air pollutants that can be harmful to human health and cause negative impacts to ecosystems. CASTNET data are used to demonstrate NAAQS compliance, assess spatial and temporal trends in air quality in response to regulatory actions, and evaluate climate-driven impacts on air quality. The U.S. Environmental Protection Agency (EPA) manages CASTNET, in cooperation with the National Park Service, and other partners, including Tribal Nations. In collaboration with the National Atmospheric Deposition Program (NADP), CASTNET also provides data on other air pollutants and precipitation chemistry at most locations.

Through networks like CASTNET and NADP, EPA has developed fruitful relationships with Tribal agencies and continually seeks new partnership opportunities to build monitoring capacity. Establishing a CASTNET or NADP site on Tribal lands helps to address tribal air quality data and training needs without the burden of managing procurements for equipment, developing quality assurance documents, and supporting data management activities. Over the past two decades, EPA has grown the CASTNET tribal program through Federal-Tribal cost-sharing and in-kind support. This expansion of EPA's Tribal air monitoring has resulted in overall improved spatial and temporal representation of air quality in Indian Country and provided a mechanism to ensure accessible air quality data are sustained.

In 2024, the EPA's Science Advisory Board (SAB) released a report prioritizing actions that CASTNET should take to maintain its value and continue to be sustainable. Emphasis was placed on continuing to expand the CASTNET Tribal monitoring program to inform policy decisions in Tribal and other rural EJ communities. The panel noted that CASTNET offers the essential platform and infrastructure for sensors and other monitoring equipment that can be used for the protection of public health, especially with increasing pollution burdens from wildfires, dust, and other extreme weather events.

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Session 7: Measuring emerging and toxic pollutants

Measurement of Gas-Phase Perfluoroalkyl Carboxylic Acids (PFCAs) Using Passive Air Samplers

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Perfluoroalkyl carboxylic acids (PFCAs), a subcategory of poly- or perfluoroalkyl substances (PFAS), have become chemicals of environmental concern because many have the characteristics of persistent organic pollutants; toxicity, stability and persistence in the environment, high mobility, and bioaccumulation. PFCAs are extremely persistent and ubiquitous in environmental matrices, as well as in wildlife and humans, worldwide. PFCAs and their precursors can undergo long-range atmospheric transport leading to their worldwide distribution through wet and dry deposition.

Our custom-built passive air samplers (PAS) contain an overlying polypropylene filter which blocks particles and allows gases to permeate through to a nylon filter onto which gas phase acids, including PFCAs, selectively sorb. Each PAS is enclosed inside a weatherproof cap which protects it from wind, precipitation, and sunlight, while allowing continuous diffusion of acids to the nylon filter. Our PAS are capable of sampling gas-phase PFCAs, offering a simple, low-cost alternative to active samplers, meaning that the PAS can be deployed virtually anywhere due to their power-free and low maintenance design. Demonstration of the capabilities of these PAS will enable more widespread research on contamination levels and long-range transport processes of PFCAs. Such research is essential for a comprehensive understanding of the risks PFCAs pose to the environment and human health.

The objectives of this research are selection of internal standards for quantitative method optimization at ultra-trace levels, and ambient monitoring of short chain (C2-C6) PFCAs in the atmosphere with passive air samplers, using Ion Chromatography-Mass Spectrometry for analysis.

One preliminary finding related to internal standards is that in the absence of a ^{13}C-PFPrA internal standard (IS), the ^{13}C-TFA IS should be used to normalize PFPrA peaks, as the PFPrA recoveries using the ^{13}C-PFBA internal standard were not equivalent to those using the ^{13}C-PFPrA IS.

Triplicate passive air samplers (PAS) were deployed at four Toronto locations to obtain ultra trace data (ppqv to pptv-levels) on the atmospheric concentrations of C2-C6 PFCAs. Measurements were obtained from three locations as part of the Study of Winter Air Pollution in Toronto (SWAPIT) campaign, and at Pearson International Airport, a suspected hotspot. PAS from the SWAPIT sampling sites showed similar ppqv-level PFCA concentrations, with mixing ratios for the shortest chain PFCAs (TFA and PFPrA) 6 to 9 times higher than PFBA. These observations provide further insight on the abundance, sources, transport, and deposition of PFCAs in an urban megacity, where use and release of precursors is substantial.

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Developing of a statistical model to explore the influencing mechanisms on atmospheric mercury concentration in Taiwan

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Mercury (Hg) is a toxic metal with persistent and bioaccumulative properties, primarily dispersed globally through atmospheric circulation. The United Nations Environment Programme (UNEP) published the Global Mercury Assessment 2018 in 2019, estimating that global anthropogenic atmospheric mercury emissions in 2015 amounted to 2,220 tons. East and Southeast Asia were identified as the major emission source regions, contributing 38.6% of global emissions (approximately 859 tons). To simulate atmospheric mercury concentration changes and investigate influencing factors, besides chemical transport models, recent studies have increasingly employed Generalized Additive Models (GAMs) to model variations in air pollutant concentrations and explore the mechanisms affecting these changes.

This study utilizes GAMs to quantify the impact of meteorological factors and air pollutants on the concentration of gaseous elemental mercury (GEM) at a low-altitude station (National Central University, NCU) and a high-altitude station (Lulin Atmospheric Background Station, LABS). The study further explores the mechanisms by which various meteorological factors influence GEM concentrations. The results indicate that from2019 to 2020, the average GEM concentration measured at NCU was 2.16 ±3.13 ng m-3, while at LABS, it was 1.40 ± 0.36 ng m-3. Due to the difference in altitude, air quality at NCU, located in the suburban area of Taoyuan, is affected by local emissions as well as pollutants transported by the northeast monsoon from mainland China. However, in high-altitude regions such as LABS, the primary influences are monsoons and regional factors, such as biomass-burning emissions from the Indochina Peninsula, which are transported over long distances to the high mountain stations in Taiwan.

GAMs analysis revealed that carbon monoxide (CO) had the greatest contribution to GEM variation at both LABS and NCU stations, indicating that both sites were primarily influenced by anthropogenic emissions. At LABS, the next most significant factors were the month and relative humidity (RH), whereas at NCU, the most influential factors were hour and wind direction (WD). Additionally, GEM concentrations at NCU were higher when the wind direction was predominantly from the south and southwest, suggesting the presence of emission sources between the south-southwest and southern directions. When using GAMs to predict GEM concentrations in other years, the model tended to overestimate during the spring and summer at LABS and underestimate in all seasons at NCU. This discrepancy is mainly attributed to the impact of local emissions, where the model struggles to capture extremely high values during pollution events.

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Atmospheric Deposition of Microplastics in South Central Appalachia, United States

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The increasing prevalence of plastic pollution globally has made the atmospheric deposition of microplastics (MPs) a critical issue, necessitating a deeper understanding of its environmental and human health impacts. This study is the first to quantify and characterize atmospheric MP deposition in the Eastern United States. Sampling was conducted at two locations: the National Atmospheric Deposition Program (NADP) Site NTN VA13 and Virginia Tech's Kentland Farm in remote South Central Appalachia, from March to September 2023. Each site underwent five sampling periods, with collections spanning 21 days each. Samples were processed to remove biological material, and the presence of MPs was confirmed using Raman spectroscopy, which matched particles based on polymer similarity. The average atmospheric MP deposition in South Central Appalachia was determined to be 68 MPs m^{-2} d^{-1}. Most confirmed MPs were fibers, with polyethylene terephthalate (PET) being the most abundant polymer type identified. This study's average MP deposition rate is comparable to rates reported in other studies using similar methodologies and landscapes. When scaled to the entirety of South Central Appalachia, covering an area of over 94,000 km^2 and home to five million people, the estimated yearly MP deposition is approximately 321 metric tonnes. Our findings underscore the prevalence of atmospheric MP deposition in rural areas of the United States and highlight the importance of establishing a new network for MP deposition within the NADP.

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The importance of assessing Mercury in ambient air in Mexico City

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The impact of mercury on the environment has long been widely known: air, water and soil, as well as its concentrating effect in food chains. Likewise, the complexity of its measurement must be recognized, especially due to technical difficulties and of course the cost involved in the measurement. In the case of the determination of mercury in ambient air, the National Atmospheric Deposition Program (NADP) carries out its measurement through the Atmospheric Mercury Network (AMNet).

The National Autonomous University of Mexico (UNAM) collaborates with NADP in the lines of research on the assessment of wet atmospheric deposition in some regions of North America, the evaluation of reactive nitrogen in ambient air and in wet atmospheric deposition and, starting in 2023, in the measurement of mercury in ambient air, having installed a Tekran analyzer at the air quality monitoring station located at the Institute of Atmospheric Sciences and Climate Change (ICAyCC) of the UNAM.

The monitoring of mercury in ambient air began on June 6, 2023, and through March 8, 2024, made 74,576 measurements of elemental mercury concentration every 5 minutes. The data analysis corresponded to different levels of validation according to US-EPA protocols. The maximum concentrations of mercury were 10 to 20 ng/m^3 for some days, with the minimum concentration of 1.33 ng/m^3. The average and median of the study period were 3.33 and 3.10 ng/m^3, respectively. A daily average concentration of 3.31 ng/m^3 and a median of 3.14 ng/m^3 over the 276 days of monitoring. The minimum and maximum daily concentrations were between 1.97 and 6.52 ng/m^3. The hourly behavior (0 to 23 hours) of mercury concentrations indicated that the maximum value was measured between 5 and 6 am at 3.66 ng/m^3 and a minimum of 2.90 ng/m^3 at 3 pm. The hourly average was 3.33 ng/m^3 with a median of 3.34 ng/m^3. Finally, the maximum mercury concentration of 20.36 ng/m^3 was recorded on Wednesday, followed by Thursday with 15.85 ng/m^3 and Monday with 15.69 ng/m^3. The rest of the days indicated a maximum concentration level between 11.20 and 14.49 ng/m^3.

It is worth mentioning that the monitoring site at UNAM corresponds to a school activity in an urban area. It is also recommended to increase the number of sites for measuring mercury in ambient air in industrial areas and in regions of international interest such as the Gulf of Mexico.

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Assessing Atmospheric Mercury Sources using Stable Isotope Methods

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The application of mercury (Hg) stable isotopes has become an important tool for tracking Hg sources and delivery pathways in the environment. With the onset of the Minamata Convention, a global treaty aimed to mitigate environmental Hg emissions, Hg stable isotopes may be important in assessing whether reductions under the treatise are actively resulting in Hg declines across matrices. Here, we present the application of a low-cost active sampler for the measurement of Hg stable isotopes in total gaseous mercury (TGM). We will discuss modifications to the sampler to operate on both gold and carbon traps as well as compare isotope measurements between this unit and passive sampling devices to determine potential offsets between the methods. TGM isotope collectors were further used to assess regional sources of Hg emissions we deployed a national scale network as well as targeted study locations including contaminated sites, volcanic regions, and offshore oceanic measurements (i.e., representative of global emission pools). From this work we were able to characterize local and regional emission sources of Hg as well as seasonal patterns in isotope composition.

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Measuring short-chain per- and polyfluoroalkyl substances in Central New Jersey air using chemical ionization mass spectrometry

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Real-time measurements of gas phase per- and polyfluoroalkyl substances (PFAS) were performed in Central New Jersey air using chemical ionization mass spectrometry (CIMS). The CIMS was operated with Iodide as the reagent gas. Calibrations were performed for C_2 – C_6 perfluorinated carboxylic acids, and 4:2 and 6:2 fluorotelomer alcohols. Of these target analytes, only trifluoroacetic acid (TFA) was detected above instrumental detection limits in ambient air. Instrumental sensitivities were estimated for other detected PFAS including $C_3H_2F_6O$ and $C_6HF_{11}O_3$. Mixing ratios of TFA reached up to 0.7 parts-per-trillion by volume (pptv). Estimated mixing ratios of $C_3H_2F_6O$ and $C_6HF_{11}O_3$ reached the single pptv level. These latter two formulas are consistent with hexafluoroisopropanol (HFIP), & hexafluoropropylene oxide dimer acid (HFPO-DA) respectively, yet may represent multiple isomers. Diurnal profiles of detected PFAS, along with local meteorological data, may provide insight into potential local sources of these compounds. These results demonstrate the potential of online CIMS instrumentation for measuring certain PFAS in ambient air, in real time, at or below the pptv level. This approach also has potential for fenceline monitoring, and other near-source applications.

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