UC DAVIS 2024 NETWORK UPDATE

IMPROVE Fall Steering Committee Meeting

2024 October 29-30

Nicole Hyslop, Xiaolu Zhang, Yongjing Zhao, Marcus Langston and the whole team

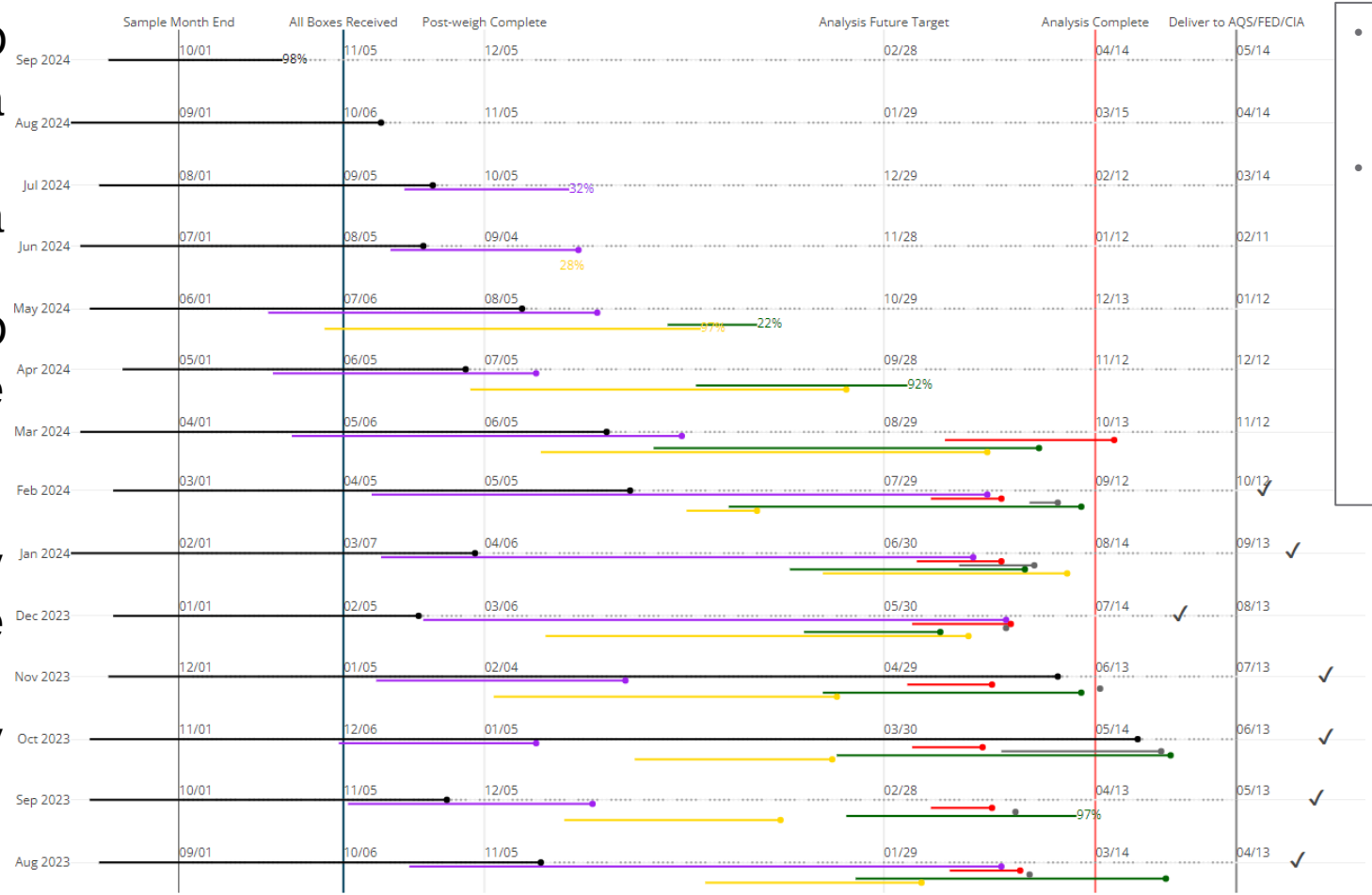
UC DAVIS
AIR QUALITY RESEARCH CENTER

NEBR1, Photo credit: Lawrence Tsai

2024 Site Updates

- Completed 10 field maintenance trip so far
  - VIIS1 next month
- Shelters relocated/rebuilt
  - NEBR1 (rebuilt)
  - GAMO1 (relocated to MAPA1)
  - SHEN1 (relocated to new structure)
- Resumed sampling
  - ULBE1
  - GAMO1 (now MAPA1)
  - NEBR1
  - KAIS1
- New module installed
  - FRES1 (5A)
  - TRIN1 (5B)

Data Delivery



- XRF instruments are currently undergoing annual maintenance
- Will switch back to the old protocol with April 2024 samples
  - Adding back KBr target for better As detection
  - Slightly shorter analysis time

RHR Completeness Failures in 2024

1. Agua Tibia, CA (AGTI1): late and no sample changes
2. Gates of the Mountains, MT (GAMO1): inaccessible, relocated to MAPA1
3. Kaiser Wilderness, CA (KAIS1): power out, resumed sampling in October 2024
4. Nebraska National Forest, NE (NEBR1): fire damage, rebuilt October 2024
5. San Rafael, CA (RAFA1): major power problems, looking to move site
6. San Gabriel, CA (SAGA1): no operator
7. UL Bend, MT (ULBE1): no operator, resumed sampling in August 2024

Active Flow Control Field Deployment

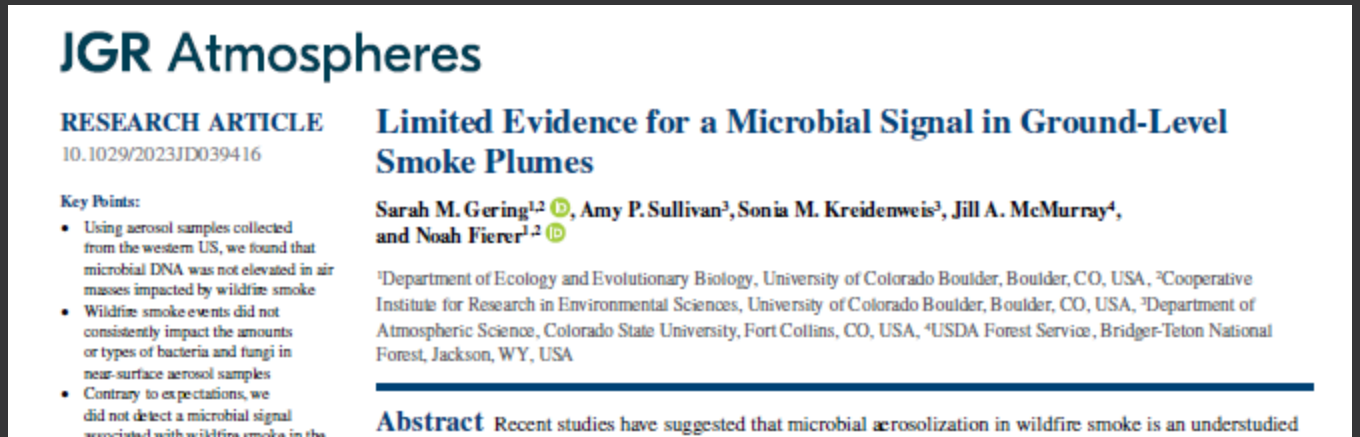
- Purchased and assembled 300 new DC pumps for active flow control
- Deployed active flow control to about half the network
  - Will deploy to remaining sites next year
  - Still working out bugs in software
- Testing new model AC pumps for PM_{10} modules at some sites
  - Old model AC pumps (made in 2004-14) were discontinued
  - Tried a replacement model (made in 2016-18) but recalled them for unreliability
- Installed 3 wind sensors (homemade drag-and-move anemometer) at ISLE1, HOOV1, DOME1

Clogging Protocol – Stop sampling

- If flow rate falls below 15 LPM for more than 15 minutes
  - If ≥18 hours into sample
    - Shut off all modules
    - Data are still valid for RHR
  - Else
    - Shut off the clogged module
    - Shut off the companion module for PM coarse calculation (i.e., shut off PM_{10} PTFE if $PM_{2.5}$ PTFE clogs)
    - Data invalid for RHR but delivered with an accurate concentration and a qualifier flag indicating a short sample time
- Short Duration (SD) flag applied to samples
  - Sampling halted on 47 out of 18,891 sampling events in 2023 (0.2%)
  - Sampling halted on 16 out of 10,358 sampling events so far in 2024 (0.2%)
  - Note: These rates are low because flow control is only deployed in a fraction of the network

IMPROVE Sample Archive Requests

- More interest this year
- Paper published finding DNA in IMPROVE samples
- Last week, researcher interested in looking for covid virus in IMIPROVE samples
- Earlier this month, group at UCD interested in studying biologicals from natural disasters



JGR Atmospheres

RESEARCH ARTICLE
10.1029/2023JD039416

Key Points:

- Using aerosol samples collected from the western US, we found that microbial DNA was not elevated in air masses impacted by wildfire smoke
- Wildfire smoke events did not consistently impact the amounts or types of bacteria and fungi in near-surface aerosol samples
- Contrary to expectations, we did not detect a microbial signal

Limited Evidence for a Microbial Signal in Ground-Level Smoke Plumes

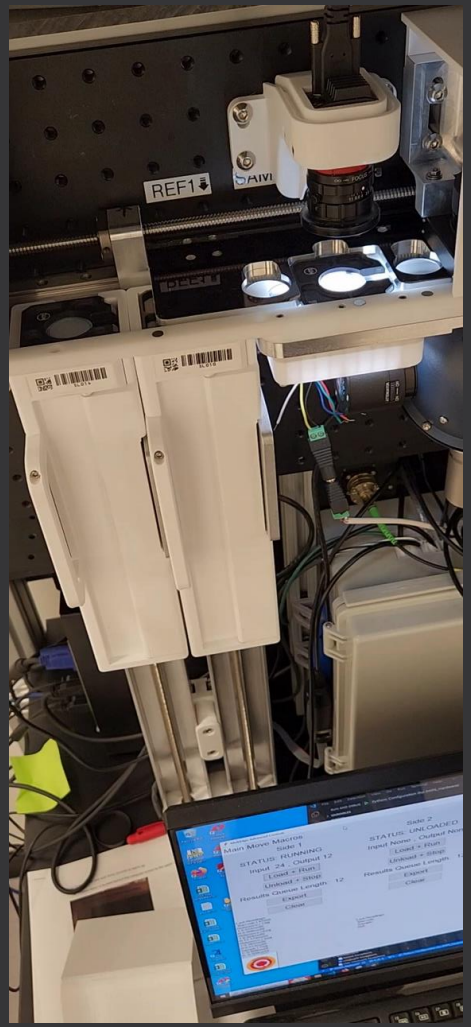
Sarah M. Gering[1,2], Amy P. Sullivan[3], Sonia M. Kreidenweis[3], Jill A. McMurray[4], and Noah Fierer[1,2]

[1]Department of Ecology and Evolutionary Biology, University of Colorado Boulder, Boulder, CO, USA, [2]Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, CO, USA, [3]Department of Atmospheric Science, Colorado State University, Fort Collins, CO, USA, [4]USDA Forest Service, Bridger-Teton National Forest, Jackson, WY, USA

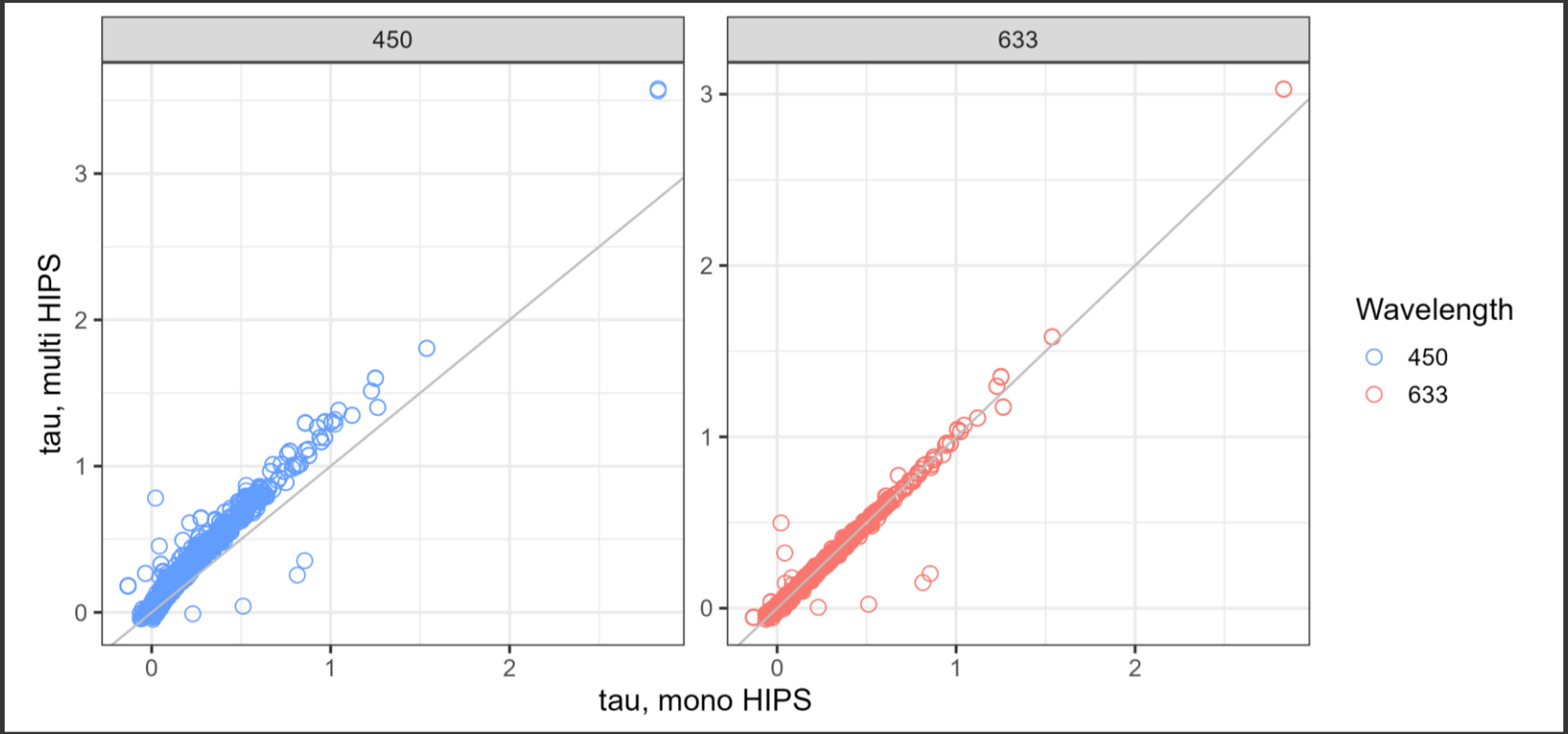
Abstract Recent studies have suggested that microbial aerosolization in wildfire smoke is an understudied

Multi-wavelength HIPS Refinement

- Existing instrument has one wavelength at 633 nm
- Multi-HIPS has 4 wavelengths at 450, 553, 633, and 730 nm
- Multi-HIPS operated by lab staff analyzing fraction of current IMPROVE filters between October 2023 and April 2024
  - 553 nm and 730 nm lasers are being repaired
- Analyses to-date include:
  - 5,097 IMPROVE samples (2,551 $PM_{2.5}$ & 2,546 PM_{10})
  - 98 field blanks
  - 1,159 paired pre- and post-sampling measurements (587 $PM_{2.5}$)
- Refining image collection at multi-HIPS



Multi- to mono-HIPS comparison



- 1626 IMPROVE samples (lot 253, Oct23-Feb24 sample dates)
- mono-hips currently analyzing Mar 2024; multi-hips analyzed through Apr 2024

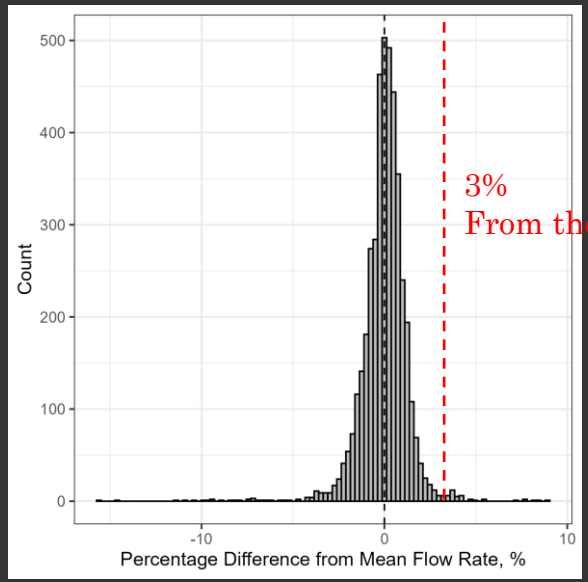
Quality Assurance Activities

Updates on Undersized Quartz Filters

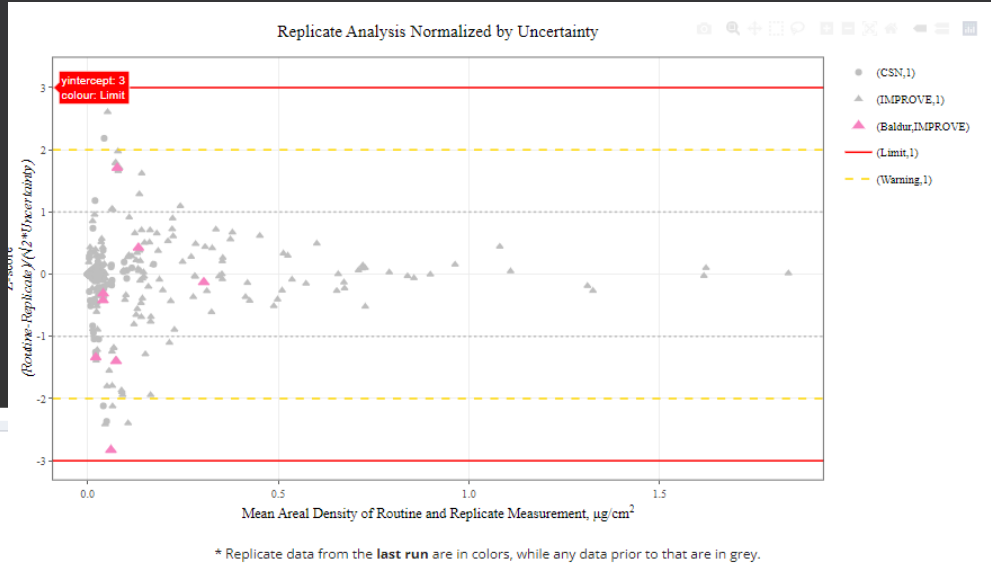
- Testing performed at UCD shop suggests that any flow variation caused by undersized quartz filters cannot be detected
- No filter loaded (extreme case): flow only ~8% higher than nominal
- “Usual” undersized filter:

  flow within 3% higher than nominal

2021 Q1 C module (quartz) flow variation



Replicates added to XRF QC pages



XRF Daily Operations | QC Summary | Weekly Replicates | Replicates Thumbnails

Daily QC Checks

	Blanks	ME
Odin	OK	OK
Froya	OK	OK
Thor	OK	OK
Nanna	OK	OK
Baldur	OK	OK

Weekly QC Checks

Analyzer	Replicate	ME
Odin	Na	OK
Froya	Mg, Na, P	OK
Thor	P	OK
Nanna	As, Na	OK
Baldur	Mg, Na	OK

Daily Check Status

Approved

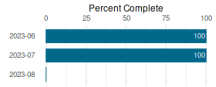
Last Check
Initials: LK
Date: Sat 14 Oct 2023 06:51:38 AM PDT
Comment: QC passes for all instruments.

Last Analysis

Odin	Froya	Thor	Nanna	Baldur
39 min	17 min	42 min	14 min	40 min

CSN Network

Batch	Analyzed	Total
2023-06	973	973
2023-07	1187	1187
2023-08	0	1240



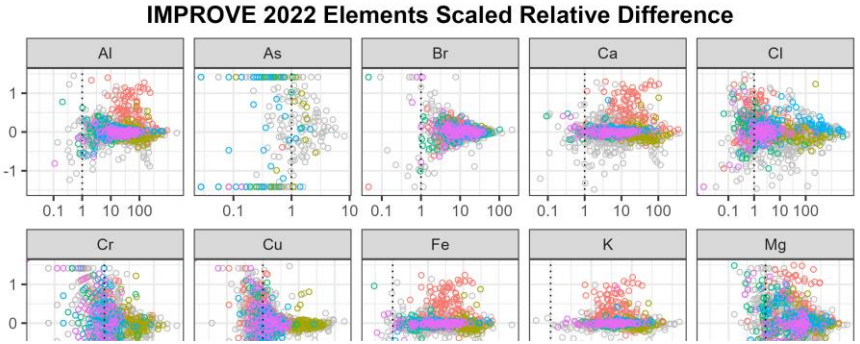
Misused Applications (last 2 weeks)

No misused applications.

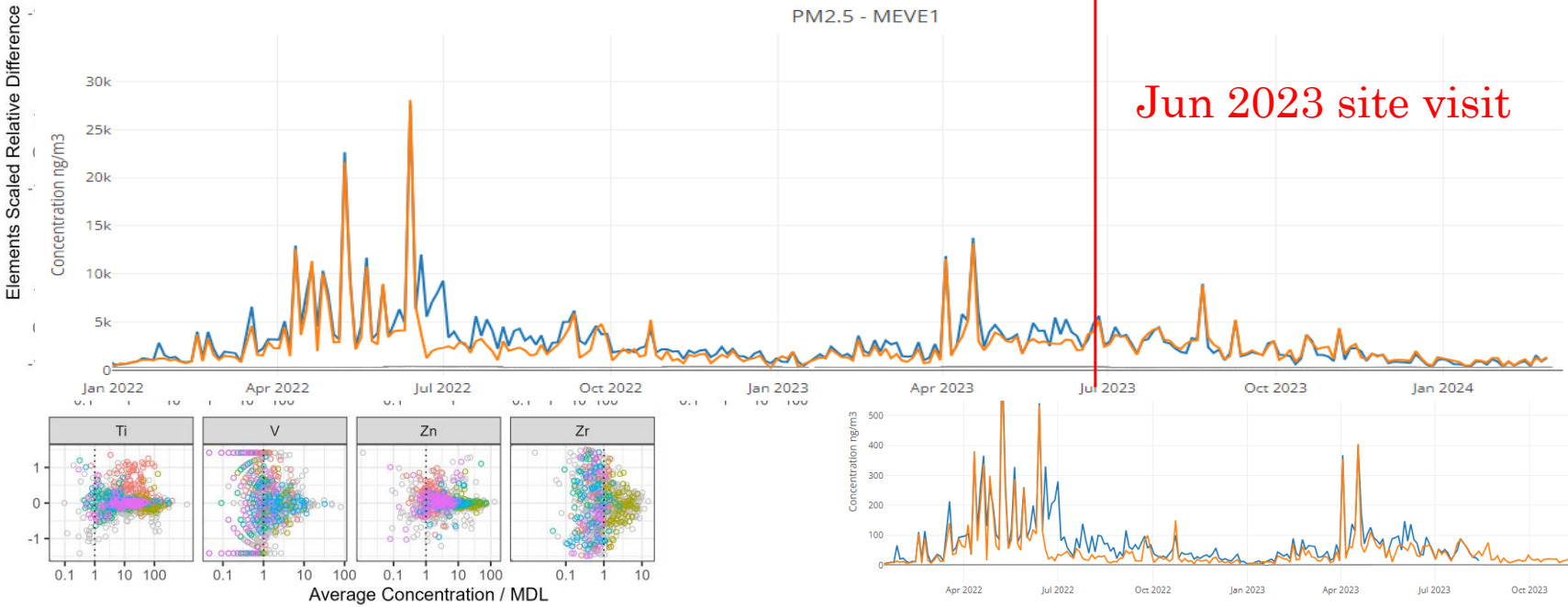
Instrument Stats

	Odin	Froya	Thor	Nanna	Baldur	All
Network	IMPROVE	IMPROVE	IMPROVE	IMPROVE	IMPROVE	
Samples in last 12 hours	15	16	15	16	15	77
Samples per day	27	24	29	26	28	134
Monday	23	13	23	17	22	98
Tuesday	25	23	32	31	32	143
Wednesday	31	30	31	31	31	154
Thursday	32	32	32	31	31	158
Friday	32	32	32	32	32	160
Saturday	17	18	17	18	17	87
Sunday	18	17	24	17	18	94
Weekly Total	**178**	**165**	**191**	**177**	**183**	**894**

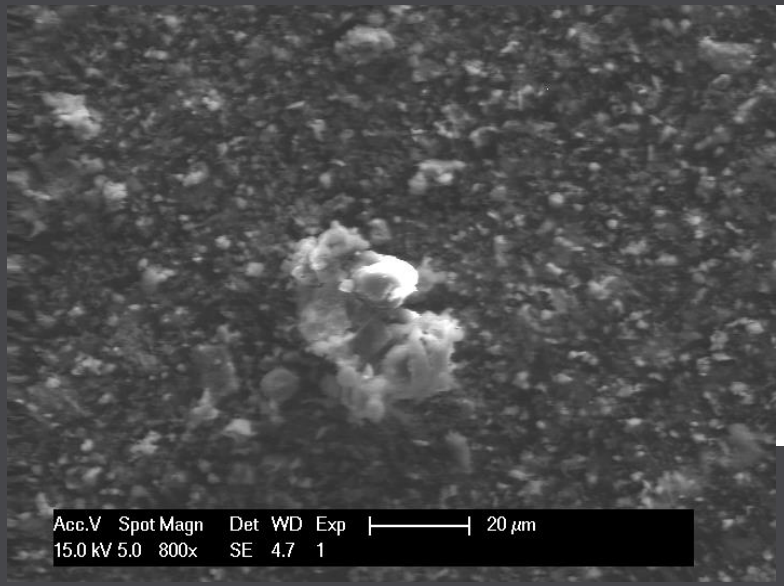
- Warnings to alert technicians of failures

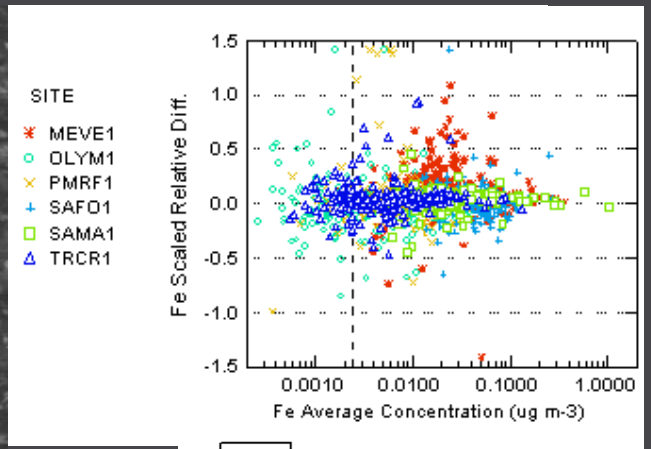


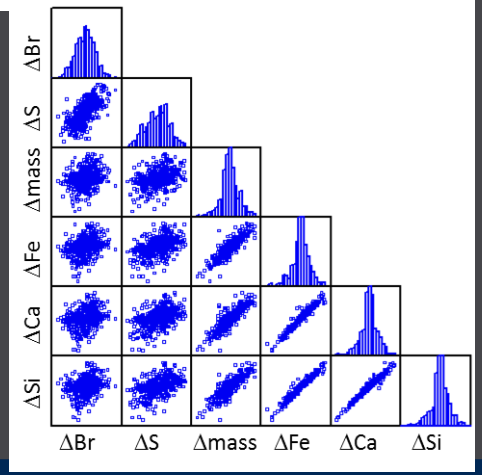
- Mesa Verde A-module collocated agreement degraded for some soil elements (Al, Ca, Fe, K, Mn, Si, Ti) in 2022 and early 2023.
- Field Crew visited MEVE1 in



$PM_{2.5}$ Cut Point Discrepancies (slide from 2013)



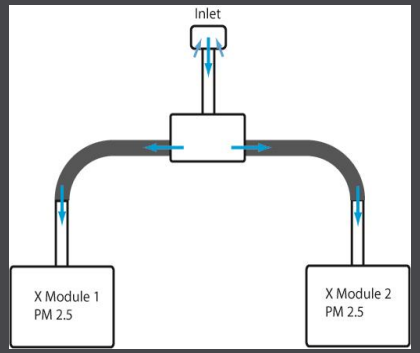


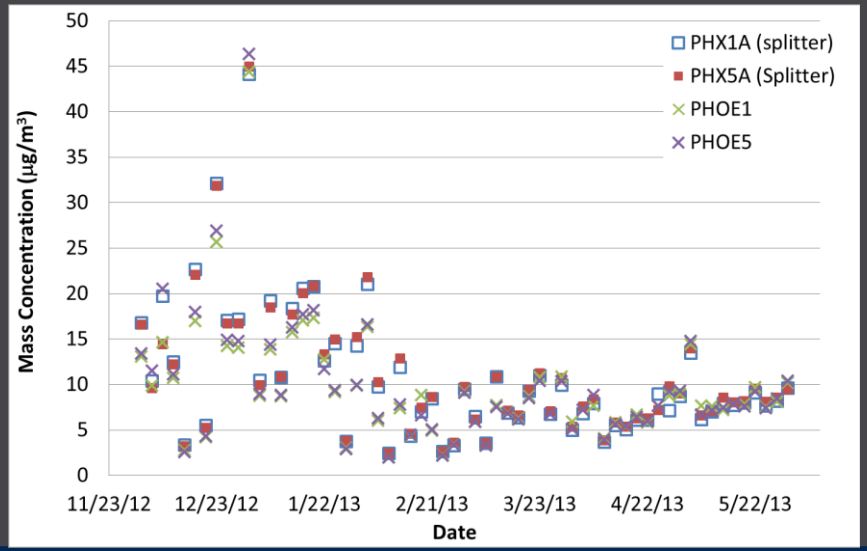


Collocated data have much larger differences for soil-derived elements than expected

Local Sources Test (slide from 2013)

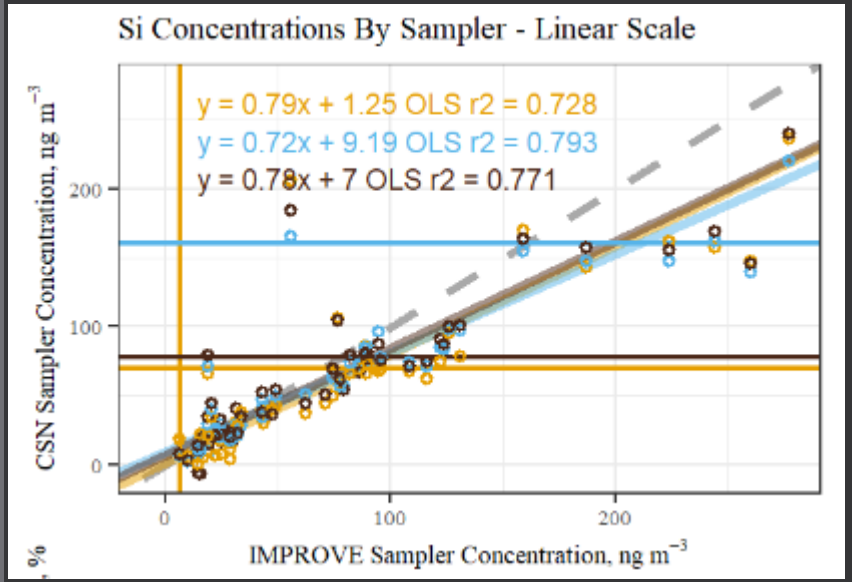
- Four total modules at Phoenix
  - Two with normal inlets
  - Two modules sampling from single inlet
    - To remove possibility of local sources encountering one sampler and not another.

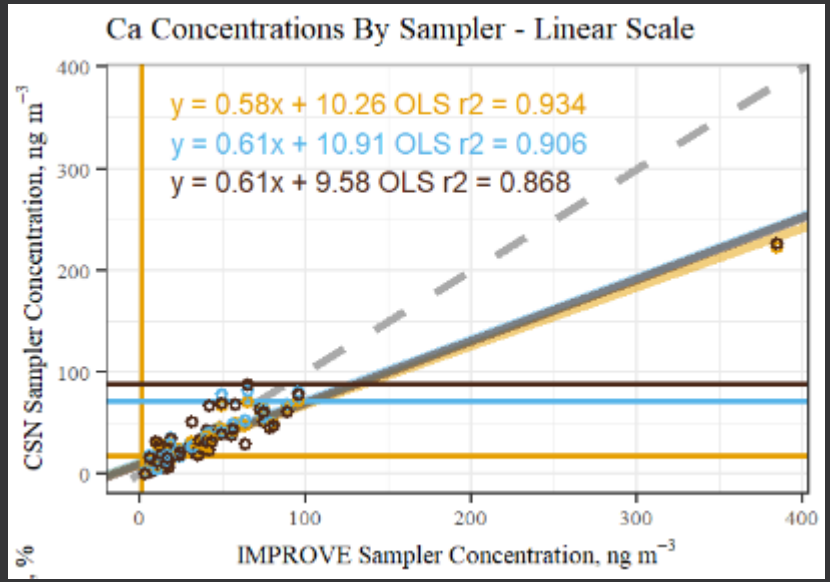




$PM_{2.5}$ Size Cut Concerns

- Poor agreement between soil elements in collocated measurements at soil-dominated sites
- IMPROVE versus CSN soil concentrations



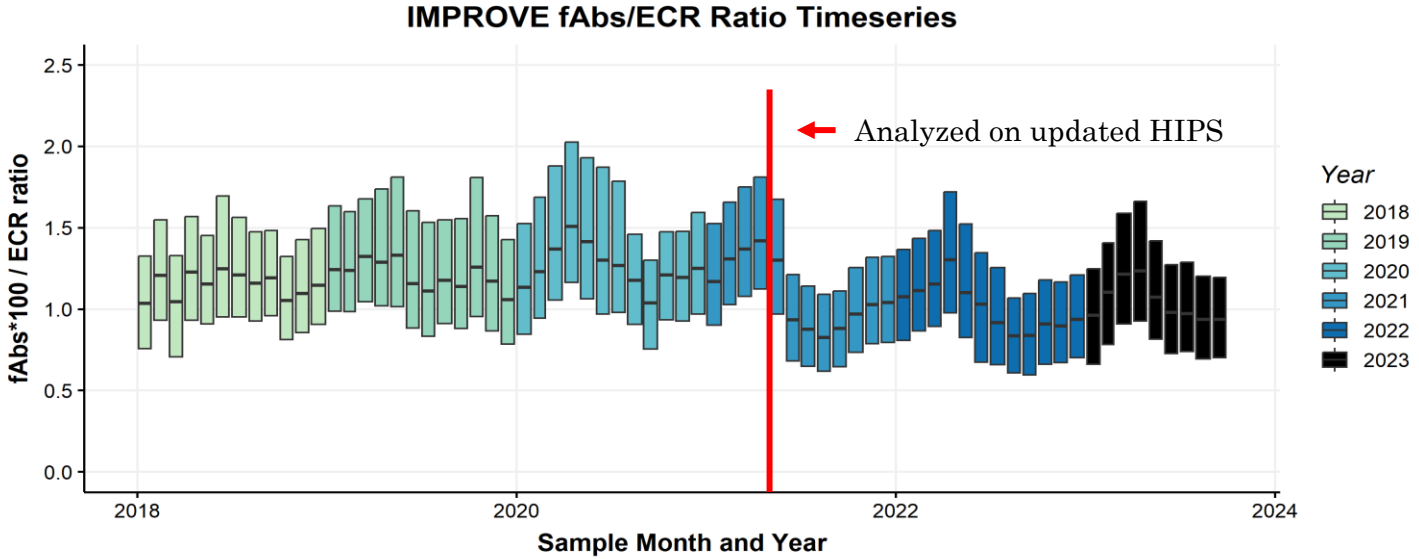


$PM_{2.5}$ Cut Point Tests (slide from 2013)

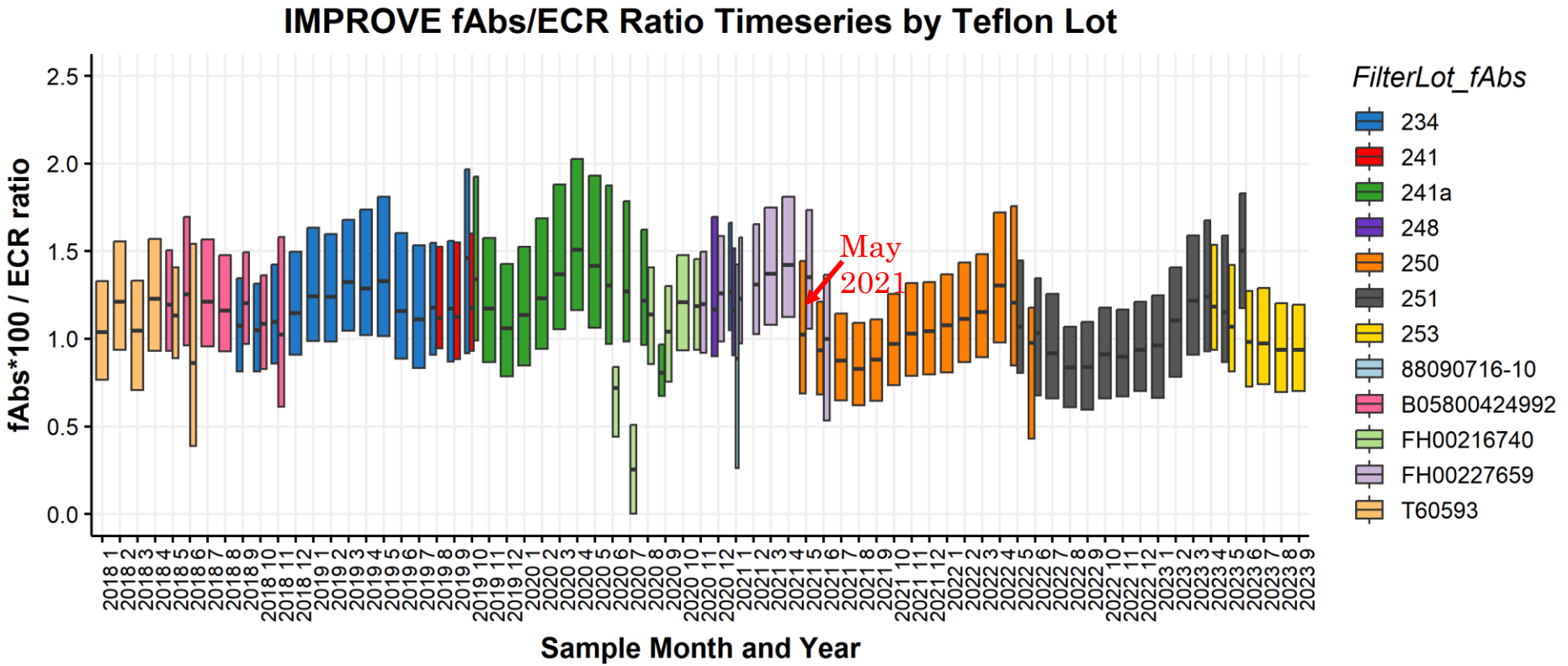
- Pre-Cut: Testing two-cyclone system
  - Prototype cyclone designed for 5μm cut point at 23LPM
  - Fabricated on 3D printer out of cornstarch, cheap $

- Further testing is on hold until higher priority work is completed (or funding situation changes)
- Next step: Test PM_{10} inlet on top of $PM_{2.5}$ stack on collocated Phoenix module (PHOE5)

Cross-Module Ratios



- Filter manufacturer changed (Pall to MTL) around May 2021
- New collimating/focusing lens was installed on the HIPS instrument and all samples back to May 2021 were reanalyzed
- Started an experiment to compare HIPS measurements on Pall versus MTL filters

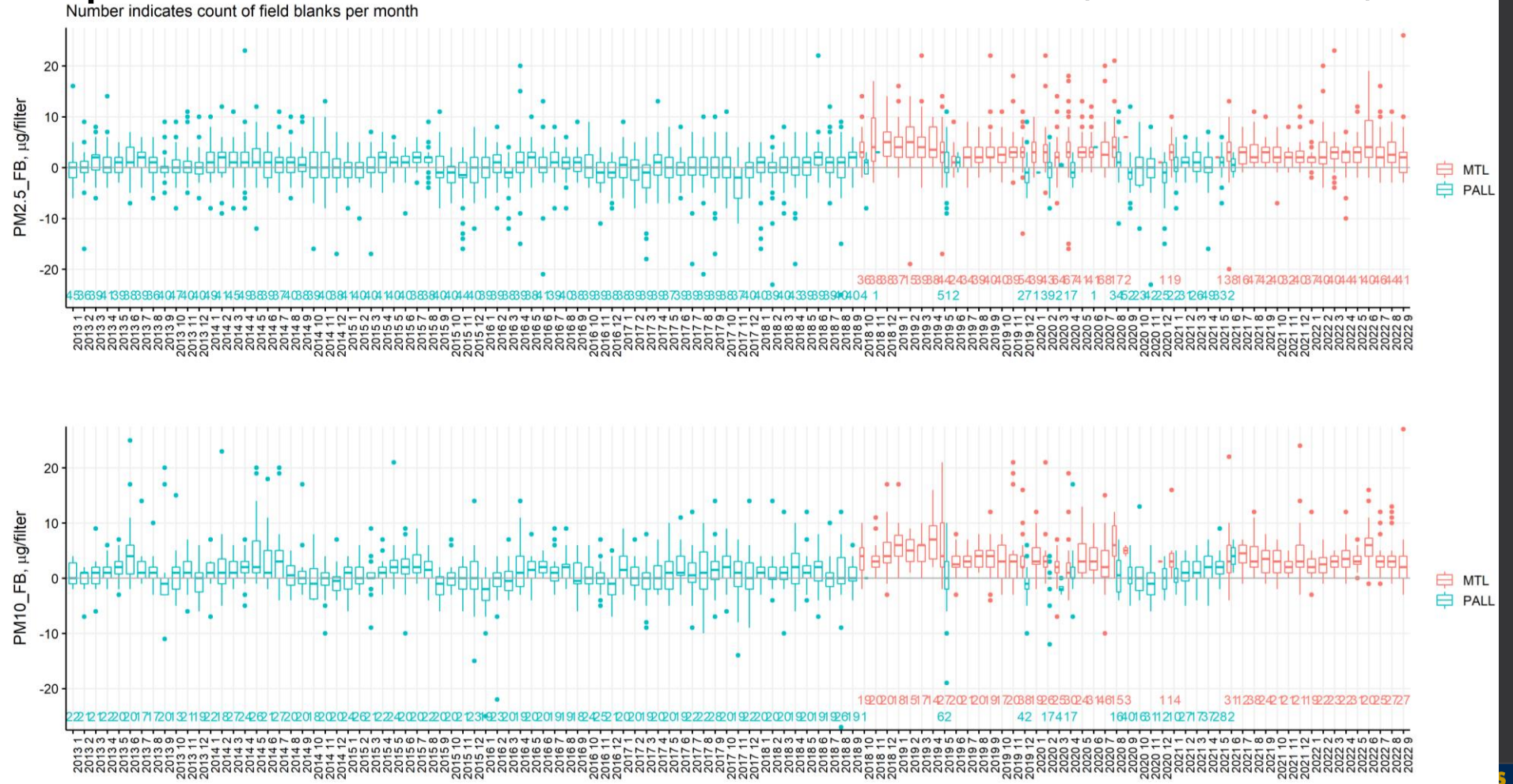


MTL Lot 250: May 2021 – June 2022
MTL Lot 251: May 2022 – June 2023

Still Exploring Possible Causes

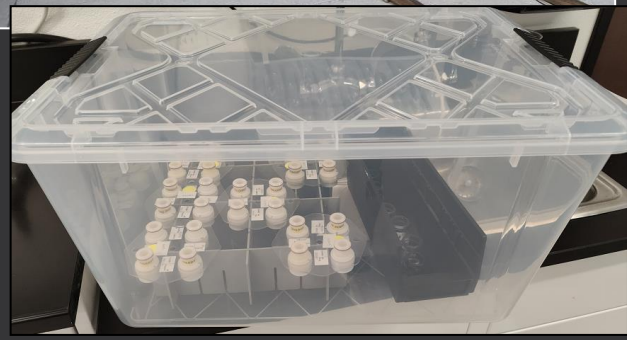
- Collected collocated Pall and MTL PTFE filters at PHOE5 to check if light absorption (HIPS) results are significantly different
    - Samples collected Aug 2023 thru March 2024
    - Just finished HIPS analyses, nothing to show yet
- Ongoing experiments on both Pall and MTL PTFE filters
    - Optical consistency
        - Analyze by HIPS
        - Install in sampler in chamber and pull clean air through filters for 24 hours
        - Analyze by HIPS to see if filter properties are the same
    - Result: No change in optical properties detected after pulling clean air through filters

Updates on MTL Filter Blank Mass Gain (slide from 2022)



Experiments on PTFE filters

- MTL filter mass gain
  - Field blank roof testing
  - Extended field blank testing
  - VOC contamination chamber test
  - Result: Mass gain related to ring material, likely static charge
    - MTL looking into alternate material
- Pixilated deposits
  - Drain disks for PHOE5 from August 2024 thru Feb 2025



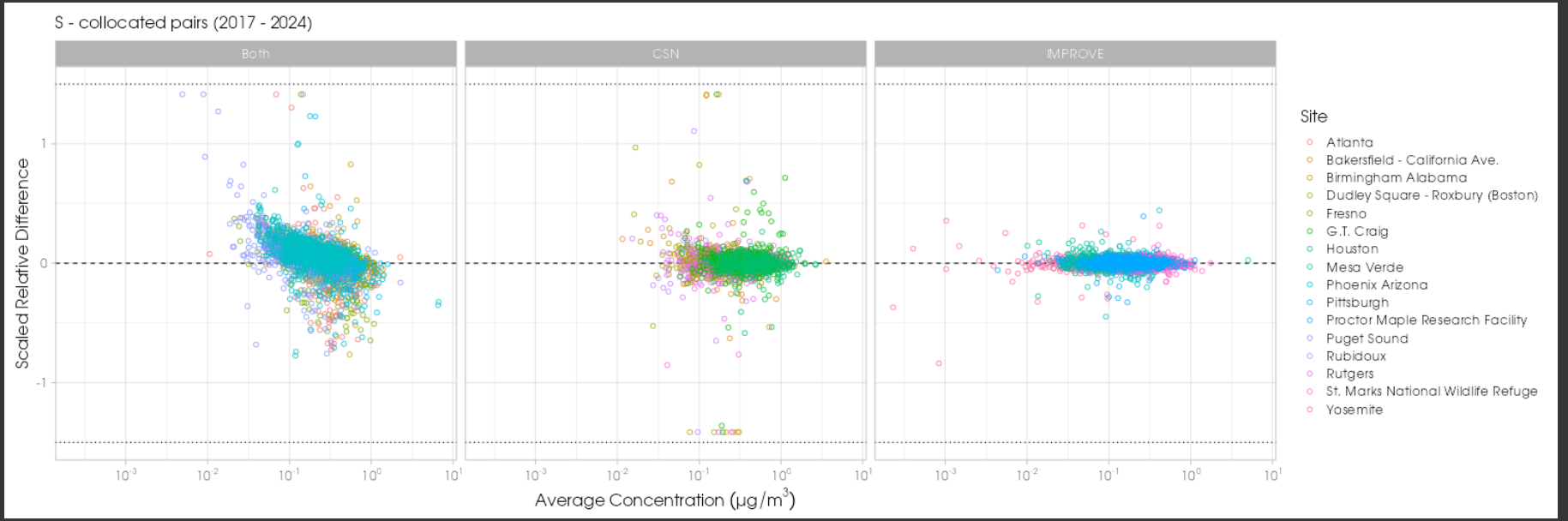
Experiments on PTFE filters (Continued)

- Pore size
  - CSN uses 2 µm pore size, IMPROVE uses 3 µm pore size filters
    - capture efficiency specifications are almost identical, but limited tests suggest otherwise
  - Passive flow control could not accommodate 2 µm pore size
  - Active flow control allows for higher pressure drop and changes in pressure drop with a new lot!
  - Tested with flow control on roof – worked well and didn't clog faster than 3 µm filters
  - Currently testing on newly installed collocated module in Fresno

Cost Reducing Ideas

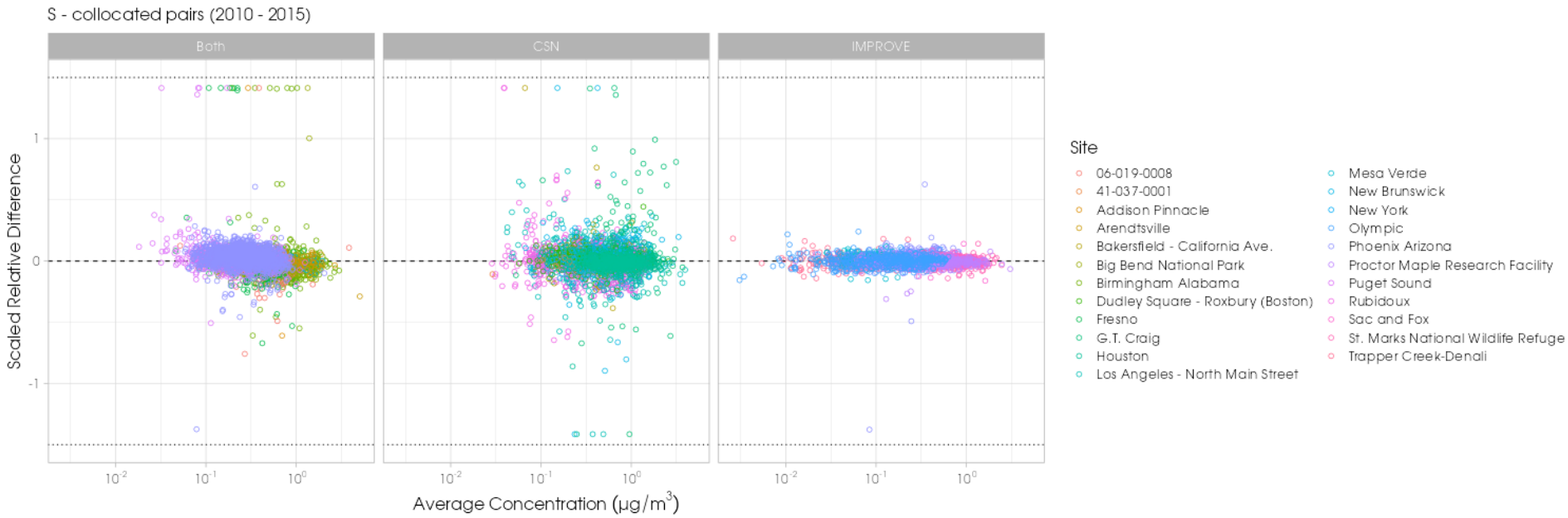
- PTFE $7.50/filter compared to Nylon $3/filter
- If PM_{10} switched to using another type of filter for gravimetric measurements, potentially save thousand dollars per sampling day on filters
    - Will be looking into filter options for gravimetric mass

Sulfur Cross-Network Agreement



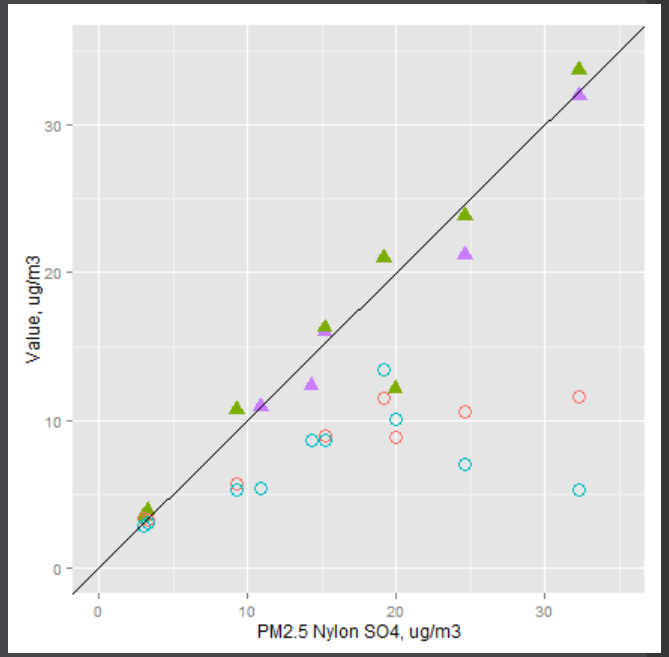
- CSN sulfur underestimated at low concentrations – see Bruker presentation
- Hypothesis: IMPROVE sulfur underestimated when filters are damp (e.g. Fresno in winter months; Atlanta in summer months)
- Agreement was better prior to 2016

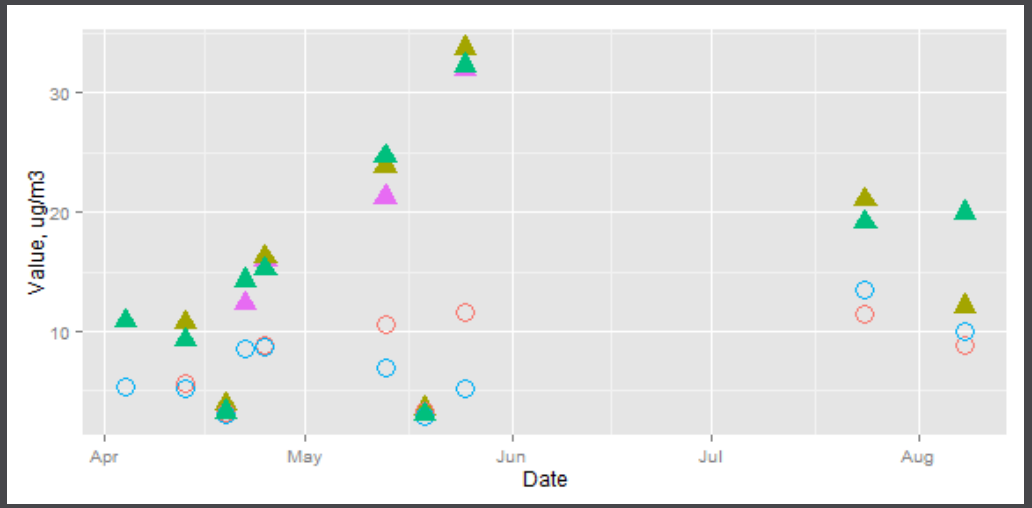
Sulfur Cross-network Agreement



- Decreasing concentrations and lightly loaded samples in CSN are making XRF measurements difficult even for sulfur
- Bruker instruments may improve comparison for sulfur

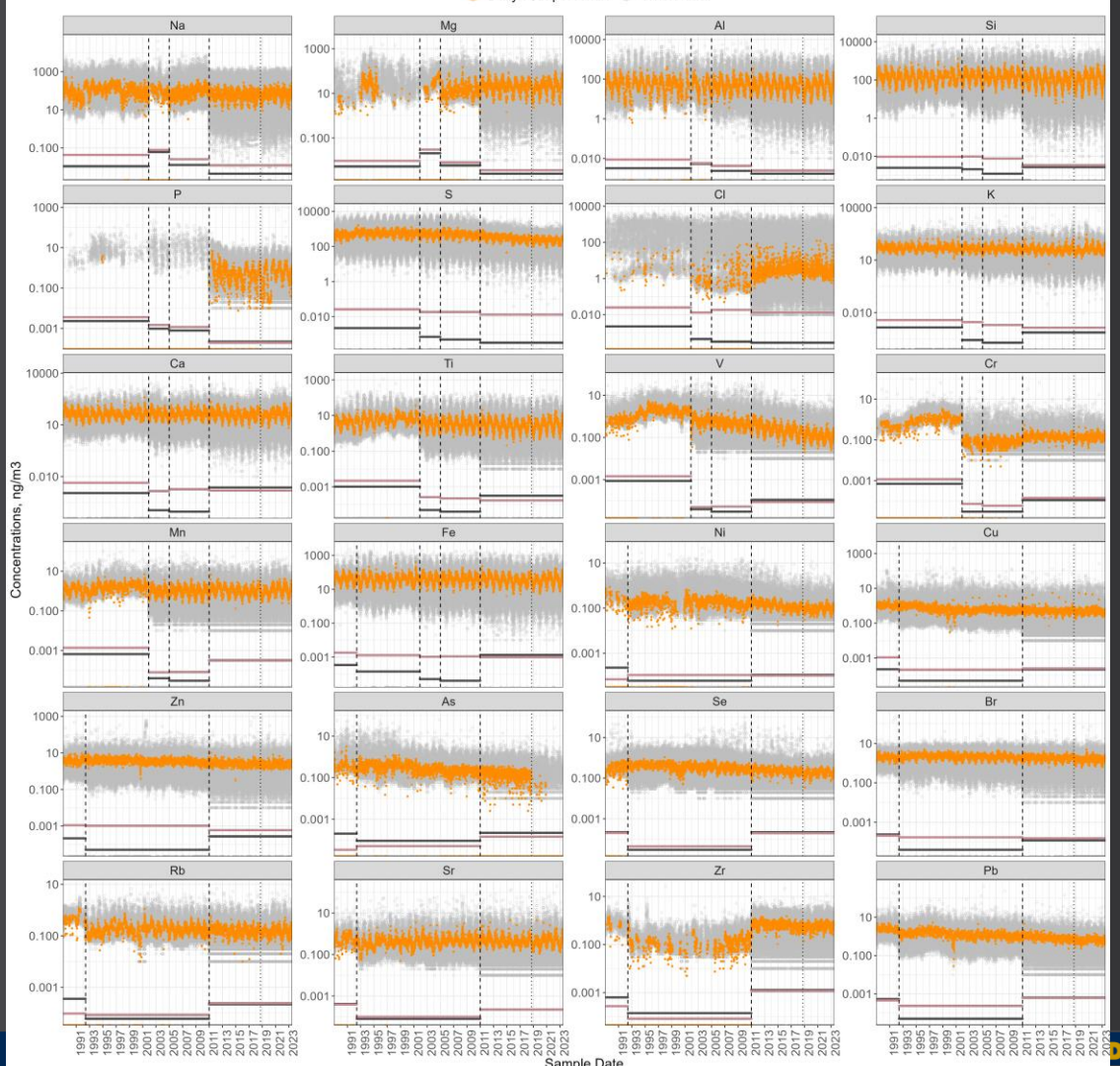
Additional Measurements on the BYIS Filters (2014 slide)





Element Long-term Trends

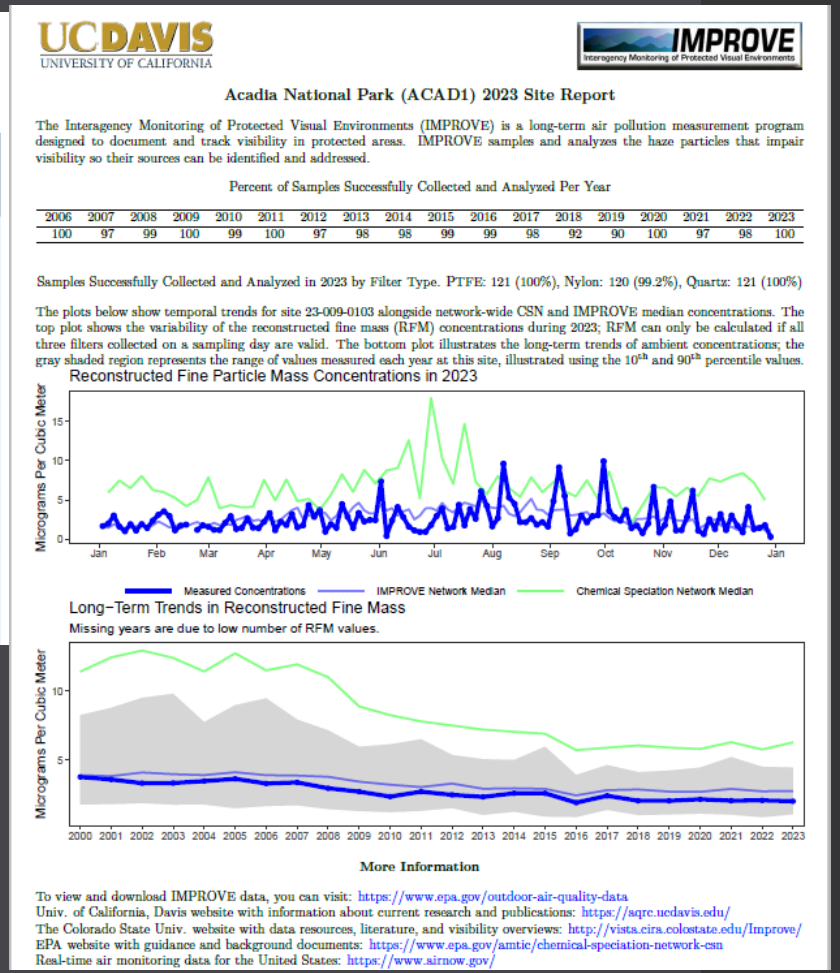
- Investigating stability of element measurements
- Goal is to provide guidance to community on suitability for trend analysis



IMPROVE Annual Site Reports

Select a site report from a location and year to view the PDF. Scroll down or click for the map of IMPROVE site locations.

Site Name	2015 Report	2016 Report	2017 Report	2019 Report	2020 Report	2021 Report	2022 Report
Acadia National Park	ACAD1—15	ACAD1—16	ACAD1—17	ACAD1—19	ACAD1—20	ACAD1—21	ACAD1—22
Agua Tibia	AGTI1—15	AGTI1—16	AGTI1—17	AGTI1—19	AGTI1—20	AGTI1—21	AGTI1—22
Atlanta				ATLA1—19	ATLA1—20	ATLA1—21	ATLA1—22
Badlands	BADL1—15	BADL1—16	BADL1—17	BADL1—19	BADL1—20	BADL1—21	BADL1—22
Baengnyeong Island	BYIS1—15	BYIS1—16	BYIS1—17				
Bandelier	BAND1—15	BAND1—16	BAND1—17	BAND1—19	BAND1—20	BAND1—21	BAND1—22



UCDAVIS UNIVERSITY OF CALIFORNIA

IMPROVE Interagency Monitoring of Protected Visual Environments

Acadia National Park (ACAD1) 2023 Site Report

The Interagency Monitoring of Protected Visual Environments (IMPROVE) is a long-term air pollution measurement program designed to document and track visibility in protected areas. IMPROVE samples and analyzes the haze particles that impair visibility so their sources can be identified and addressed.

Percent of Samples Successfully Collected and Analyzed Per Year

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
100	97	99	100	99	100	97	98	98	99	99	98	92	90	100	97	98	100

Samples Successfully Collected and Analyzed in 2023 by Filter Type. PTFE: 121 (100%), Nylon: 120 (99.2%), Quartz: 121 (100%)

The plots below show temporal trends for site 23-009-0103 alongside network-wide CSN and IMPROVE median concentrations. The top plot shows the variability of the reconstructed fine mass (RFM) concentrations during 2023; RFM can only be calculated if all three filters collected on a sampling day are valid. The bottom plot illustrates the long-term trends of ambient concentrations; the gray shaded region represents the range of values measured each year at this site, illustrated using the 10th and 90th percentile values.

Reconstructed Fine Particle Mass Concentrations in 2023

Micrograms Per Cubic Meter

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

Measured Concentrations IMPROVE Network Median Chemical Speciation Network Median

Long−Term Trends in Reconstructed Fine Mass

Missing years are due to low number of RFM values.

Micrograms Per Cubic Meter

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

More Information

To view and download IMPROVE data, you can visit: https://www.epa.gov/outdoor-air-quality-data
Univ. of California, Davis website with information about current research and publications: https://aqrc.ucdavis.edu/
The Colorado State Univ. website with data resources, literature, and visibility overviews: http://vista.cira.colostate.edu/Improve/
EPA website with guidance and background documents: https://www.epa.gov/amtic/chemical-speciation-network-csn
Real-time air monitoring data for the United States: https://www.airnow.gov/

- 2023 Site reports are under review and will be posted in a few weeks http://aqrc.ucdavis.edu/field-site-reports

Any questions?

New MAPA1 site, Photo credit: Lawrence Tsai