

UC DAVIS 2022 NETWORK UPDATE

IMPROVE Steering Committee Meeting
2022.11.2 – 2022.11.3

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

UC DAVIS
AIR QUALITY RESEARCH CENTER

Total = 157 Sites

2022 Site Updates

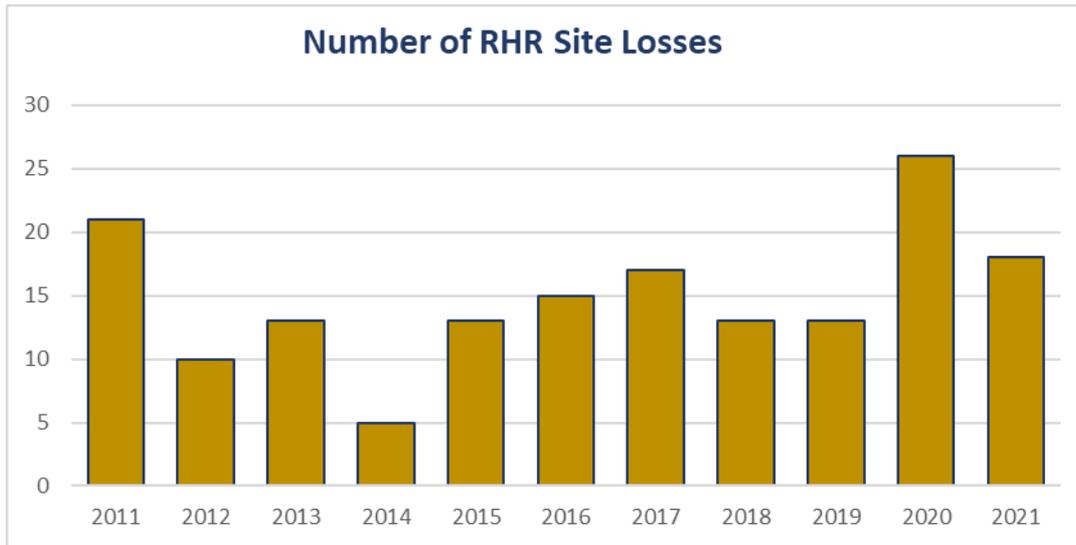
- SHMI1 (USFS, CO) restarted on 8/9/22
- Rebuilding NOCH1 right now
- 3 sites not active due to operators unavailable
 - IKBA1 (USFS, AZ)
 - TRIN1 (USFS, CA)
 - ULBE1 (FWS, MT)
- Field Maintenance
 - Visited 81 sites including EGBE1 (skipped last year)
 - Visit to VIIS1 scheduled in Dec 2022



Regional Haze Rule (RHR) Completeness Criteria

RHR requires for all modules:

- < 11 consecutive missed samples
- > 50% recovery in each quarter
- > 75% annual recovery



2011-2021: Final number of losses after validation

2022: Number of losses year-to-date

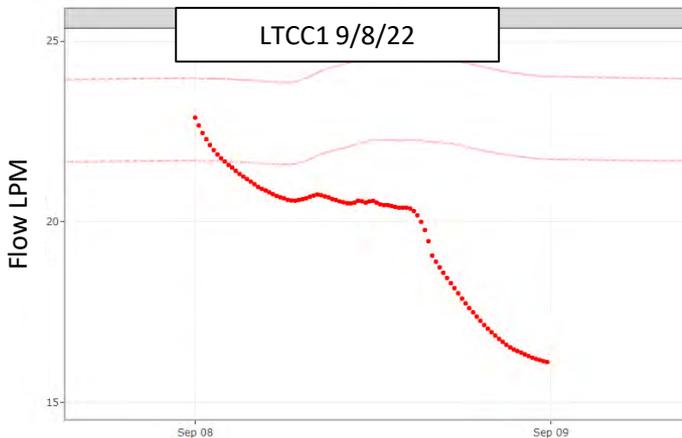
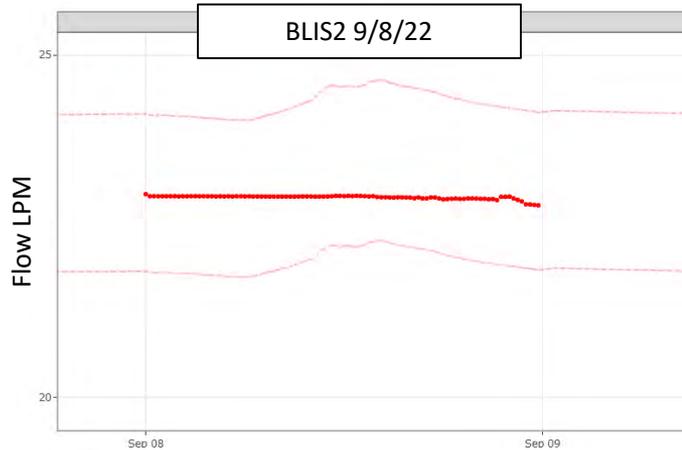
Site status report distributed every quarter; if you aren't on the list, let us know.

Active Flow Control – Development Update 2022



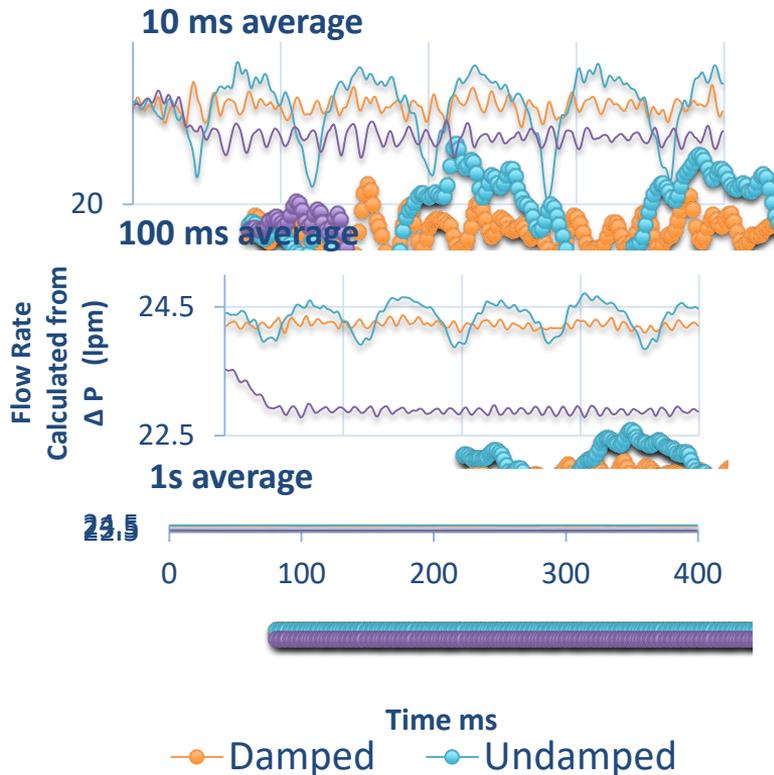
- Requires new hardware, including variable speed pumps, and software
- This year
 - Finalized interface board design and enclosure
 - Finalized software modifications and performed beta testing
 - Tested active flow control against passive flow control at UCD
 - Updating audit instructions and worksheets for flow control sites. Will be available to auditors on request

Active Flow Control – Deployment Update 2022



- ~320 pumps capable of active flow control have been deployed into network
- 2 Sites (FRES1 and BLIS1) are running active flow control
- Will deploy to more sites after additional testing and bug fixes
- Graph shows nearby sites LTCC1 and BLIS2 on a medium/heavy filter loading day
 - The flow control site (BLIS2) maintains a constant flow rate
- Filter clogging is delayed but inevitable with heavy loadings even with active flow control

Flow Control- Testing Pulsation Damper Effectiveness



- Large flow pulses from a piston pump could potentially affect volumetric flow measurement and cyclone size cut
- We currently use large cylinder pulsation damper to prevent flow pulses
- Test with no damper show pump pulses with a 100ms period
- Pulses are not significant when averaged over 1 second
- We are considering using much smaller damper/no damper to make deployment easier
- Planning to test PM size cut if flow is undamped

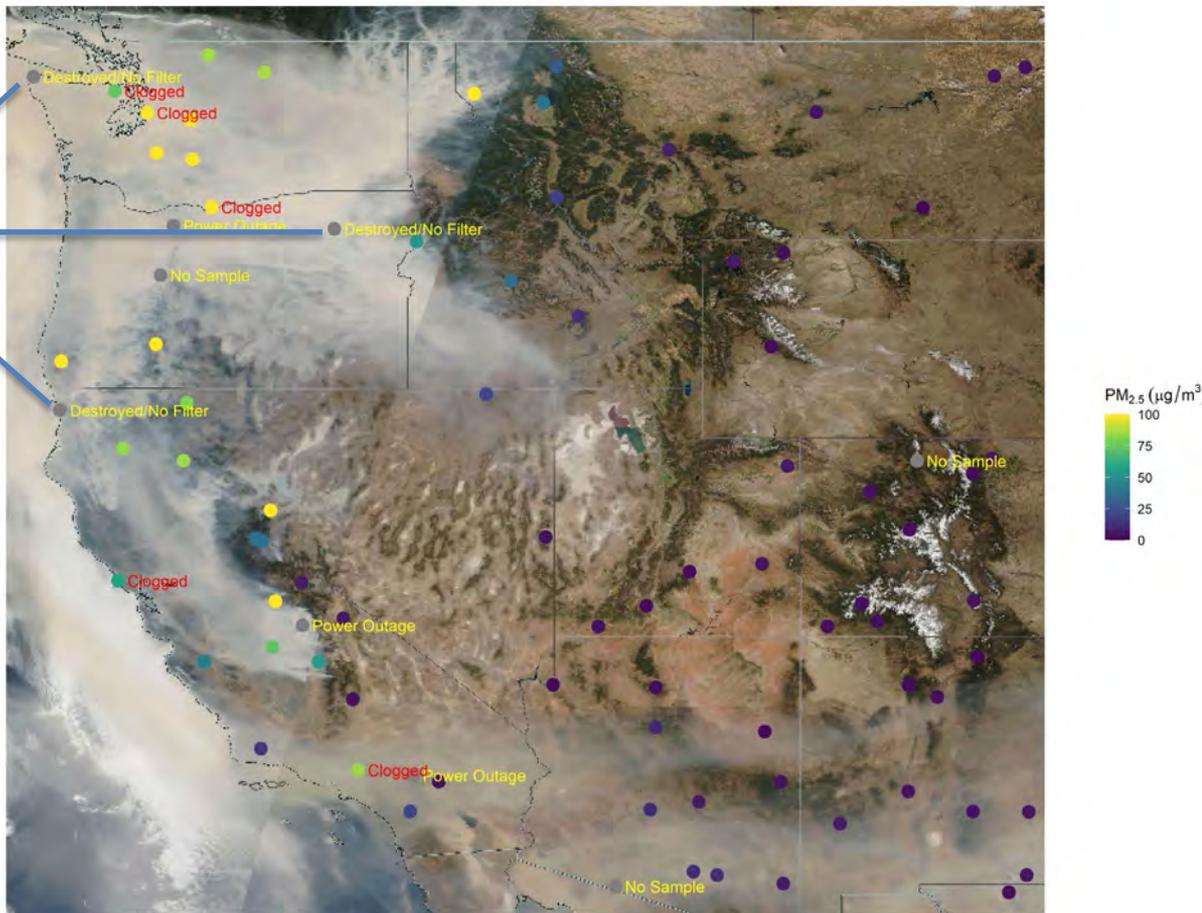
Sample Clogging/Sticking

- MAKA – filter stuck ($43 \mu\text{g}/\text{m}^3$ OC)
- STAR – filter stuck ($200 \mu\text{g}/\text{m}^3$ OC)
- REDW – filter stuck ($76 \mu\text{g}/\text{m}^3$ OC)



- 27 filters in September 2020 invalidated because of holes
- 45 filter invalidated because of **clogged** flow

September 12, 2020



Can we capture useful data on any of these days?

- These data may be dead for RHR purposes, but they still have significant value to the broader community for model and satellite validation, exposure modeling, communication, etc.
- By shutting off flow to the clogging module, we can retain an accurate measurement of sample volume and concentration.
- May also save some samples that would have become stuck filters.

Clogging Protocol

If the 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 PM₁₀ PTFE if PM_{2.5} PTFE clogs)
 - Data are invalid for RHR but will be delivered with an accurate concentration and a qualifier flag indicating a short sample time

Status: code is developed and currently in testing

QUALITY ASSURANCE ACTIVITIES

Quality Management System

- Hired Quality Assurance Engineer to lead QA
- Introduced structured system with standard forms to track, document, and report issues.
- Piloted in 2022, integrated into QMP covering IMPROVE, CSN, and other networks.
 - 11 Non-conformances
 - 1 Corrective Action (CSN OC4)
 - 7 Planned Deviations from SOP
 - 12 Investigations of Issues
- Sponsors informed when data impact is significant. In most-cases, the reports are minor and remain internal.

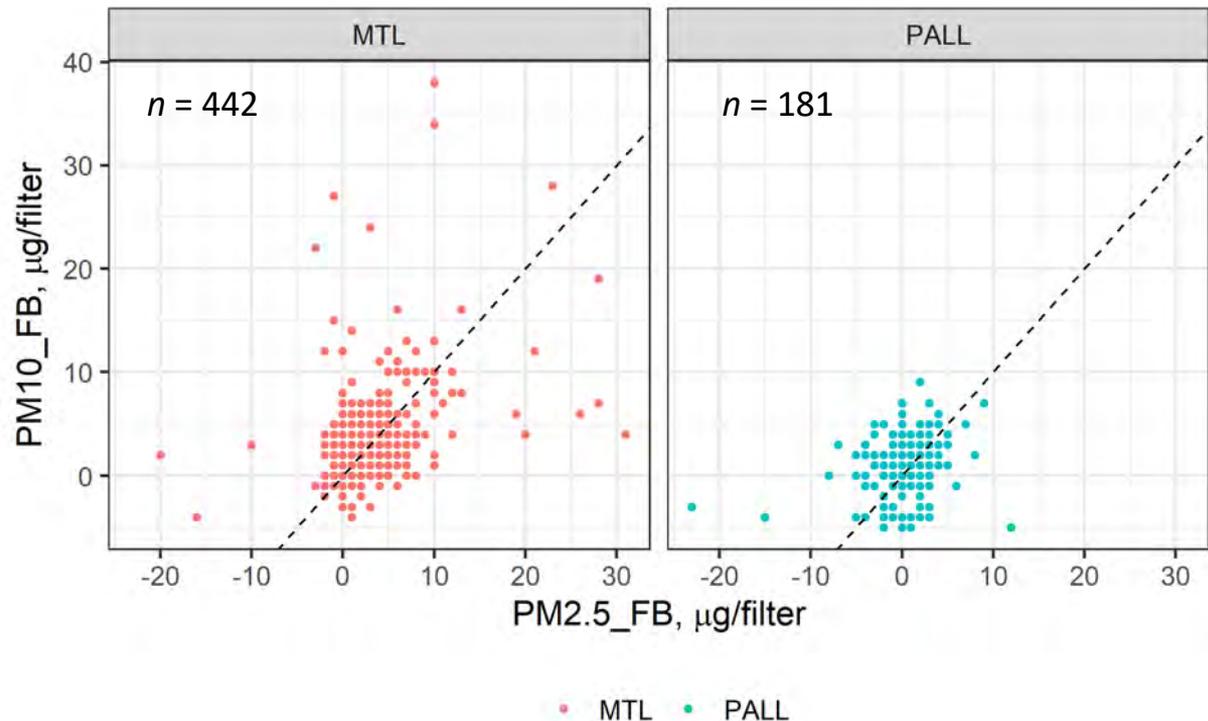
AIR QUALITY RESEARCH CENTER		Deviation Report				UC Davis AQMT 1560 Drew Ave. Davis, CA 95618			
DV#	Ref #	Open Date		Planned Close		Extended to			
Status	Audit Finding <input type="checkbox"/>	Group		Actual Close		Related QC Criteria SOP/TI			
Initiated By	Location	Process		Equipment		Area Manager			
Category	<input type="checkbox"/> Improve <input type="checkbox"/> CSN	<input type="checkbox"/> Other							
Project	Affected Item(s) and Time Period		Short Summary						
Batches & QTY	<Select Project>	<Select Project>							
Sample Dates									
Analysis Dates									
Describe what is being deviated from SOP and Why									
Risk Assessment									
							Max Score: <input type="text"/>		
List each possible risk associated with this change and the negative impact(s) that most-likely to occur. Score each risk according to the criteria defined. Use multiple pages if necessary.									
Recommended strategy: start with the assumption that all criteria start at 3 and adjust higher or lower as needed.									
Risk Factor		Risk Factor Descriptions				Scale Criteria		RPN	
(P) Probability	Probability that the identified risk will occur.				1	Very Low	1 to 3		
(S) Severity	How severe is the negative impact.				2	Somewhat Low	4 to 17		
(D) Detectability	How likely are we to <u>MISS</u> detection?				3	Neutral/Moderate	18 to 47		
RPN	Risk Priority Number = P x S x D				4	Somewhat High	48 to 99		
					5	Very High	100 to 125		
#	Potential Risk + Impact	Risk Area	RPN Calculation				Mitigation		
			P	S	D	RPN	Strategy	Method	
1						-			
2						-			
3						-			
Supplemental Explanations for Above (optional)			Approvers				Date		
			Submitter:						
			Area Manager:						
			Quality:						
Supplemental Data on Server <input type="checkbox"/> Yes			Approval is for plan only. Extension and Close dates recorded later.						

Gravimetric Mass Procedural Updates

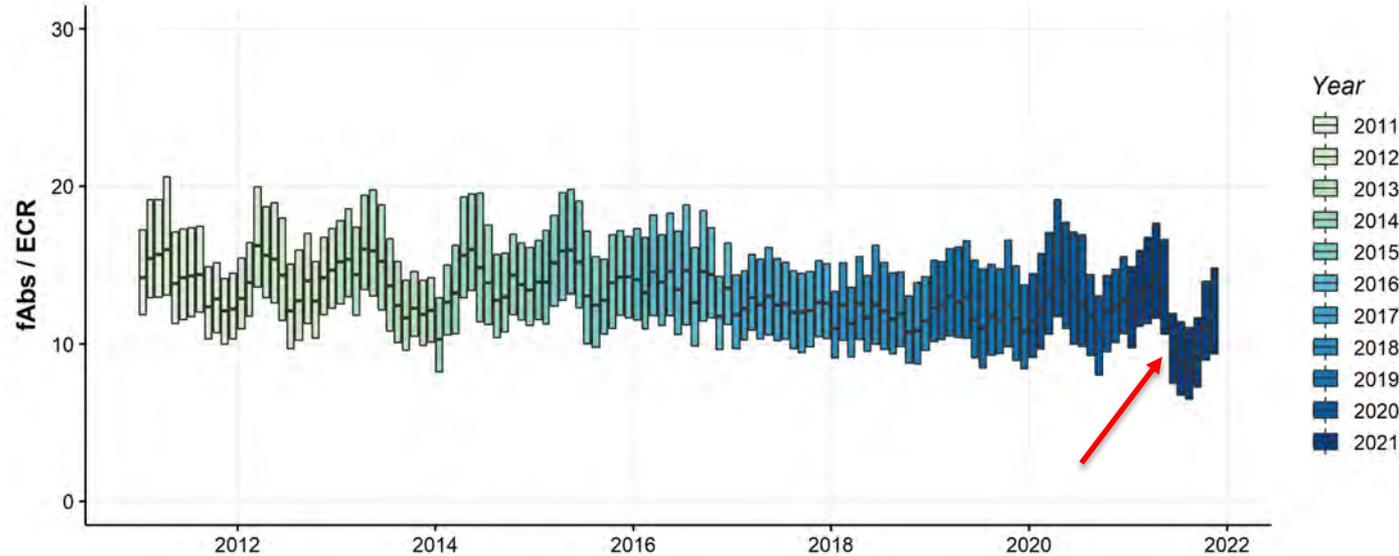
- Comprehensive review of QC and data analysis practices
- Key improvements:
 - Replace daily 400 mg test weight with 50 mg test weight
 - Change target humidity from **39%** +/- 2% to **38%** +/- 2%
 - Temperature and Humidity limits will be applied to every filter measurement
 - Initially, set up limits to apply to test weight measurements every 4 hours and re-weighed any filters measured around a failure
 - Chamber software is limited in what we can stop measuring automatically after a failure to wait for the environment to condition back into tolerance
- Changes will be implemented in early 2023 when software and SOPs can be updated

Paired PM_{2.5} and PM₁₀ Field blanks

- Started sending paired PM_{2.5} and PM₁₀ field blanks (FB) from the same manufacturer since March 2020
- PM_{2.5} and PM₁₀ mass from paired FB show similar MTL > PALL pattern
- Pall is not responding to our requests for filters
- Investigations ongoing
 - Analyzed a few MTL FB using Gas Chromatography (GC) for organics but concentrations too low to draw any conclusions

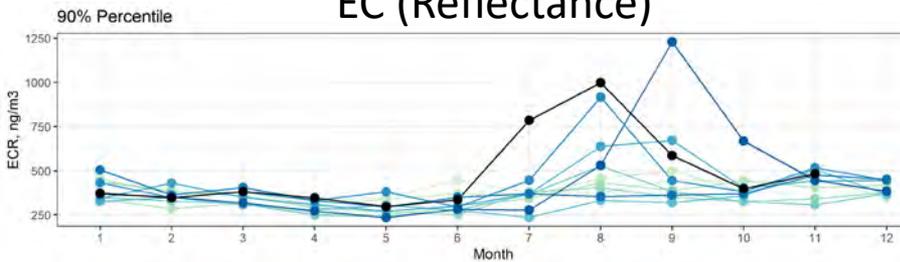


Cross-Module fAbs/ECR Ratio

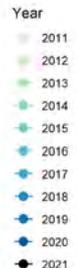
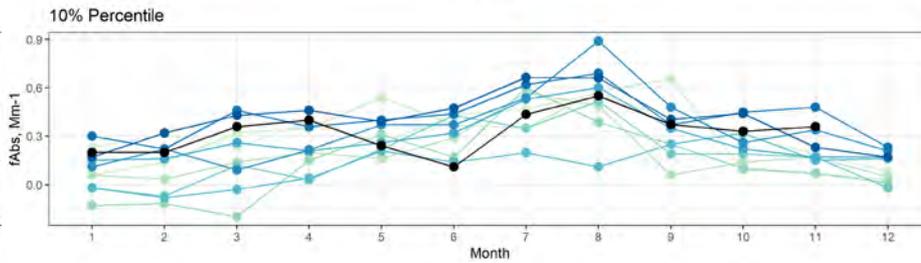
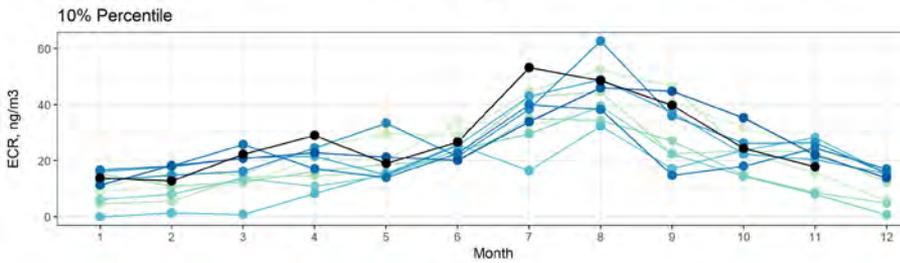
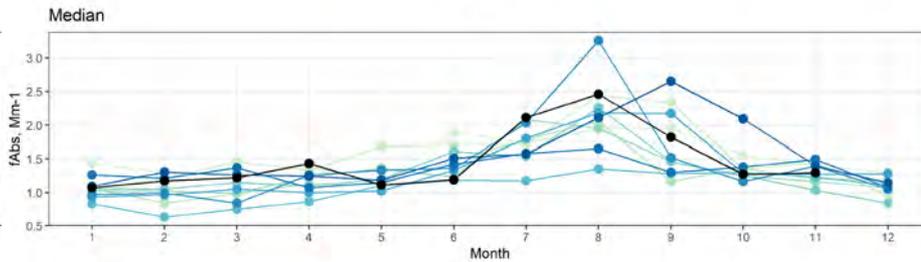
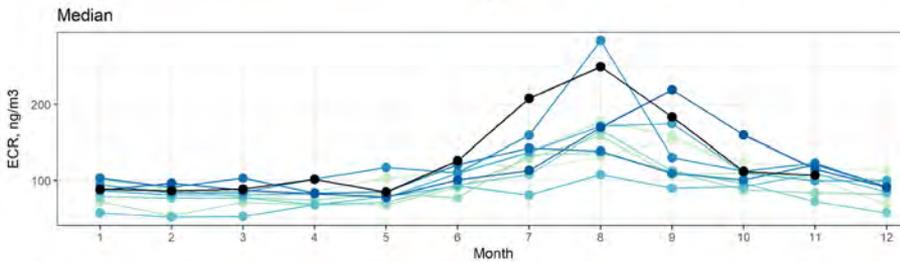
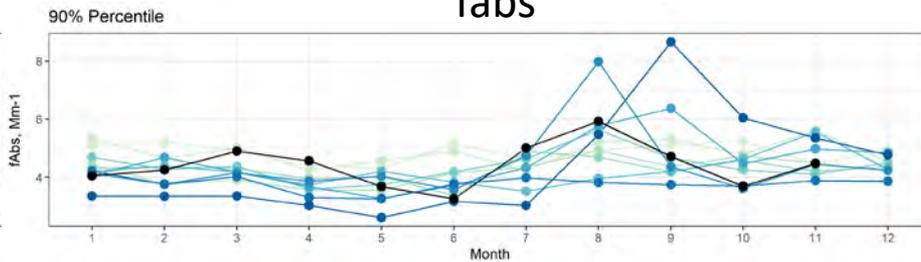


- Hybrid Integrating Plate and Sphere (HIPS) Instrument used to measure filter absorption (f_{Abs}) was modified prior to analysis of June 2021 samples
- Small number of reanalyses identified HIPS stability issues
- f_{Abs} data after June 2021 will not be delivered until investigations are complete

EC (Reflectance)



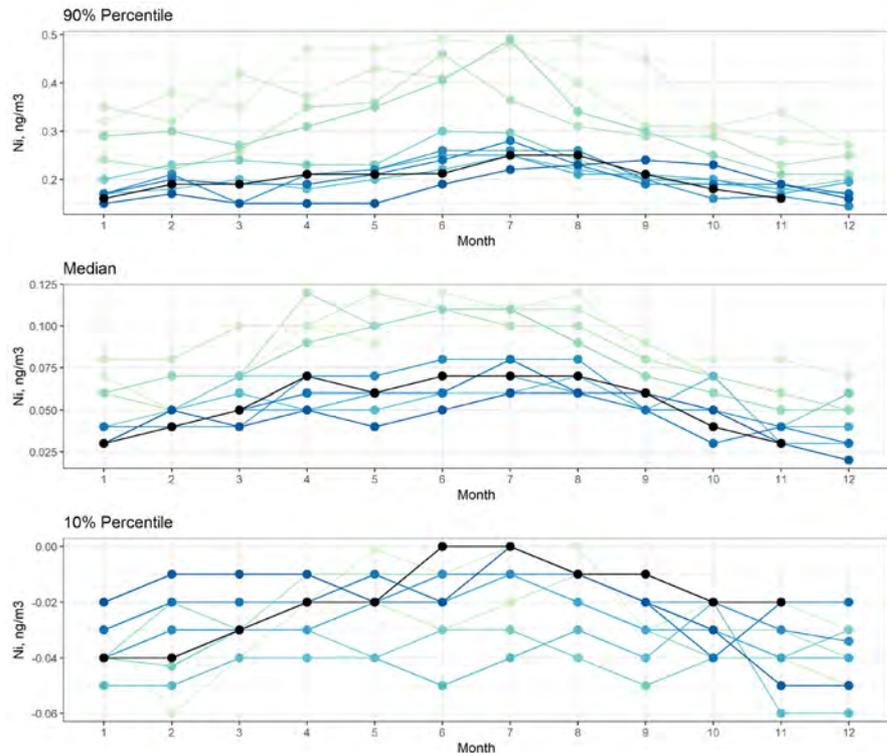
fAbs



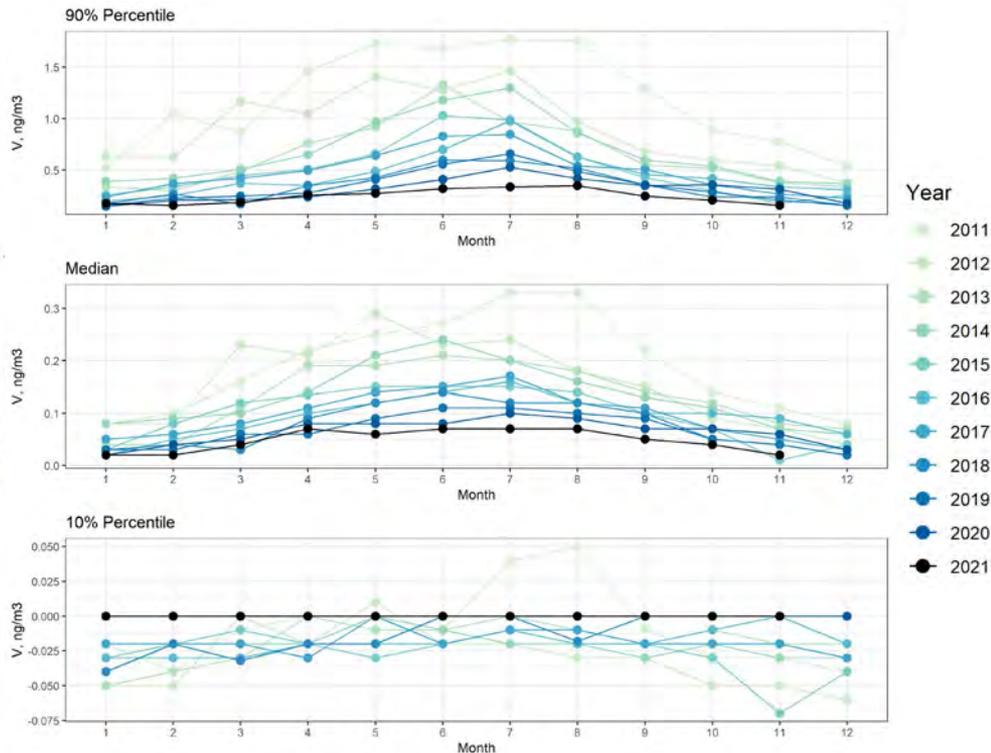
QA Report

- $PM_{2.5}$ Ni and V were early 2020 due to COVID
- $PM_{2.5}$ V median and 90%th-tile continued to be low in 2021
- $PM_{2.5}$ Ni back to pre-COVID concentrations

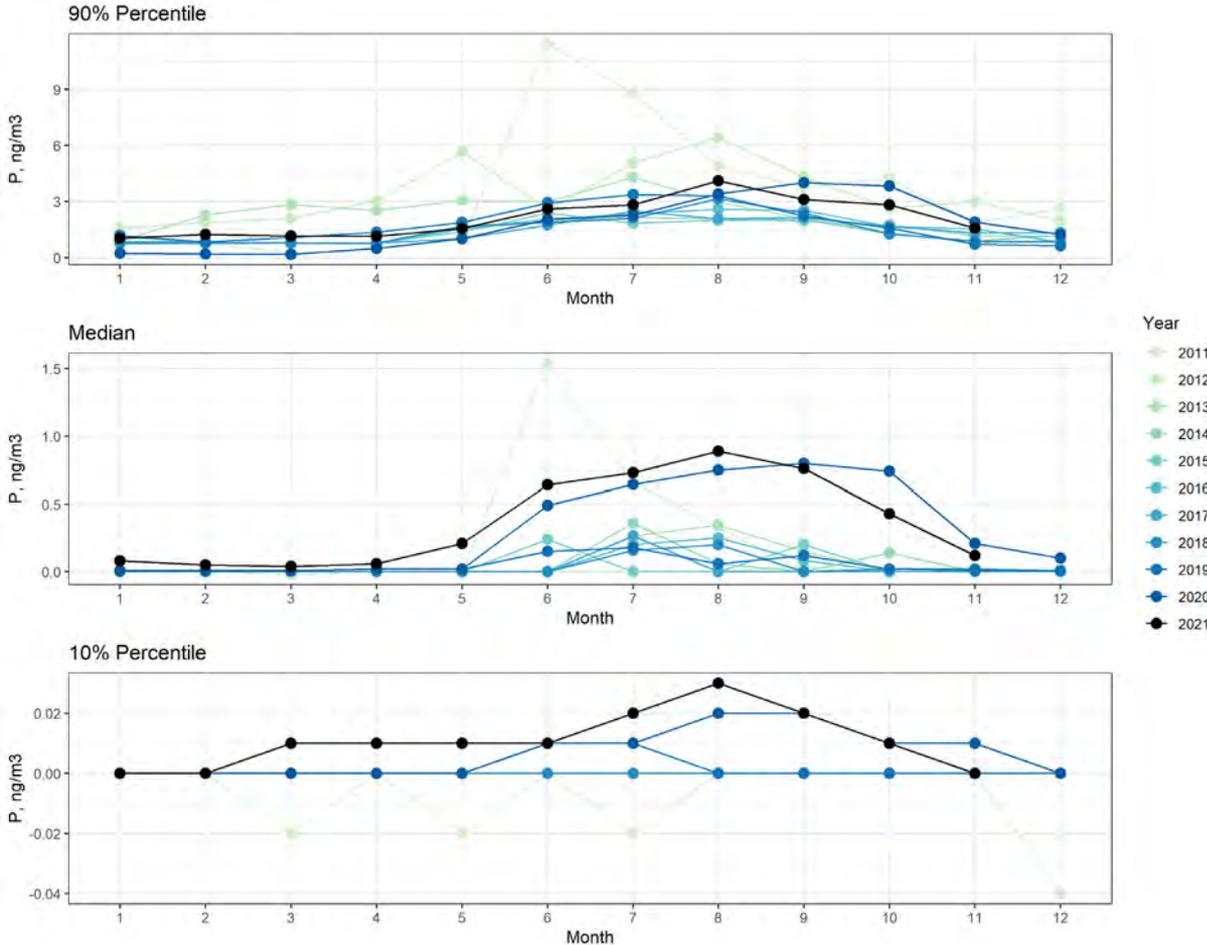
PM2.5 Nickel (Ni)



PM2.5 Vanadium (V)



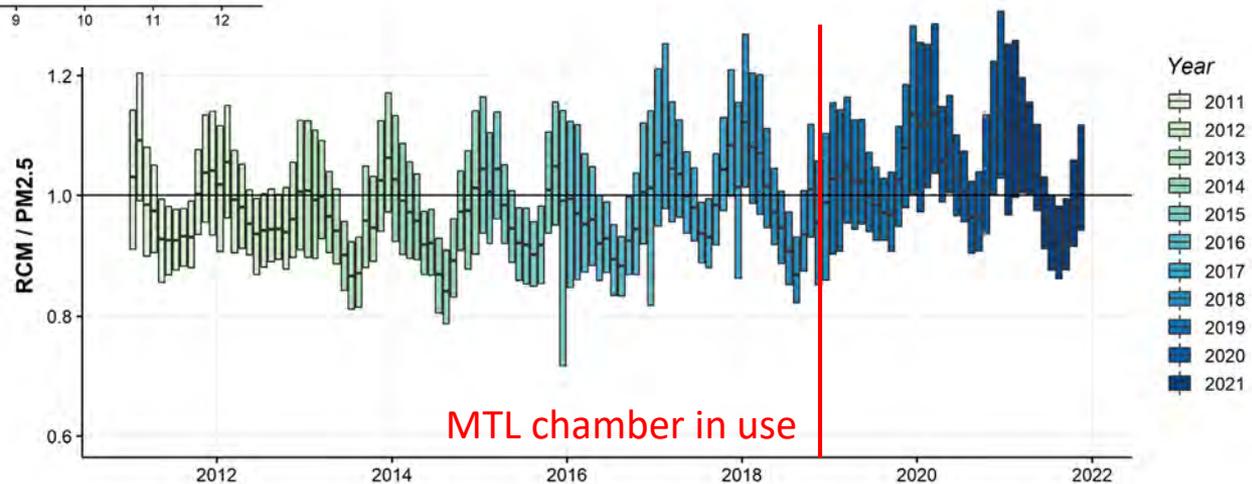
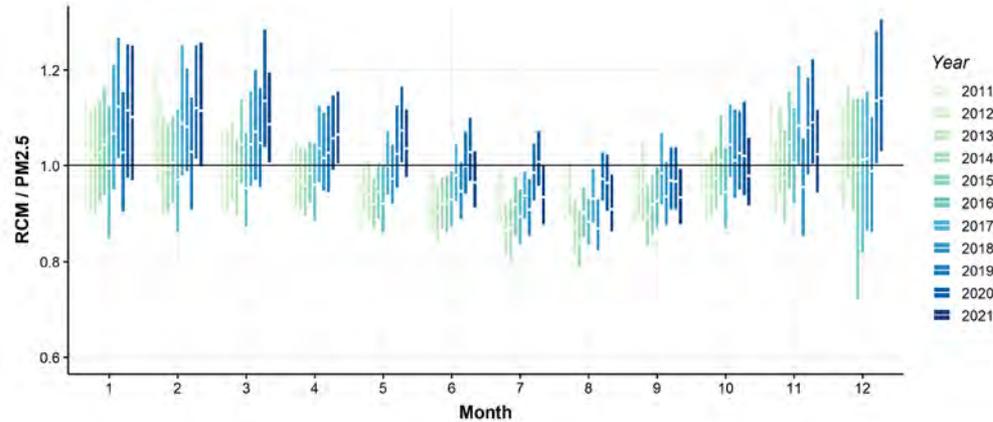
PM_{2.5} Phosphorus (P)



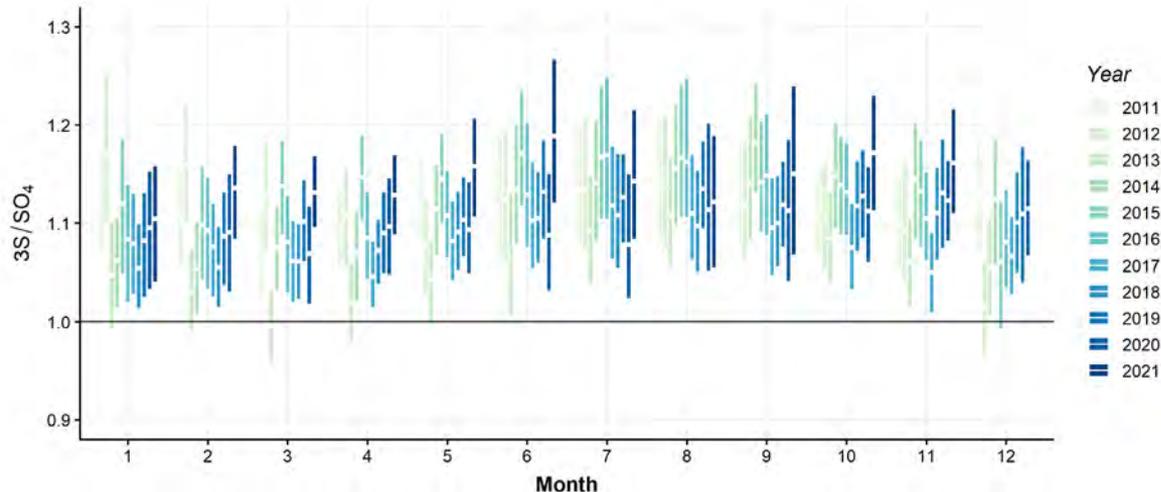
- P is difficult to measure by XRF
- XRF data show much higher median P concentrations during summer-fall in 2020 and 2021
- Higher P appears to be associated with wildfire and high dust samples
- Collaborating with RTI to validate XRF P measurement

QA Report

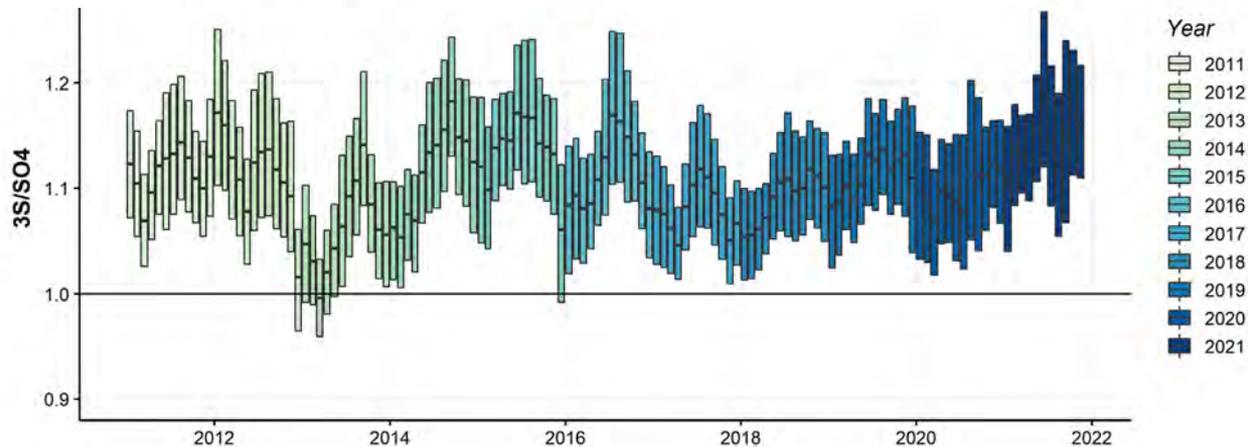
- RCM/PM2.5 ratio in Summer-Fall 2021 lower than in 2019/2020



QA Report

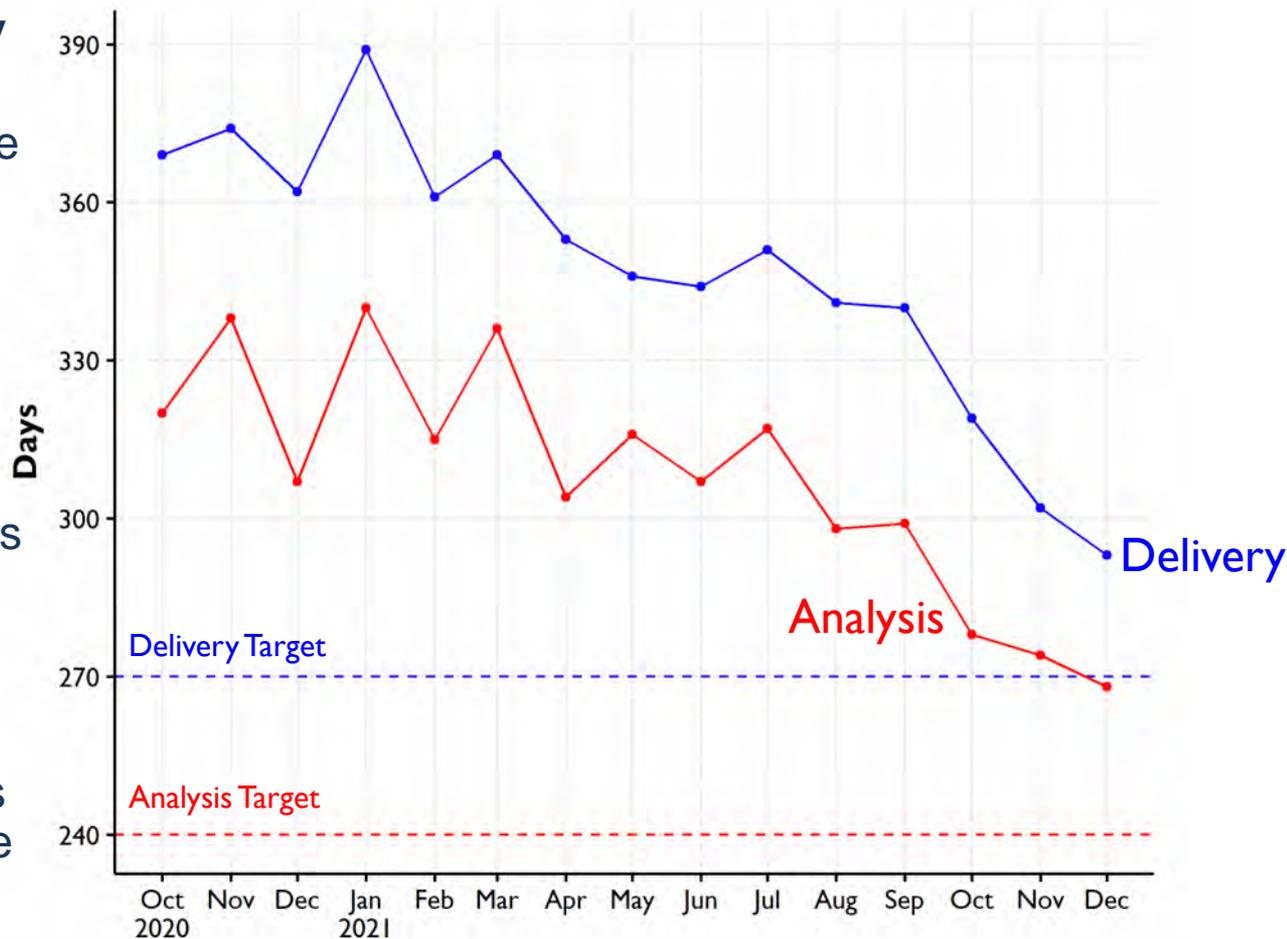


- Lacks seasonality in recent years (2020-2021)
- High in 2021



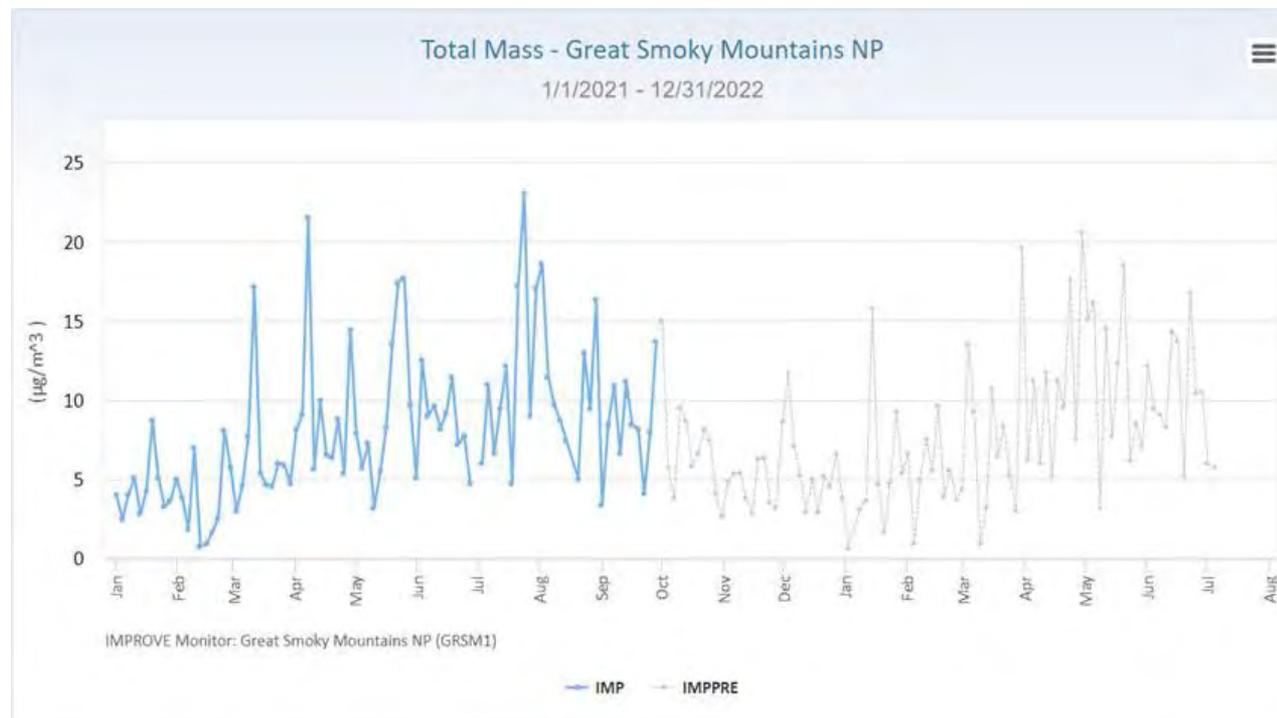
Delivery Latency

- As of last year, data were delivered >1 year after sampling
 - Pandemic hangover
 - Lab move
 - Aging XRF instruments
- Recent better luck has us closer to our interim delivery target of 270 days
- Aspirational long-term goal is delivery 200 days after the end of a sample month



Preliminary Raw data

- Delivered to FED monthly
- All data that has been analyzed so far
- Raw Preliminary
 - Not validated
 - No blank correction
 - No uncertainty
 - No MDL
 - Parameters vary by month
- Use with caution!



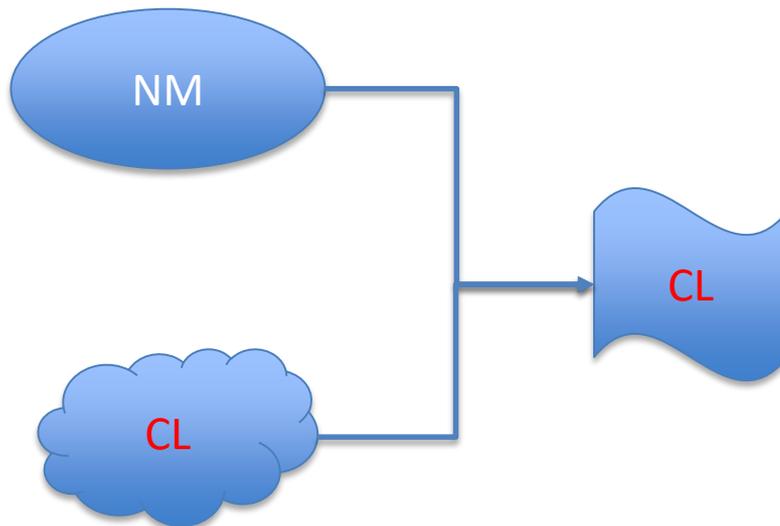
Analysis-level flagging

Abbreviation	Meaning	Action	Usage	AqsCode	AqsQualifierDescription	Severity
NM	Normal	informational	Lab	NULL	NULL	26
QV	Data quality check (for Data Group only)	informational	Validation	NULL	NULL	25
NF	No Flow Yet	informational	Lab	NULL	NULL	24
TO	Timing Outside normal bounds	informational	Lab	Y	Elapsed Sample Time out of Spec.	22
QD	Questionable Data	informational	Lab	4	Lab Issue	21
LF	Low Flow	informational	Lab	W	Flow Rate Average out of Spec.	20
CG	Clogging	informational	Lab	W	Flow Rate Average out of Spec.	17
TU	Time incorrect (used when time shift >= 6hrs)	informational	Lab	3	Field Issue	16
SW	Swapped Sample Dates	informational	Lab	NULL	NULL	15
SP	Field Blank/Sample Swap	informational	Lab	NULL	NULL	14
PC	Possible Contamination	informational	Lab	4	Lab Issue	13
SA	Sampling Anomaly	informational	Lab	1	Deviation from a CFR/Critical Criteria Requirement	12
DE	Estimated value	informational	Lab	LJ	Identification Of Analyte Is Acceptable; Reporte...	11
UN	Undetermined Weight	informational	Lab	AM	Miscellaneous Void	10
SO	Still out	informational	Lab	NULL	NULL	9
DA	Do not analyze	terminal	Lab	AM	Miscellaneous Void	8
OL	Off Line	terminal	Lab	AD	Shelter Storm Damage	7
NS	No Sample	terminal	Lab	AF	Scheduled but not Collected	6
CL	Clogged	terminal	Lab	AH	Sample Flow Rate out of Limits	5
XX	Destroyed/No Filter	terminal	Lab	AJ	Filter Damage	4
BI	Bad Install	terminal	Lab	BJ	Operator Error	3
PO	Power Outage	terminal	Lab	AV	Power Failure	2
EP	Equipment Problem	terminal	Lab	AN	Machine Malfunction	1

Previously

Flag on filter
Normal
Severity = 23
Valid

Flag on flow
Clogged
Severity = 5
Invalid



Flag on final data
Clogged
Invalid

Filter Normal



Flow Clogging



Weigh



Mass Normal

XRF

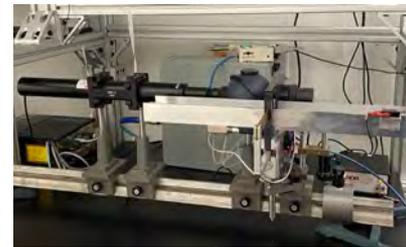


Zn Contamination



Dropped
the filter!

HIPS



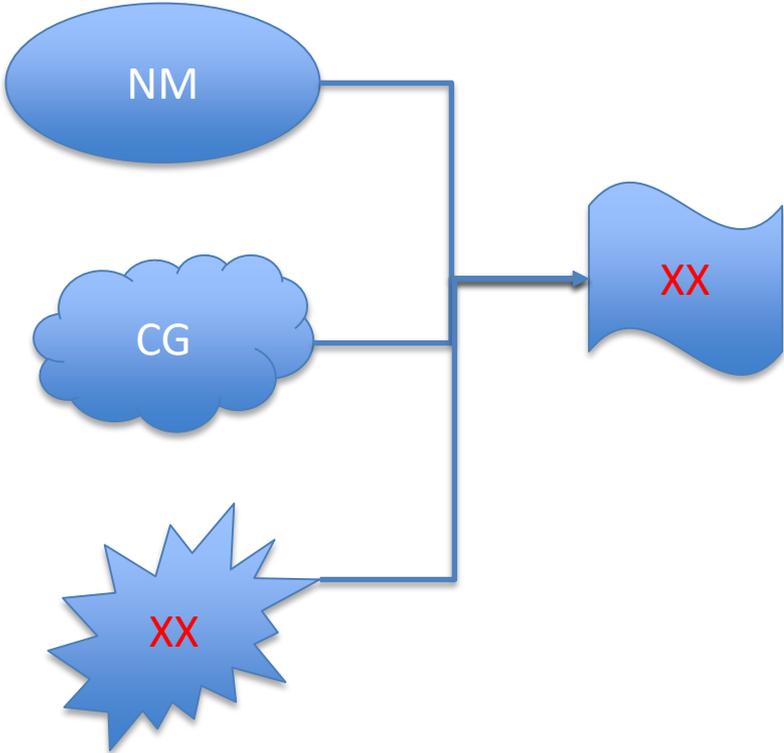
Destroyed/No
Filter

HIPS fAbs Results

Flag on filter
Normal
Severity = 23
Valid

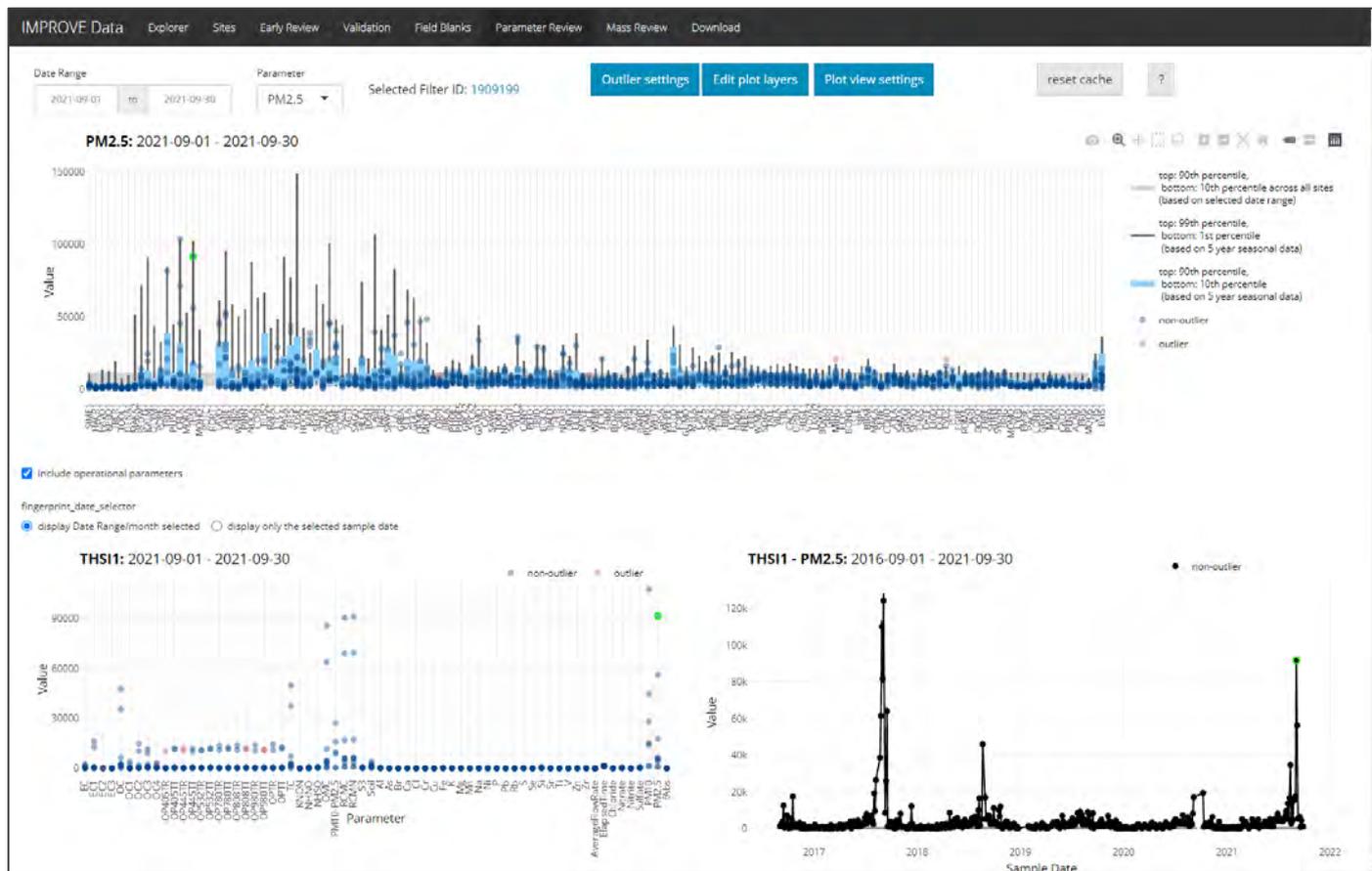
Flag on flow
Clogging
Severity = 17
Valid

Flag on analysis
Destroyed/No filter
Severity = 4
Invalid



Flag on final data
Destroyed/No Filter
Invalid

Parameter Review Tool



Filter Archive

National Ambient Aerosol Filter Library

Find Filters

119 filters in the archive

State(s):

Draw a region 17 sites selected Reset region

Site setting(s):

Land use(s):

Month(s):

Jan Feb Dec

Day(s) of the week:

Date Range:

2016-01-01 to 2021-01-14

Filter media:

PTFE (Teflon) Quartz

Sample Type:

Ambient Sample Field Blank

Parameter Constraints:

AND OR + Add rule + Add group

Nitrate greater 10 ✖ Delete

Show 10 entries

Search:

	Id	SampleStartDate	FilterType	AvgAmbTemp	Purpose	SiteName	AqsSiteId	State	Latitude	Longitude
1	6187	Fri Jan 15 2016	Teflon	12.3	Sample	Riverside - Rubidoux	06-065-8001	CA	33.99958	-117.41601
2	6190	Mon Jan 18 2016	Teflon	13.8	Sample	Riverside - Rubidoux	06-065-8001	CA	33.99958	-117.41601
3	6166	Fri Feb 05 2016	Teflon	10.5	Sample	Bakersfield California Ave (collocated)	06-029-0014	CA	35.356092	-119.041209
4	6154	Wed Jan 27 2016	Teflon	11.1	Sample	Bakersfield - California Ave.	06-029-0014	CA	35.356092	-119.041209
5	41521	Wed Dec 07 2016	Teflon	13.4	Sample	Bakersfield - California Ave.	06-029-0014	CA	35.356092	-119.041209
6	8256	Fri Feb 26 2016	Teflon	18.2	Sample	Riverside - Rubidoux	06-065-8001	CA	33.99958	-117.41601
7	8168	Fri Feb 05 2016	Teflon	10.8	Sample	Bakersfield - California Ave.	06-029-0014	CA	35.356092	-119.041209
8	6205	Mon Jan 18 2016	Teflon	14.7	Sample	Riverside - Rubidoux (collocated)	06-065-8001	CA	33.99958	-117.41601
9	8149	Sun Feb 14 2016	Teflon	15.2	Sample	Fresno - Garland	06-019-0011	CA	36.785322	-119.774174
10	43959	Mon Dec 19 2016	Teflon	5.7	Sample	Bakersfield - California Ave.	06-029-0014	CA	35.356092	-119.041209

Showing 1 to 10 of 119 entries

Previous 1 2 3 4 5 ... 12 Next

Any questions?

