

UC DAVIS 2020 NETWORK UPDATE

IMPROVE Steering Committee Meeting
2020.10.13 – 2020.10.14

Nicole Hyslop, Xiaolu Zhang, Sean Raffuse, Jason Giacomo, Yongjing Zhao, Ilia Potanin, Dominique Young and the whole team

UC DAVIS
AIR QUALITY RESEARCH CENTER



Total = 160 Sites

- 25 sites shutdown due to COVID-19; most were back online within 2 months.
- 2 sites remain shutdown
 - IKBA1
 - MONT1

* Inserts not to scale

Effective 10/1/2020

UCD Network Operations during COVID-19

- Davis “Shelter-In-Place” directives issued on Mar.18, 2020, all employees sent home
 - Sample handling operations resumed with reduced capacity in mid-April
 - XRF, HIPS and post-mass measurements resumed in May
 - Laboratory analyses are behind schedule
- Field Operations
 - Field maintenance crew started traveling
 - by truck in June
 - one loop by plane in September
 - Scheduled to service 83 sites in 2020
 - With travel restrictions visited 65 sites
 - Plan to visit ~9 more sites in the coming months

We are moving to a new location off campus



Analysis and Delivery Status

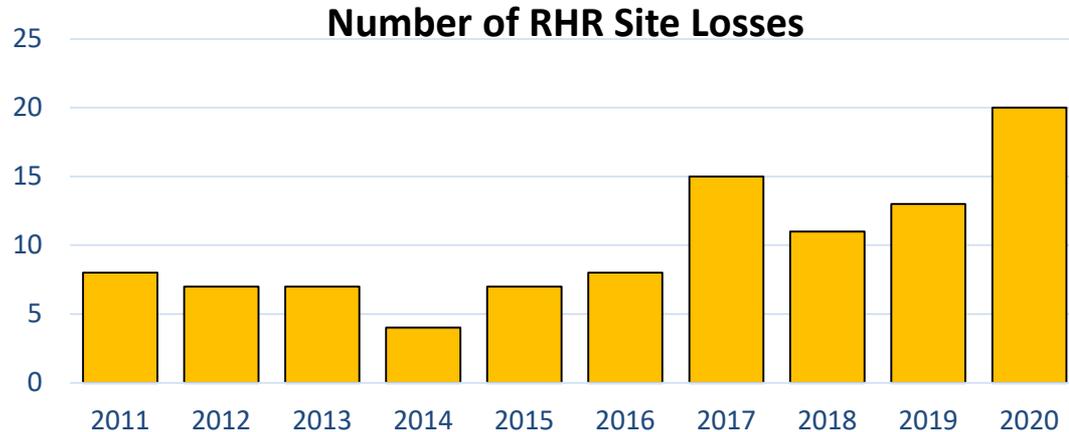
| Analysis | 2020-01 | 2020-02 | ★ | 2020-03 | 2020-04 | 2020-05 | 2020-06 | 2020-07 | 2020-08 | 2020-09 | 2020-10 |
|----------|---------|---------|---|---------|---------|---------|---------|---------|---------|---------|---------|
| Carbon | ✓ | ✓ | | 95% | 96% | 86% | 21% | | | | |
| FTIR | ✓ | ✓ | | 96% | 97% | 97% | 88% | 32% | | | |
| HIPS | ✓ | ✓ | | | | | | | | | |
| Ions | ✓ | ✓ | | 95% | 94% | 72% | 7.6% | | | | |
| Mass | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | 95% | 73% | 5.8% | |
| XRF | ✓ | ✓ | | 81% | 44% | | | | | | |

- ★ 10 February samples recently sent to carbon/ion labs for analysis due to sites being offline
- January 2020 data have been delivered to AQS and FED; February data are being validated
- All 2019 data have been delivered (and will be redelivered soon)

Regional Haze Rule (RHR) Completeness Criteria

RHR requires for all modules:

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



2011-2019: Final number of losses after validation

2020: Number of losses year-to-date

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

RHR Site Losses in 2020 So Far

- 18 site losses due to COVID-19 shutdowns
 - BIRM, BRIG, BRIS, GAMO, IKBA, LABE, MING, MOHO, MONT, MOOS, MOZI, PUSO, SAPE, SHRO, SIPS, SNPA, STIL, and TONT
- 2 site losses due to missing and/or late sample changes
 - FOPE1 (NS, 33 missed samples)
 - WHPA1 (NS, 16 missed samples in Q2)
- SAGA and KAIS recently lost power as a result of fires, will fail RHR this week

Show readings

Show all sites

Network Summary

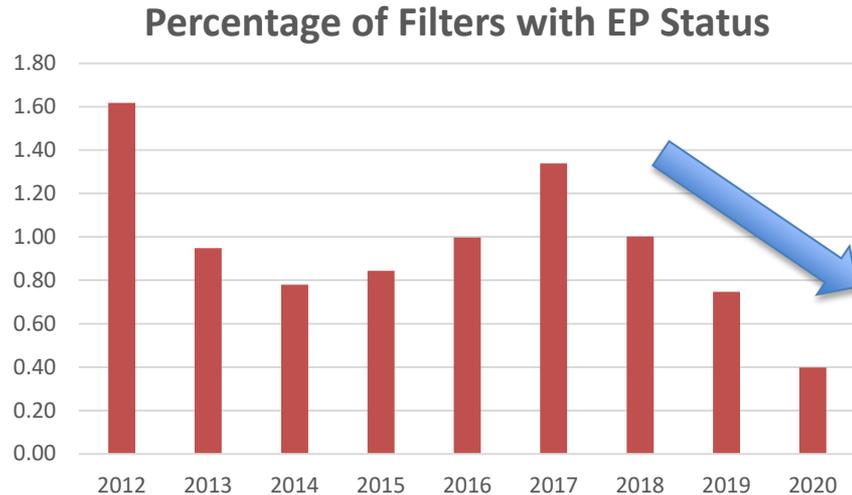
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|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| ACAD1 | AGT11 | ATLA1 | BADL1 | BALD1 | BAND1 | BIBE1 | BIRM1 | BLIS1 | BOAP1 | BOLA1 | BOND1 | BOWA1 | BRCA1 | BRID1 | BRIG1 | BRIS1 | CABA1 | CABI1 | CACO1 | CACR1 | CANY1 | CAP11 | | | |
| CAVE1 | CEBL1 | CHAS1 | CHIR1 | COBA1 | COBA5 | COHU1 | CORI1 | CRLA1 | CRMO1 | DENA1 | DETR1 | DINO1 | DOME1 | DOSO1 | EGBE1 | EVER1 | FCPC1 | FLAT1 | FLT01 | FOCO1 | FOCO2 | FOPE1 | | | |
| FRES1 | FRRE1 | GAM01 | GICL1 | GLAC1 | GRBA1 | GRCA2 | GRGU1 | GRR11 | GRSA1 | GRSM1 | GUM01 | HACR1 | HAV01 | HECA1 | HEGL1 | HOOV1 | IKBA1 | ISLE1 | JARB1 | JARI1 | JOSH1 | KAIS1 | | | |
| KALM1 | KPBO1 | LABE1 | LASU2 | LAV01 | LIGO1 | LOND1 | LOST1 | LTCC1 | LYEB1 | MACA1 | MAKA2 | MAVI1 | MEAD1 | MELA1 | MEVE1 | MING1 | MOHO1 | MOMO1 | MONT1 | MOOS1 | MORA1 | MOZI1 | | | |
| NEBR1 | NOAB1 | NOCA1 | NOCH1 | NOGA1 | OKEF1 | OLYM1 | ORPI1 | OWVL1 | PACK1 | PASA1 | PEFO1 | PEN01 | PHOE1 | PHOE5 | PINN1 | PITT1 | PMRF1 | PORE1 | PRIS1 | PUS01 | QUCI1 | RAFA1 | | | |
| REDW1 | RENO1 | RENO2 | RENO3 | ROMA1 | ROM01 | SACR1 | SAGA1 | SAGO1 | SAGU1 | SAMA1 | SAPE1 | SAWE1 | SAWT1 | SENE1 | SEQU1 | SHEN1 | SHMI1 | SHRO1 | SIME1 | SIPS1 | SNPA1 | SOGP1 | | | |
| STAR1 | STIL1 | SULA1 | SWAN1 | SYCA2 | TALL1 | THRO1 | THS11 | TONT1 | TOOL1 | TRCR1 | TRIN1 | ULBE1 | UPBU1 | VII51 | VILA1 | VOYA2 | WHIT1 | WHPA1 | WHPE1 | WHRI1 | WICA1 | WIMO1 | YELL2 | YOSE1 | ZICA1 |

Color key:

Good Offline site Missed check in Internet problem Warning Needs attention Info

| Name !! | Last Checkin | Last Flow Data | Alert Count | Online Modules | Controller State | Installed Filters |
|---------|------------------------|------------------------|-------------|----------------|------------------|--|
| ACAD1 | 10/02/2020 01:00:05 AM | 10/02/2020 12:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| AGT11 | 10/02/2020 08:40:00 AM | 10/02/2020 08:39:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| ATLA1 | 10/02/2020 01:00:05 AM | 10/02/2020 12:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| BADL1 | 10/02/2020 02:00:00 AM | 10/02/2020 01:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| BALD1 | 10/02/2020 01:00:05 AM | 10/02/2020 12:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| BAND1 | 10/02/2020 02:00:00 AM | 10/02/2020 01:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |
| BIBE1 | 10/02/2020 01:00:05 AM | 10/02/2020 12:59:02 AM | 0 Alerts | 4/4 Online | NORMAL | 1 09/30/2020 12:00:01 AM 2 10/03/2020 12:00:01 AM 3 10/06/2020 12:00:01 AM |

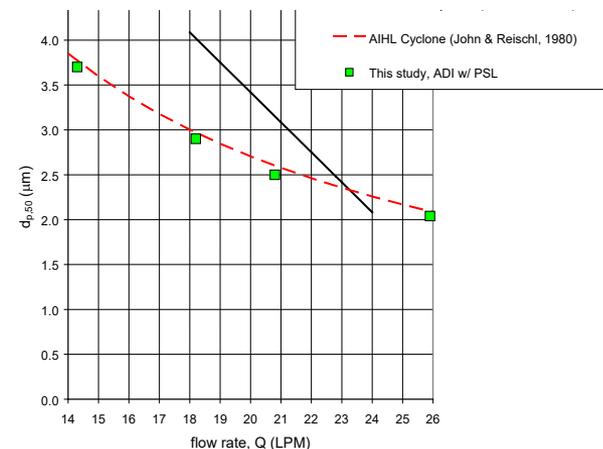
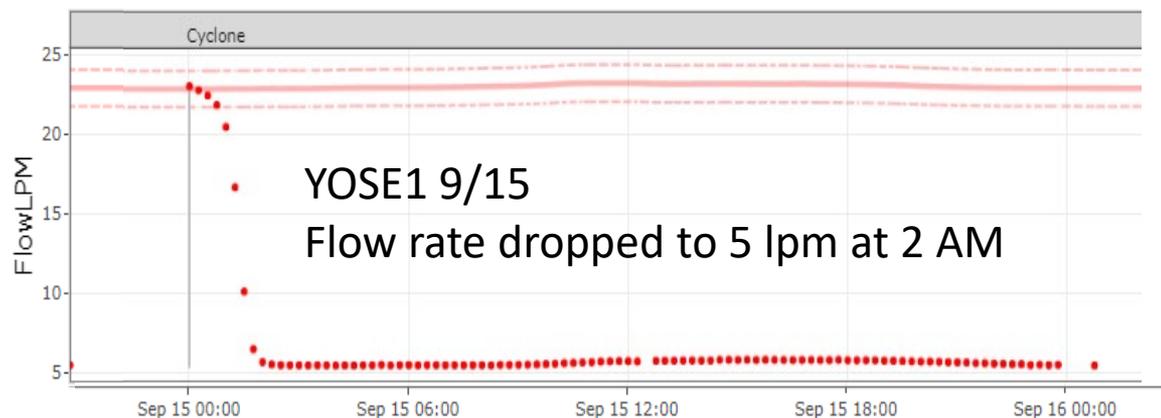
New Controller Helps Save Samples



- Internet-connected new controllers have been deployed throughout the IMPROVE network since Oct. 2019
- Daily data downloads
- Fast problem identification and troubleshooting
- *New Feature in 2020*
 - Remote control of sampler manifold: saves samples from bad installation (“BI”)

Stop Sampling on Clogging Filters?

- One planned feature of the new controller is to stop sampling if flow rate drops below a certain point to preserve a valuable fire sample.
 - The question is when to stop sampling.
- Current flow check: if flow $< 15\text{L/min}$ for > 6 hours, terminal flag (“CL” flag) applied
- However, samples under fire impact often clog within the first few hours (see YOSE1 example below);



(Figure 1A from Hyslop 2006, Addendum to Memo: Flow Rate Validation)

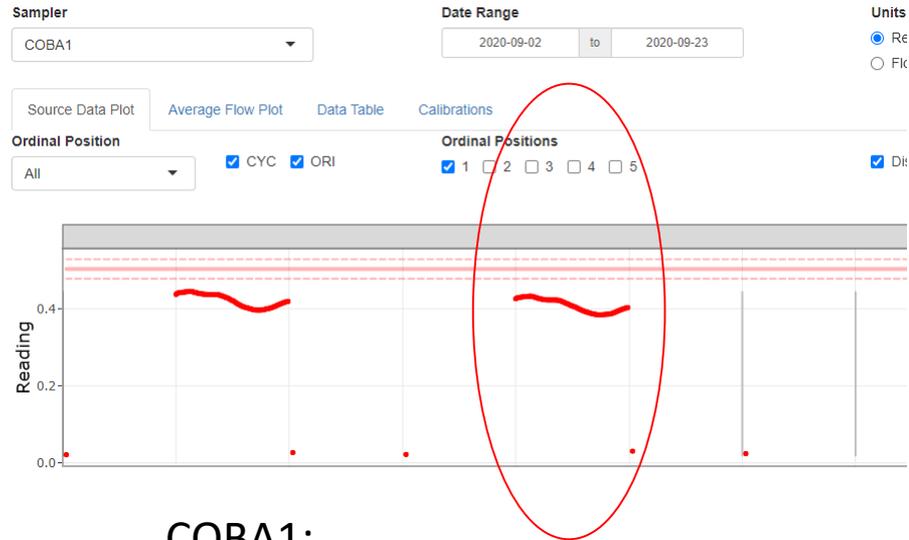
Active Flow Control Development Update

- Brushless DC Pump Durability Test results are promising
 - 3 pump durability rigs deployed and running smoothly
 - PORE1 (1yr), DENA1(1.5yr), PHOE1(0.5yr)
- Comparison Testing ongoing in Davis
 - 5 regular vs 5 DC-pump IMPROVE PM_{2.5} modules currently running in Davis
 - Flow rate is more stable on DC pump side especially on smokey days
 - Gravimetric analysis will show if DC pump has collection bias and quantify the effect
- Developing 5 channel Pump Driver
 - Custom pump control PCBs being prototyped
 - Programmed flow control using IMPROVE Controller

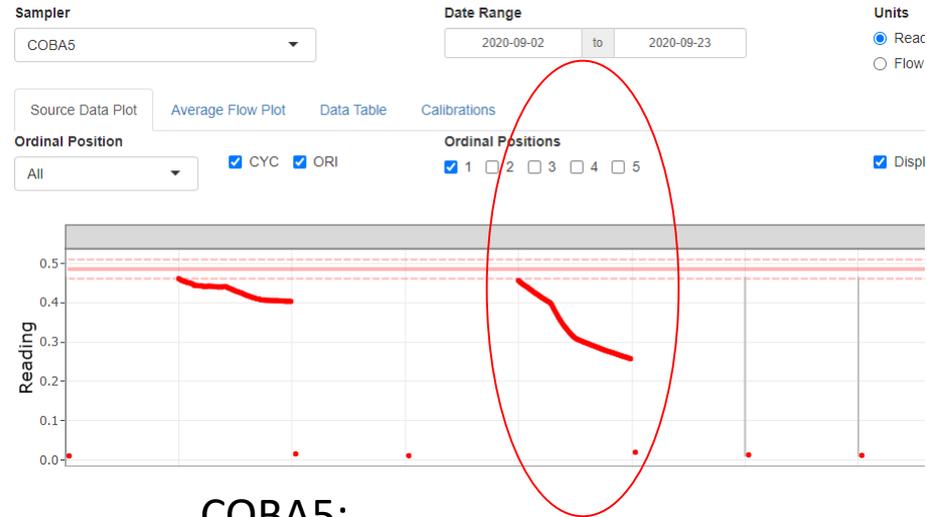


Collocated Flow Rates Comparison

- On 9/6, UCD campus was impacted by nearby wildfires



COBA1:
New pump (active flow control)
-> more stable flow rate



COBA5:
Old pump (passive)
-> decreasing flow rate

Laboratory Updates

MTL Automated Weighing Chamber



First chamber “operational” since October 5, 2018

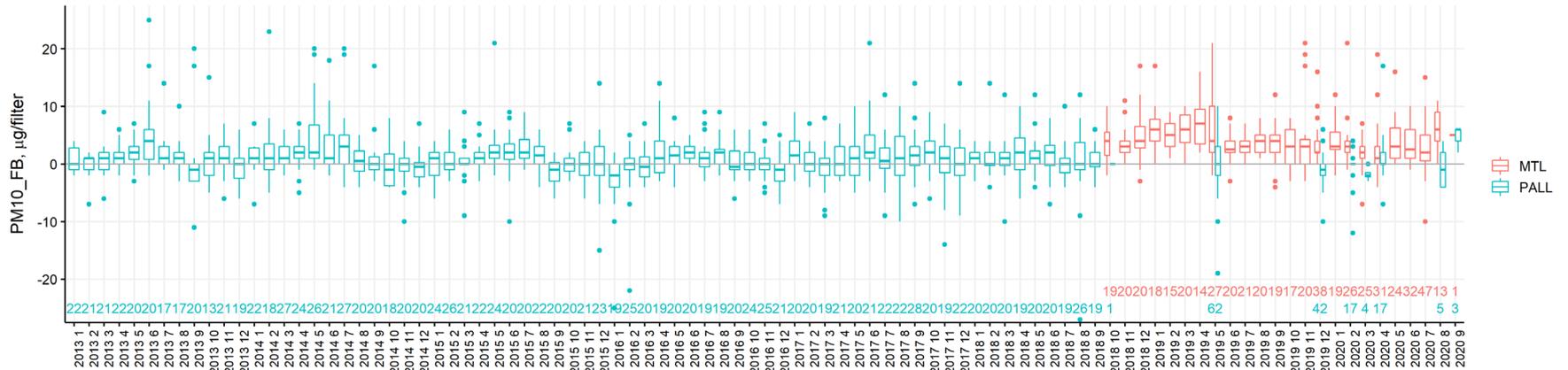
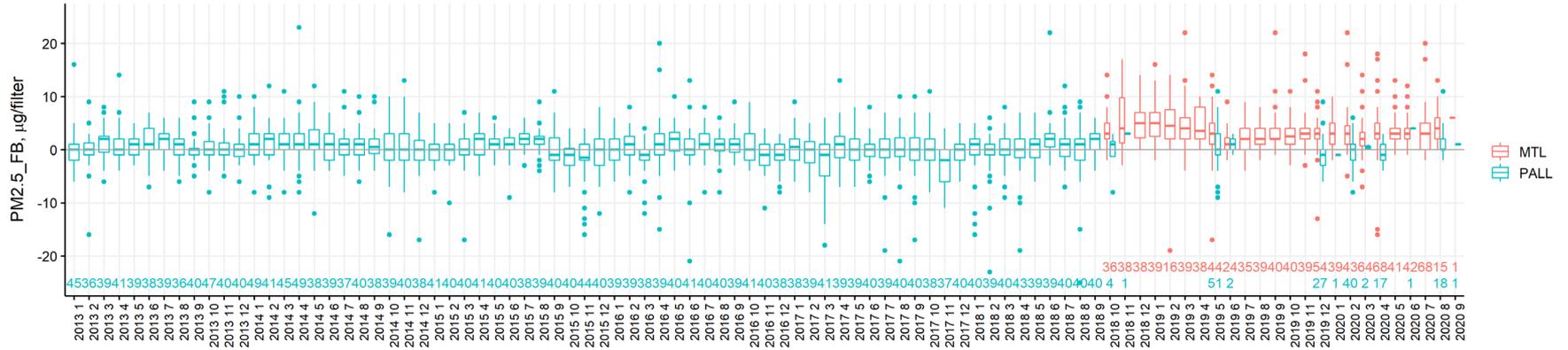
- Relative humidity set to 39% ($\pm 0.4\%$ with door closed)
- Temperature set to 21.5 °C
- 2-4 hour equilibration time (operationally limited)

Second chamber (leased) to catch up from Covid19 shut down, to facilitate move, and to perform testing:

- Determine analytical MDL for mass measurement
- Test longer equilibration time
- Evaluate measurement bias among balances

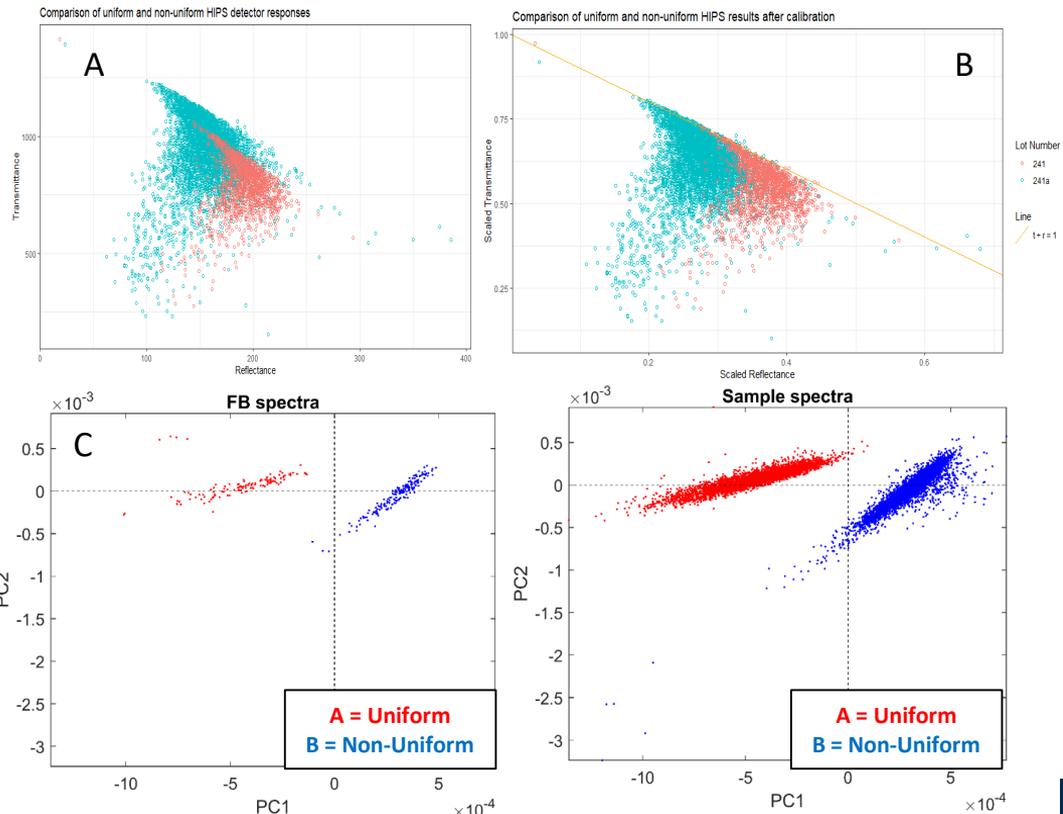
Updates on MTL Filter Blank Mass Gain

Number indicates count of field blanks per month



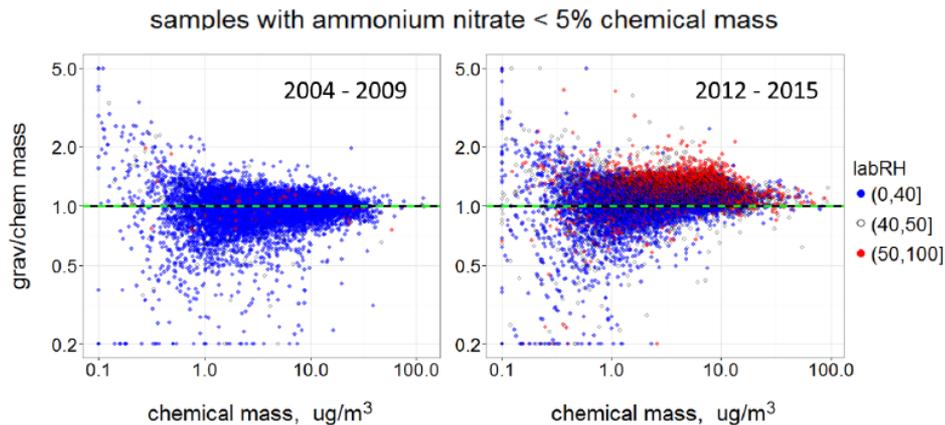
Identification of changes in PTFE filters impacting HIPS and FTIR measurements

- An unexplained offset in HIPS responses began with samples collected in October 2019 (A)
- The two filter types – uniform and non-uniform - were identified visually and by HIPS using blank filters
- However, sampled filters could not be categorized due to similar responses of sampled filters (A)
- The two filter types were identified by FTIR in blanks (C) and sampled filters (D)
- Using the identification by FTIR, fAbs measurements were properly calibrated for IMPROVE data October 2019 - July, 2020 (B)

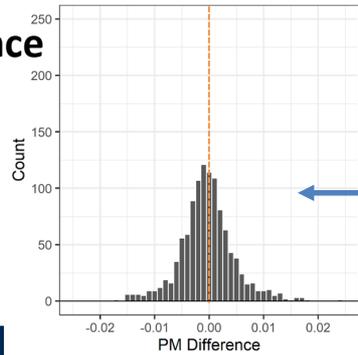
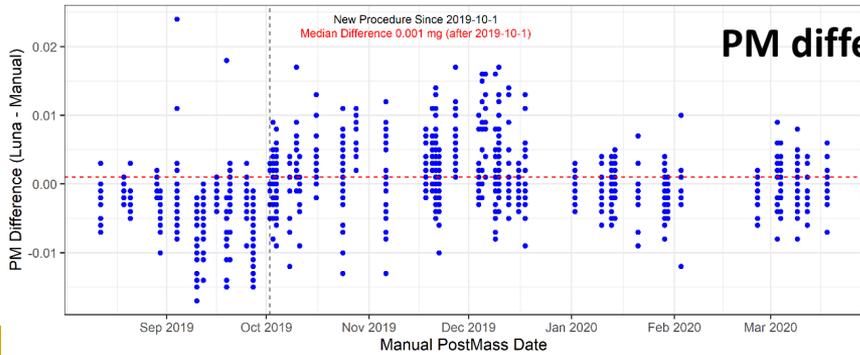
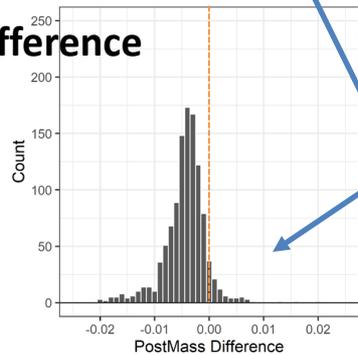
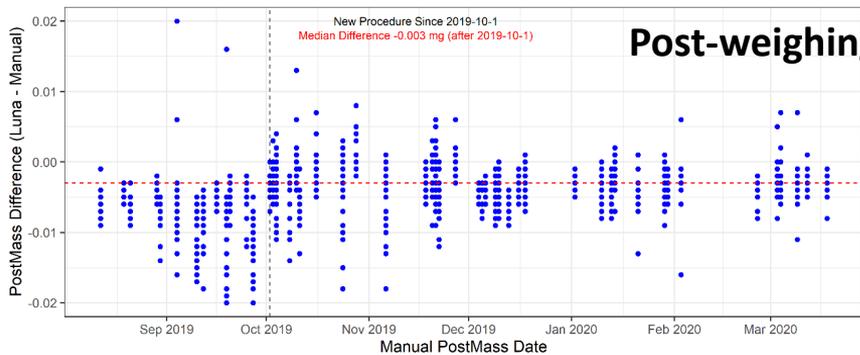
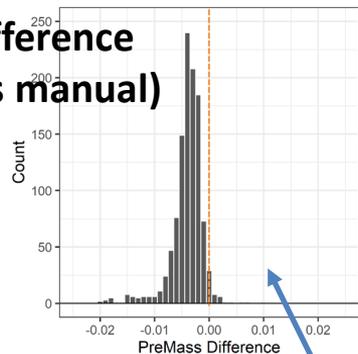
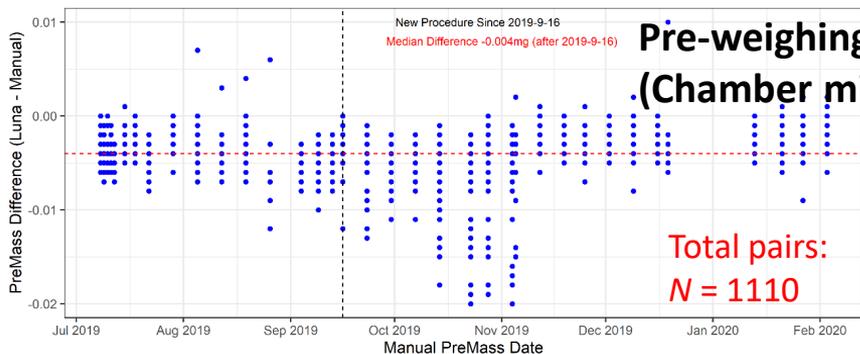


Updates on Manual vs Chamber Comparison

| | |
|-----------------------|--|
| Posting type | Advisory |
| Subject | Increased variation of humidity in the weighing laboratory |
| Module/Species | A/ MF, D/ MT |
| Sites | All |
| Period | 2011 and later |
| Recommendation | Recognize that gravimetric measurements are not FRM-compliant |
| Submitter | W.H. White, whwhite@ucdavis.edu . |



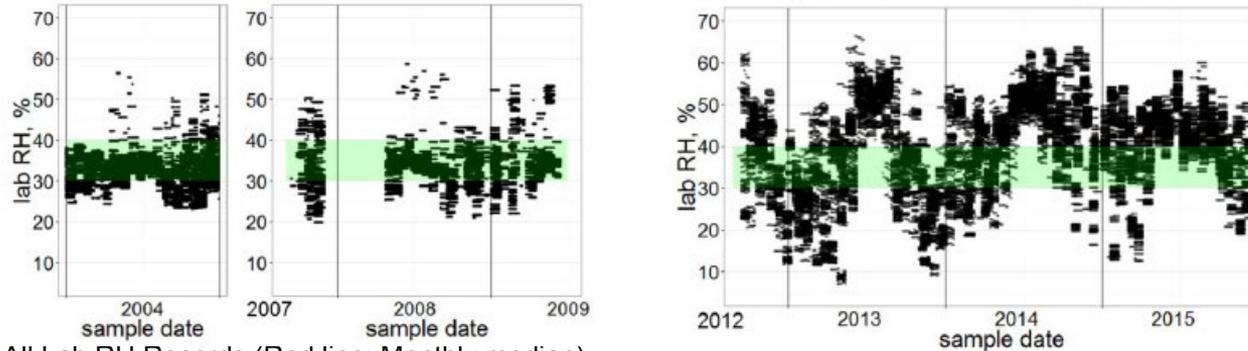
- Pre- and post-weighed 1110 filters both in chamber (controlled RH) and on the manual (lab RH) balance between July 2019 and March 2020 to investigate possible effect of lab RH on gravimetric measurements.



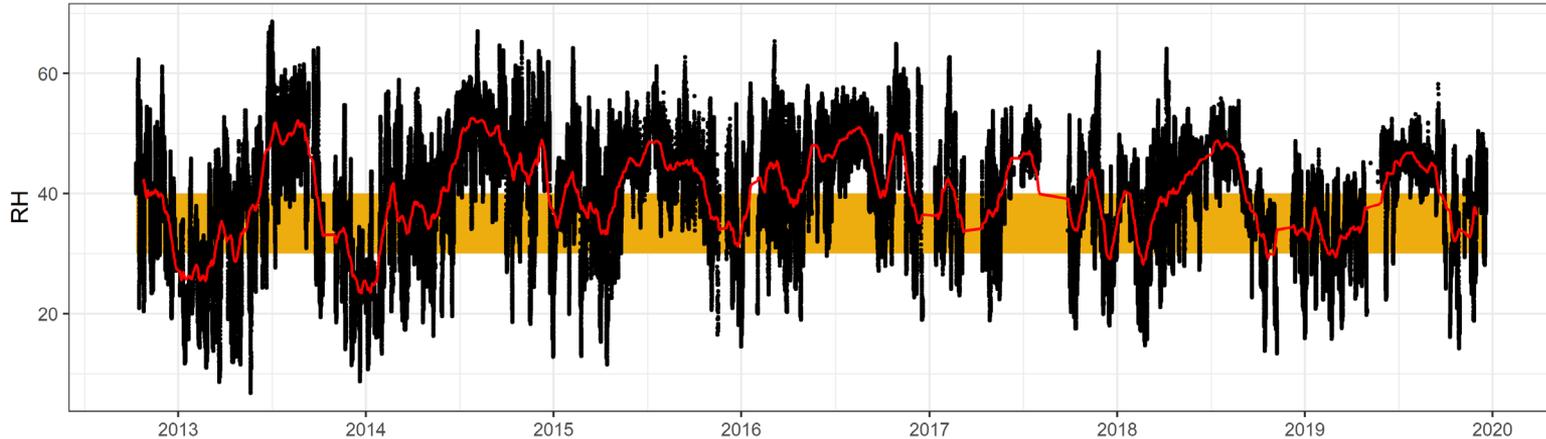
- Weighing samples in chamber first then on manual balance caused systematic bias; Reversed the weighing order in Sep 2019
- Small bias (3-4 μg) in both pre- and post-masses, suggests bias between the two balances (Chamber balance weighs less)
- PM difference is small (median = $1\mu\text{g}$) and not correlated with RH difference (lab-chamber)

Laboratory RH has decreased over the years

Is this why no correlation is observed?



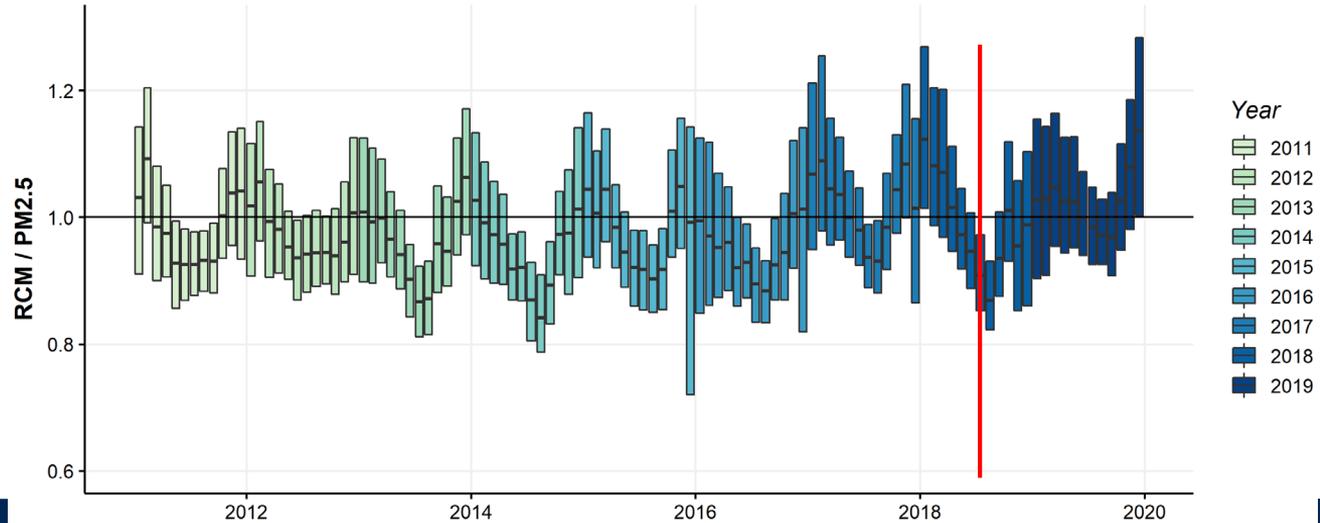
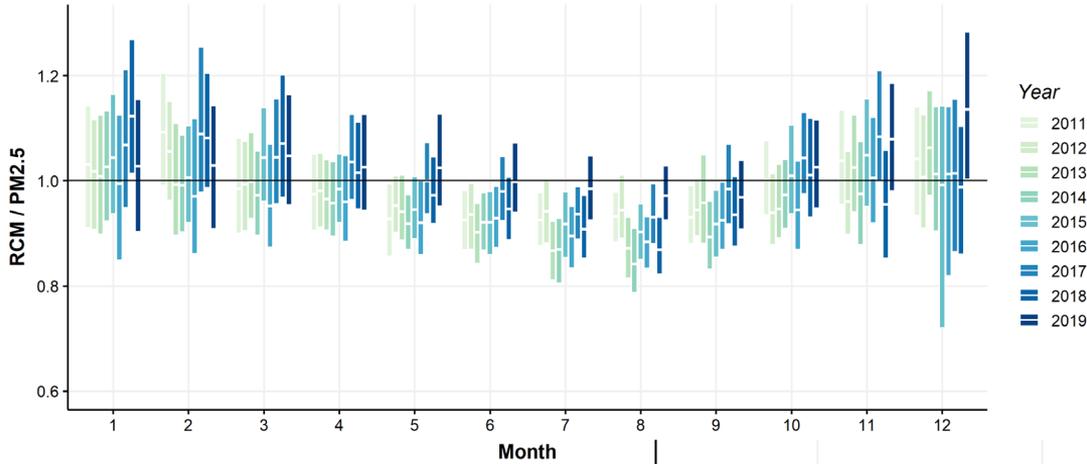
All Lab RH Records (Red line: Monthly median)



QUALITY ASSURANCE ACTIVITIES

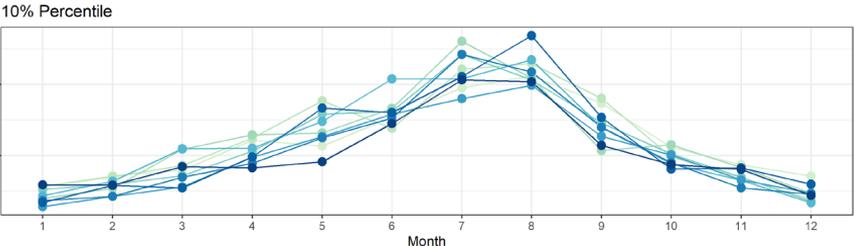
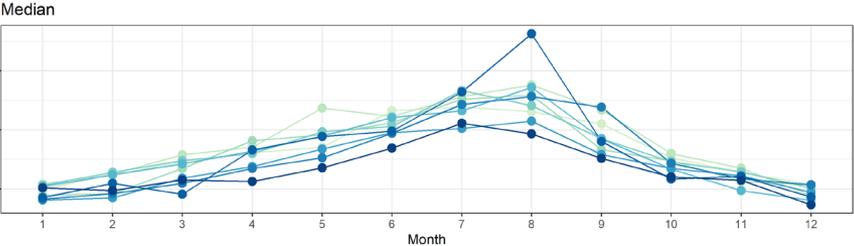
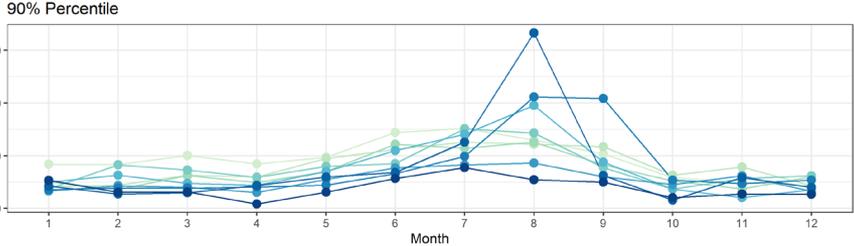
QA Report

- Increased RCM/PM2.5 ratio in 2019, especially in summer months

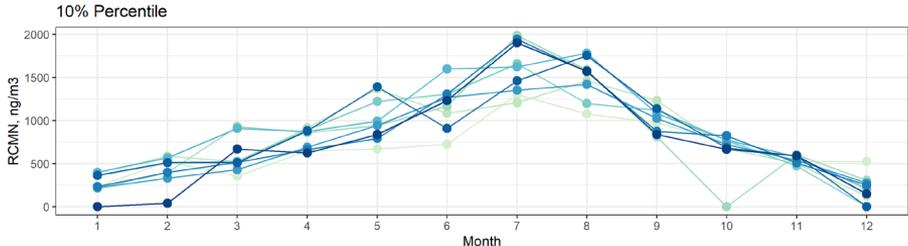
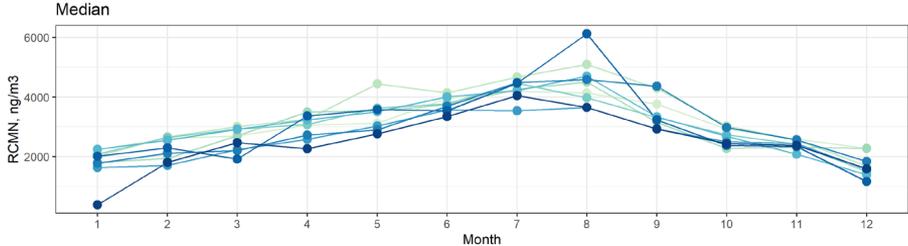
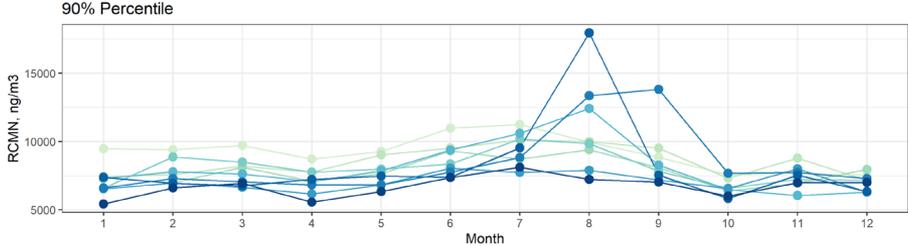


QA Report

Gravimetric PM2.5



Reconstructed PM2.5

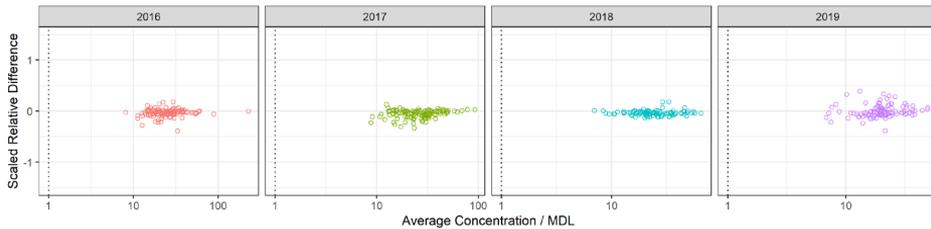


- Year
- 2011
 - 2012
 - 2013
 - 2014
 - 2015
 - 2016
 - 2017
 - 2018
 - 2019

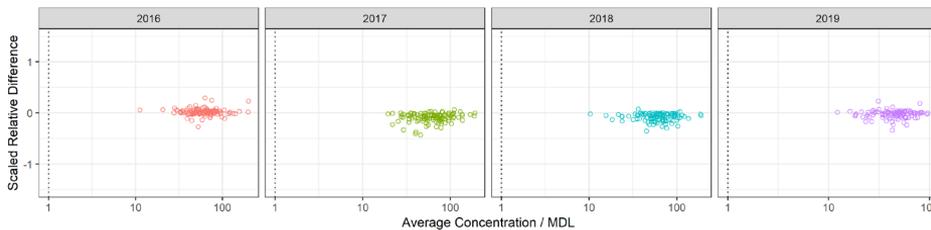
QA Report – Deja Vu

- Collocated agreement of some soil elements (Al, Si, Ca) at PHOE site worsened in 2019.

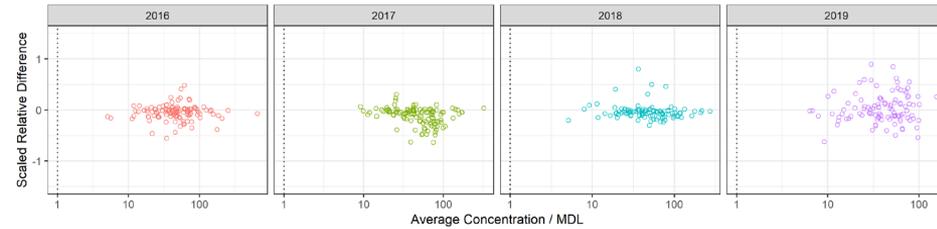
PM2.5



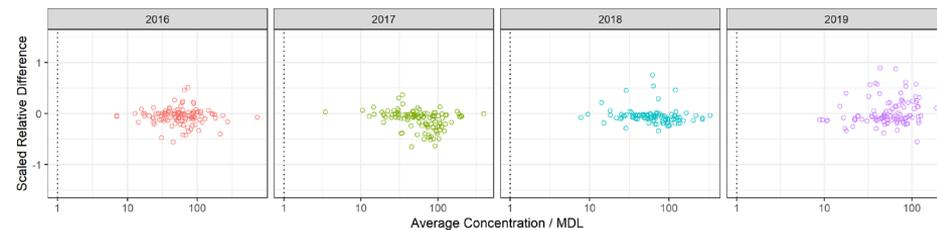
PM10



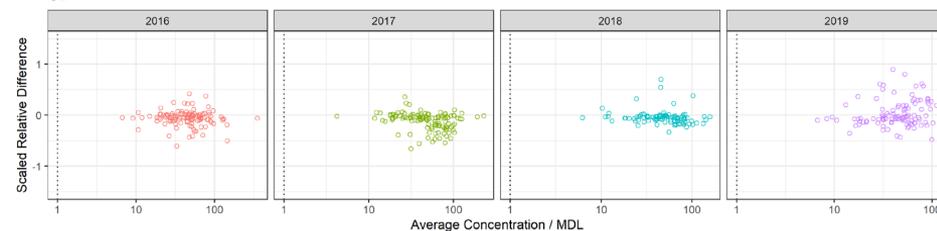
Al



Si

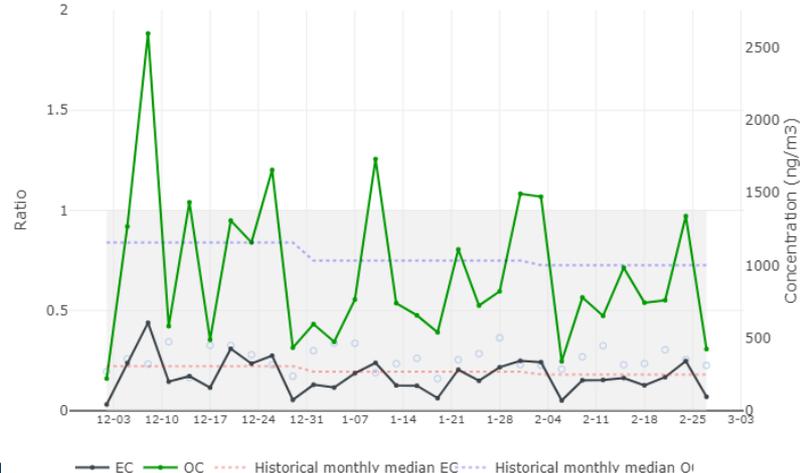
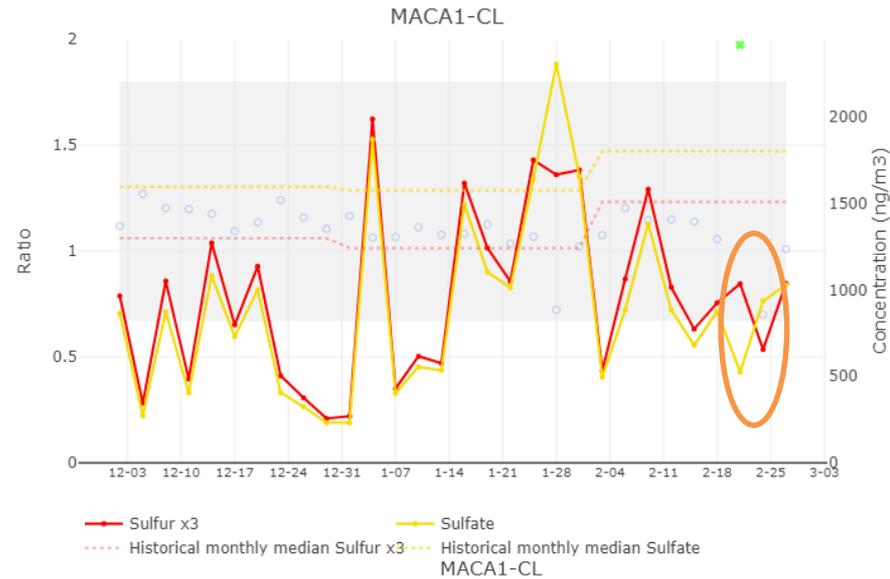


Ca



Using FTIR measurements in data validation

- MACA1 on 2/21/20 and 2/24/20 (top plot) don't compare well
 - Suspect nylon filter swap
 - FTIR measurements of sulfate (and S), could confirm
- Nothing to compare to OC carbon (bottom plot) for validation
 - FTIR OC would provide new capability to validate OC
- FTIR OC, EC, sulfate, S, Si, Al, Ca, Fe, Ti, fAbs, PM2.5 mass, soil and RCMF (RCM using FTIR measurements) will all be added to data validation plots to provide additional validation checks



XRF Reference Materials

- Caught up on some overdue publications



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Microchemical Journal

journal homepage: www.elsevier.com/locate/microc

Comparison of a priori and interlaboratory-measurement-consensus approaches for value assignment of multi-element reference materials on PTFE filters

Sinan Yatkin^{a,*}, Krystyna Trzepla^a, Nicole Pauly Hyslop^a, Warren H. White^a, Owen Butler^b, Travis Ancelet^c, Perry Davy^c, Michel Gerboles^d, Steven D. Kohl^e, Andrea McWilliams^f, Laura Saucedo^g, Marco Van Der Haar^h

^aAir Quality Research Center, University of California Davis, Davis, CA, USA
^bHealth and Safety Executive, Buxton, UK
^cInstitute of Geological and Nuclear Sciences, Lower Hutt, New Zealand
^dEuropean Commission, Joint Research Centre, Ispra, Italy
^eDesert Research Institute, Reno, Nevada, USA
^fResearch Triangle Institute, Research Triangle Park, NC, USA
^gSouth Coast Air Quality Management District, Diamond Bar, CA, USA
^hMalvern Panalytical, Almere, The Netherlands



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Spectrochimica Acta B

journal homepage: www.elsevier.com/locate/sab

Development of single-compound reference materials on polytetrafluoroethylene filters for analysis of aerosol samples

Sinan Yatkin^a, Krystyna Trzepla, Warren H. White, Nicholas James Spada, Nicole Pauly Hyslop

^aAir Quality Research Center, University of California Davis, Davis, CA, USA

AEROSOL SCIENCE AND TECHNOLOGY
2019, VOL. 53, NO. 7, 771–782
<https://doi.org/10.1080/02786826.2019.1606413>



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An inter-laboratory evaluation of new multi-element reference materials for atmospheric particulate matter measurements

Nicole Pauly Hyslop^a, Krystyna Trzepla^a, Sinan Yatkin^a, Warren H. White^a, Travis Ancelet^b, Perry Davy^b, Owen Butler^c, Michel Gerboles^d, Steven Kohl^e, Andrea McWilliams^f, Laura Saucedo^g, Marco Van Der Haar^h, and Armand Jonkers^h

^aAir Quality Research Center, University of California, Davis, California, USA; ^bInstitute of Geological and Nuclear Sciences, Lower Hutt, New Zealand; ^cHealth and Safety Laboratory, Buxton, United Kingdom; ^dEuropean Commission, Joint Research Centre, Directorate for Energy, Transport and Climate, Ispra, Italy; ^eDesert Research Institute, Reno, Nevada; ^fResearch Triangle Institute, Research Triangle Park, North Carolina, USA; ^gSouth Coast Air Quality Management District, Diamond Bar, California, USA; ^hMalvern Panalytical, Almere, The Netherlands





Short communication

Comparison of recent speciated PM_{2.5} data from collocated CSN and IMPROVE measurements

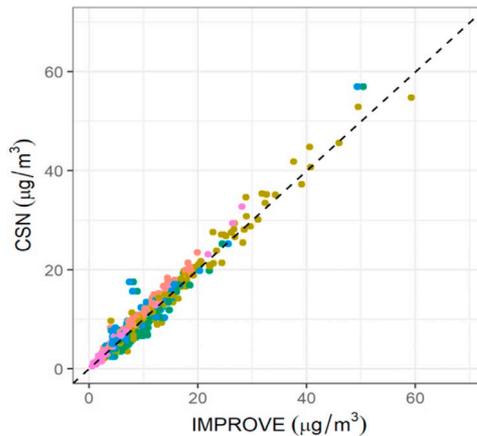
Katrine A. Gorham , Sean M. Raffuse, Nicole P. Hyslop, Warren H. White

Show more 

<https://doi.org/10.1016/j.atmosenv.2020.117977>

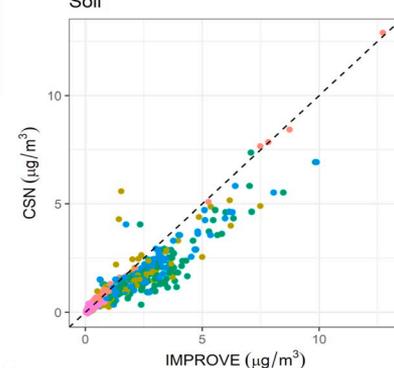
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Reconstructed Mass



Site

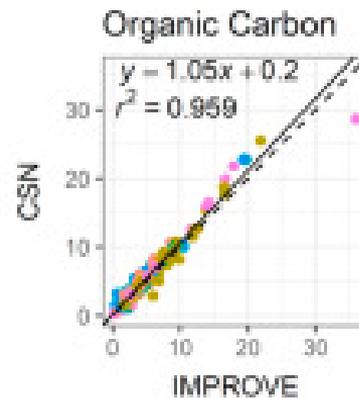
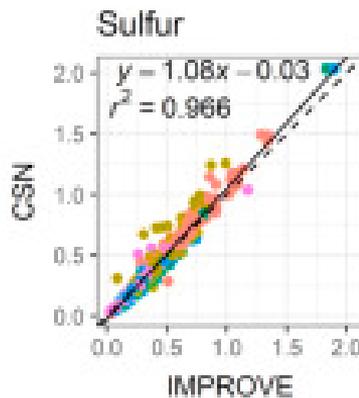
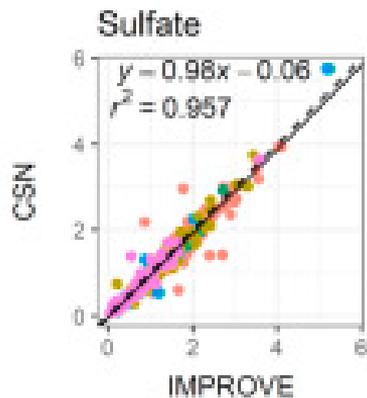
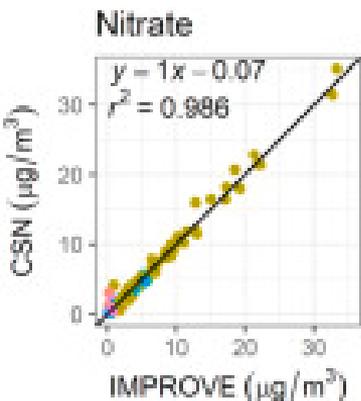
- Birmingham
- Fresno
- Phoenix 1
- Phoenix 2
- Seattle
- Soil



$$\text{Soil} = 2.2 \cdot \text{Al} + 2.49 \cdot \text{Si} + 1.63 \cdot \text{Ca} + 2.42 \cdot \text{Fe} + 1.94 \cdot \text{Ti}$$

Site

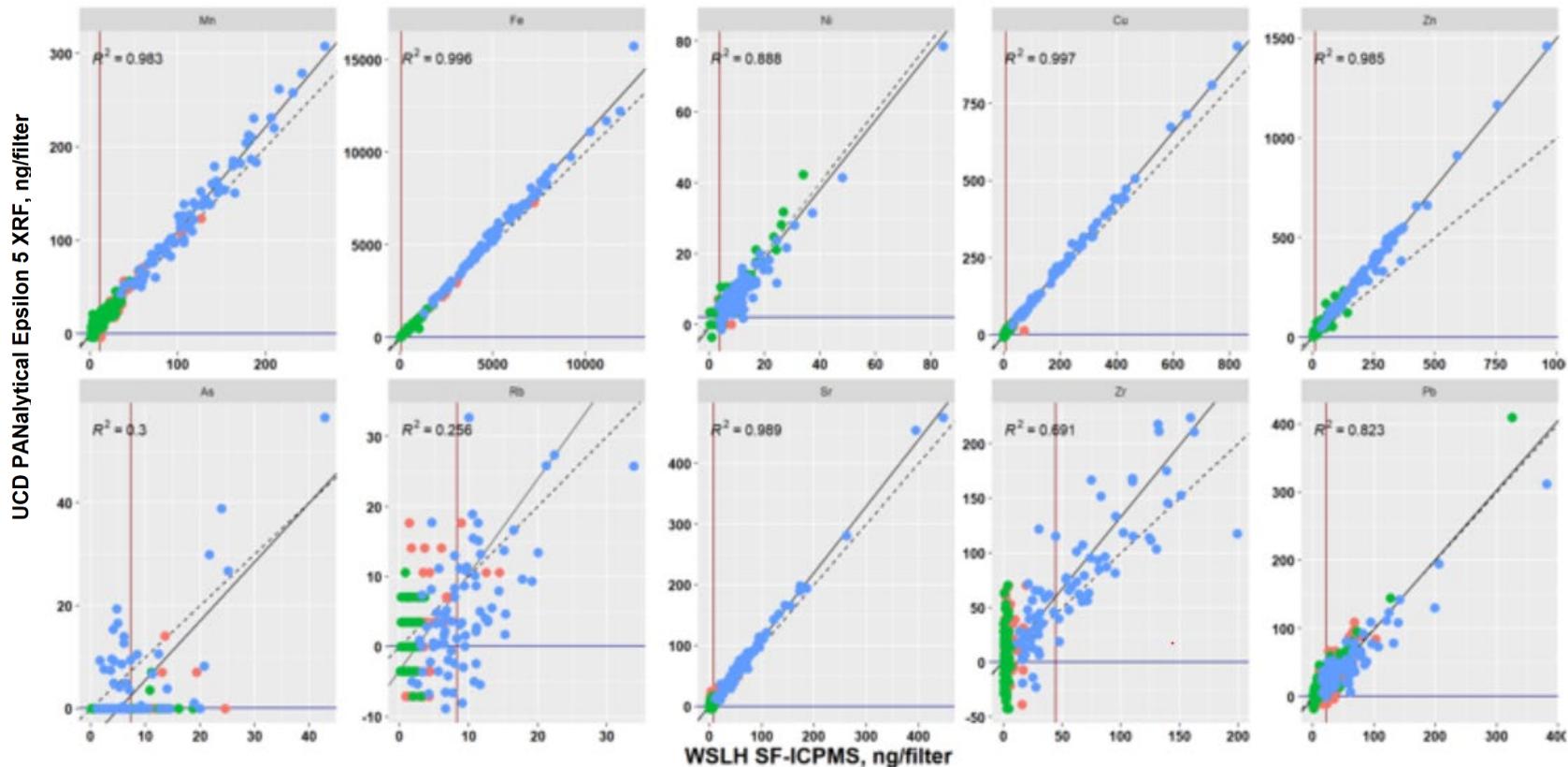
- Birmingham
- Fresno
- Phoenix 1
- Phoenix 2
- Seattle



SF-ICP-MS vs. XRF Comparison

with University of Wisconsin Madison

Site ● GRSM ● MORA ● PHOE



Any questions?



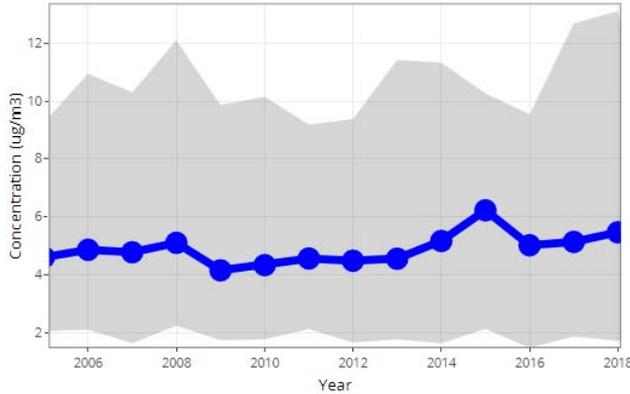
Select a Site Code

PORE1

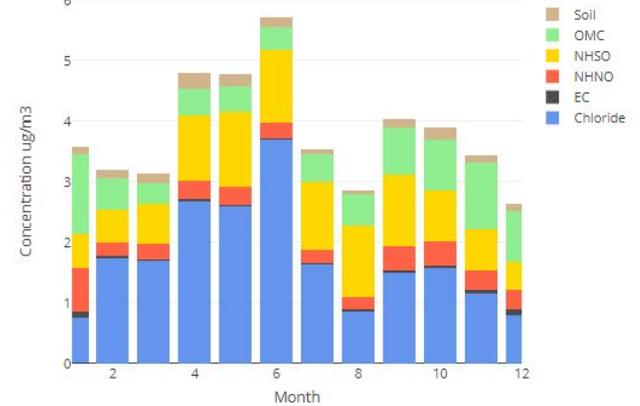
Site: Point Reyes National Seashore (CA)
Start Date: 1988-03-02
Latitude: 38.122422
Longitude: -122.908532
Elevation (m): 97
Affiliation: NPS
Site Type: IMPROVE



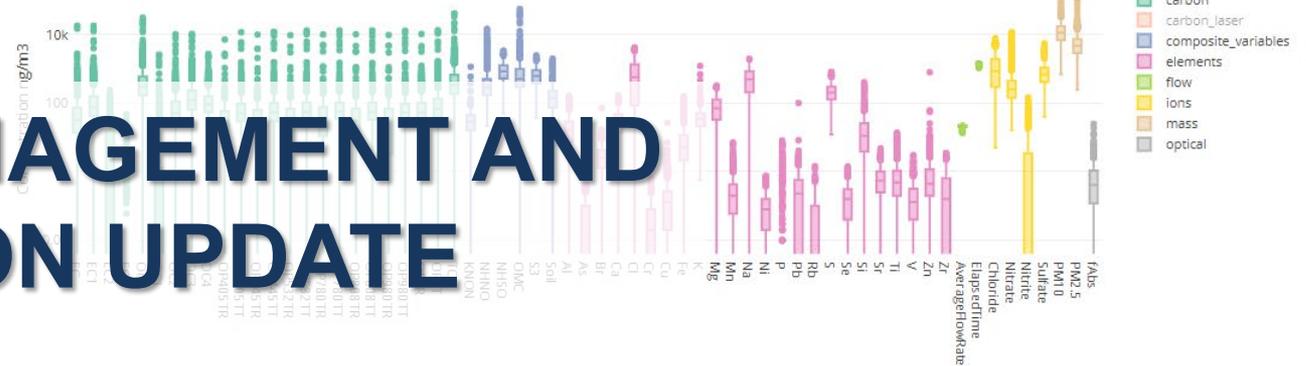
Annual Median PM2.5 Conc. (shaded area shows 10th-90th %)



Monthly Median Reconstructed Mass (since 2011)



Overall Fingerprint (elements and composite variables since 2011; others since 2005)



DATA MANAGEMENT AND VALIDATION UPDATE

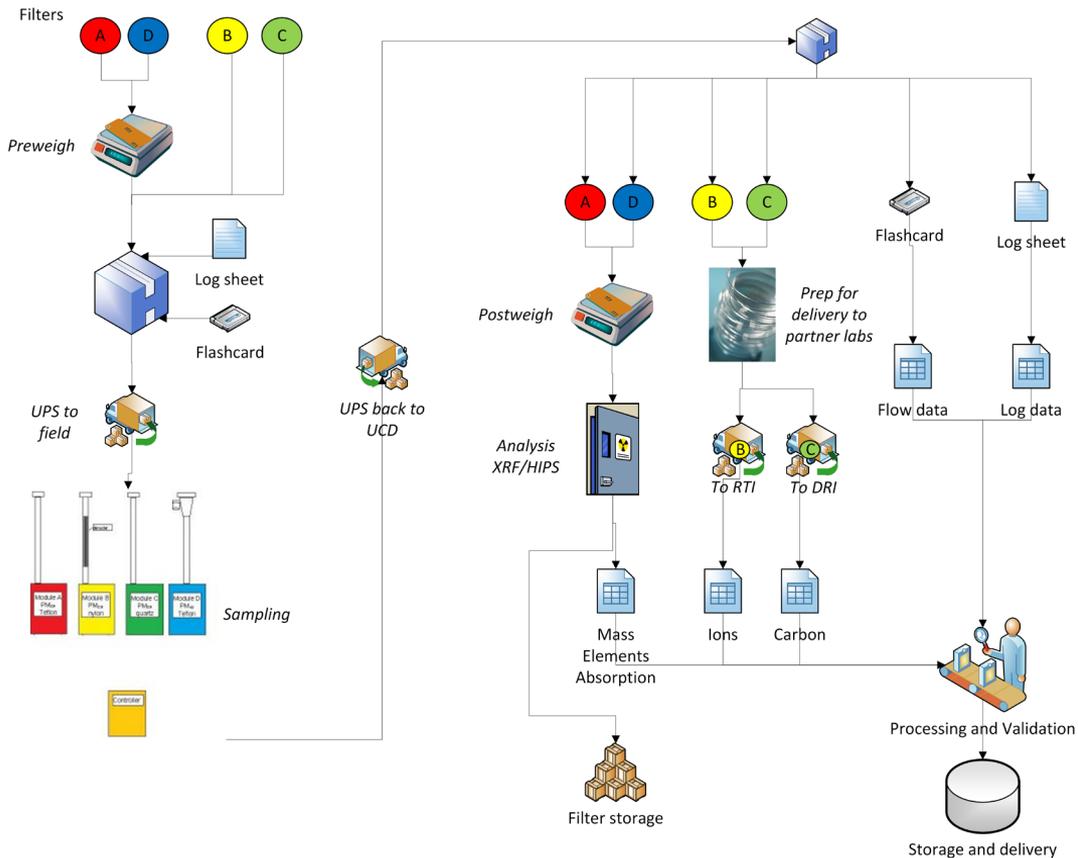
SEAN RAFFUSE
RUDI DE MARCO RAMEY, BRIAN TROUT, XIAOYA CHENG
UC DAVIS AIR QUALITY RESEARCH CENTER

IMPROVE Steering Committee Meeting
Everywhere, October 13, 2020

What's New in Data Management and Validation

1. Towards better supporting special studies
2. Tracking lab conditions
3. Incorporating field notes into validation tools
4. New home for the CSN/IMPROVE Archive tool (CIA)

We are not a typical analytical lab, we're an analytical factory

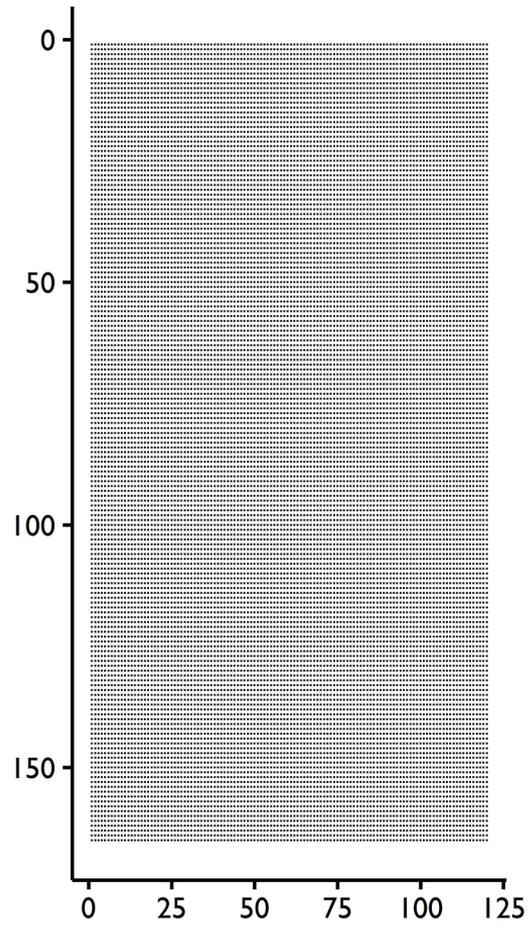


One filter



125 sample days
(every 3rd day)

0 25 50 75 100 125



165 sites



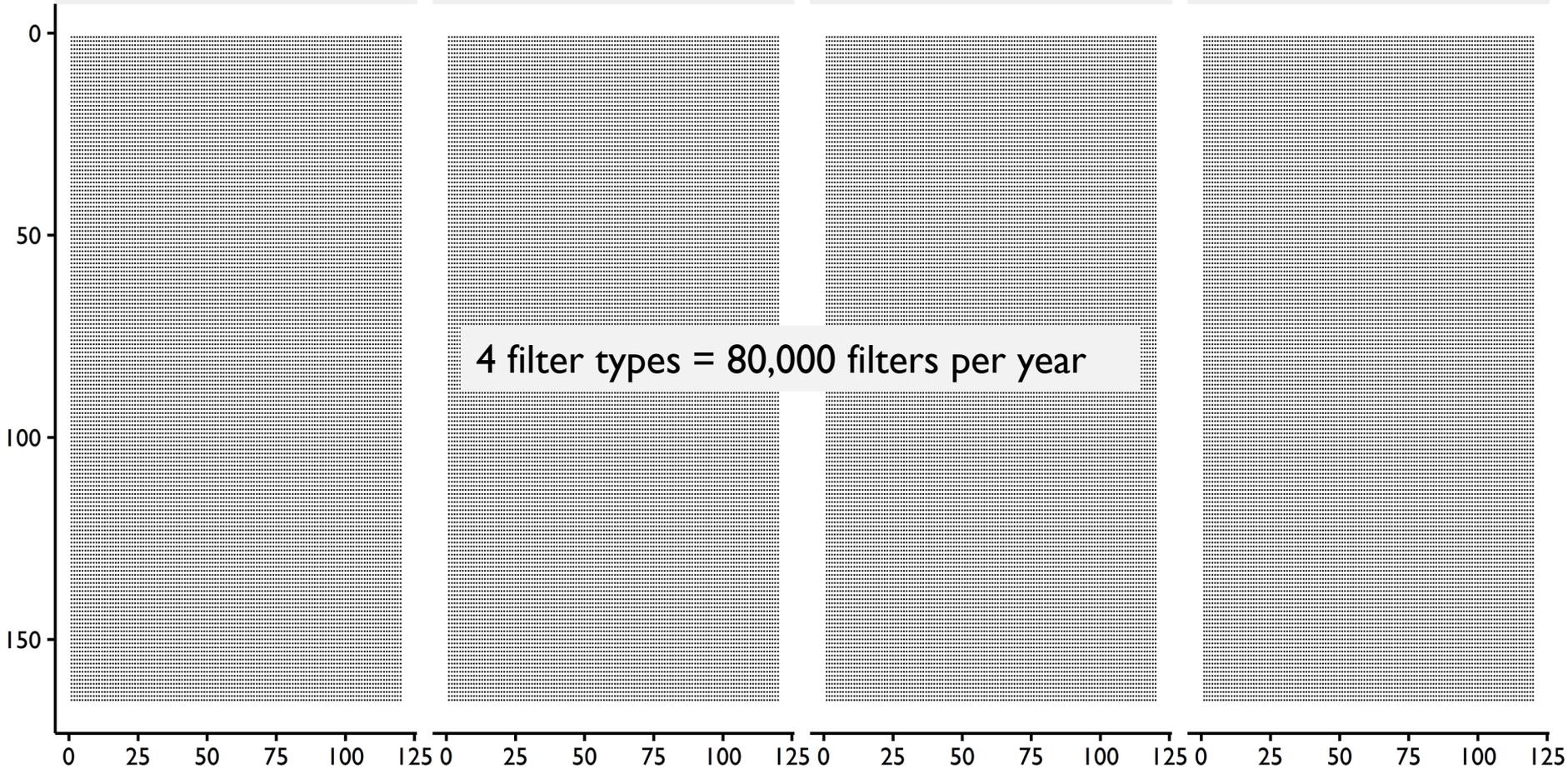
Teflon

Nylon

Quartz

Teflon PM10

4 filter types = 80,000 filters per year



The Pain of Special Studies

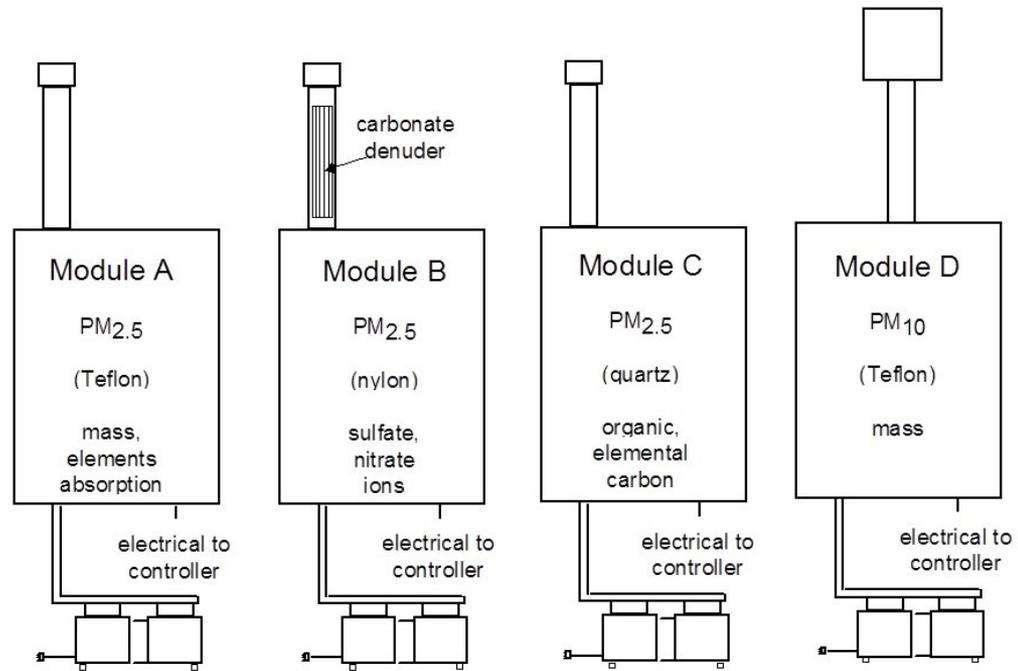
- To ensure quality and throughput, our tooling is somewhat rigid
- Seemingly simple changes from the standard setup can be difficult to accommodate
 - Non 1-in-3 sampling
 - Different filter media
 - Exotic module setups
 - Different/additional analyses



Slowly adding flexibility – starting with the database

What does it mean to be an A module?

- $PM_{2.5}$ particle cut point
- No denuder
- Teflon filter media
- 3.53 cm^2 sample deposit area
- Cyclone primary transducer
- Analyses performed
 - Gravimetric mass
 - Elements by XRF
 - Absorption by HIPS
 - FTIR



Custom module configuration and analysis paths

The database can now better support non-standard setups

- BYIS (Korea) uses a 37 mm filter instead of 25 mm for its “A” module so sample deposit area is 7.92 cm²
- DINO has a D-ish module that requires XRF analysis in addition to mass
- DINO has a B-ish module that has a PM₁₀ particle size cut

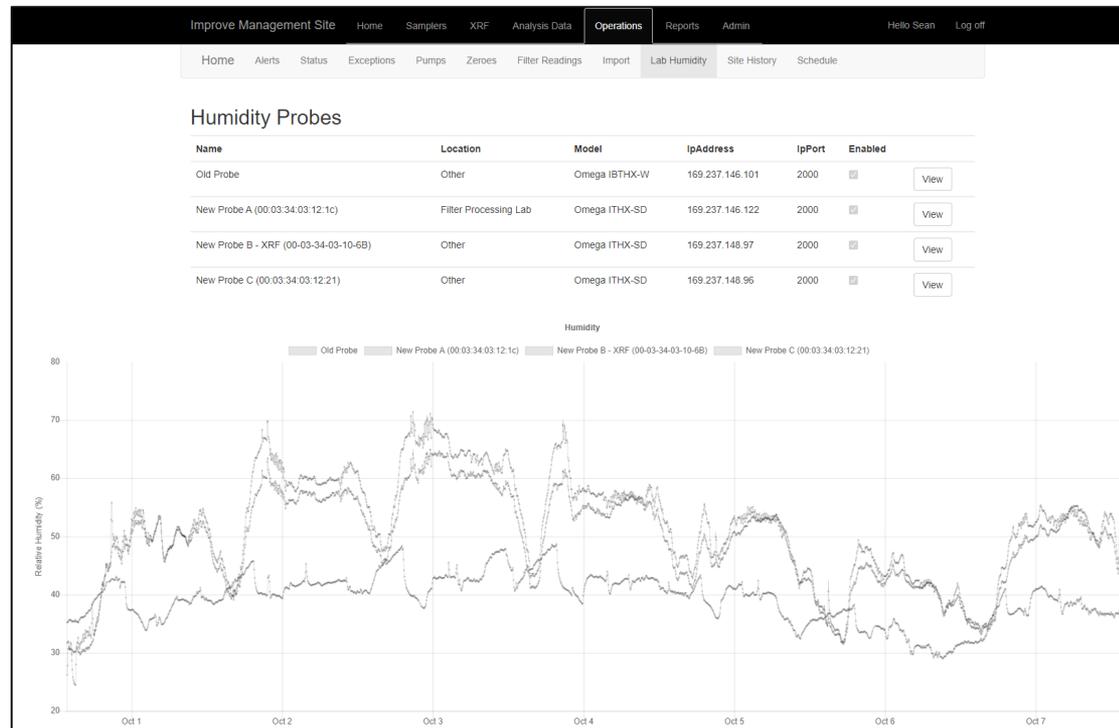
But the database is only part of our data infrastructure

- Box processing, cartridge prep, preweights, flow processing, analysis queues, concentration/uncertainty processing, data validation, inventory, etc.
- The goal is to fully support custom setups without manual intervention in the field, lab, or validation

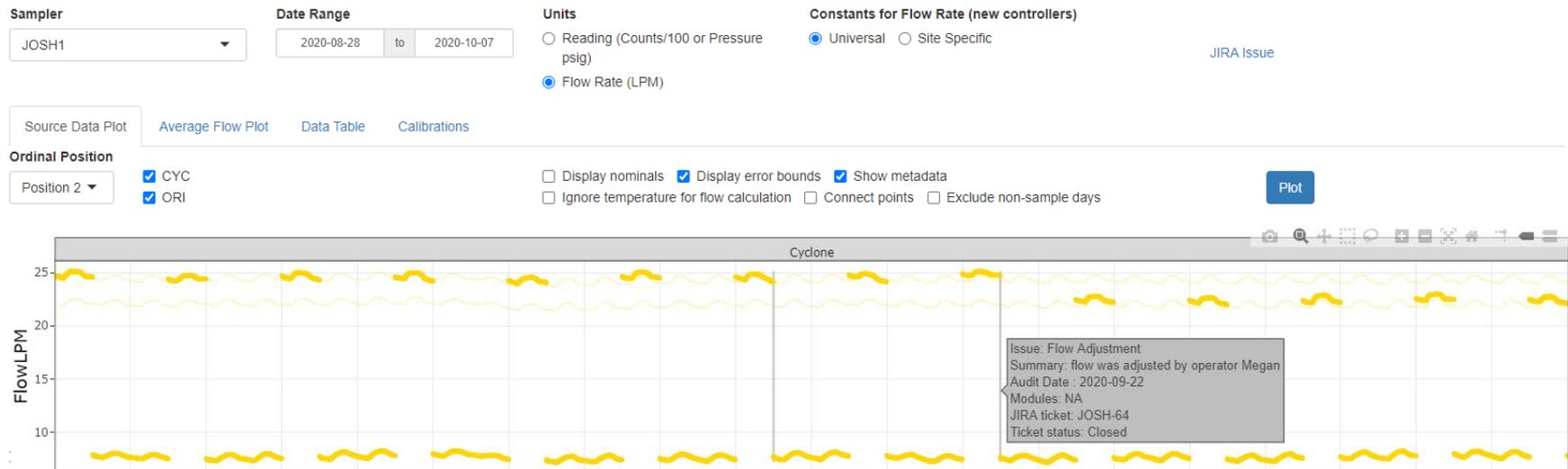
Tracking Lab Conditions

Real time temperature and relative humidity conditions are now available in the database and web tools

- Linked to weight records
- Heat testing for new building



Integrating field notes into validation tools



CIA Has Moved to <https://particles.ucdavis.edu>

The old site is going away

- Your old account will not work (sorry!)
- New user management system
- New site supports more concurrent users

