UC Davis Network Update: Field, Laboratory & Data

IMPROVE Steering Committee Meeting

Petaluma, CA

2019.10.22 – 2019.10.23

Nicole Hyslop, Xiaolu Zhang, Sean Raffuse, Krystyna Trzepla, Jason Giacomo, Chris Wallis, and the whole team

University of California, Davis

Total = 160 Sites

- New Sites

1. DINO, 10/29/2018
2. TOOL, 11/9/2018
3. SOGP, 10/1/2019

- VIIS back online since 12/2018
- Full suite of modules at ATLA1 and PITT1 as of summer 2019

Analysis and Delivery Status

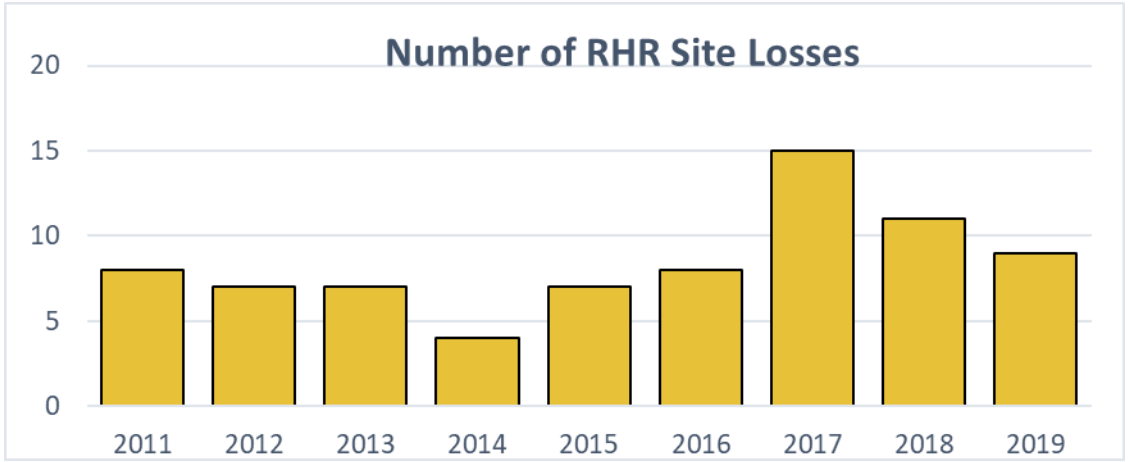
All 2018 data have been delivered to AQS and FED.

2019	Ions	Carbon	Elements	HIPS	Validation	Delivery (AQS & FED)
January	✓	✓	✓	✓	🕒	✘
February	✓	✓	✓	✓	🕒	✘
March	✓	✘	✓	✓	✘	✘
April	✓	✘	✓	✘	✘	✘
May	✓	✘	✓	✘	✘	✘
June	✘	✘	✘	✘	✘	✘
July	✘	✘	✘	✘	✘	✘
August	✘	✘	✘	✘	✘	✘
September	✘	✘	✘	✘	✘	✘

Regional Haze Rule (RHR) Completeness Criteria

RHR requires for all modules:

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



2011-2018: Final number of losses after completion of full validation.

2019: Number of losses year-to-date.

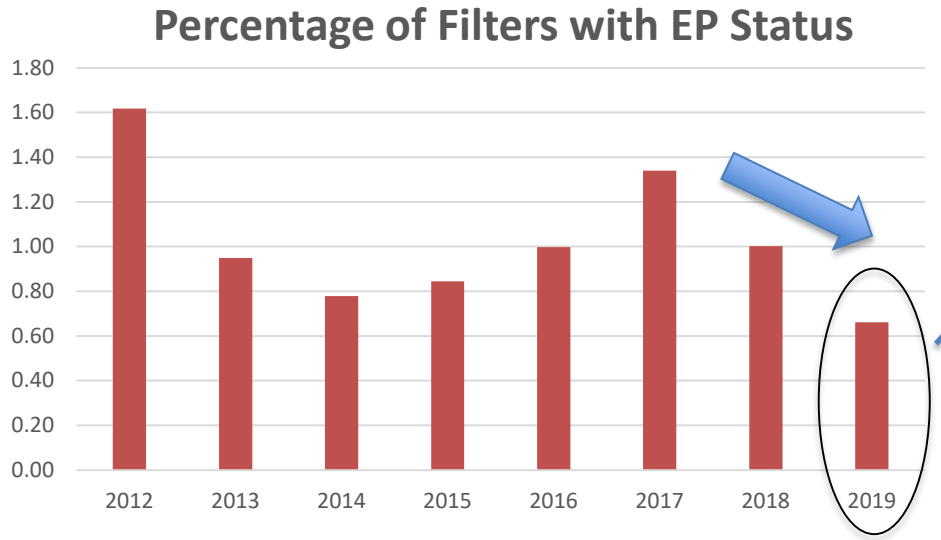
Site status report distributed every quarter; if you aren't on the list, let us know

Site losses in 2019

Government shutdown in January resulted in 9+ consecutive lost samples (NS) at most sites

1. BOAP1 (FWS): 12 consecutive PO samples in Q1
2. BYIS1 (SKorea): 13 consecutive NS samples
3. FLAT1 (Tribe): 31 samples lost this year (mostly NS samples)
4. FLTO1 (FS): 12 consecutive samples lost in Q1 (mostly NS samples)
5. FOPE1 (Tribe): 19 samples lost in Q1 (mostly NS samples)
6. IKBA1 (FS): 20 samples lost in Q1 (mostly NS samples)
7. MING1 (FWS): 12 consecutive NS samples in Q1
8. THRO1 (NPS): 12 consecutive NS+EP samples in Q1
9. BLIS1 (FS): >10 consecutive PO, electricity shut due to code violations

New Controller Helps Save Samples



- As of this week, internet-connected new controllers have been deployed throughout the IMPROVE network
- Daily data downloads
- Fast problem identification and troubleshooting


Improve Management Site
Home
XRF
Analysis Data
Operations
Reports
Admin
Log in
Home
Alerts
Status
Exceptions
Pumps
Zeroes
Filter Readings
Import
Network Summary (157 out of 160 samplers)
Show readings
Show all sites
ACAD1 0
AGTI1 0
ATLA1 0
BADL1 0
BALD1 0
BAND1 0
BIBE1 0
BIRM1 0
BLIS1 0
BOAP1 0
BOLA1 0
BOND1 0
BOWA1 0
BRCA1 0
BRID1 0
BRIG1 0
BRIS1 0
CABA1 0
CABI1 0
CACO1 0
CACR1 0
CANY1 0
CAPI1 0
CAVE1 0
CEBL1 0
CHAS1 0
CHIR1 0
COHU1 0
CORI1 0
CRLA1 0
CRMO1 0
DENA1 0
DETR1 0
DINO1 0
DOME1 0
DOSO1 0
EGBE1 0
EVER1 0
FCPC1 0
FLAT1 0
FLTO1 0
FOPE1 0
FRES1 0
FRRE1 0
GAMO1 0
GICL1 0
GLAC1 0
GRBA1 0
GRCA2 0
GRGU1 0
GRRI1 0
GRSA1 0
GRSM1 0
GUMO1 0
HECA1 0
HEGL1 0
HOOV1 0
IKBA1 0
ISLE1 0
JARB1 0
JARI1 0
JOSH1 0
KAIS1 0
KALM1 0
KPBO1 0
LABE1 0
LASU2 0
LAVO1 0
LIGO1 0
LOND1 0
LOST1 0
LTCC1 0
LYEB1 0
MACA1 0
MAKA2 0
MAVI1 3
MEAD1 0
MELA1 0
MEVE1 0
MING1 4
MOHO1 0
MOMO1 0
MONT1 0
MOOS1 0
MORA1 0
MOZI1 0
NEBR1 0
NOAB1 0
NOCA1 0
NOCH1 0
NOGA1 0
OKEF1 0
OLYM1 0
ORPI1 0
OWVL1 0
PACK1 0
PASA1 0
PEFO1 0
PENO1 0
PHOE1 0
PHOE5 0
PINN1 0
PITT1 0
PMRF1 0
PORE1 0
PRIS1 0
PUSO1 0
QUCI1 0
RAFA1 0
REDW1 0
ROMA1 0
ROMO1 0
SACR1 0
SAGA1 0
SAGO1 0
SAGU1 0
SAMA1 0
SAPE1 0
SAWE1 0
SAWT1 0
SENE1 0
SEQU1 0
SHEN1 0
SHMI1 0
SHRO1 0
SIME1 0
SIPS1 0
SNPA1 0
SOGP1 0
STAR1 0
STIL1 0
SULA1 0
SWAN1 0
SYCA2 0
TALL1 0
THBA1 0
THRO1 0
THSI1 0
TONT1 0
TOOL1 0
TRCR1 0
TRIN1 0
ULBE1 0
UPBU1 0
VIIS1 0
VILA1 0
VOYA2 0
WEMI1 0
WHIT1 0
WHPA1 0
WHPE1 0
WHRI1 0
WICA1 0
WIMO1 0
YELL2 0
YOSE1 0
ZICA1 0
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
10/17/2019 1:00:05 AM
10/17/2019 12:59:02 AM
0 Alerts
4/4 Online
NORMAL
[1: 10/18/2019]
[2: 10/21/2019]
[3: 10/15/2019]
AGTI1
10/17/2019 1:00:05 AM
10/17/2019 12:59:02 AM
0 Alerts
4/4 Online
NORMAL
[1: 10/9/2019]
[2: 10/12/2019]
[3: 10/15/2019]
ATLA1
10/17/2019 1:00:05 AM
10/17/2019 12:59:02 AM
0 Alerts
4/4 Online
NORMAL
[1: 10/18/2019]
[2: 10/21/2019]
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BADL1
10/17/2019 2:00:00 AM
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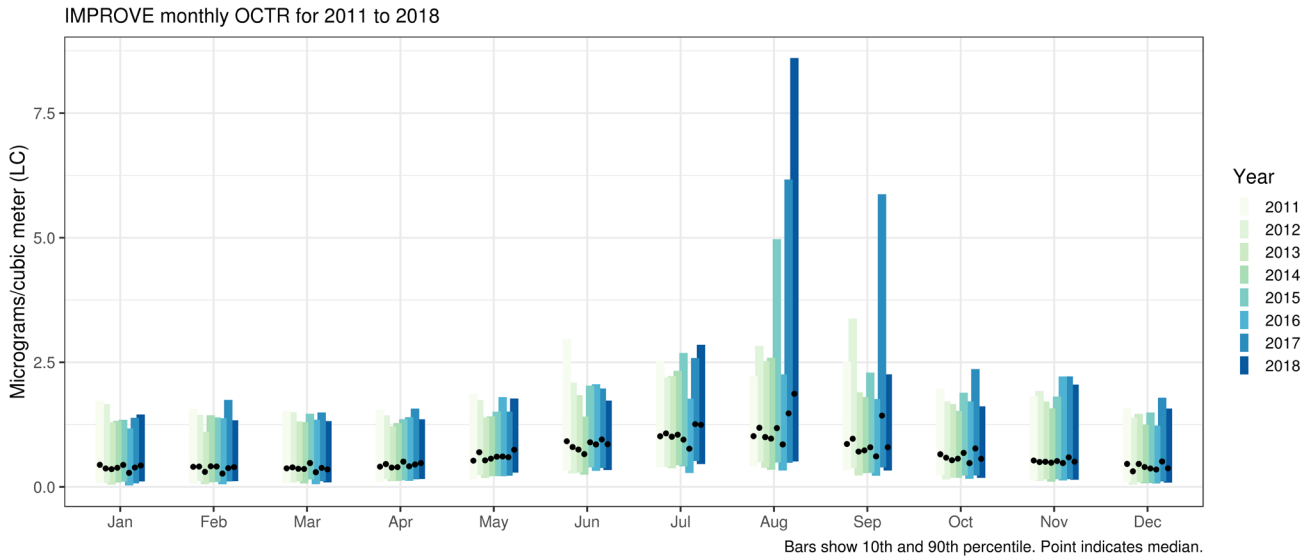
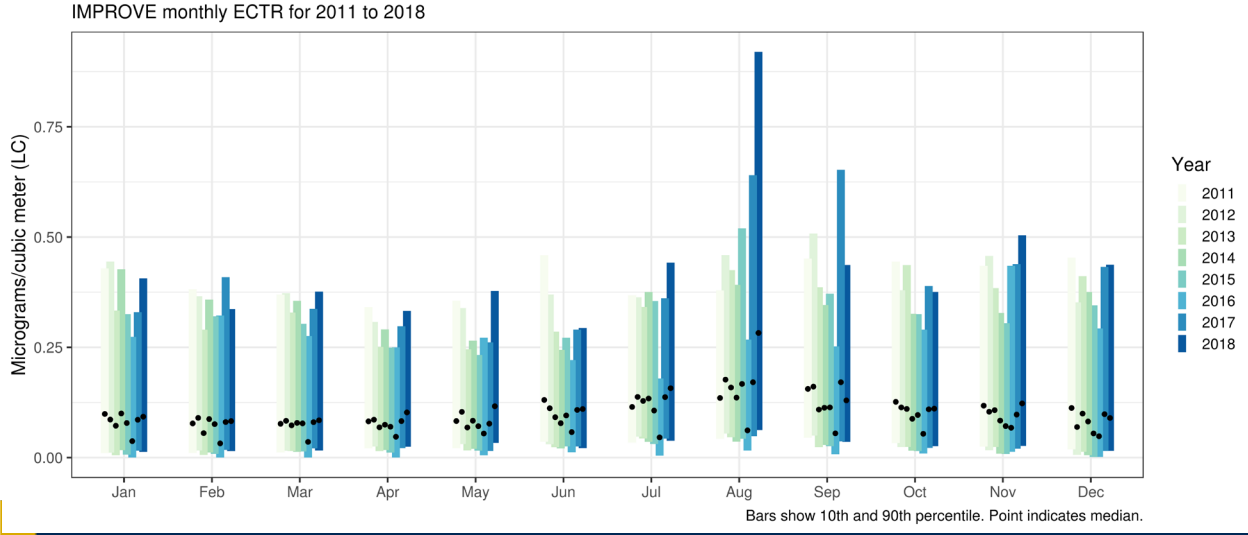
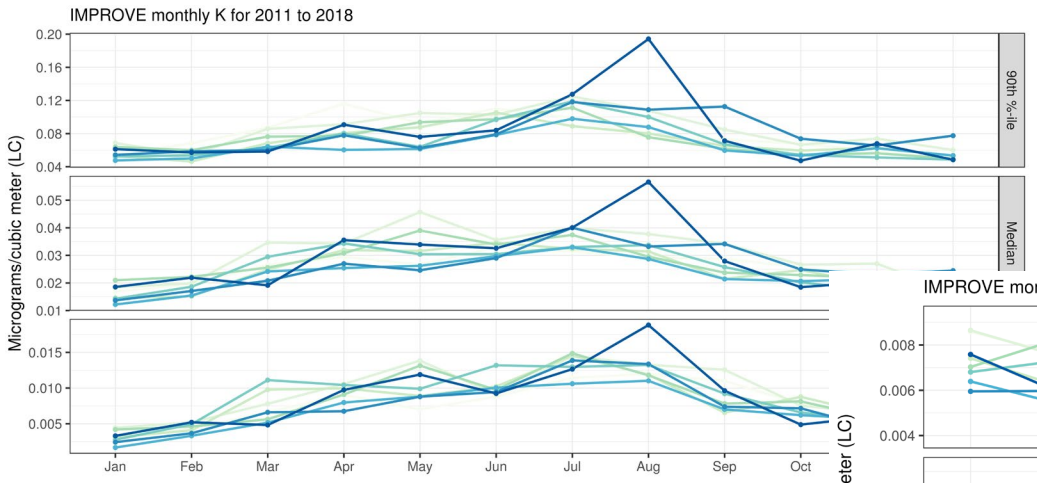
0 Alerts
4/4 Online
NORMAL
[1: 10/18/2019]
[2: 10/21/2019]

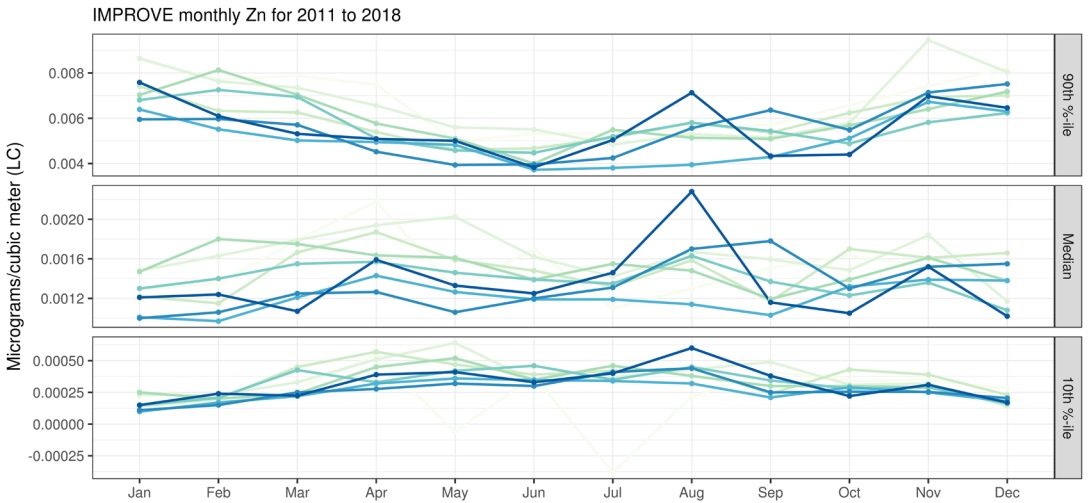
Semi-annual QA Report

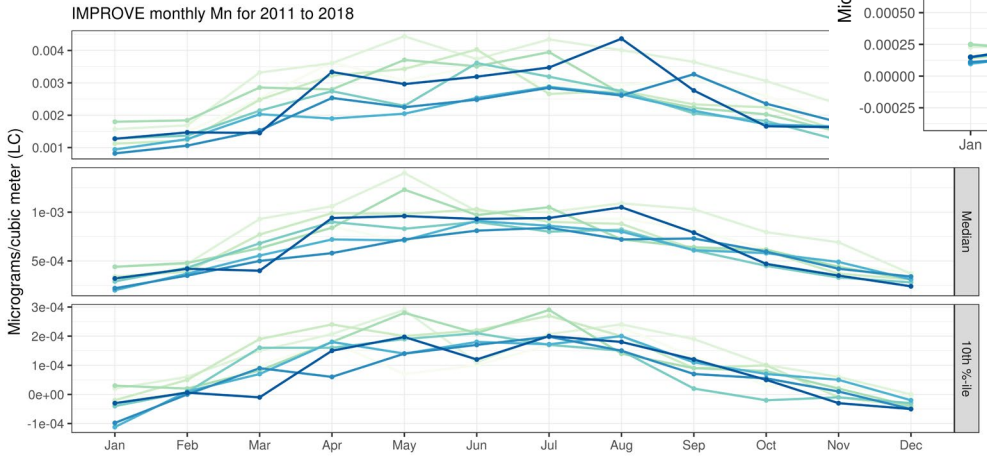




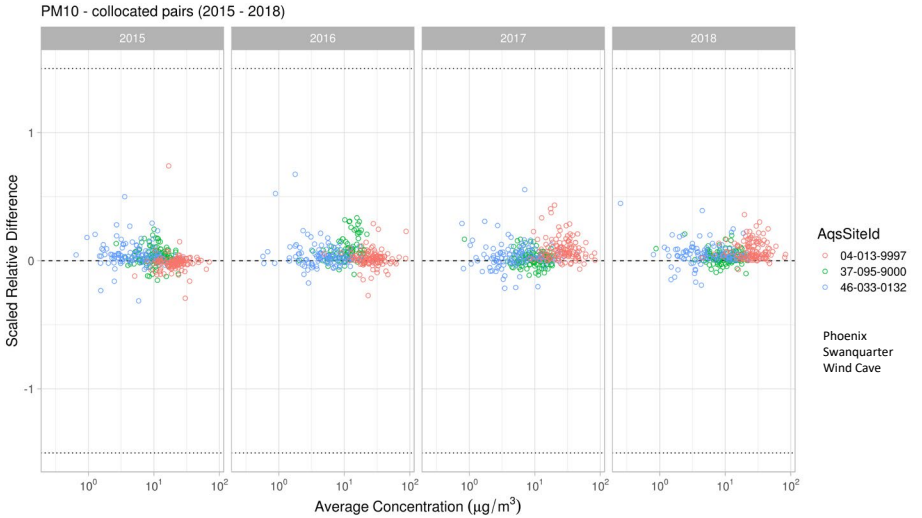
What other species showed up in the smoke?

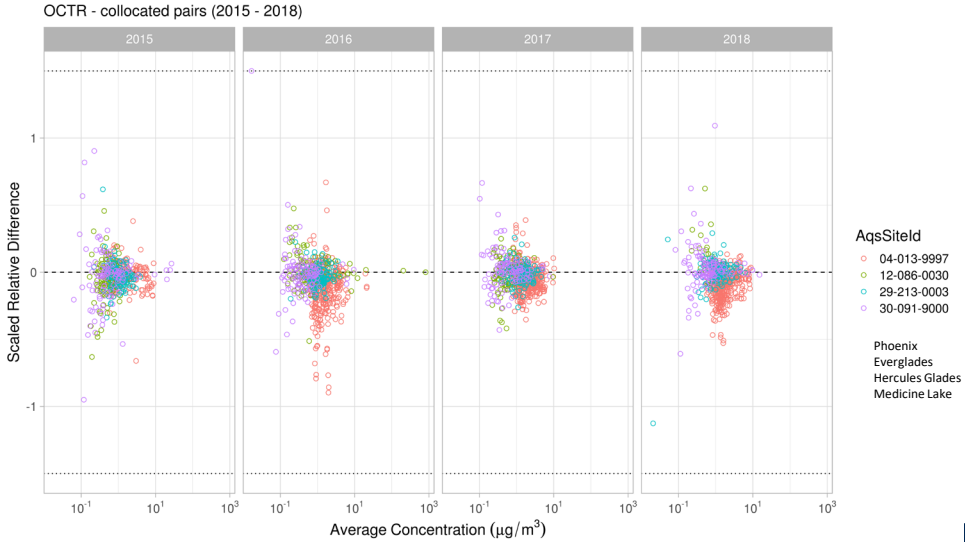


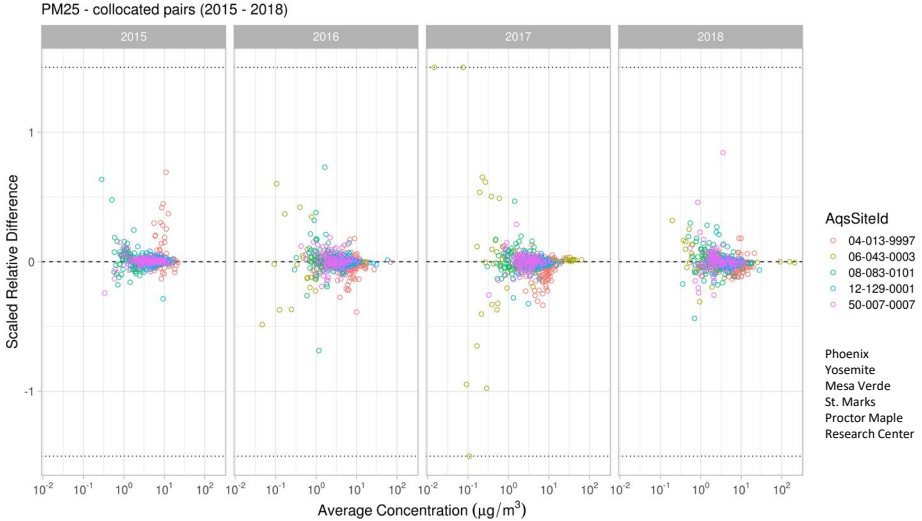




Semi-annual QA Report Collocated Measurements

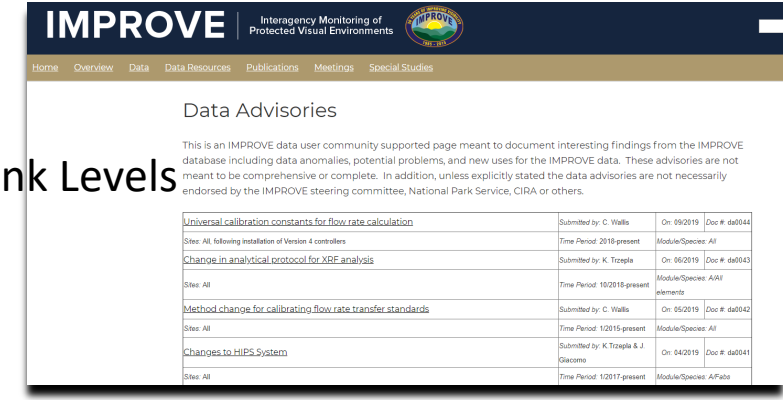






Data Advisories in 2019

1. Correction of Chloride Concentrations for Filter Blank Levels
   Released: 03/2019
   Period Impacted: 2007 - 2011
2. Changes to HIPS System
   Released: 04/2019
   Period Impacted: January 2017 to present
3. Method Change for Calibrating Flow Rate Transfer Standards
   Released: 05/2019
   Period Impacted: January 2015 to present
4. Change in Analytical Protocol for XRF Analysis
   Released: 06/2019
   Period Impacted: October 2018 to present
5. Universal Calibration Constants for Flow Rate Calculation
   Released: 09/2019
   Period Impacted: 2018 to present



Field Updates

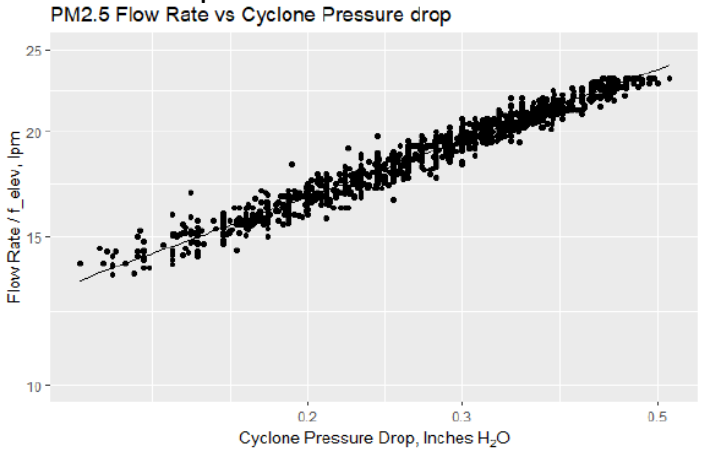
New Universal Flow Rate Constants (Data Advisory)

- Digital pressure transducers are consistent and provide absolute measures of pressure in inches of H_2O
- Data from 2018 and 2019 at 128 sites are combined to derive universal flow calibration constants for $PM_{2.5}$ and PM_{10} samplers across the network
  - $PM_{2.5}$ Module

$$Log_{10}(Flow) = A + B \times Log_{10}(\Delta P_{cyc})$$

where A = intercept constant = 1.489

B = slope constant = 0.3797

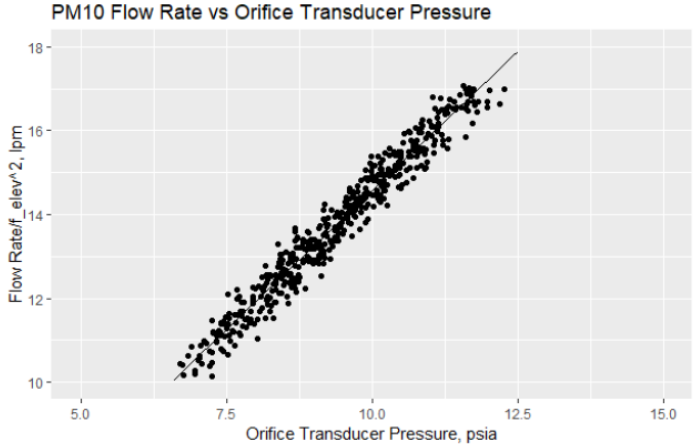


  - PM_{10} Module

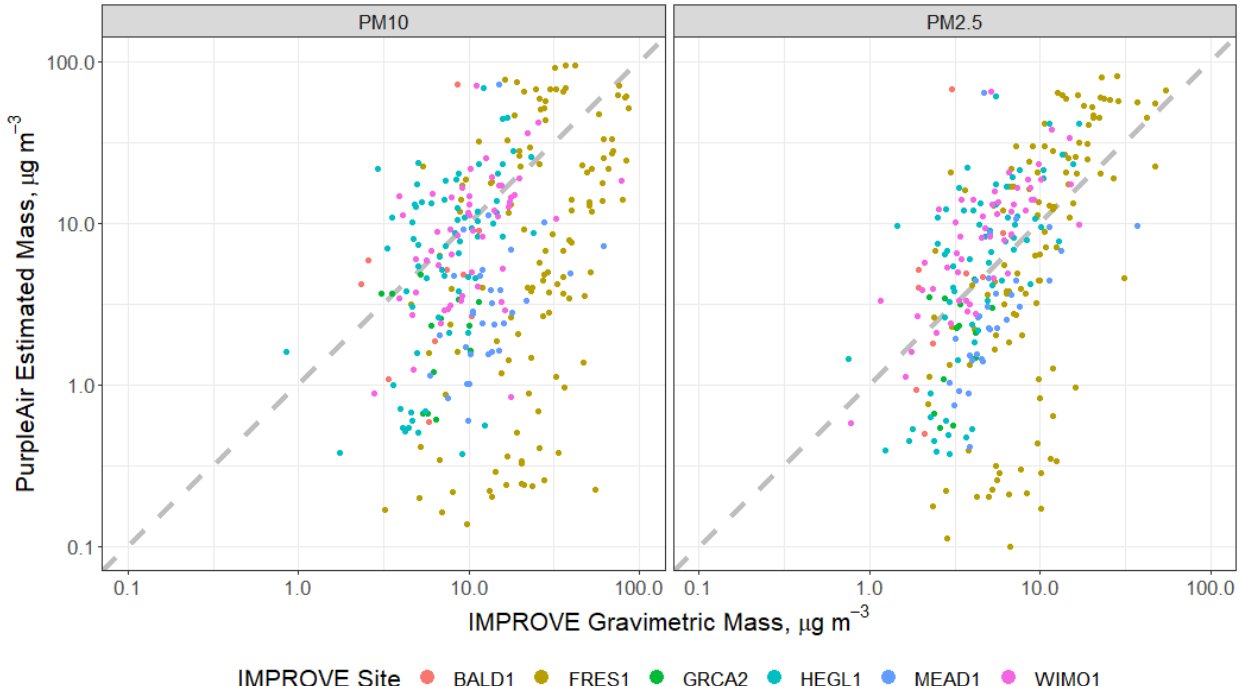
$$Flow = C + D \times P_{ori}$$

where C = intercept constant = 1.320

D = slope constant = 1.325



Purple Air Sensors



Location	Data Output	Installed
Fresno, CO (FRES1)	Public	05/14/2018
Meadview, AZ (MEAD1)*	SD Card	06/04/2018
Grand Canyon, AZ (GRCA2)	SD Card	06/05/2018
Mount Baldy, AZ (BALD1*)	SD Card	06/07/2018
Wichita Mountain, OK (WIMO1)	Public	07/26/2018
Hercules-Glades, MO (HEGL1)	Public	07/29/2018
Mammoth Cave, KY (MACA1)	Controller	05/07/2019
Great Smoky Mountains, TN (GRSM1)	Controller	05/10/2019
University of CA – Davis	SD Card	05/22/2019
Shenandoah, VA (SHEN1)	Controller	7/26/2019
Theodore Rosevelt, ND (THRO1)	Controller	8/22/2019

New Pump Durability Testing

- Exploring new brushless DC pumps for IMPROVE sampler
    - Variable speed allows for flow control
        - Control software would need to be developed
    - Existing pumps were discontinued
    - Cheaper than existing pumps
- First step is to test durability
    - Existing pumps last 4+ years in field running every 3 days
    - Testing DC pumps in Denali and Davis by running 6 hours on and 2 hours off - will mimic 3 years of service in ~1 year.

Laboratory Updates

MTL Automated Weighing Chamber

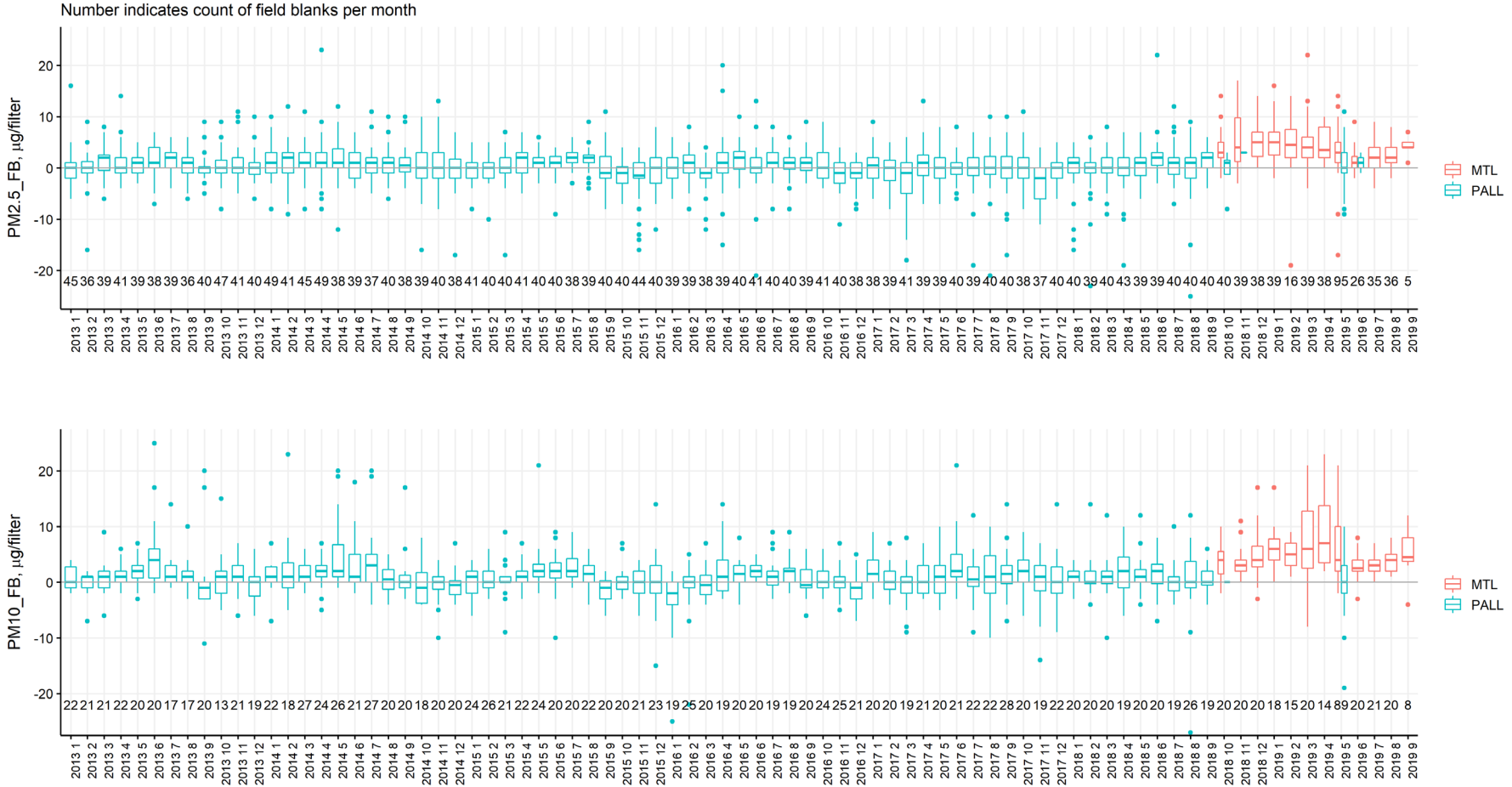
Operational starting October 5, 2018

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

Long term testing ongoing:

- Longer equilibration time
- Manual balance vs. chamber system
- Mass gain on blanks

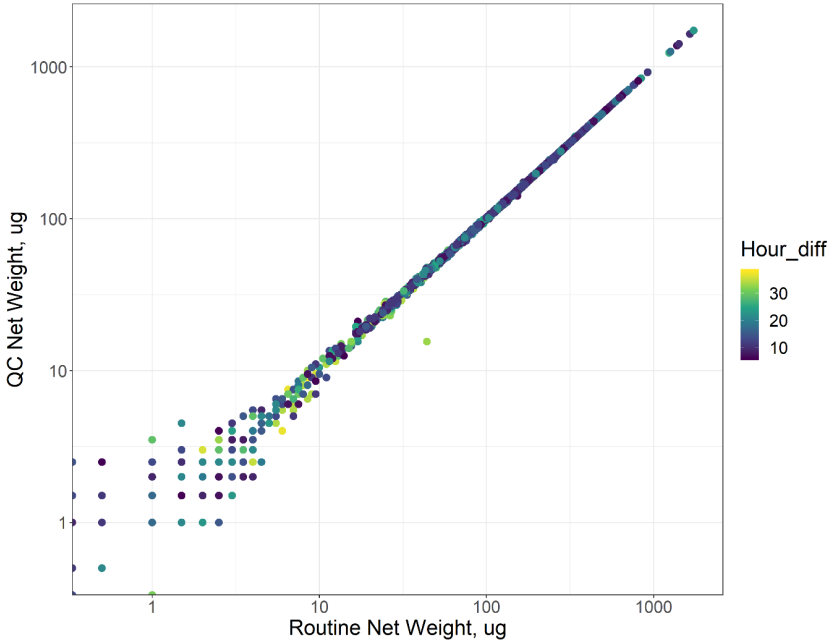
MTL Filter Blank Mass Gain

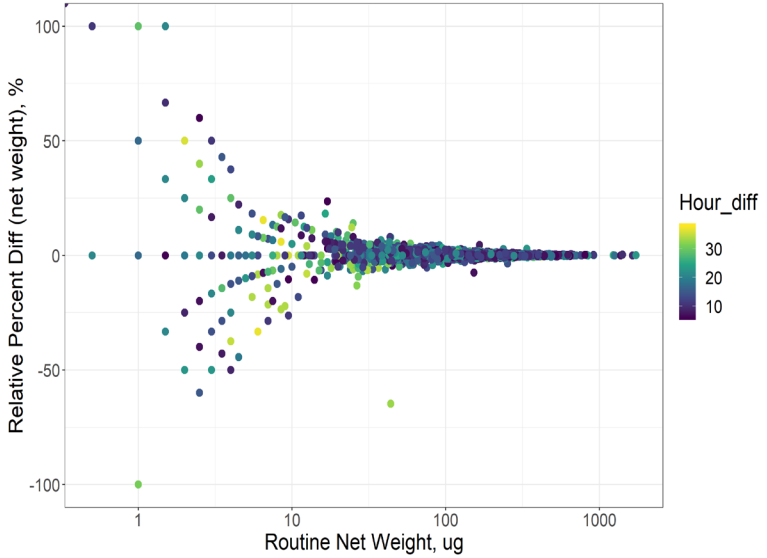


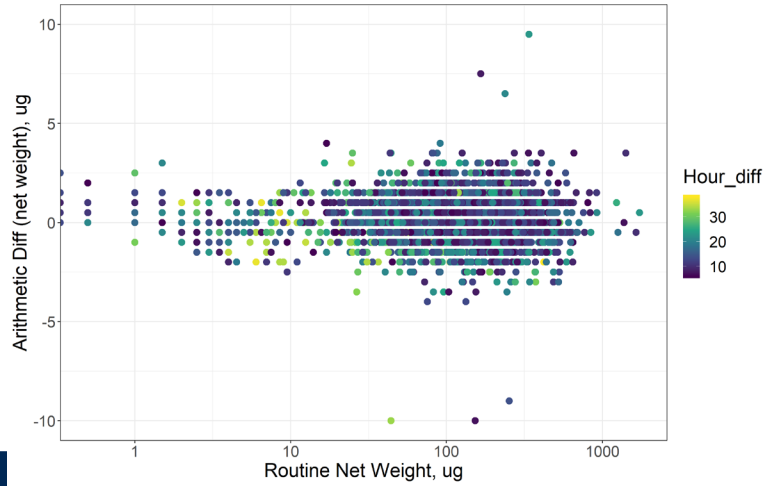
Long-term Testing: Longer Equilibration Time

- Routine equilibration time is 2-4 hours (operationally constrained)
- Repeated weight measurements with longer equilibration time (4 – 40+ hours) during the weekends since 4/20/2019
- A total of 5428 pairs of routine and repeated QC measurements; 2023 pre-weight pairs & 3405 post-weight pairs
- Relative difference (RPD) = (QC – routine)/routine * 100
- Arithmetic difference = QC – routine mass

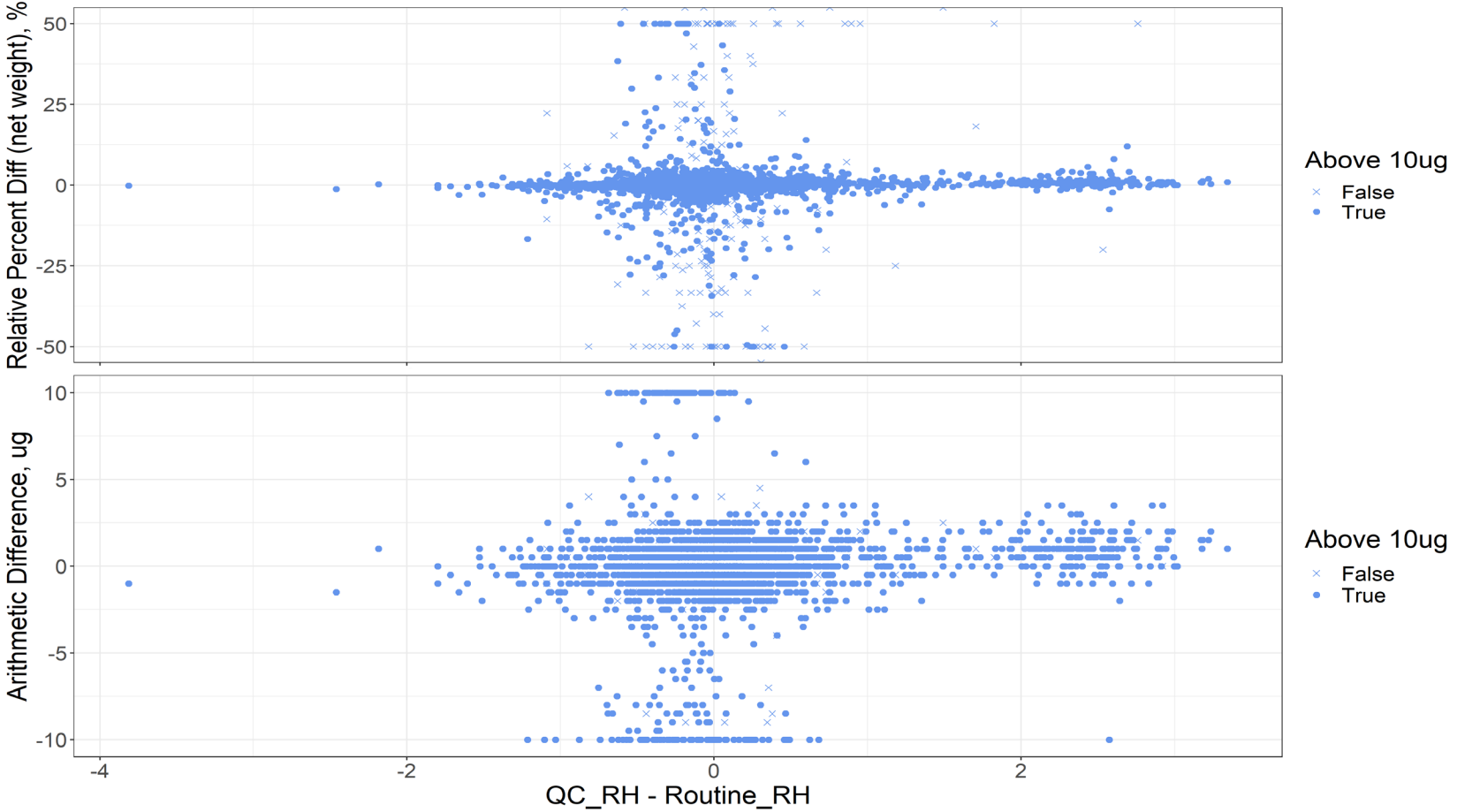
No dependence of differences on equilibration time difference







Weight Difference versus RH Difference



Long-term Testing: Manual vs Chamber Comparison

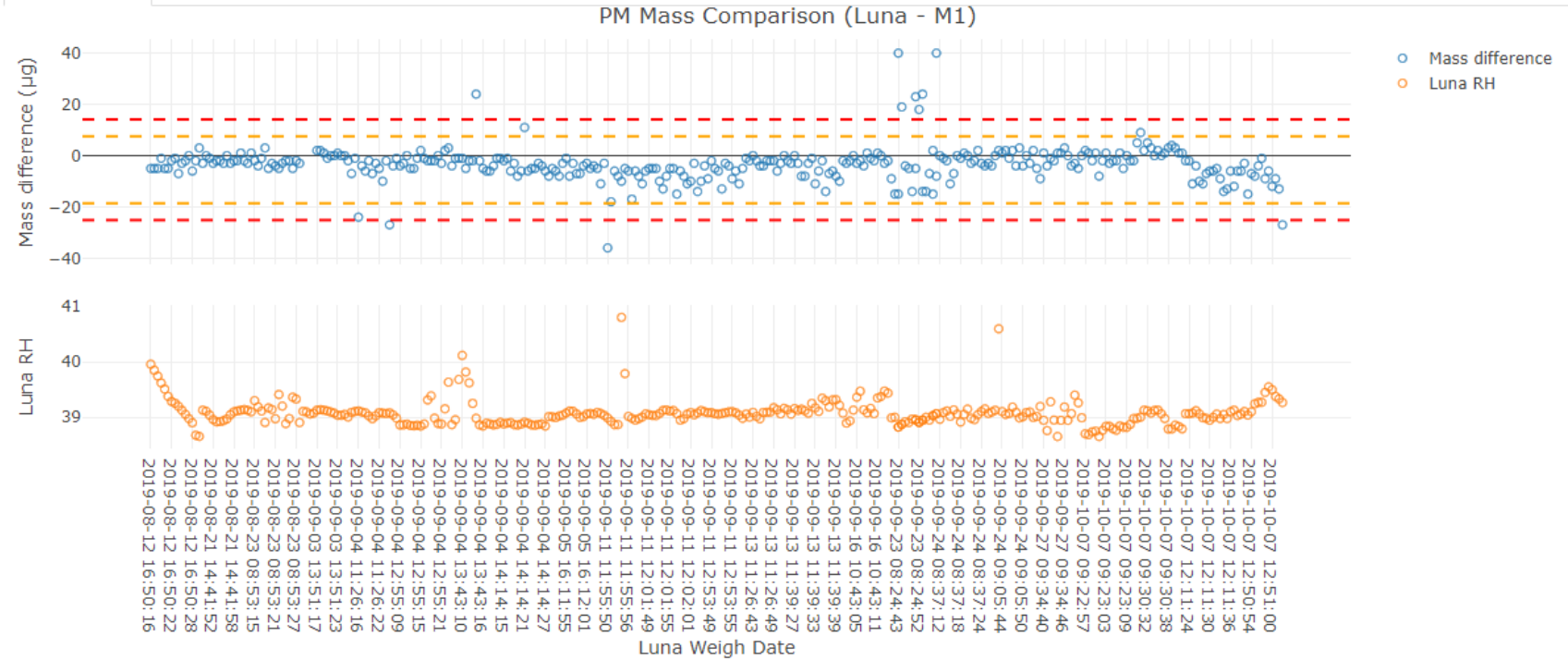
- Pre- and post-weighing a small number of filters on both chamber and manual balances since July 2019.
- Collected 653 pre-mass pairs and 331 post-mass pairs as of 10/7/2019.
- Median “chamber – manual” difference is 6 µg for post-mass, 4 µg for pre-mass, and 3 µg difference in net mass for network samples.

Prototype Lab QC tool for Chamber/Manual Balance Comparison

Range of Luna weighing dates

2019-08-09 to 2019-10-08

PM-mass | Pre-mass | Post-mass



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New XRF Analysis Protocol (Data Advisory)

- KBr secondary target (for better As detection) is eliminated
- Longer irradiation time for some of the other targets to improve sensitivity
- New protocol applied to Oct. 2018 sample analysis onward

Sample Element	Secondary Target	Exposure (sec), Old	Exposure (sec), New
Na – K	CaF_2	600	600
Ca – Cr	Fe	400	400
Mn – Zn	Ge	300	400
As	KBr	300	
Se – Br	SrF_2	300	
As– Br	SrF_2		400
Rb – Sr, Pb	Mo	300	400
Zr	Al_2O_3	200	200

XRF Calibration Reference Materials Publications

Contents lists available at ScienceDirect

Atmospheric Environment

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

Generation of multi-element reference materials on PTFE filters mimicking ambient aerosol characteristics

Sinan Yatkin*, Krystyna Trzepla, Warren H. White, Nicole Pauly Hyslop

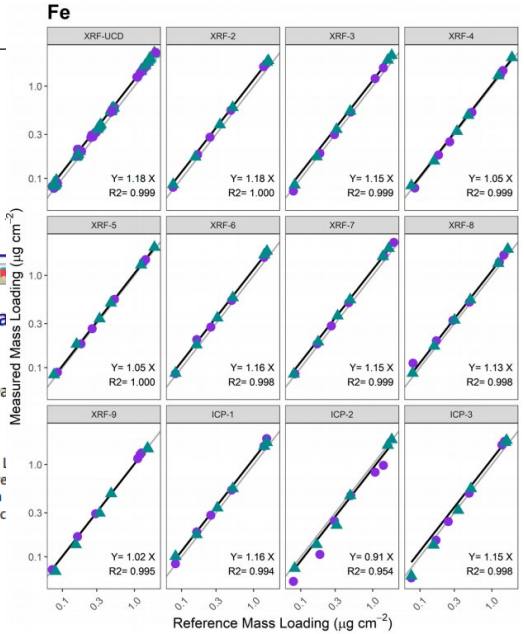
Air Quality Research Center, University of California, Davis, CA, 95616, United States

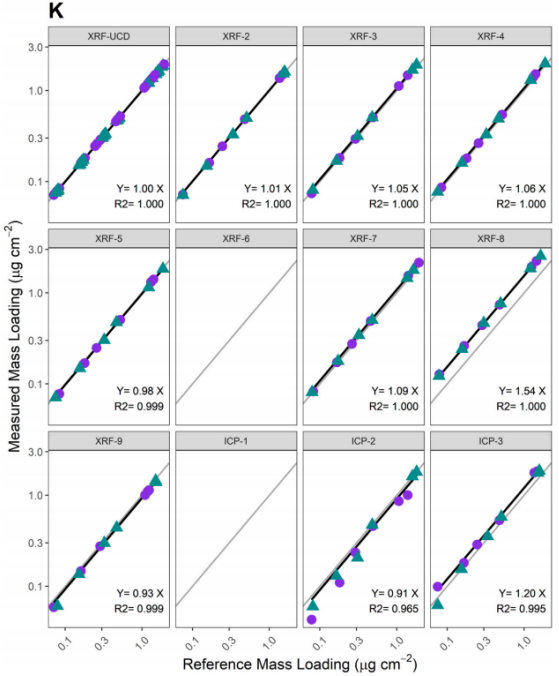
AEROSOL SCIENCE AND TECHNOLOGY
2019, VOL. 53, NO. 7, 771–782
https://doi.org/10.1080/02786826.2019.1606413

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

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

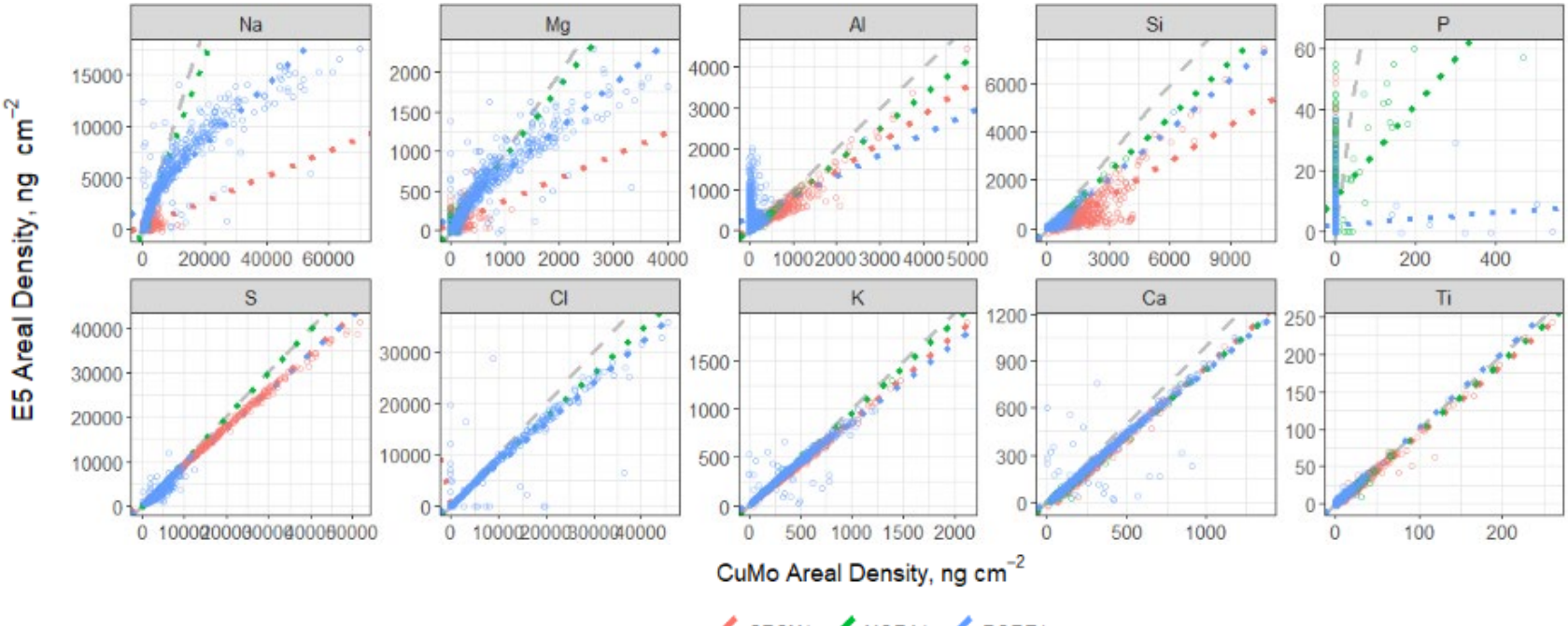
[a]Air Quality Research Center, University of California, Davis, California, USA; [b]Institute of Geological and Nuclear Sciences, I New Zealand; [c]Health and Safety Laboratory, Buxton, United Kingdom; [d]European Commission, Joint Research Centre, Dire Energy, Transport and Climate, Ispra, Italy; [e]Desert Research Institute, Reno, Nevada; [f]Research Triangle Institute, Research Park, North Carolina, USA; [g]South Coast Air Quality Management District, Diamond Bar, California, USA; [h]Malvern Panalytic The Netherlands



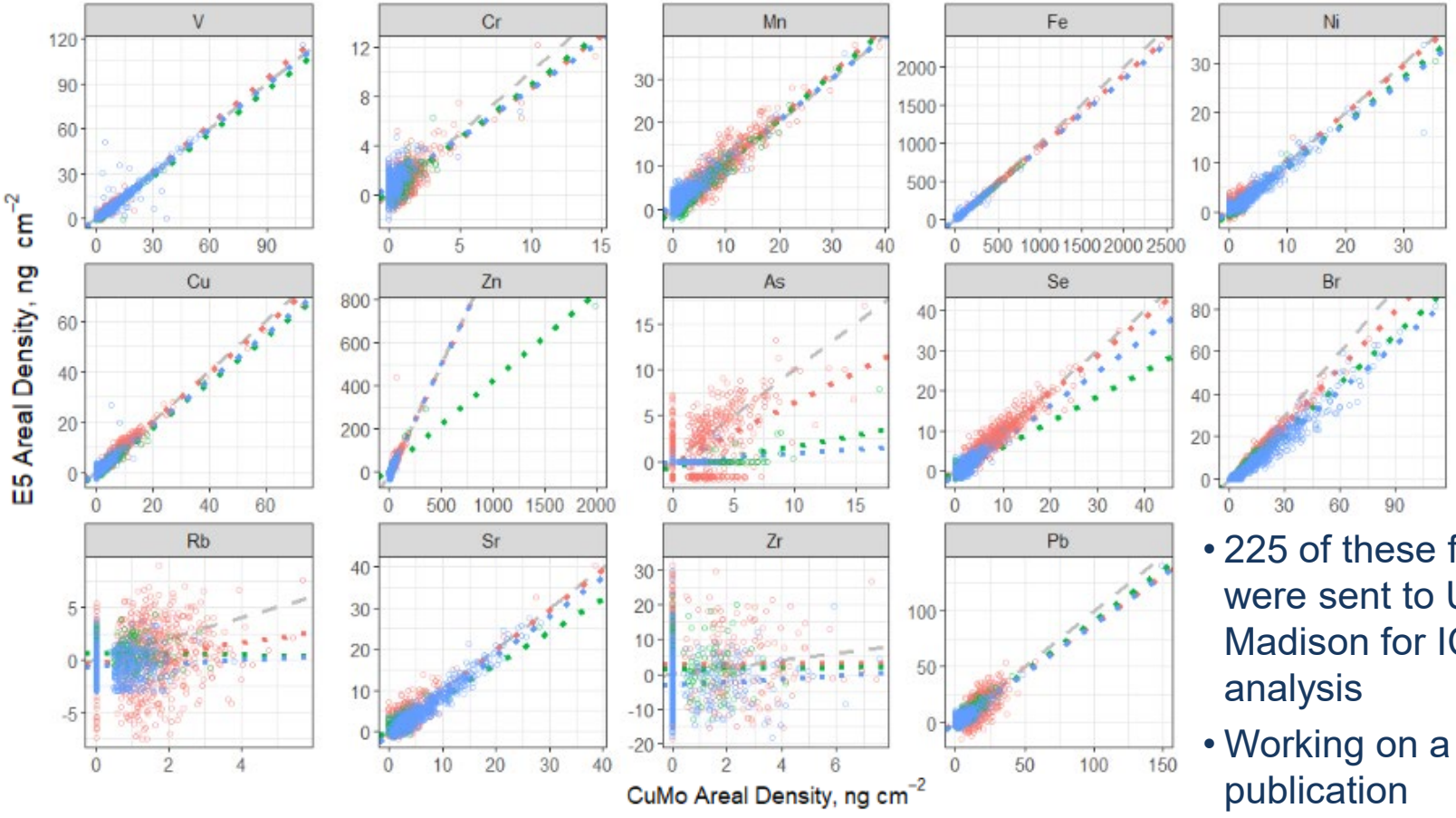


XRF Reanalysis on Archived Filters

- Archived filters from Great Smoky Mountains (GRSM1), Mount Rainier (MORA1), and Point Reyes (PORE1) were reanalyzed on the Panalytical Epsilon5 XRF and compared to results from the legacy Cu-Mo XRF



XRF Reanalysis on Archived Filters (Continued)



- 225 of these filters were sent to UW-Madison for ICP-MS analysis
- Working on a publication

Any questions?