

Select a Site Code

SAMA1

Site: St. Marks National Wildlife Refuge (FL)

Start Date: 2000-06-13

Latitude: 30.092559

Longitude: -84.16135325

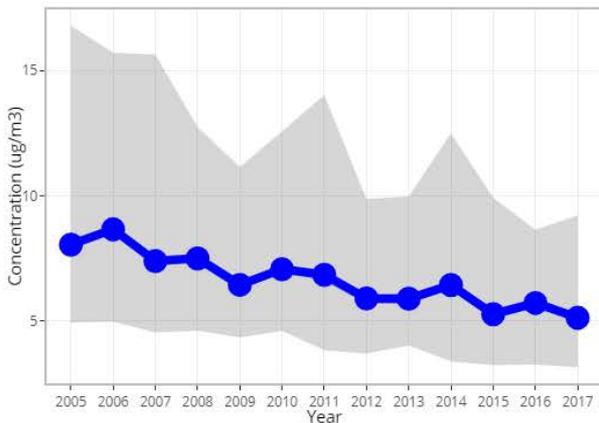
Elevation (m): 7.75

Affiliation: FWS

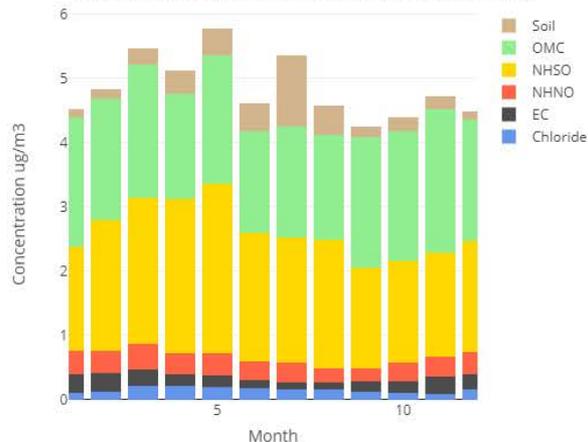
Site Type: IMPROVE



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

UC DAVIS AIR QUALITY RESEARCH CENTER

IMPROVE Steering Committee Meeting
Fort Collins, CO October 16, 2018

What's New in Data Management and Validation

Last year I presented our transition to new databases and software.

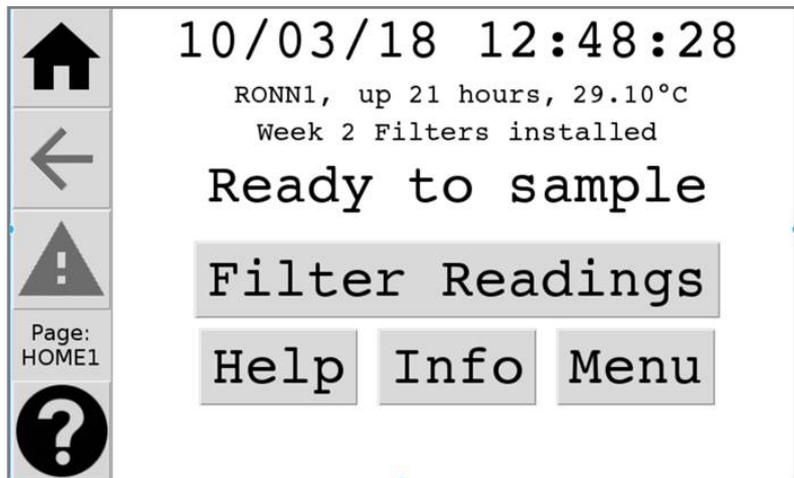
Today I will discuss some of the larger new features to support

- The redesigned controller
- The new automated weighing system
- Improvements in data validation
- Improvements in data analysis/exploration

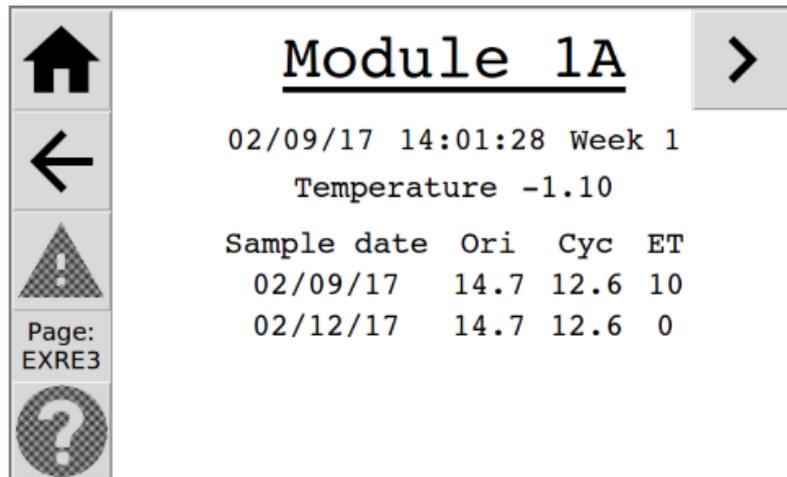
New Controller Software

Software for the new controller was designed in house from the ground up

Touch screen UI with guidance for the operator

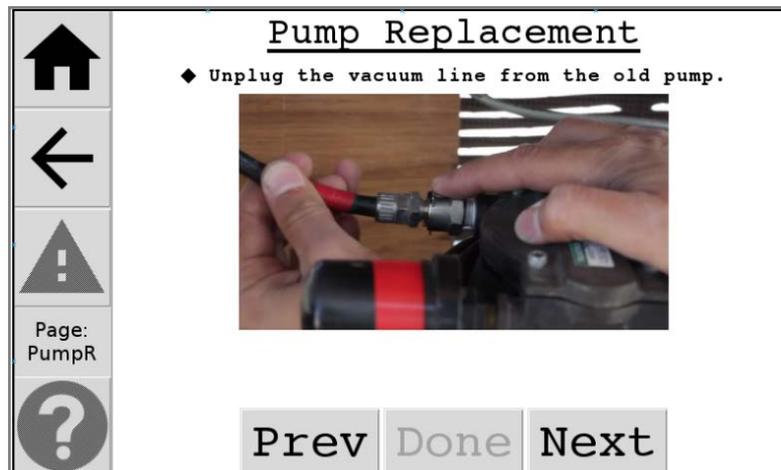


Home screen of the controller software. The interface includes a navigation sidebar on the left with icons for Home, Back, Warning, Page: HOME1, and Help. The main display shows the date and time (10/03/18 12:48:28), system status (RONN1, up 21 hours, 29.10°C), and operational details (Week 2 Filters installed). The status is 'Ready to sample'. A 'Filter Readings' button is present, along with 'Help', 'Info', and 'Menu' buttons.



Module 1A screen of the controller software. The interface includes a navigation sidebar on the left with icons for Home, Back, Warning, Page: EXRE3, and Help. The main display shows the module name (Module 1A), date and time (02/09/17 14:01:28 Week 1), and temperature (-1.10). A table displays sample data:

| Sample date | Ori | Cyc | ET |
|-------------|------|------|----|
| 02/09/17 | 14.7 | 12.6 | 10 |
| 02/12/17 | 14.7 | 12.6 | 0 |

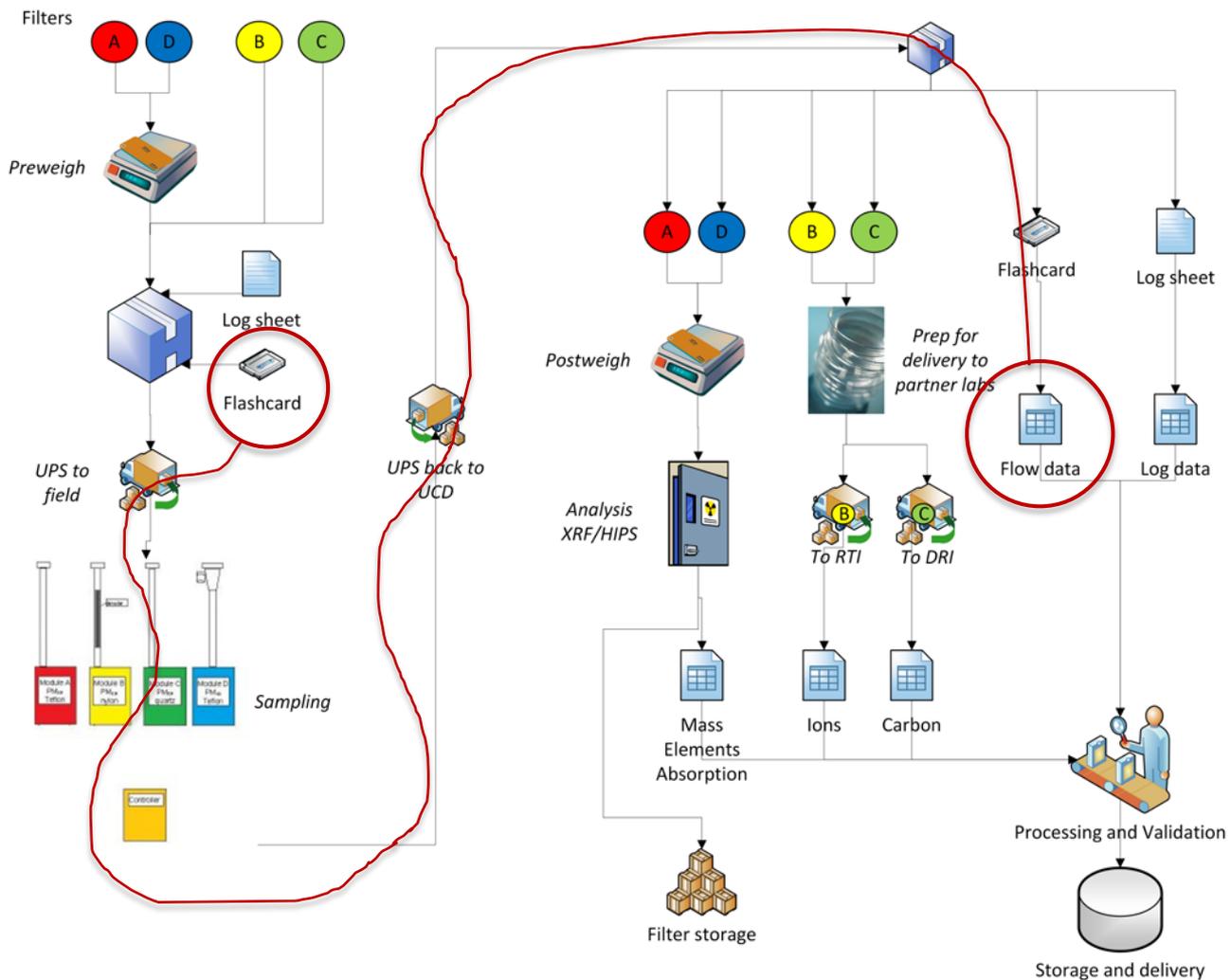


Pump Replacement screen of the controller software. The interface includes a navigation sidebar on the left with icons for Home, Back, Warning, Page: PumpR, and Help. The main display shows the title (Pump Replacement) and a step instruction: '◆ Unplug the vacuum line from the old pump.' Below the instruction is a photograph showing hands disconnecting a vacuum line from a pump. At the bottom, there are 'Prev', 'Done', and 'Next' buttons.

New Controller Data Management

The old way:

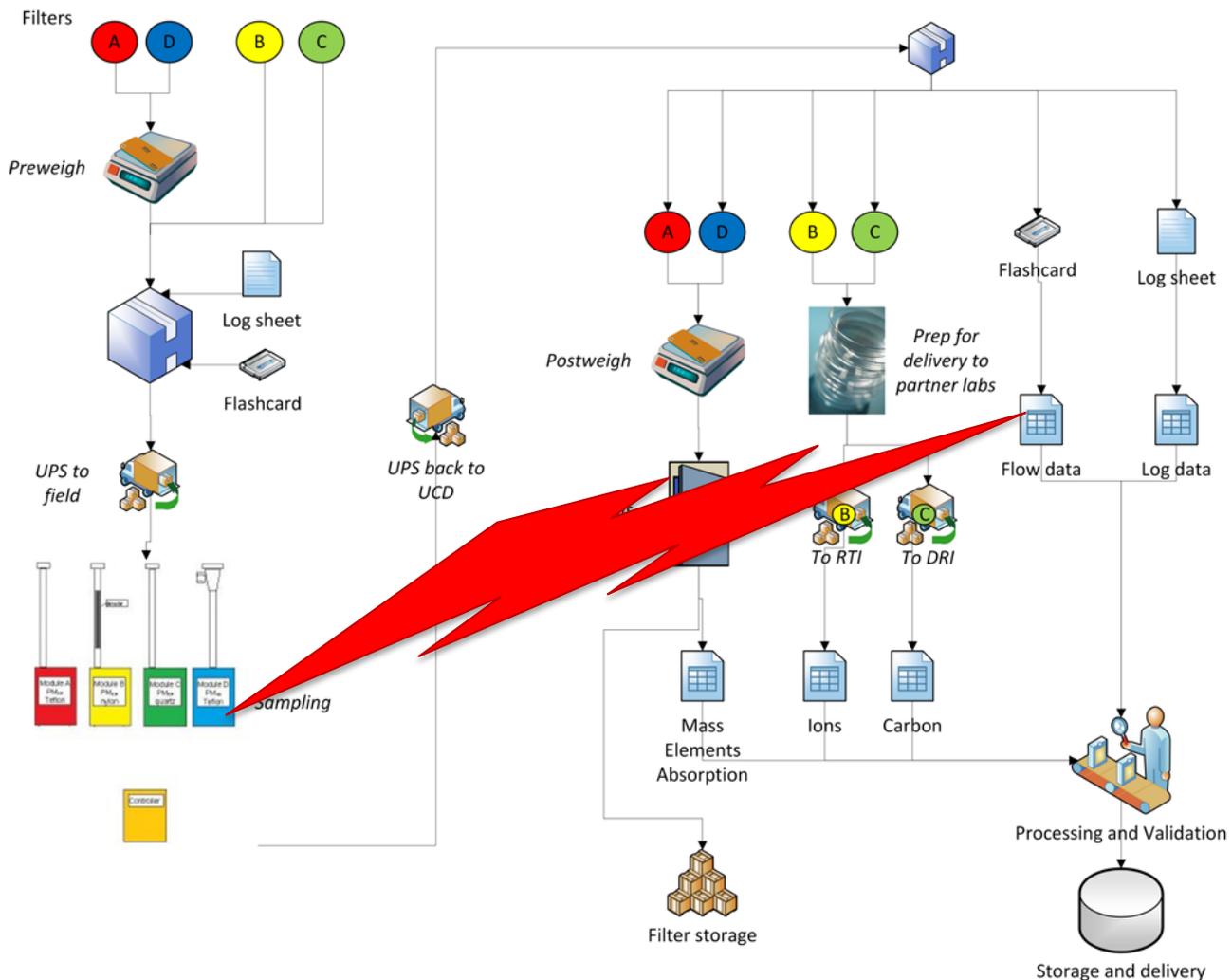
- Flow data collected on flashcards
- Flow data not seen by the lab until weeks (or more!) after sampling
- Potential for many lost samples before issues are caught



New Controller Data Management

The new way:

- Sites connected via Wi-Fi, cellular, or satellite
- Flow data delivered overnight
- Many tools to review flow information and respond quickly



Tracking Sampler Health – Network Summary

At-a-glance view of all sites with the new controller

Color-coded to show where attention may be needed

The screenshot shows a web interface for 'Improve Management Site' with a navigation bar containing 'Home', 'Alerts', 'Status', 'Exceptions', 'Pumps', 'Zeroes', 'Filter Readings', and 'Import'. The main content area is titled 'Network Summary' and features a grid of 56 site status indicators. Each indicator is a small box with a site ID and a colored circle representing its status. Most are green (Good), but some are grey (Missed check in), yellow (Warning), or red (Needs attention). For example, 'HOOV1' is yellow, 'FLAT1' is grey, and 'LOND1' is grey. Below the grid is a 'Color key' legend: Good (green), Offline site (grey), Missed check in (grey), Internet problem (grey), Warning (yellow), Needs attention (red), Info (blue). Below the legend is a table with columns: Name, Last Checkin, Last Flow Data, Alert Count, Online Modules, Controller State, and Installed Filters. The table lists the first three sites: ACAD1, BALD1, and BOLA1, all with 0 alerts and 4/4 online modules.

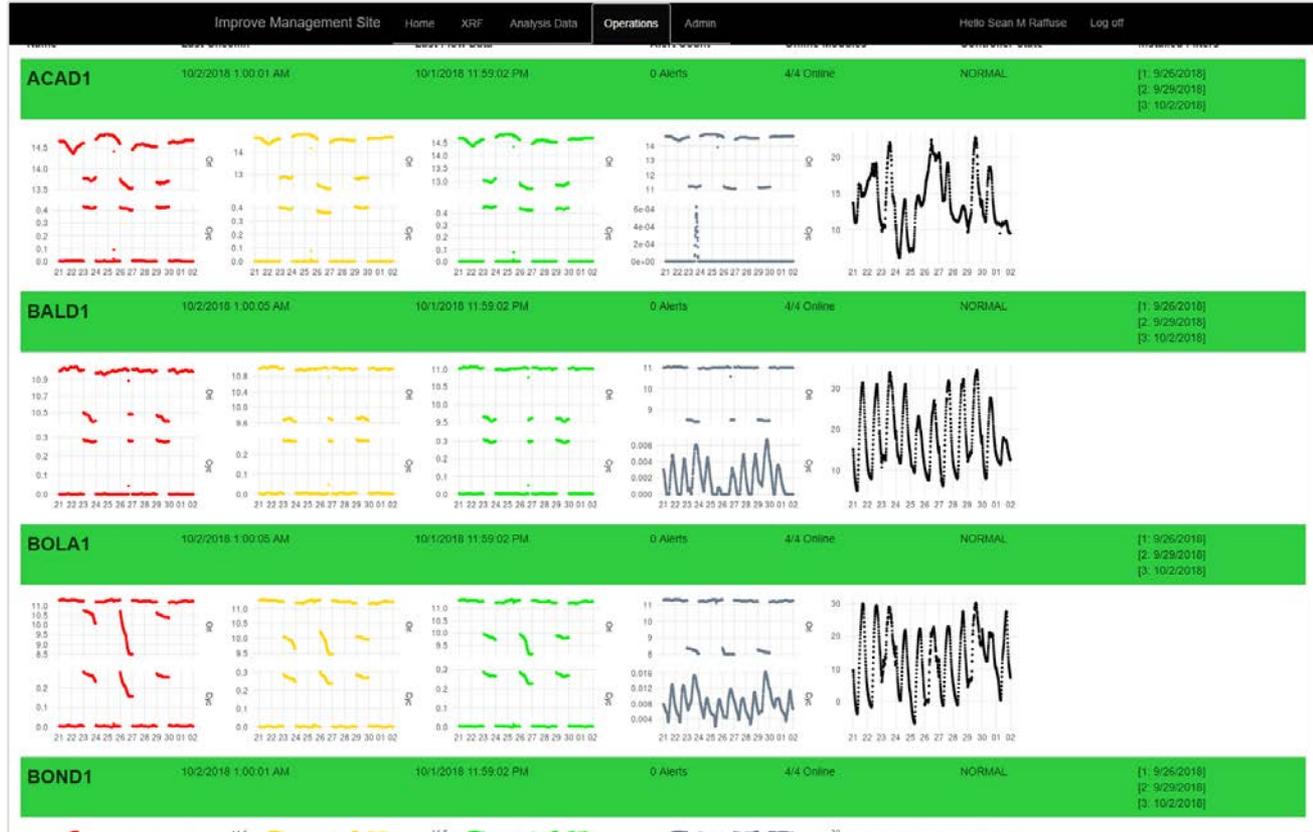
| Name | Last Checkin | Last Flow Data | Alert Count | Online Modules | Controller State | Installed Filters |
|-------|----------------------|-----------------------|-------------|----------------|------------------|--|
| ACAD1 | 10/2/2018 1:00:01 AM | 10/1/2018 11:59:02 PM | 0 Alerts | 4/4 Online | NORMAL | [1. 9/26/2018] [2. 9/29/2018] [3. 10/2/2018] |
| BALD1 | 10/2/2018 1:00:06 AM | 10/1/2018 11:59:02 PM | 0 Alerts | 4/4 Online | NORMAL | [1. 9/26/2018] [2. 9/29/2018] [3. 10/2/2018] |
| BOLA1 | 10/2/2018 1:00:05 AM | 10/1/2018 11:59:02 PM | 0 Alerts | 4/4 Online | NORMAL | [1. 9/26/2018] [2. 9/29/2018] [3. 10/2/2018] |

Color key:

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

Tracking Sampler Health – Network Summary

Thumbnails of flow readings and temperature for quick scan



Tracking Sampler Health – Controller Alerts

Nightly (or faster) harvesting of logs allows for review by the field group each morning

Responders can mark an alert as cleared and add notes for further follow up

Improve Management Site Home XRF Analysis Data **Operations** Admin Hello Sean M Raffuse Log off

Home Alerts Status Exceptions Pumps Zeroses Filter Readings Import

Controller Alerts (37) Create New Upload

Sampler: All

| Sampler | Timestamp | AlertType | AlertSource | ModuleTitle | Code | Message | Handled | Notes | ClearedBy | ClearedDate |
|---------|-----------------------|------------|--------------------------------|-------------|------|--|-------------------------------------|-------|--------------------------------------|---|
| FARM4 | 10/2/2018 3:20:23 PM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | <input type="button" value="Clear"/> | Details |
| FARM4 | 10/2/2018 2:21:22 PM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | <input type="button" value="Clear"/> | Details |
| FARM4 | 10/2/2018 1:20:23 PM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| FARM4 | 10/2/2018 12:20:22 PM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| FARM4 | 10/2/2018 11:20:33 AM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| PORE1 | 10/2/2018 10:27:58 AM | Import | PORE1-leakcheck-2018-10-02.csv | 2B | | Cyclone flow for module '2B' was above max flow '24.725' (reading: 24.734) for filter '10/5/2018 12:00:01 AM.' | <input checked="" type="checkbox"/> | | Faris T Jawda | 10/2/2018 1:10:22 PM Details |
| FARM4 | 10/2/2018 10:20:54 AM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| FARM4 | 10/2/2018 9:31:40 AM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| FARM4 | 10/2/2018 9:23:20 AM | Import | rsync server | | | Failed to find data folder for sampler 'FARM4' | <input checked="" type="checkbox"/> | | Illa Vladislavovich Potanin | 10/2/2018 2:05:37 PM Details |
| VOYA2 | 10/2/2018 9:20:35 AM | Controller | VOYA2-alerts.csv | | | Controller restarted (version: release-1806.2144) | <input type="checkbox"/> | | Yongjing Zhao | 10/2/2018 11:59:37 AM Details |
| VOYA2 | 10/2/2018 9:18:02 AM | Import | VOYA2-combined-2018-10-02.csv | | | line 559: Gap in records from 10/2/2018 9:18:02 AM to 10/2/2018 9:20:36 AM (2.6 minutes). | <input checked="" type="checkbox"/> | | Faris T Jawda | 10/2/2018 9:21:26 AM Details |
| VOYA2 | 10/2/2018 | Controller | VOYA2-alerts.csv | | | Controller restarted (version: release-1806.2144) | <input type="checkbox"/> | | Faris T Jawda | 10/2/2018 Details |

Tracking Sampler Health – Controller Alerts

Generated on controller:

- Controller restarted
- Orifice min pressure below 5.0 during initial test
- Ebox failed to communicate on CAN
- Ebox went offline
- Out of range module ids
- Ebox had sensor read errors

Generated on Sawmill (log processing server):

- Failed to find data folder for sampler
- Found two folders for sampler

Generated on import to database:

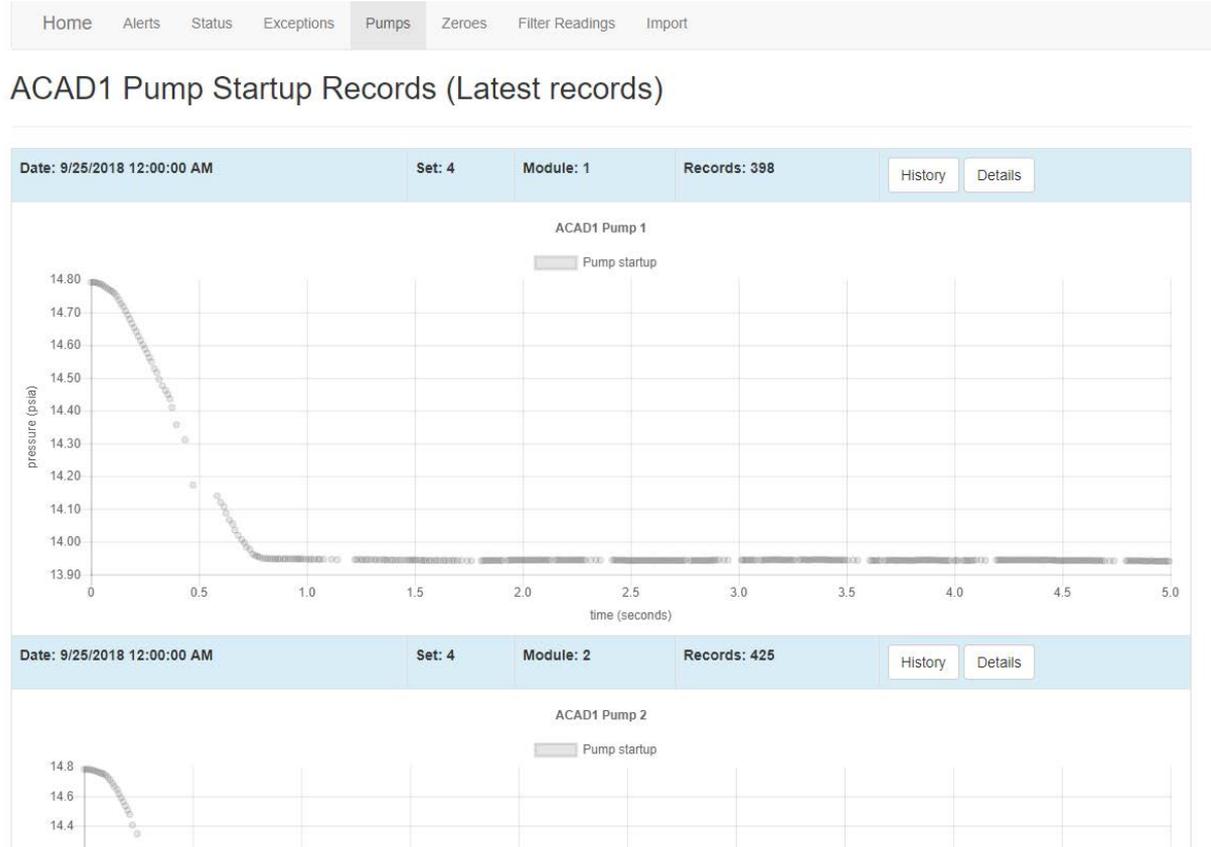
- Ebox is offline
- Controller timezone offset does not match database
- Ebox position was removed/added to controller config file
- Hostname changed
- Cyclone/Orifice was stuck for [#] hours
- Gap in flow records
- Cyclone/Orifice pressure below threshold
- Cyclone/Orifice pressure above threshold
- Time went backward in flow data
- Max vacuum below min/above max flow
- Cyclone/Orifice flow/pressure below min/above max

Tracking Sampler Health – Pump Starts

On startup, pressure is recorded at high time resolution

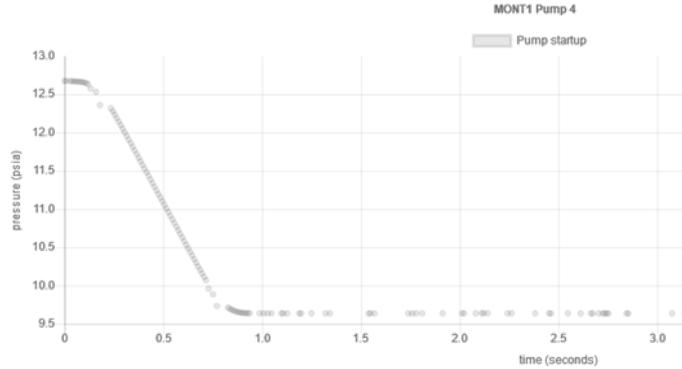
Slow response is an indication of poor pump health needing attention

Plots now available on demand

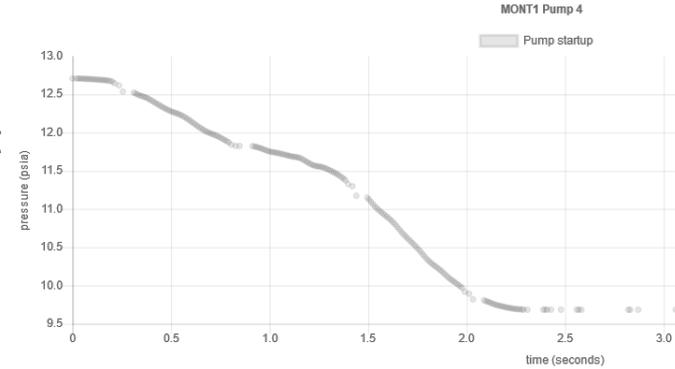


Pump Health Case Study – Monture (MONT)

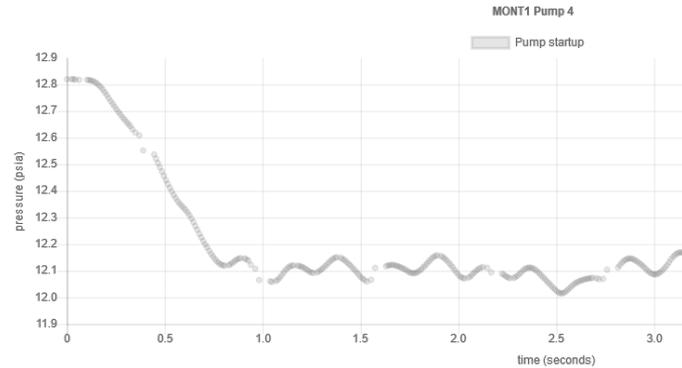
9/11
Normal



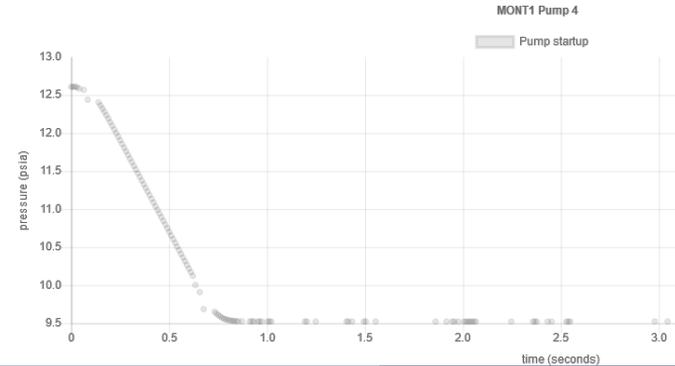
9/18
Slow start



9/25
Weak pump
Alerted by system



10/2
Pump replaced



Automated Weighing System

We've wanted to move to barcode scanning for a long time. The automated weighing system (Luna), which can load 400 filters in a batch, made it a necessity.

Barcodes printed directly on the filter media are incompatible with HIPS and XRF.

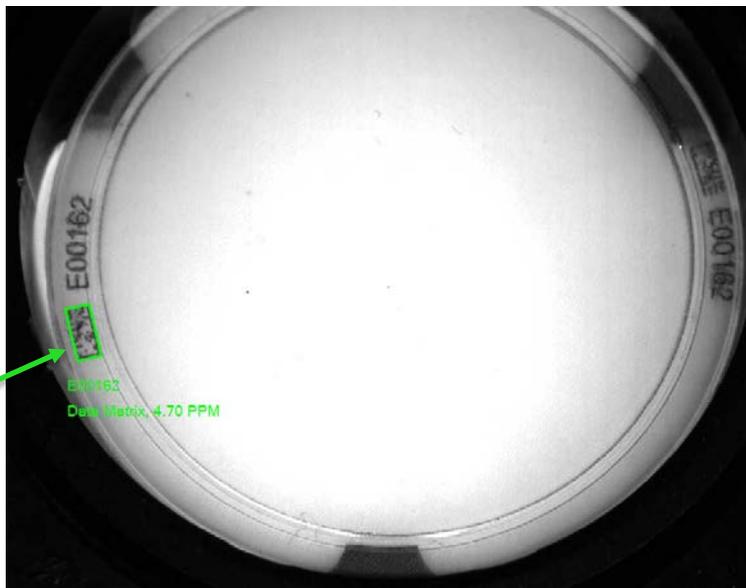
Thus, we needed a code printed on the ring, but that means the “matrix code” is tiny.



Automated Weighing System

- Modern, high-end scanner
- Scanner trained to conditions of our setup
- Custom-built jig to center filter in tray

1 x 2 mm (!!)



Automated Weighing System

Modifications to our Lab application to support Luna
Additional support screens currently in development

The screenshot displays the 'Pre-sample Weigh In' interface for site SAMA1. It features a data table with columns for date, module, QTR, POS, Pre-Weight, and Barcode. The data is organized into three sections: Module 1A, Module 4D, and Module 5A. A 'Selected Scanner Device' section shows 'CONNECTED' status and a 'Default Device' (169.237.146.50) with a 'DISCONNECT' button. A 'Live Display' section shows a camera view of a weighing pan. The 'Scanner Status' is 'Ready to trigger' with an 'EXIT' checkbox and 'ACCEPT' and 'TRIGGER' buttons.

Main Menu Current User Initials: JGD

Station: Pre-sample Weigh In for site: **SAMA1 (1A, 2B, 3C, 4D, 5A)**

Weight Data Source: FWS - Luna

| Module 1A | | | | | Module 4D | | | | | Module 5A | | | | |
|------------|-----|-----|------------|---------|------------|-----|-----|------------|---------|------------|-----|-----|------------|---------|
| SAMDAT | QTR | POS | Pre-Weight | Barcode | SAMDAT | QTR | POS | Pre-Weight | Barcode | SAMDAT | QTR | POS | Pre-Weight | Barcode |
| 10/17/2018 | D18 | 6 | 96.202 | E03039 | 10/17/2018 | D18 | 6 | 97.065 | E03037 | 10/17/2018 | D18 | 6 | 94.528 | E03390 |
| 10/20/2018 | D18 | 7 | 98.560 | E03041 | 10/20/2018 | D18 | 7 | 95.122 | E03387 | 10/20/2018 | D18 | 7 | 94.994 | E03391 |
| 10/23/2018 | D18 | 8 | 93.904 | E03042 | 10/23/2018 | D18 | 8 | 95.512 | E03388 | 10/23/2018 | D18 | 8 | 96.780 | E03043 |
| 10/26/2018 | D18 | 9 | 95.529 | E03389 | 10/26/2018 | D18 | 9 | 94.722 | E03047 | 10/26/2018 | D18 | 9 | 94.316 | E03050 |
| 10/29/2018 | D18 | 10 | 97.340 | E03046 | 10/29/2018 | D18 | 10 | 95.702 | E03048 | 10/29/2018 | D18 | 10 | 96.082 | E03051 |
| 11/01/2018 | D18 | 11 | 94.820 | E03052 | 11/01/2018 | D18 | 11 | 93.838 | E03036 | 11/01/2018 | D18 | 11 | 93.412 | E03063 |
| 11/04/2018 | D18 | 12 | 95.434 | E03053 | 11/04/2018 | D18 | 12 | 96.576 | E03062 | 11/04/2018 | D18 | 12 | 94.968 | E03064 |

Selected Scanner Device: **CONNECTED**

Default Device (169.237.146.50)

Live Display

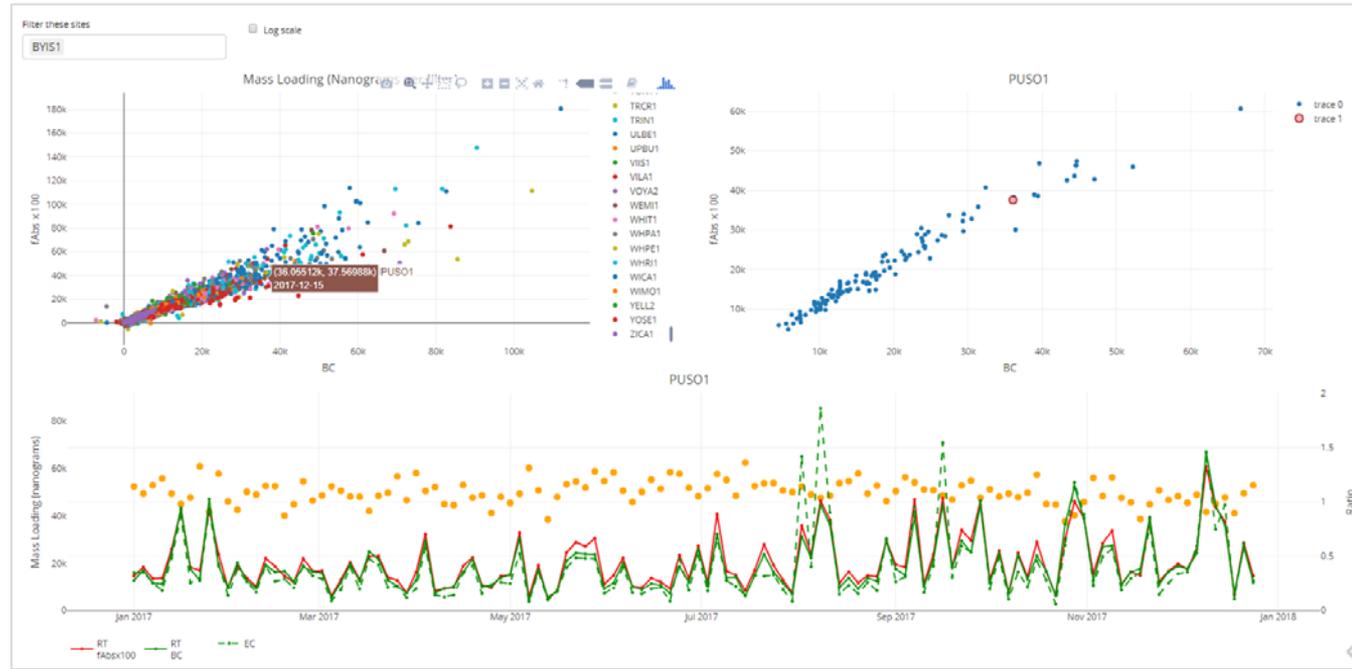
Scanner Status: Ready to trigger EXIT

New Data Validation Views – BC from TOR vs. fAbs

BC can be estimated from laser readings provided by TOR

BC_{TOR} is often better correlated with fAbs from HIPS than EC

Interactive view for cross-filter comparison



New Data Validation Views – Field Blanks

Automated view of all field blanks and resulting artifact and MDL

Compare loadings between FB and sample to assess swaps

Track FB loadings over time



New Data Validation Views – Parameter Review

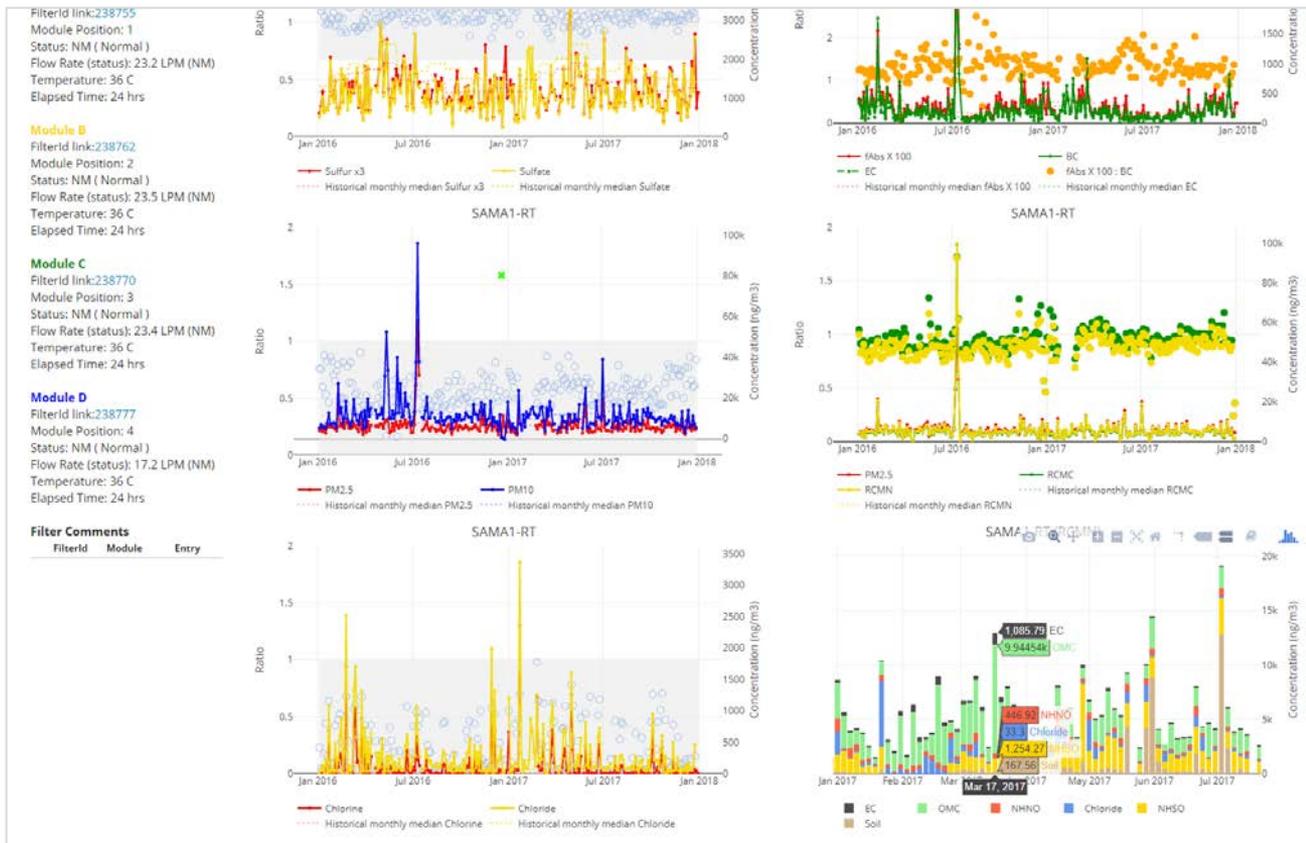
A way to assess all parameters at a site against network norms

Shows individual values, site median, and network median



New Data Validation Views – Reconstructed Mass

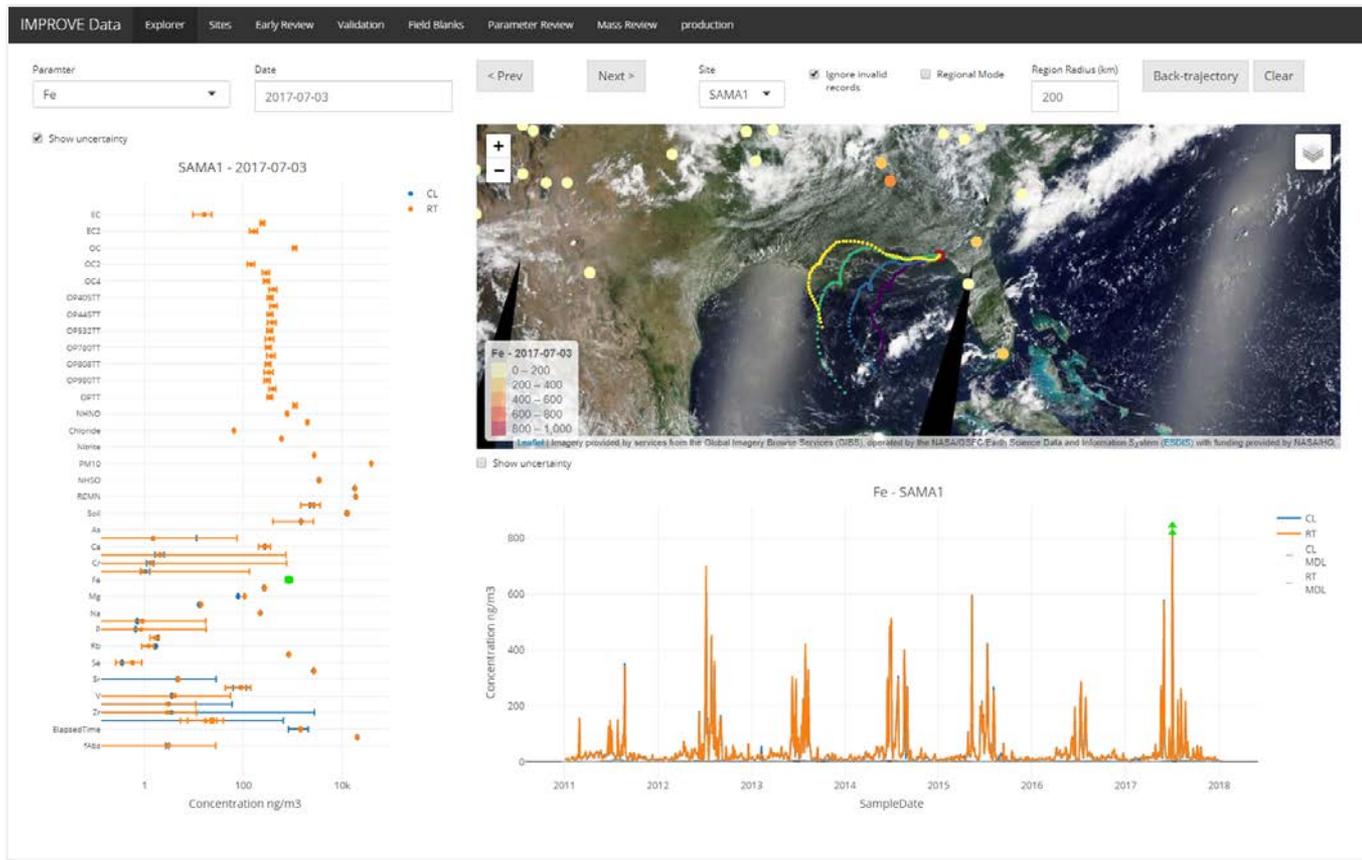
Daily site
reconstructed mass
components



New Exploratory Views – Backward Trajectories

Data explorer links views across space, time, and parameter

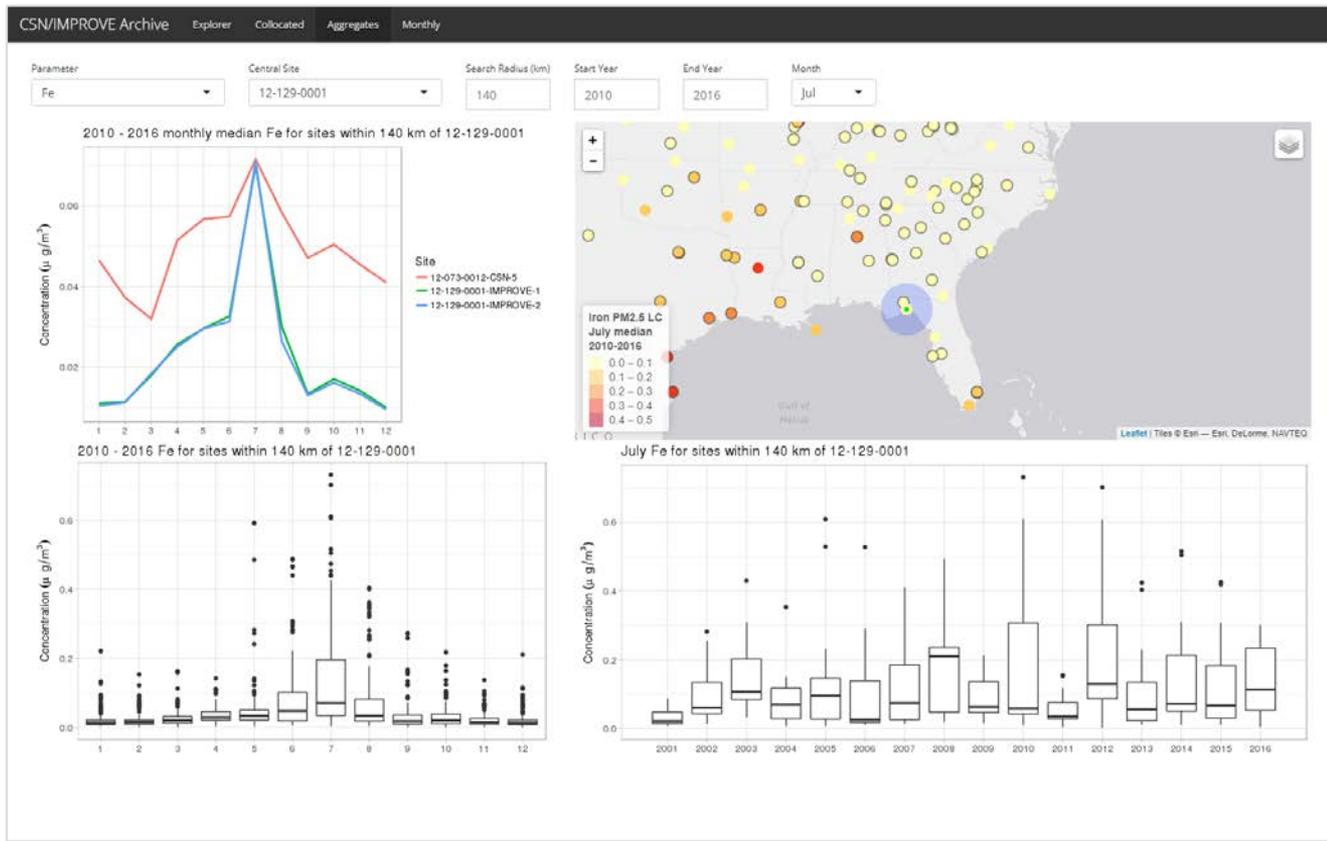
Now run back trajectories from any site on a sample day to assess transport



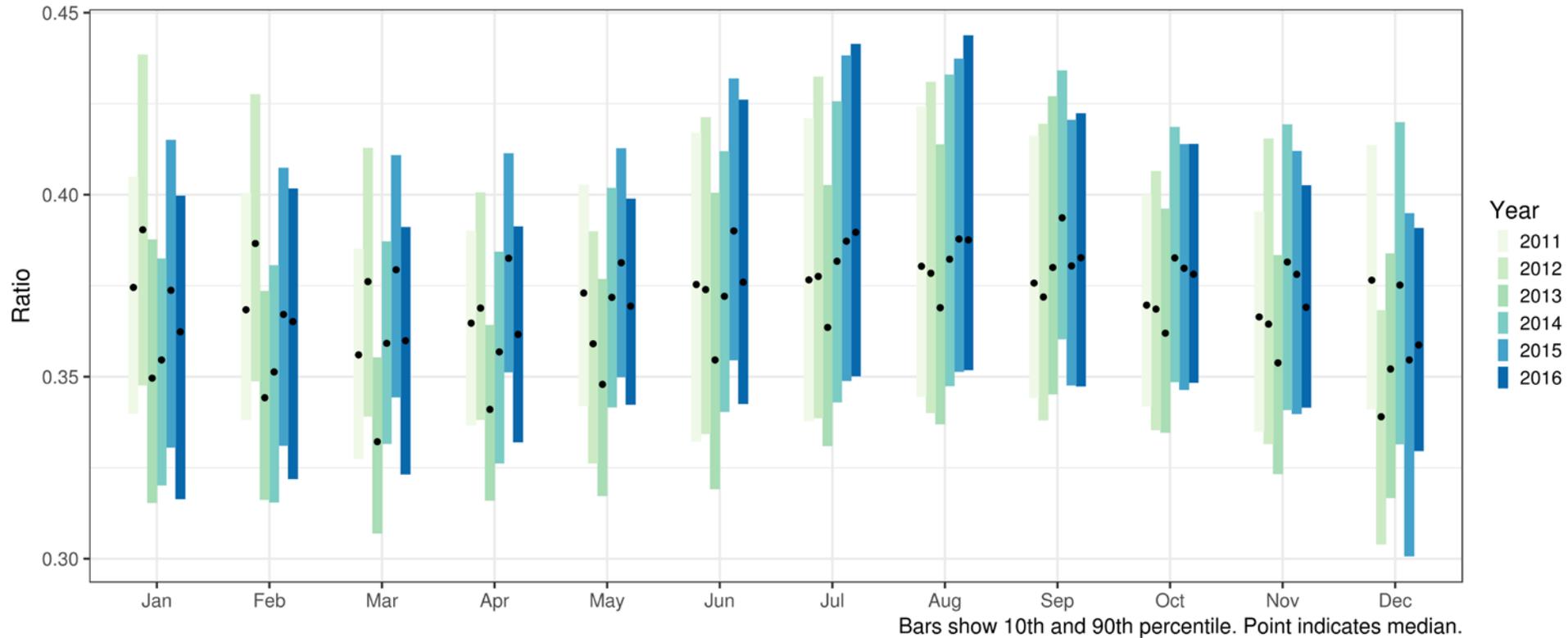
New Exploratory Views – Aggregates

Aggregates multiple sites and dates

Includes IMPROVE and CSN sites



IMPROVE monthly ratio of S/Sulfate for 2011 to 2016 - both parameters above MDL



BAND1 - Bandelier (NM)



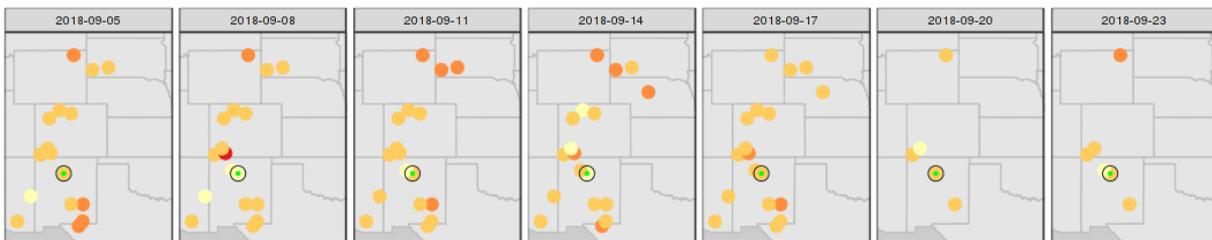
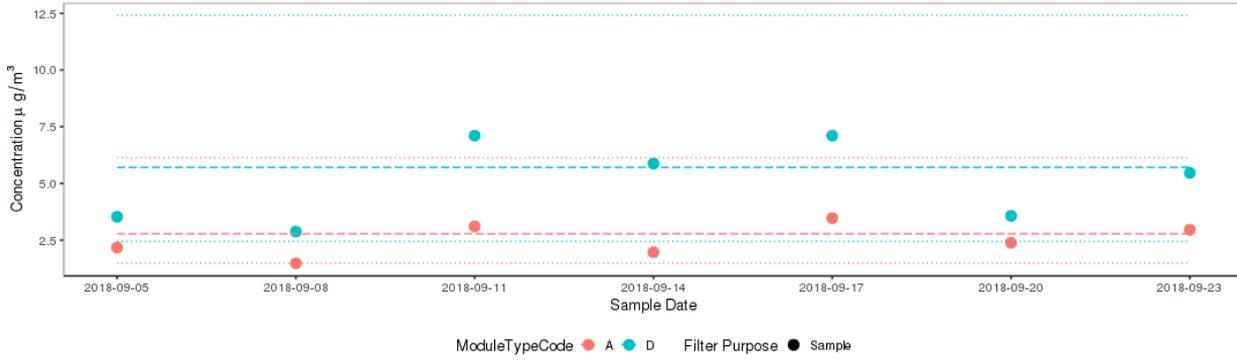
Start Date: 1988-03-02
 Latitude: 35.780
 Longitude: -106.266
 Elevation (m): 1988
 Affiliation: NPS
 Site Type: IMPROVE



Bandelier National Monument is a 33,677-acre (13,629 ha) United States National Monument near Los Alamos in Sandoval and Los Alamos Counties, New Mexico. The monument preserves the homes and territory of the Ancestral Puebloans of a later era in the Southwest. Most of the pueblo structures date to two eras, dating between 1150 and 1600 AD.

The Monument is 50 square miles (130 km²) of the Pajarito Plateau, on the slopes of the Jemez Volcanic field in the Jemez Mountains. Over 70% of the Monument is wilderness, with over one mile elevation change, from about 5,000 feet (1,500 m) along the Rio Grande to over 10,000 feet (3,000 m) at the peak of Cerro Grande on the rim of the Valles Caldera, providing for a wide range of life zones and wildlife habitats. There are three miles of road, and more than 70 miles of hiking trails. The Monument protects Ancestral Pueblo archaeological sites, a diverse and scenic landscape, and the country's largest National Park Service Civilian Conservation Corps National Landmark District.

Most recent post-weighed filters - BAND1
 Lines show 5th, median, and 95th percentile for the month



Module A filter Concentration $\mu\text{g}/\text{m}^3$ (0.2) (2.5) (5.10) (10.20] NA

* Concentration equals the mass of material on the filter divided by the volume. The volume is the air volume passing through the filter for the whole sampling period, normally 24 hours. For PM_{2.5} module (A module), it's about 33.1 m³/day; for PM₁₀ module (D module), it is about 24.3 m³/day.

Recap

Major new systems

- New controller software and data management
- New automated weighing system management

Additions to existing tools

- New views for data validation
- New views for exploration and analysis

On the Horizon

- Further improvement of controller software, data handling, alerting and response
- Continued refinement of data validation tools and practices
- Restructure of sample handling lab software to fully integrate the automated weighing system into the processing stream
- Integration of FTIR analysis into the IMPROVE operational database
- Simplification of XRF process automation and integration of scanned filter bar codes