Quality Assurance for a Wildfire Smoke Sensor Loan Program

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2023 Air Sensors Quality Assurance Workshop

Outline

- Description of Wildfire Smoke Air Monitoring Response Technology (WSMART) Pilot Loan Program
- Example Loan Use Scenario
- Quality Assurance Steps
  - Out-of-the-box Quality Control Checks
  - Before, During, and After Deployment Quality Control Checks
  - Data Review and Validation
- Lessons Learned

WSMART Smoke Sensor Loan Program

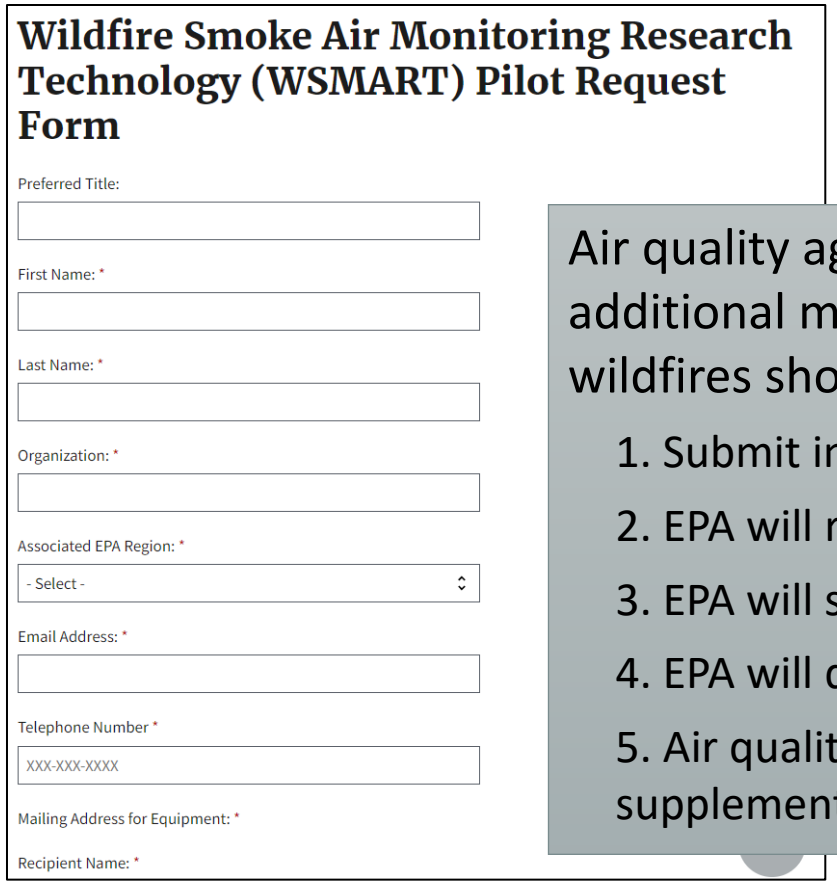
Created in 2021 in response to support the White House and EPA Administrator's goal to use new technology to identify dangerous air pollution from fires

- Technology is used for supplemental smoke monitoring:
  - Stationary sensors:
    - PurpleAir
    - Thingy AQ ($PM_{2.5}$, CO, CO_2, TVOCs)
  - Mobile $PM_{2.5}$ sensor: Vehicle Add-on Mobile Monitoring Systems (VAMMS) developed by EPA
- Provide sensor technology to state, local, and tribal air organizations when impacted by wildfire smoke
- Partner with the Interagency Wildland Fire Air Quality Response program (IWFAQRP) to provide technology to Air Resource Advisors (ARAs) deployed at major wildfires

Photo credits: Maribel Colon (left), PurpleAir (top), ThingyAQ (bottom)

Information and Request Form on Project Website

https://www.epa.gov/air-sensor-toolbox/wildfire-smoke-air-monitoring-response-technology-wsmart-pilot



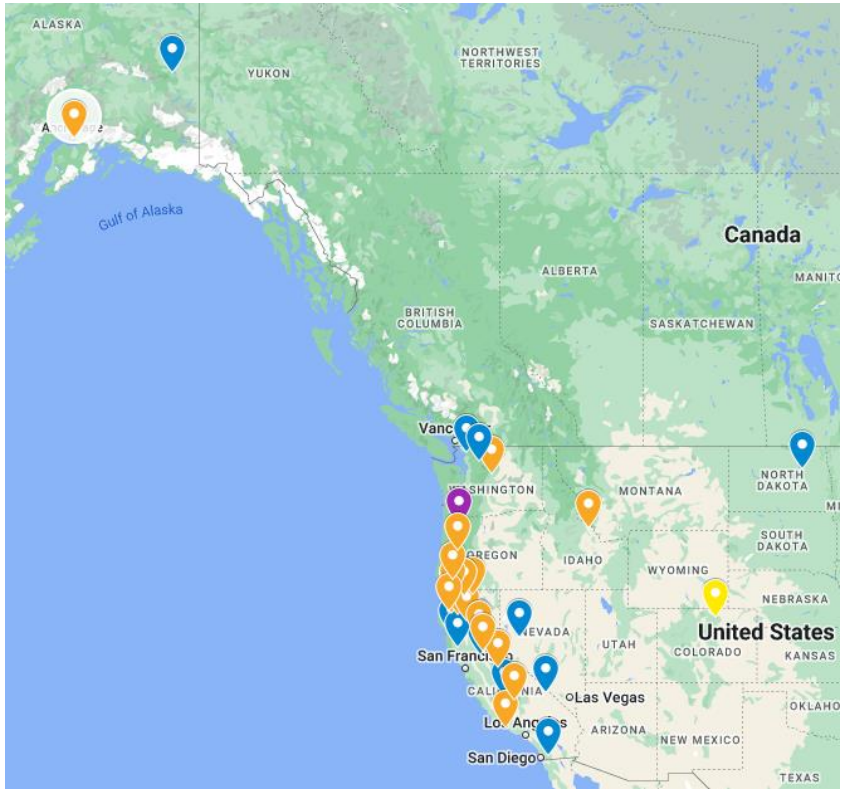
Air quality agencies in need of additional monitoring technology during wildfires should

1. Submit information to webform
2. EPA will reach out to discuss their needs
3. EPA will send out equipment
4. EPA will do virtual training sessions
5. Air quality agencies will set up supplemental monitoring

Loan Equipment Has Multiple Users and Use Cases

Since program inception, there have been 34 loan recipients

- 16 wildfires
- 3 prescribed fires
- Users have a range of monitoring experience
- Users have a variety of air quality questions:
  - Occupational exposure to CO
    25 ppm, 8hr avg
  - Ambient exposure to CO
    9 ppm, 8hr avg
  - Air quality impacts near wildfires
    ~ 1 mg/m^3, ~ 3hr
  - Air quality impacts in communities
    50 - 500 µg/m^3, ~ 3hr
  - Air quality impacts from prescribed fire
    5 – 5,000 µg/m^3, ~ 1 hr



User Organizations

Tribe	State
Local	IWFAQRP

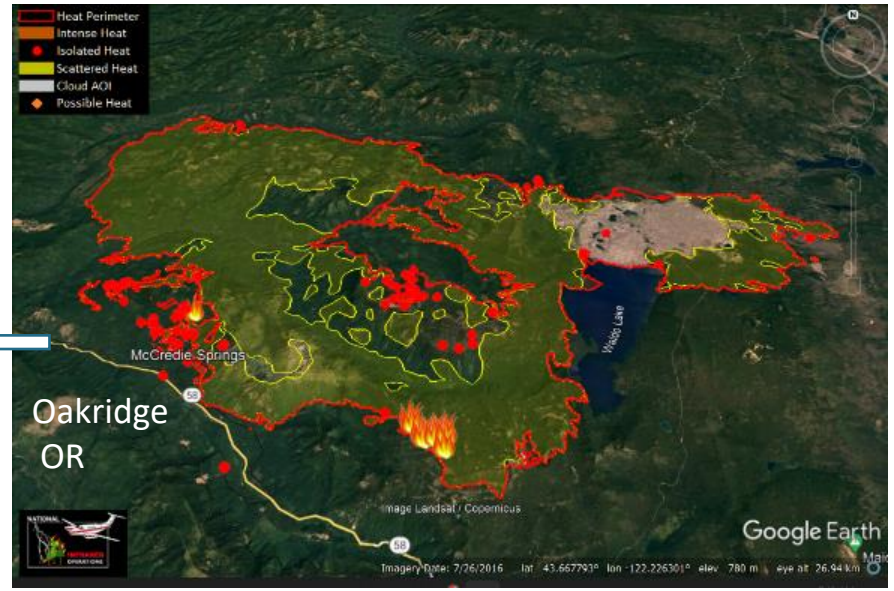
Photo credit: Air Resource Advisor – Gayle Hagler

Example Use Case: Cedar Creek Fire in Oregon, 2022

IWFAQRP Air Resource Advisor Loan

Initial request description: ARA assigned to the Cedar Creek Fire burning near Oakridge, OR. ARA requested VAMMS and Thingy on 9/22/22, equipment received on 9/23/22.

- Very large fire, heavy smoke impacting incident command post
- Several monitors in the area, but complex terrain resulted in spatially and temporally dynamic conditions
- Used to monitor identify potential CO exposures in post and smoke impacts on roadways



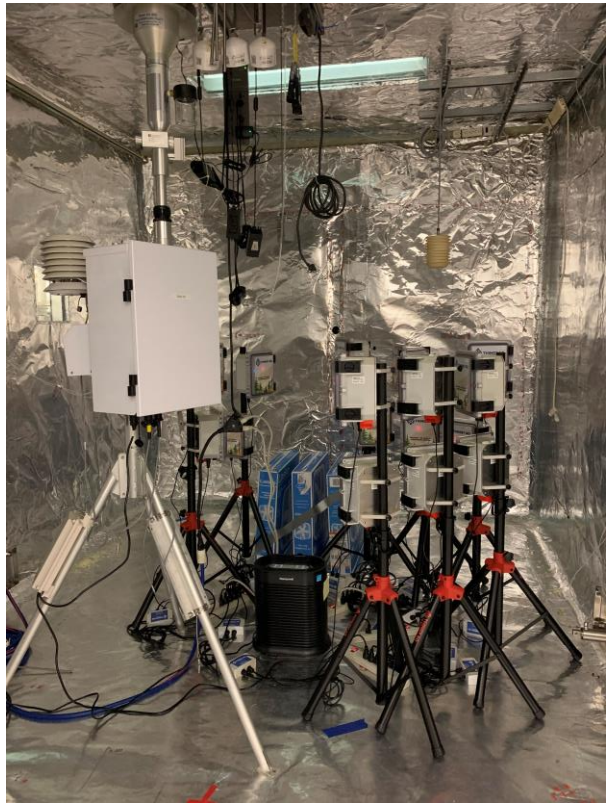
QC Steps

1. **QC checks (out-of-the-box & pre-deployment) are done before sending out equipment**
2. **Provide training materials/session on how to use equipment**
3. **Collocation in the field, when possible, to verify operation**

Photo credit: Air Resource Advisor – Gayle Hagler

1. Out of the Box Quality Control Check

- Evaluate sensors in a controlled environment with a realistic source (smoldering pine needles)
- Monitored overnight decay of smoke within the chamber
- Validate that sensor precision and accuracy compared to a reference
- Relied on EPA's $PM_{2.5}$ performance targets to inform threshold for quality control thresholds



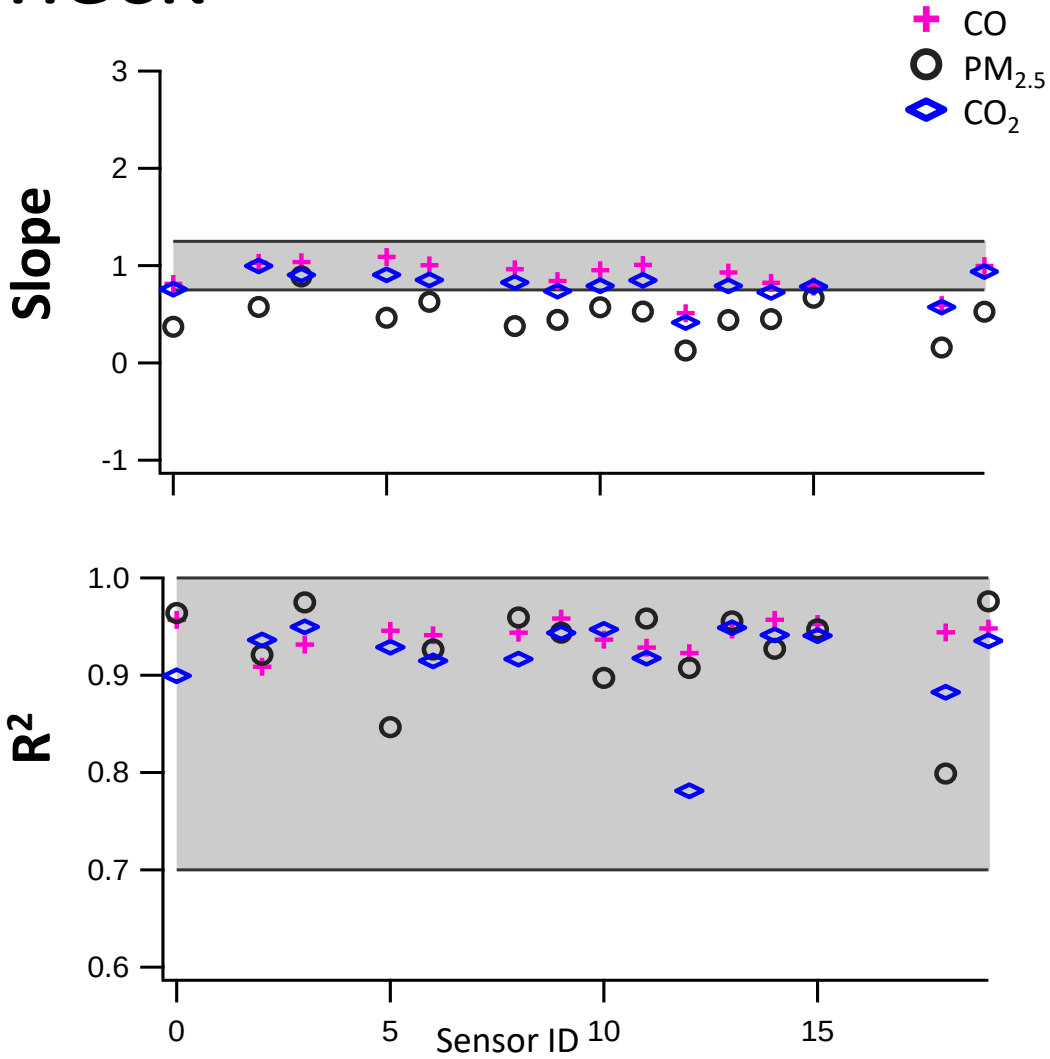


Photo credit: Amara Holder

2. Deployment Quality Control Checks*

Pre-Deployment

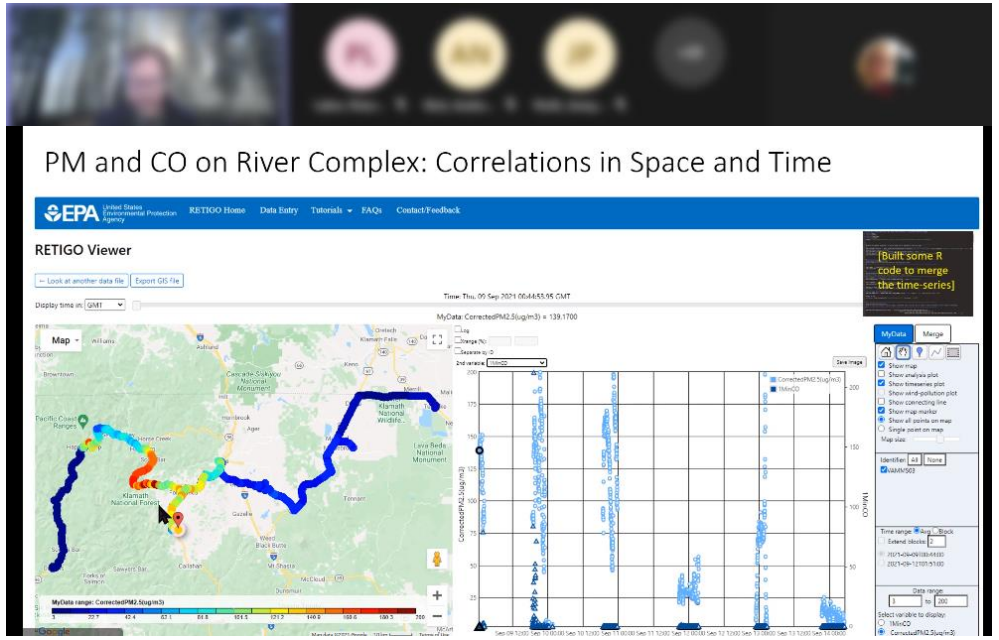
- Flow check, zero check, GPS check & pre-weighed filter for VAMMS
- Power up and reasonable readings check for multipollutant sensors

During Deployment

- Quick start training guide
- Quick video installation walk through
- In depth standard operating procedures
- Teams training calls to answer questions
- Collocate measurements whenever possible

After Deployment

- Flow check, zero check for VAMMS
- Post-weigh filter to log appropriateness of correction
- Data review to identify potential data quality issues (e.g., low speed, very high spikes = dust)



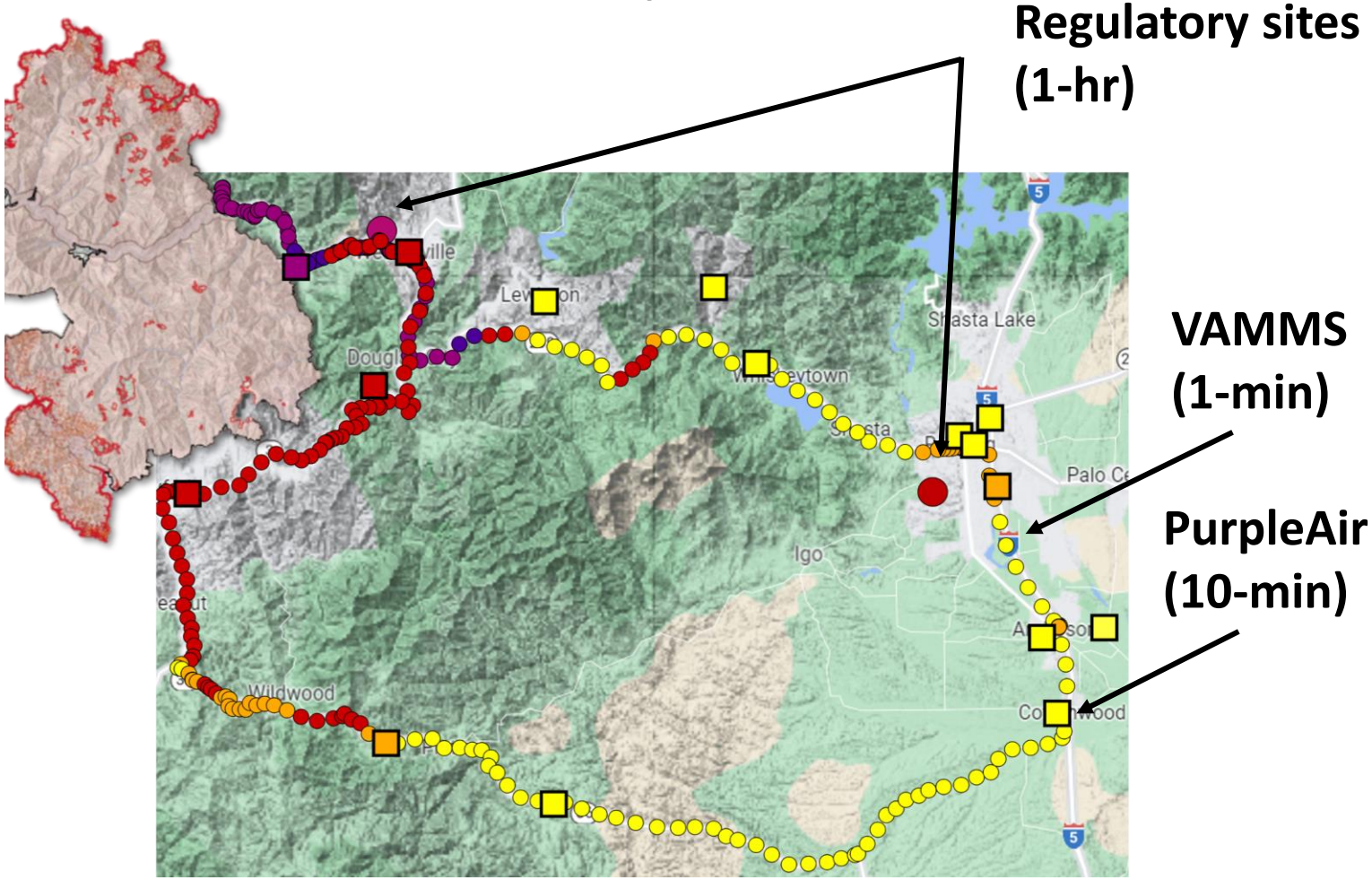
* Procedures documented in Quality Assurance Project Plan, provided upon request

3. Data Review and Validation Example

- Evaluate the VAMMS performance in the field
  - Wildfire smoke optical properties
  - High concentrations

- Comparison impeded by differing averaging times
  - Most regulatory monitors have 1-hr resolution
  - Nephelometers and PurpleAir provide 1 or 2-min resolution and corrected* for smoke
  - VAMMS 1-sec averaged to 1-min

Monument Fire, Shasta Trinity Forest, CA



* LRAPA seasonal nephelometer correction and PurpleAir corrected by Holder et al. 2020

Lessons Learned

Wildfire smoke sensor loan program poses some unique quality assurance challenges. Sensors are operated in very different altitudes, operated by a non-expert workforce with minimal time or ability to do quality control, are often the 'only' measurement available, and are tasked with measuring $PM_{2.5}$ and CO over a large dynamic range.

Out of the Box / Pre-Deployment QC Checks

- Sensor failure rates can be high, important to check system still 'works' before sending it out

During Deployment Observations and Loan Recipient Debriefs

- Training very useful but still need more resources for diverse user group (e.g., short videos)
- Desire for training on how to use the data, not just collect data
- Longer deployments may need replacement equipment to ensure continued high-quality data
- Collocate measurements whenever possible for data checks
- Duplicate measurements are a recommended when a reference for validation is not available

Thank you!

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Project Website
https://www.epa.gov/air-sensor-toolbox/wildfire-smoke-air-monitoring-response-technology-wsmart-pilot