Improving Tribal and Citizen Science with Low-Cost Air Sensor Collocation Shelters

Air Sensors International Conference

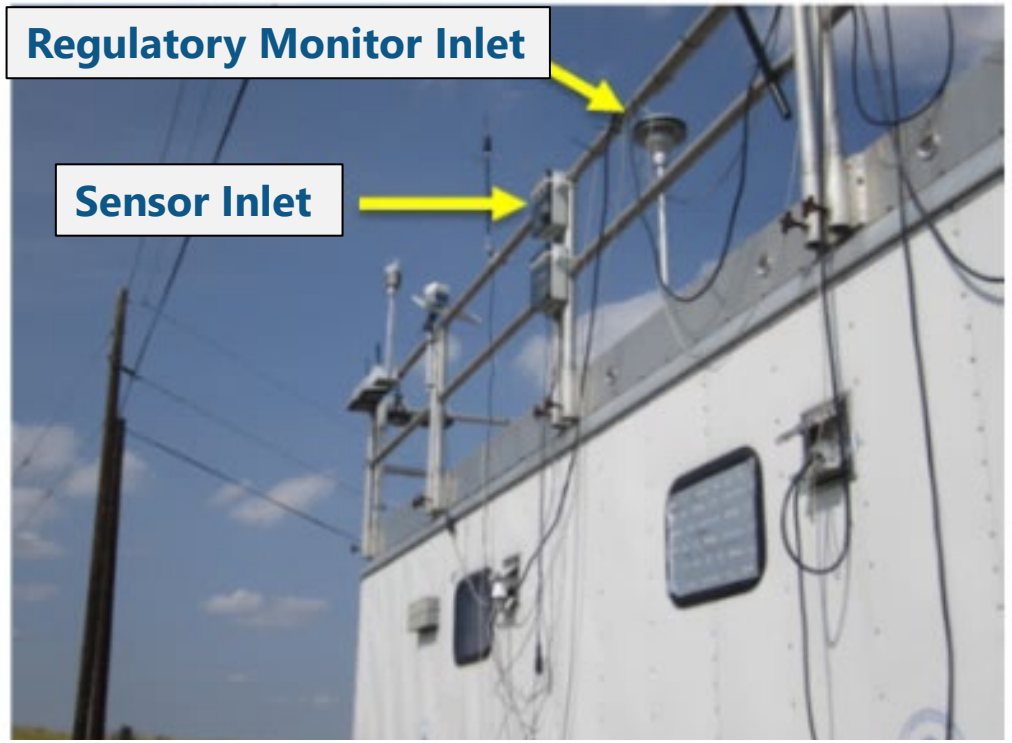
May 11, 2022

Office of Research and Development: Karoline Barkjohn, Andrea Clements
EPA Region 4: Ryan Brown, Daniel Garver
EPA Region 6: Suzy Apodaca, Mark Berry

Air Sensor Collocation: A Method to Check and Compare Sensor Measurements

- **Collocation** is the process by which air sensors are placed near regulatory instruments and operated at the same time and place under real-world conditions
- **Purpose of collocation**
  - Evaluate how a sensor performs compared to one another and against regulatory monitors that have known data quality
  - Evaluate important parameters such as accuracy, precision, and bias
  - If needed, develop correction equations to improve sensor data accuracy

Note: Collocation is most valuable if the equipment is evaluated under similar conditions of planned use (e.g., similar pollutant sources, pollutant concentrations, meteorological conditions) because environmental factors can influence sensor performance.



Air sensors located near regulatory monitors in Denver, Colorado (USA)

Overview

- **Issue**
  - Sensor precision and accuracy remains highly variable, resulting in a need to collocate sensors with regulatory grade reference monitors to better understand comparability
  - State/Local/Tribal air agencies (SLTs) are increasingly asked to support collocation efforts
  - Sites may be space and access limited making requests time and labor intensive
- **Approach**
  - Build and deploy collocation shelters in various parts of the U.S. to support collocation efforts
  - Leverage existing regulatory air monitoring network infrastructure

Collocation Shelter installed in Broward County, Florida

Collocation Shelter installed in Atlanta, Georgia

Project Goals

1) **Foster collaboration between tribal agencies and nearby air pollution regulatory agencies** to use sensors to conduct air quality studies on tribal lands;

2) **Increase the availability of sites** where the public could install sensors and compare air sensor data;

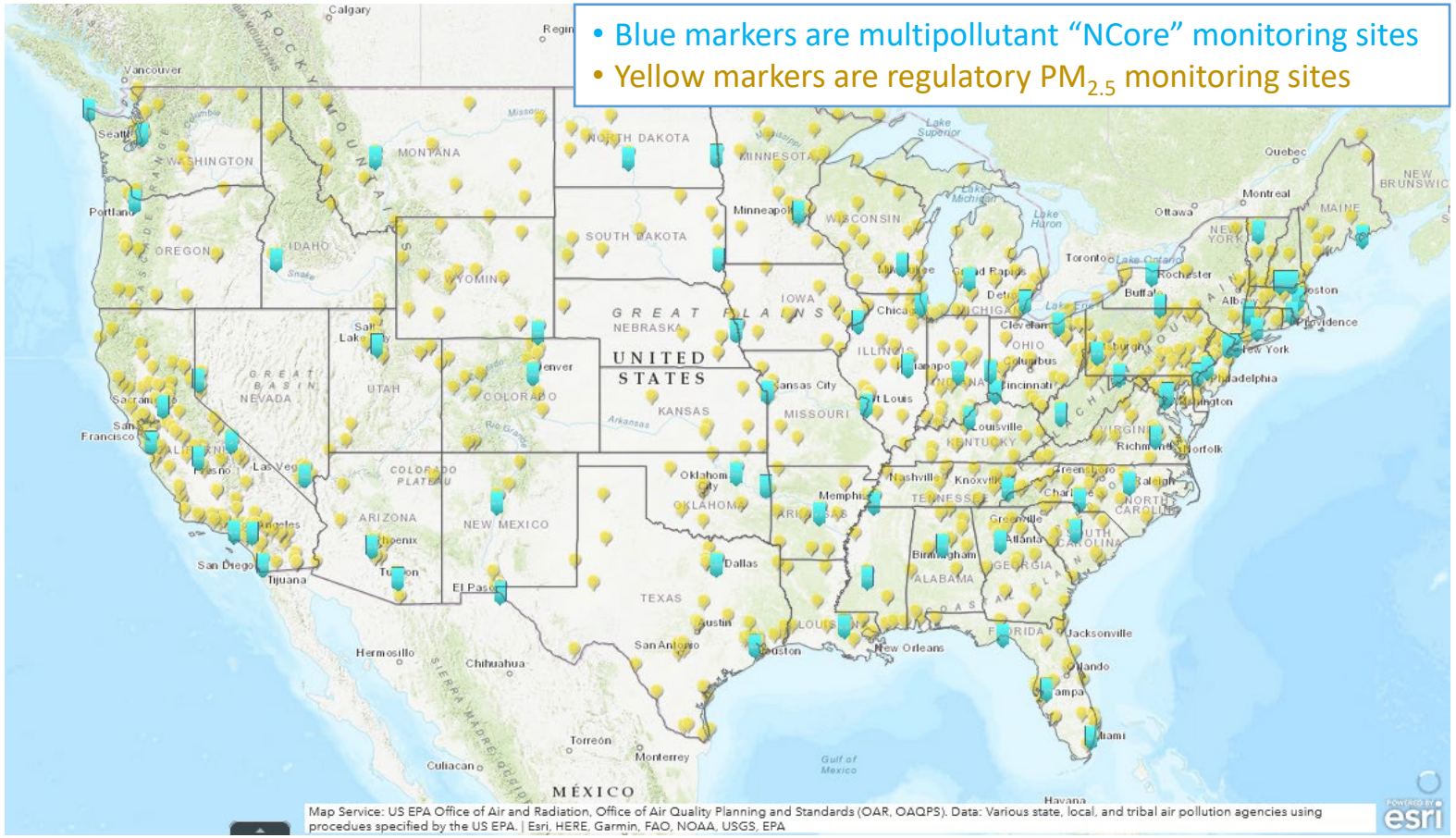
3) **Provide publicly-available plans** for building weather-shielding collocation enclosures and **guidance on best practices** for utilizing this infrastructure in conjunction with air sensor projects; and

4) **Increase communication and collaboration between external stakeholders such as citizen scientists with tribal, state, and local agencies** to produce air quality sensor data in which all parties have more confidence.

EPA Regulatory Air Monitoring Network

- Most air monitoring sites are operated by state, local, or tribal governments.
- These agencies receive grants from EPA
- EPA provides oversight related to:
  - Monitoring network design
  - Quality assurance procedures
  - Data reporting and analysis

Cannons Lane Air Monitoring Site, Louisville, Kentucky



www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

Project Approach: Gather Interest

- ***Goal:*** Deploy at least 1 collocation shelter in each interested EPA Region (For the 2nd Round of Installation)
- Interested Regions solicited interest and information about potential sites from state, local, and tribal air monitoring agencies
  - Gathered standard information about each candidate site
- Each participating region selected a deployment site

Collocation Shelter installed in Jacksonville, Florida

Project Approach: Determine Deployment Locations

- The entire project team met to discuss alternative sites and select additional deployment sites with high impact
- 18 shelters built by a metal fabrication shop
  - 6 shelters installed at initial locations in the Southeast (1st Round)
  - 12 more shelters will be installed this year (2nd Round)

Next Steps

Empower Shelter Use

- The entire project team (EPA and project partners) has regular meetings to discuss successful community collocation efforts to inspire agencies installing shelters to design and implement their own community engagement
- Ongoing meetings are being held with state, local, and tribal agencies that are receiving shelters to provide coordination / guidance on the installation and use

Collocation Shelter assembled in Orlando, Florida

Considerations for Installing a Collocation Shelter

- Advertisement/Application Process
  - Online form
  - Point of contact
- Site Security/Public Access
  - Space considerations
  - Separation from regulatory monitors (interference and fencing)
  - Public to access the shelter
  - Days and time of day
  - Agency staff escort
- Accessibility of Regulatory Site Air Monitoring data
- Liability with public access
- Available electricity and WiFi for the shelter
- Availability of staff time to engage with the public on the shelter

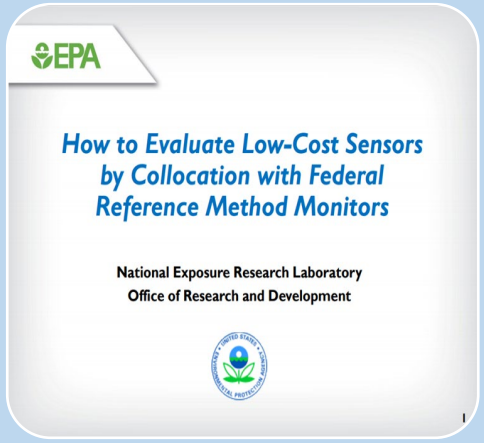
Collocation Shelter after construction in Raleigh, North Carolina

Project outcomes

- Engage tribal and community scientists in collocating air sensors to:
  - Produce higher quality air sensor data
  - Allow groups to better understand air quality in areas with limited air monitoring
  - Build relationships between tribes, communities, and air monitoring agencies
- Produce a best practice guide so additional agencies can successfully operate collocation shelters
  - Shelter plans will also be publicly available (upcoming)
  - Written in collaboration with all partner agencies and Regions
  - Shelter considerations document can be used as a template
- EPA webpage with shelter contacts (upcoming)

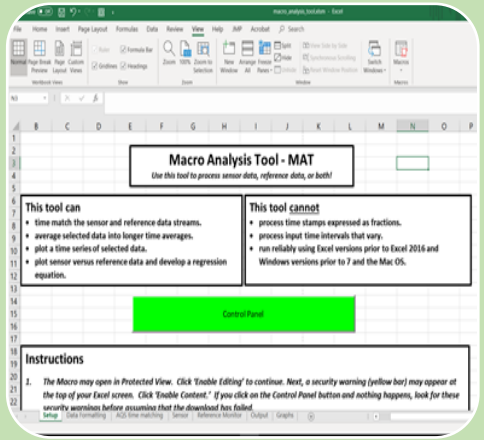
Smaller collocation shelter installation with Eastern Band of Cherokee Indians

More Information and Resources



Air Sensor Collocation Instruction Guide

- Step-by-step guide to the collocation process
- *English*: https://www.epa.gov/air-sensor-toolbox/air-sensor-collocation-instruction-guide
- *Spanish*: https://espanol.epa.gov/espanol/guia-de-instrucciones-de-colocalizacion-de-sensores-de-aire-0

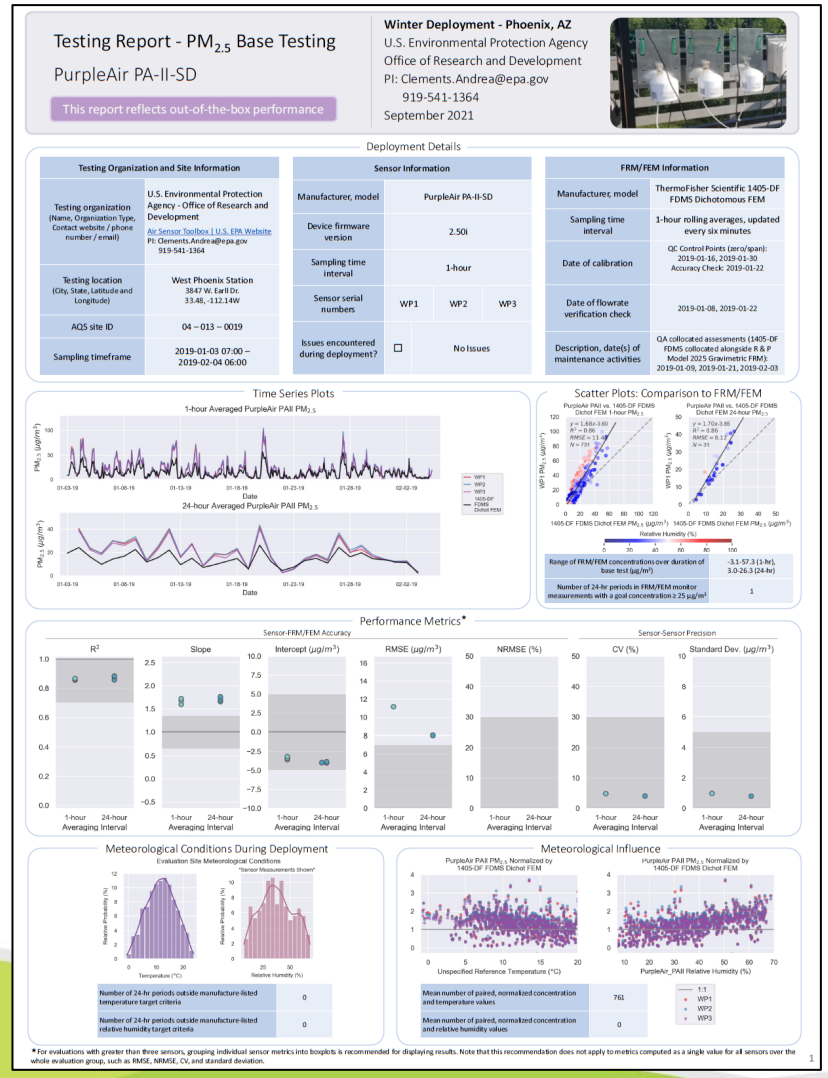


Macro Analysis Tool (MAT)

- EPA's Excel-based macro analysis tool to help non-experts compare data from air sensors with data from regulatory monitors and interpret their results
- https://www.epa.gov/air-research/instruction-guide-and-macro-analysis-tool-evaluating-low-cost-air-sensors-collocation

Resources – Air Sensor Evaluations

U.S. EPA Sensor Evaluation Report (Example)



- EPA Sensor Performance Metrics Report
  - https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols
- Suggested Metrics
  - *Sensor to reference monitor comparison* – correlation coefficient, slope, intercept, root mean squared error
  - *Sensor to sensor comparison* – standard deviation, coefficient of variation
- Published Sensor Evaluations
  - US EPA Evaluation of Emerging Air Sensor Performance https://www.epa.gov/air-sensor-toolbox/evaluation-emerging-air-sensor-performance
  - South Coast's Air Quality Sensor Performance Evaluation Center (AQ-SPEC) http://www.aqmd.gov/aq-spec
- **Local sensor evaluation, such as collocation, of your own sensors is highly recommended**

Partner Agencies (Shelter location)

- NJ Department of Environmental Protection (Newark, NJ)
- GA Environmental Protection Division (Atlanta, GA)
- NC Department of Air Quality (Raleigh, NC)
- Eastern Band of Cherokee Indians (Cherokee, NC)
- Mecklenburg County Air Quality (Charlotte, NC)
- Asheville-Buncombe Air Quality Agency (Asheville, NC)
- Orange County Environmental Protection Division (Orlando, FL)
- Catawba Indian Nation (Rock Hill, SC)
- SC Department of Health and Environmental Control (Columbia, SC)
- Broward County, FL (West Palm Beach, FL)
- Louisville Air Pollution Control District (Louisville, KY)
- City of Jacksonville (Jacksonville, FL)
- Little River Band of Ottawa Indians (Manistee, MI)
- Fond du Lac (Cloquet, MN)
- Cherokee Nation of Oklahoma (Stilwell, OK)
- California Air Resources Board (Calexico & Bakersfield, CA)
- South Coast Air Quality Management District (Azusa, CA)

Project Contacts

Karoline Barkjohn, Andrea Clements (EPA ORD)

Ryan Brown, Daniel Garver (EPA Region 4)

Suzy Apodaca, Mark Berry (EPA Region 6)