Communicating Air Sensor Data on the AirNow Fire and Smoke Map

Karoline Barkjohn[1], Amara Holder[1], Andrea Clements[1], Samuel Frederick[2], Ron Evans[3], Sim Larkin[4]

[1]US Environmental Protection Agency (EPA) Office of Research and Development

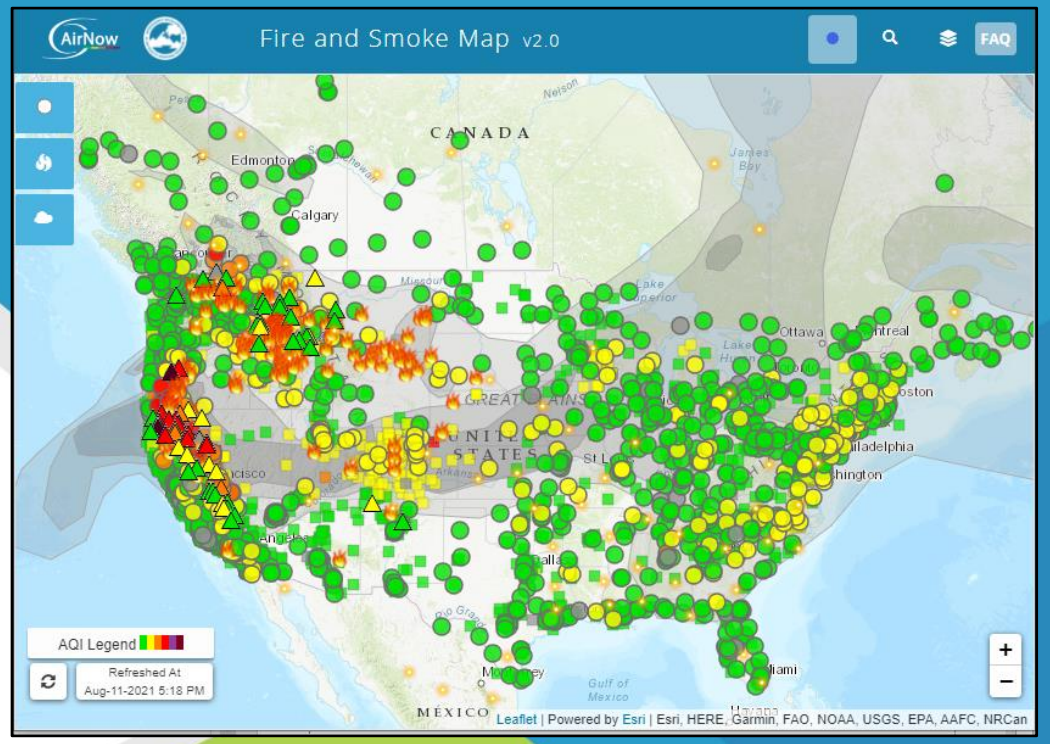
[2]Former ORAU contractor to EPA Office of Research and Development

[3]US EPA Office of Air Quality Planning and Standards

[4]US Forest Service

Office of Research and Development
Center for Environmental Measurement and Modeling,
Air Methods and Characterization Division

Fire.AirNow.gov



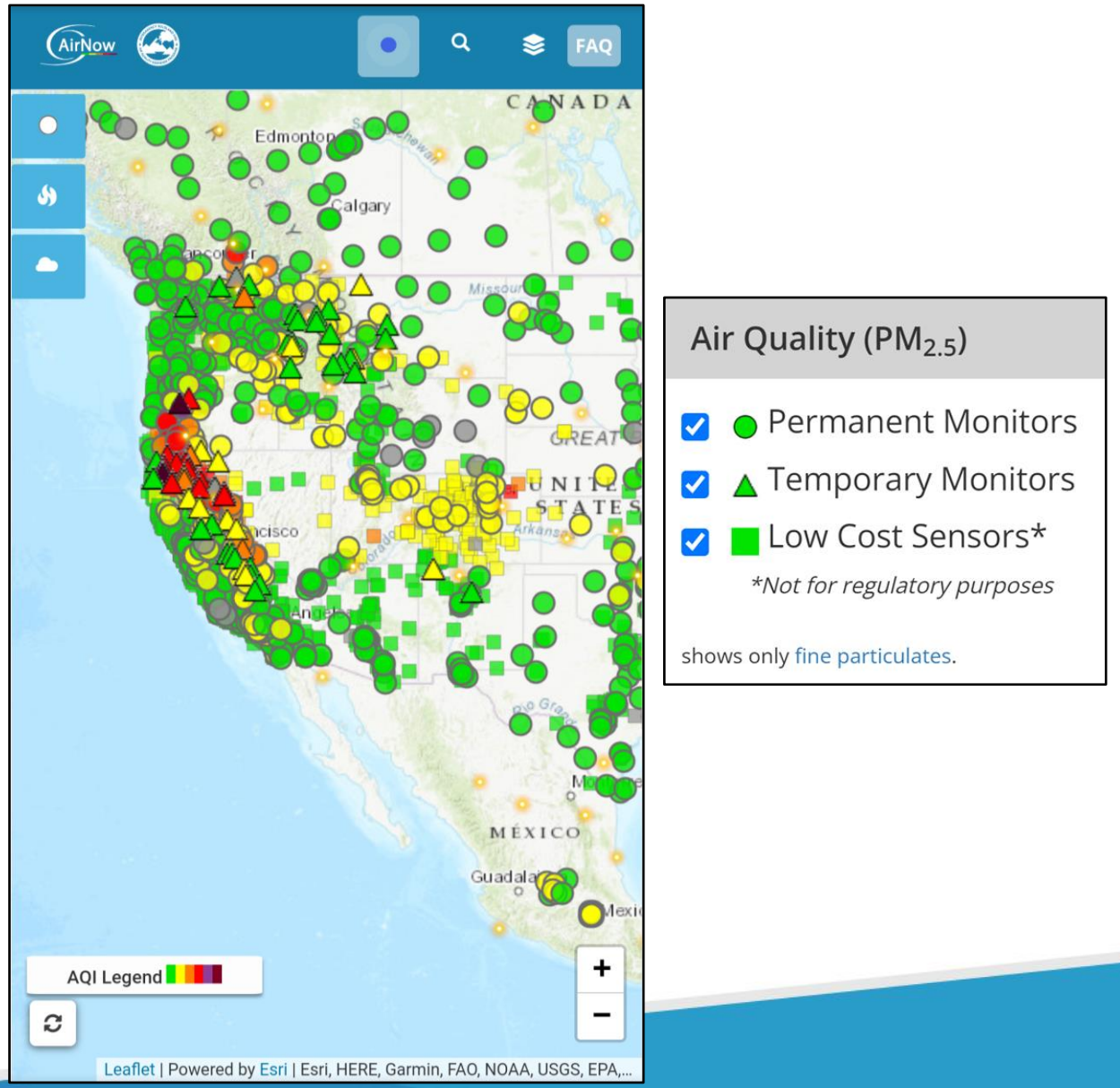
Air Sensors International Conference
Communication Strategies for Understanding, Insight, and Action
May 12th, 2022
ASIC India Webinar
Nov 30th, 2022

AirNow Fire & Smoke Map

Objective: Provide enhanced air quality information critical during periods of wildland fires and other air pollution events

- Merge multiple sources of information
- Provide higher time resolution data from low-cost air sensors

Effort is a partnership between US Environmental Protection Agency and US Forest Service



Mobile AirNow Fire and Smoke Map
(Captured: 8/11/21)

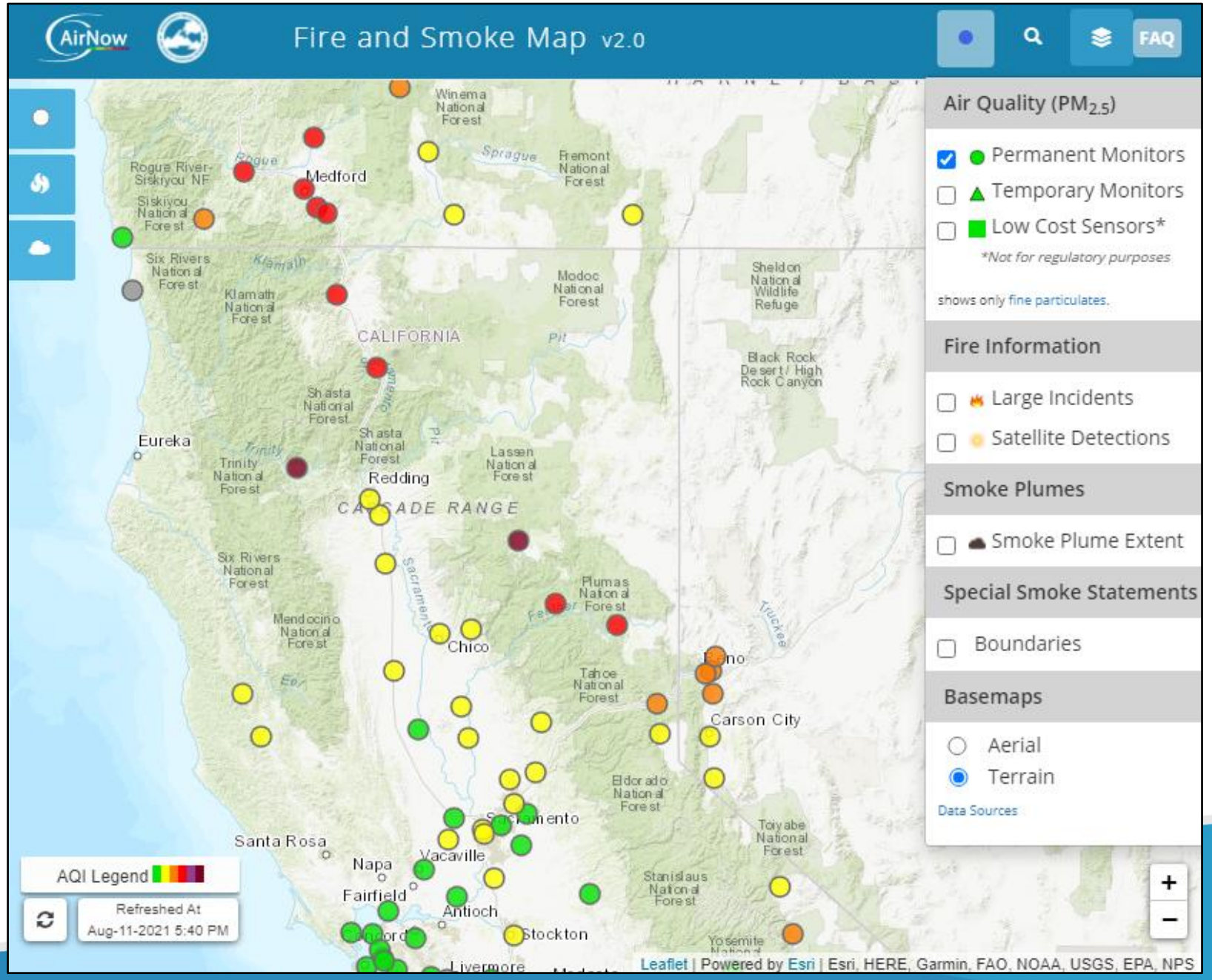
Data Layers

Permanent monitors from AirNow

- Federal Equivalent Methods (FEM)

MetOne BAM-1020

Teledyne API T640 / T640x

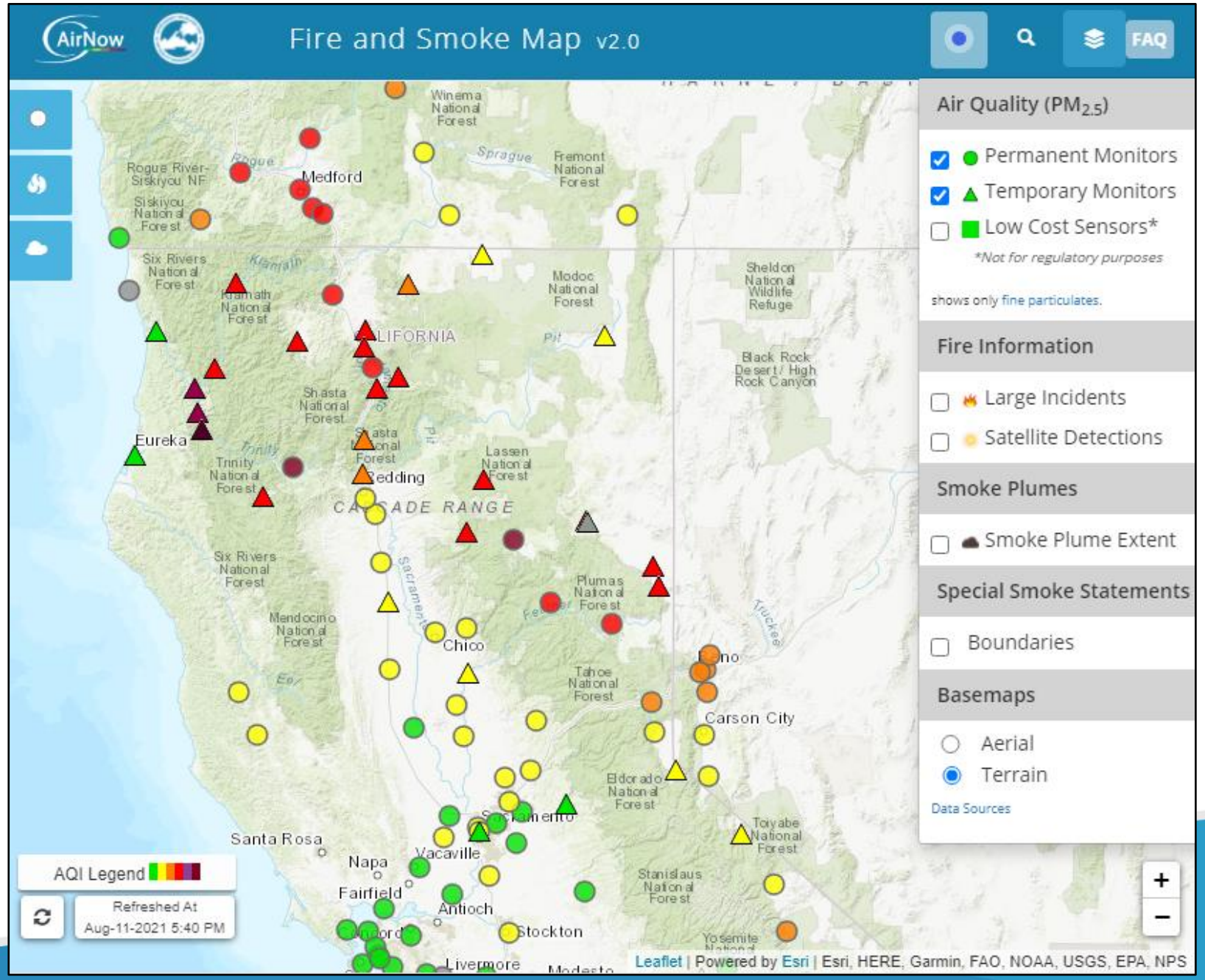


Data Layers

Temporary monitors deployed during smoke events

▲ eBAM/eSampler

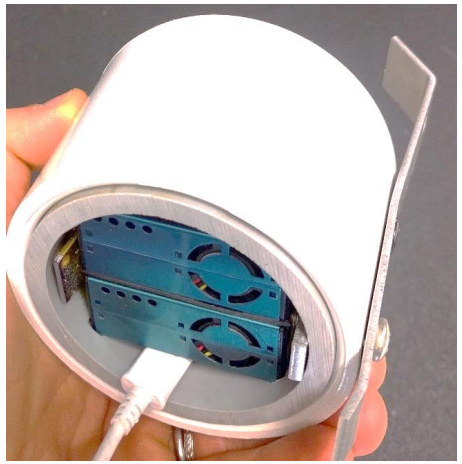
MetOne E-BAM



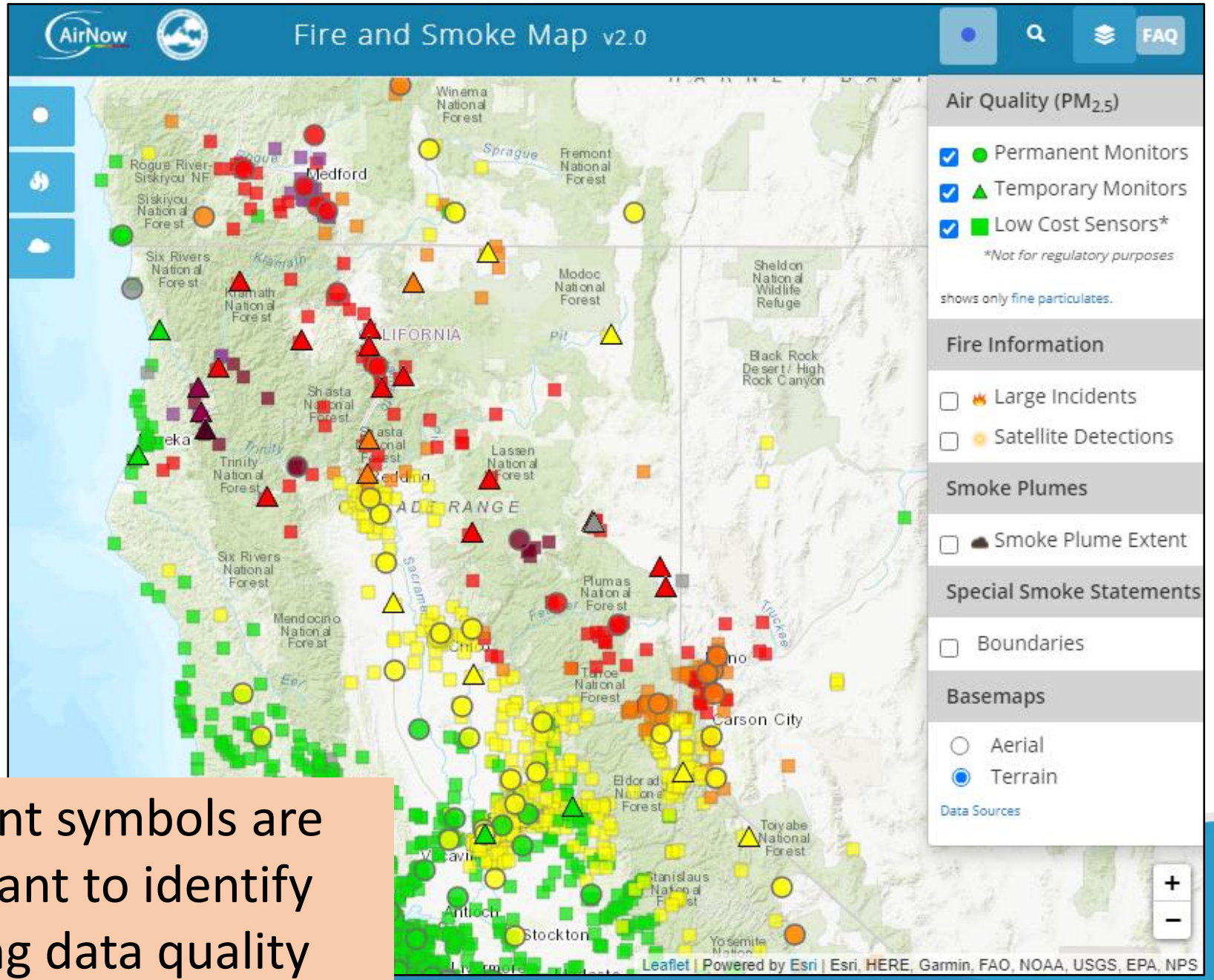
Data Layers

Low-cost sensors deployed by a variety of users

- PurpleAir PA-II & PA-II-SD



PurpleAir sensor



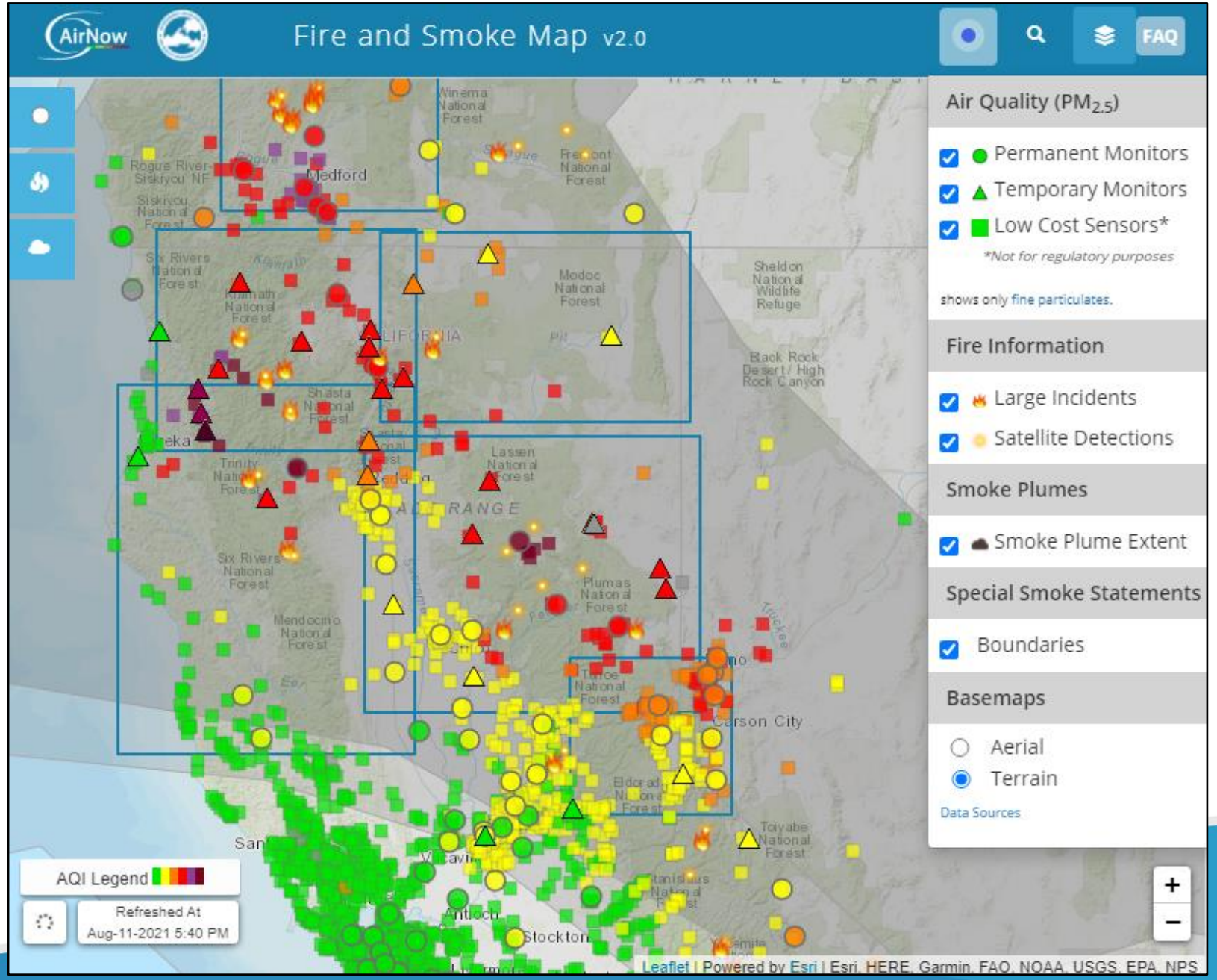
Different symbols are important to identify differing data quality

Data Layers

Large Incidents from US National Interagency Fire Center's active incident feed

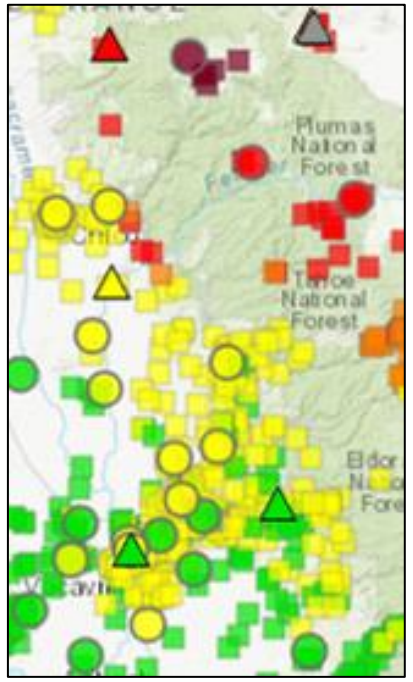
Satellite Detections & Smoke Plumes from National Oceanic and Atmospheric Administration's (NOAA) Hazard Mapping System

Special Smoke Statements from Interagency Wildland Fire Air Quality Response Program Air Resource Advisors



$PM_{2.5}$ NowCast AQI

- Markers are colored using the NowCast Air Quality Index (AQI)
  - Grey=offline/unavailable
- NowCast
  - Hourly AQI value based on the previous 12-hours of data
  - Weighted more heavily to the recent data if concentrations are changing quickly
  - Resembles 3-hour average



C_{low}	C_{high}	I_{low}	I_{high}	Category
0	12.0	0	50	Good
12.1	35.4	51	100	Moderate
35.5	55.4	101	150	Unhealthy for Sensitive Groups
55.5	150.4	151	200	Unhealthy
150.5	250.4	201	300	Very Unhealthy
250.5	350.4	301	400	Hazardous
350.5	500.4	401	500	Hazardous

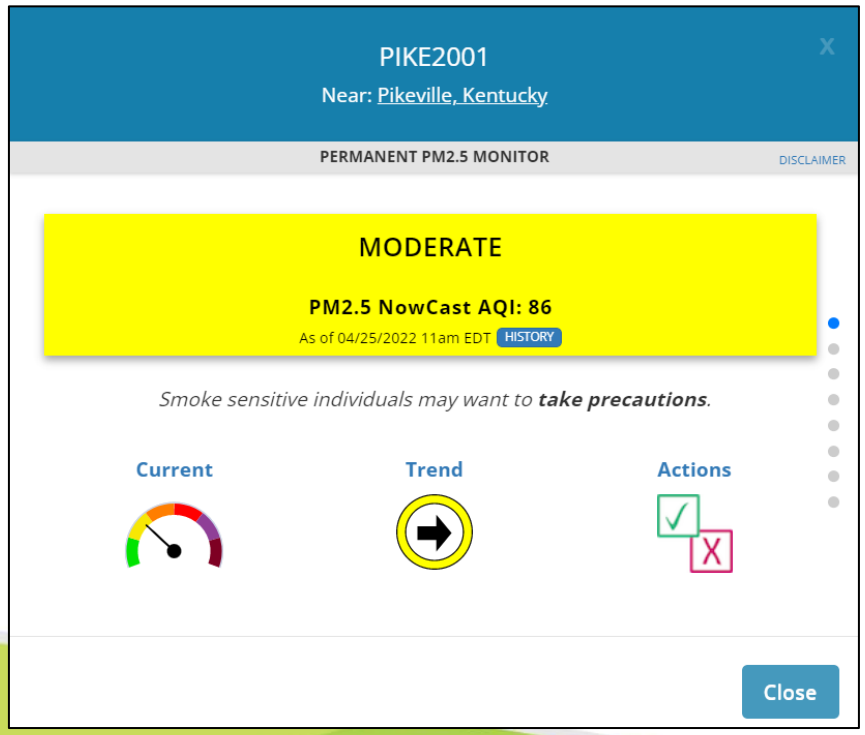
Air Quality Index categories

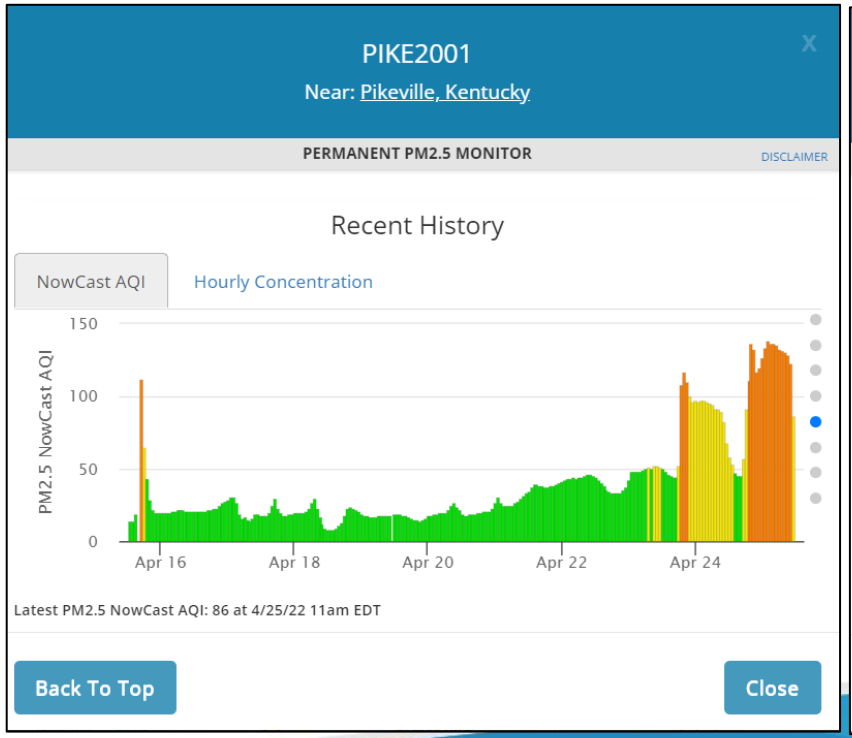
C = Concentration, I = Index (AQI)

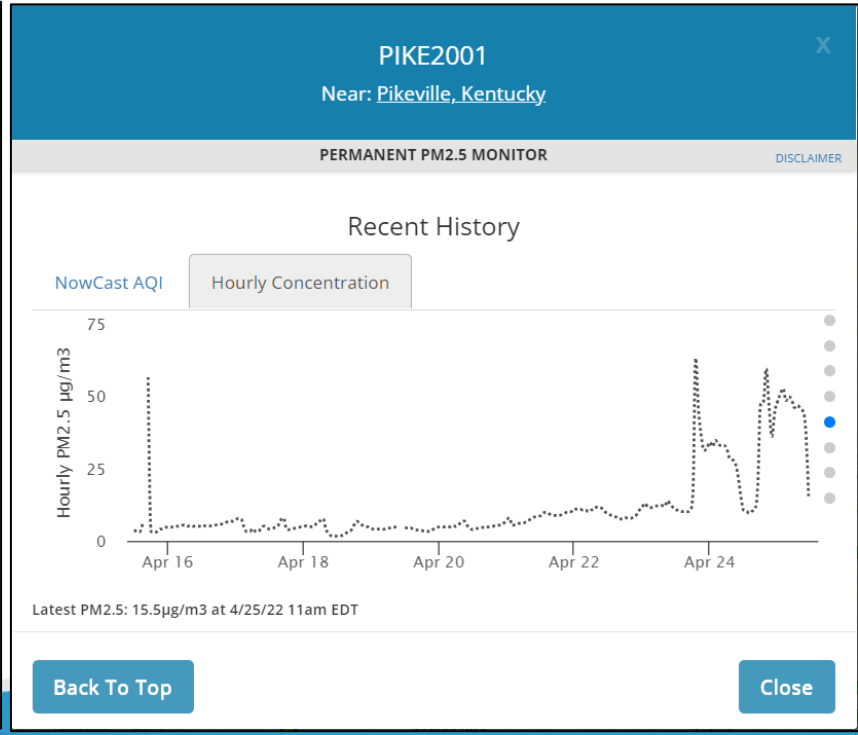
Colors give a quick indicator of air quality without needing to understand the numbers and or equate numbers to risk

Monitor Specific Information

Clicking on an individual monitor provides additional information on local conditions

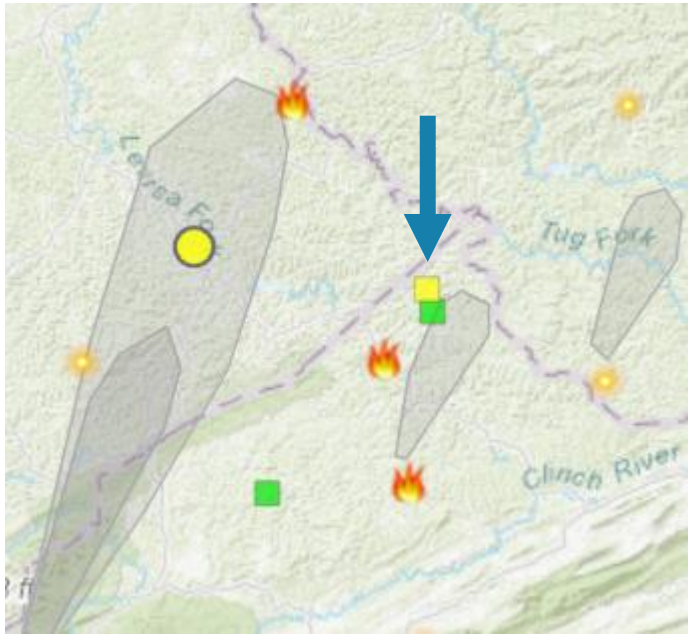




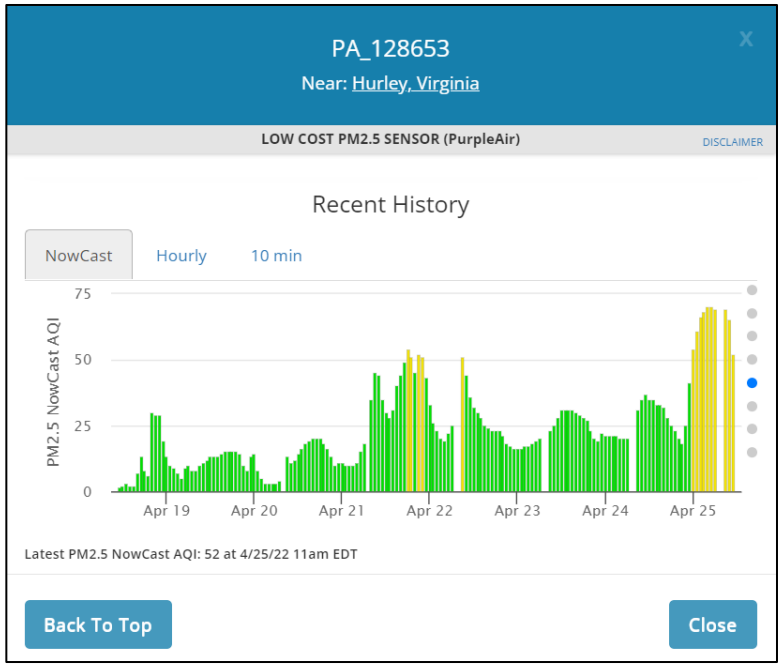


Sensor Specific Information

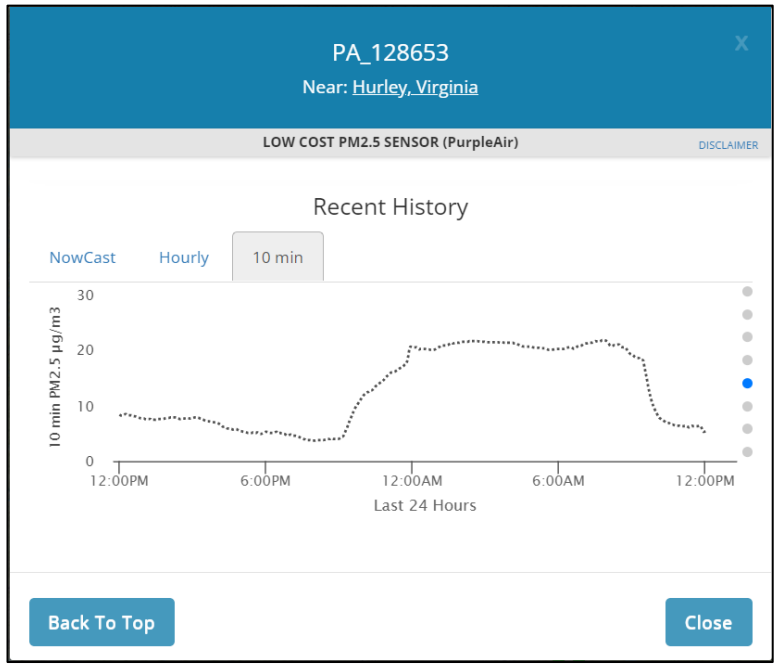
Selected PurpleAir sensor in the Appalachian mountains near the VA/KY/WV border (captured: 4/25/22)



NowCast averages help explain health risk by hour over the past week



10-min averages provide the most recent data from the past day to see where the concentration is trending



Data from low-cost sensors may have more uncertainty than monitors. However, comparison with other sensors, monitors, and information on the map can help interpretation.

Recommendations

Actions

PA_5622

Near: Maple Falls, Washington

LOW COST PM2.5 SENSOR (PurpleAir) DISCLAIMER

Recommendations

Current NowCast: **UNHEALTHY**

Everyone: Keep outdoor activities light and short, monitor how you feel.

Sensitive groups*: Consider moving all activities indoors.

Go indoors to cleaner air if you don't feel well. Learn more

**Sensitive groups include people with heart or lung disease, older adults, children, and pregnant women.*

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Current NowCast: **GOOD**

Everyone: It's a good time to open windows or go outdoors.

Local conditions can change rapidly. Pay attention and take action especially if you don't feel well.

Current NowCast: **MODERATE**

Everyone: It's a good time to open windows or go outdoors.

Smoke sensitive Individuals: Consider keeping outdoor activities light and short.

Local conditions can change rapidly. Pay attention and take action especially if you don't feel well.

Current NowCast: **UNHEALTHY FOR SENSITIVE GROUPS**

Everyone: Consider lighter and shorter outdoor activities.

Sensitive groups*: Go indoors if you have symptoms.

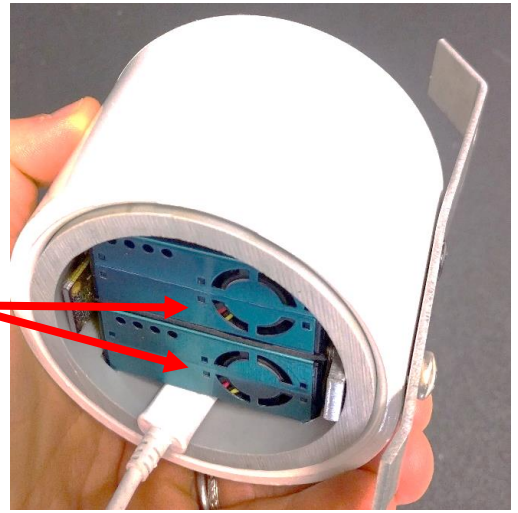
Local conditions can change rapidly. Pay attention and take action especially if you don't feel well.

**Sensitive groups include people with heart or lung disease, older adults, children, and pregnant women.*

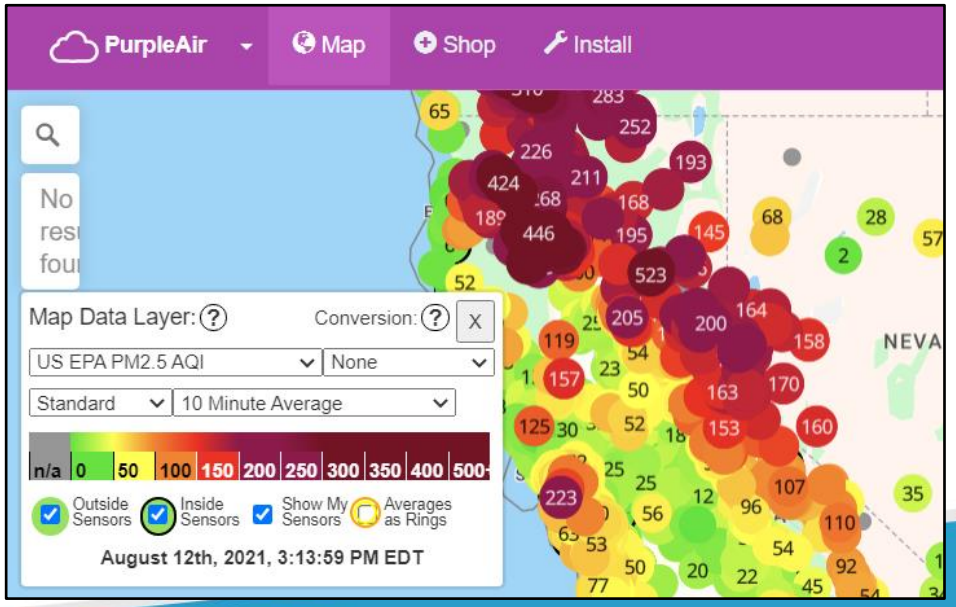
Plain language advice on appropriate actions

Sensors: Challenges

- Data quality assurance methods needed for apples-to-apples comparison with monitors
  - Crowdsourced data (unknown true location)
  - Exclusion when duplicate channels disagree
  - Correction required for bias and RH influence
- Communication: PurpleAir displays their information differently
  - NowCast vs. default 10-min averages



PurpleAir Sensor underside view



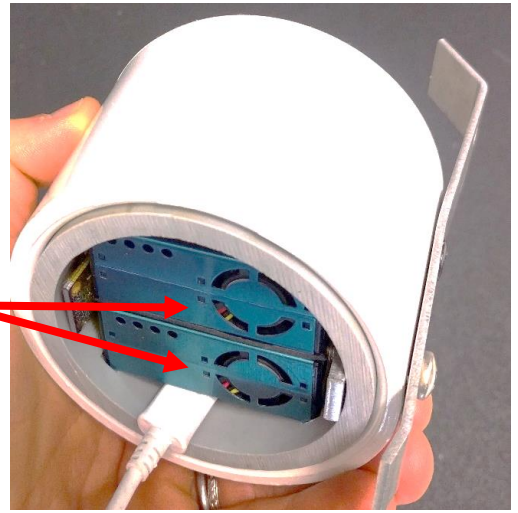
PurpleAir.com/map

RH: Relative Humidity

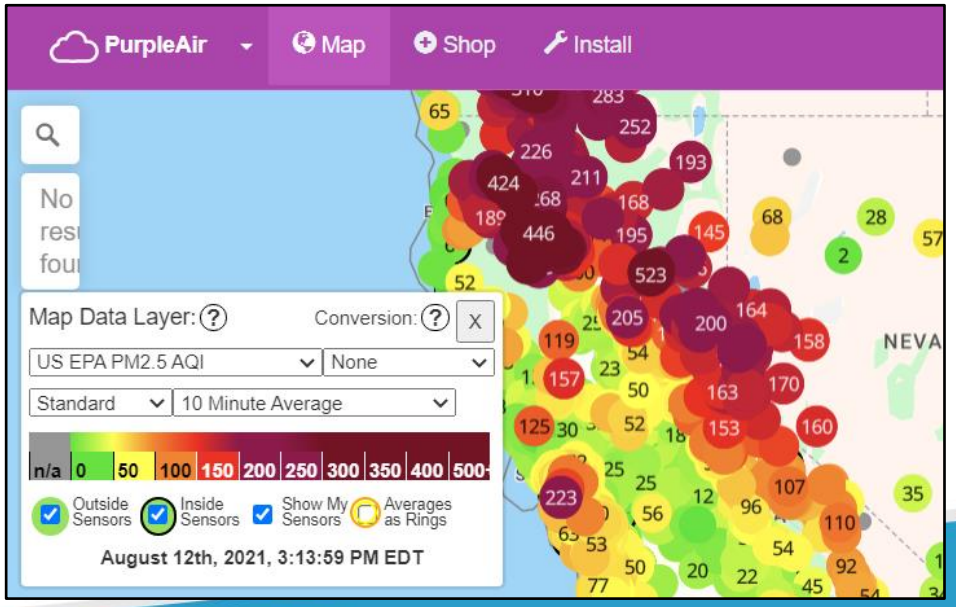
Sensors: Benefits

- Add valuable cost-effective spatial information to the map
- Allows users to make decisions from multiple sources

A & B channels



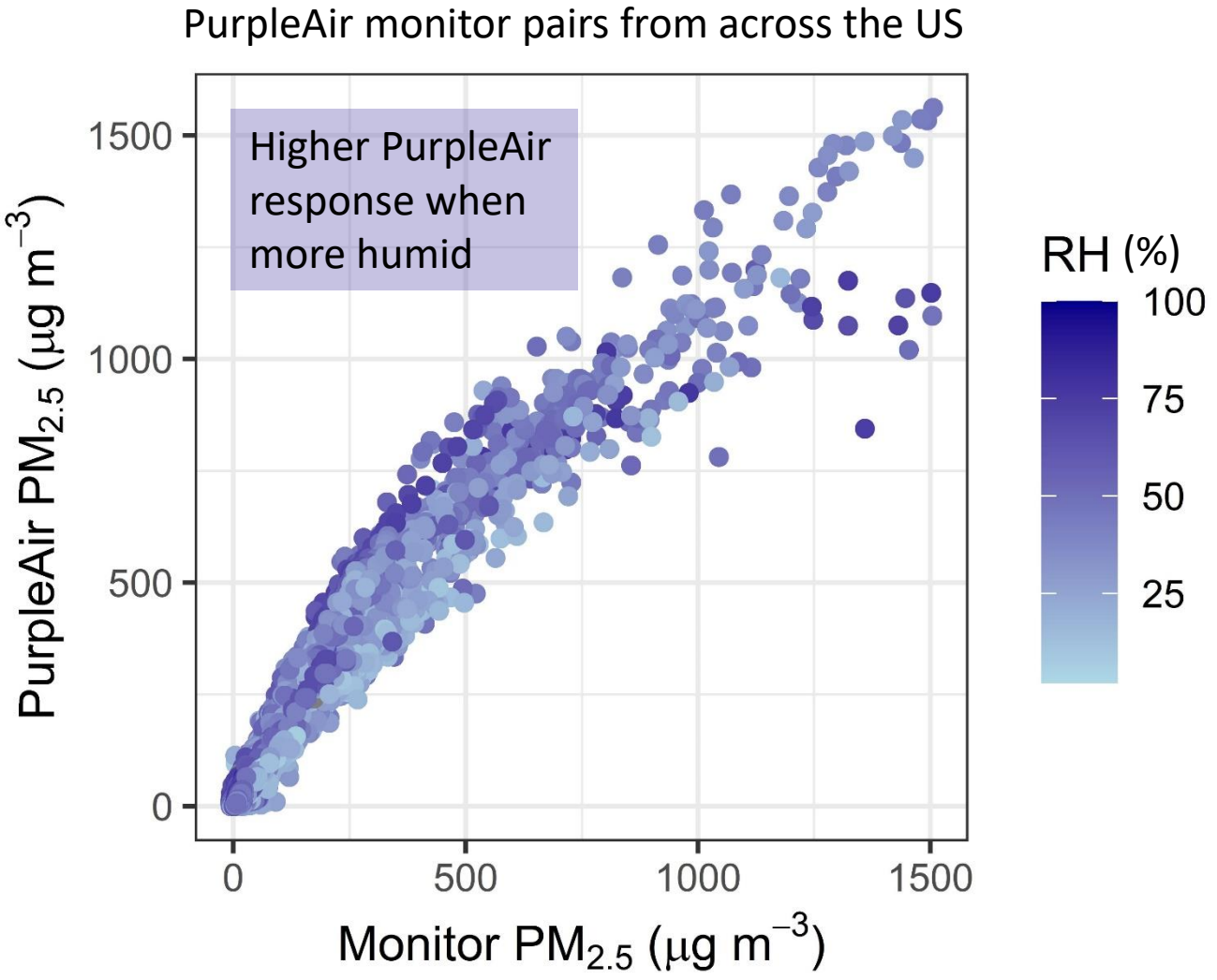
PurpleAir Sensor underside view



PurpleAir.com/map

Sensor Data Correction for the Fire and Smoke Map

- **Fits full range**
  - Important so that the map can be used during times of the year with and without smoke impacts
- **Considers relative humidity (RH) influence**
  - Important since monitors measure dry $PM_{2.5}$ and RH can increase light scattering per mass
- **Simple is better**
  - Want model to be broadly applicable and easy to interpret

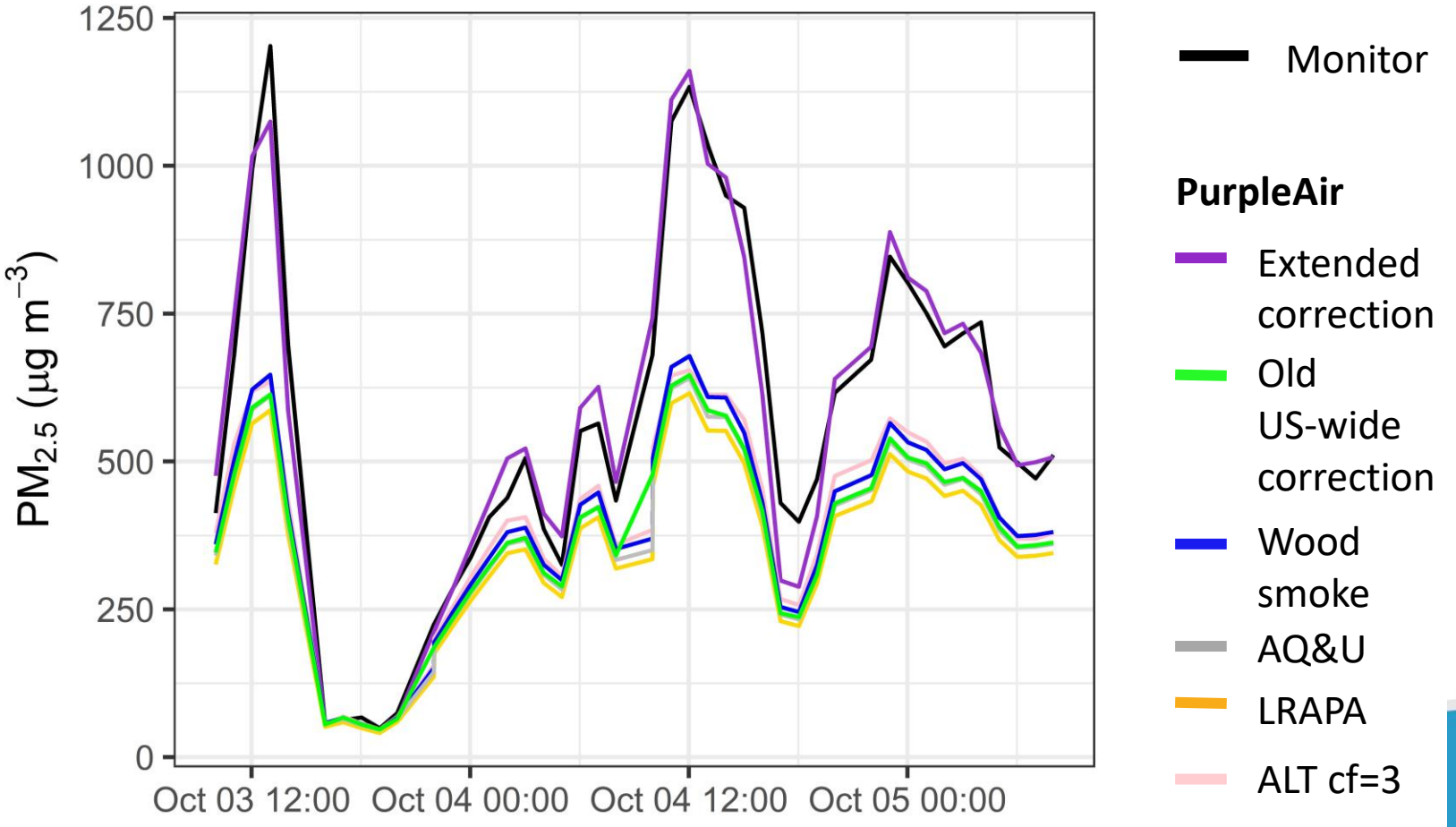


$PM_{2.5}$ = Fine particulate matter

Extended US-wide Correction

- **Linear +RH** correction at low concentration transitions to **quadratic fit**
- **Better agreement** for both ambient and smoke-impacted concentrations

Comparison of Corrections on PurpleAir.com
Red Salmon Complex wildfire
Forks of Salmon, CA 2020

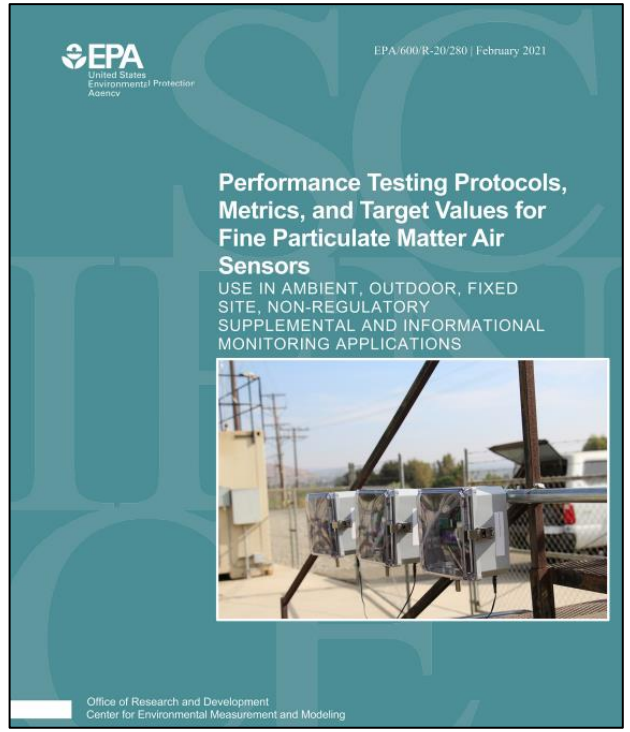


Old US-wide correction almost entirely covers AQ&U

[1]LRAPA – Lane Regional Air Protection Agency
[2]AQ&U – Air Quality and You

Recommendations for accurate smoke sensor networks

- **Evaluate sensors alongside monitors**
  - At 1-hr averages – *higher time resolution data is important to understand smoke impacts*
  - At $PM_{2.5}$ concentrations up to 500 µg/m^3
  - In areas where the sensors are used – *across the city, region, or country depending on network size*
  - Seasonally or more frequently
  - See guidance in EPA's Performance Testing Protocols, Metrics, and Target Values Report[1]
- **Corrections** may be needed to improve performance
- **Precision** between sensors of the same type is important
- **Monitors may also need additional quality control**
  - FEM or temporary smoke monitors



More details: https://www.epa.gov/research-states/how-evaluate-air-sensors-smoke-monitoring-webinar-archive

[1]US EPA Performance Targets Report: https://www.epa.gov/air-sensor-toolbox/air-sensor-performance-targets-and-testing-protocols

AirNow Fire and Smoke Map Team Effort

EPA Office of Air Quality Planning and Standards

- Ron Evans
- John White
- Phil Dickerson
- Lourdes Morales (retired)
- Michelle Wayland
- Rob Wildermann
- Alison Davis
- Susan Stone
- Kristen Benedict

EPA Office of Research and Developement

- Amara Holder
- Andrea L. Clements
- Gayle Hagler

US Forest Service AirFire

- Sim Larkin
- Stuart Illson (University of Washington)
- Jonathan Callahan (Mazama Science)

US Forest Service

- Pete Lahm

This work would not have been possible without support from partner state, tribal and local agencies, EPA regional offices and other federal agencies including the National Park Service, and the Wildland Fire Air Quality Response Program.

Resources and Contact Information

https://www.epa.gov/air-sensor-toolbox

Additional Questions

Contact:

Barkjohn.Karoline@epa.gov

Sensor Performance, Evaluation and Use

- Sensor Evaluation Results
- Standard Operating Procedures for Sensors
- Sensor Collocation Guide
- Sensor Performance Targets and Test Protocols
- Air Sensor Guidebook
- A Guide to Siting and Installing Air Sensors

Understanding Your Sensor Data Readings

- Technical Approaches for the Sensor Data on the AirNow Fire and Smoke Map
- Videos on Air Sensor Measurement, Data Quality and Interpretation
- RETIGO: Visualize Your Field Data
- Sensor Collocation Macro Analysis Tool
- Air Quality Information Exchange Workgroup Meeting Summaries