The EPA-USFS AirNow Fire and Smoke Map Sensor Data Pilot

Sim Larkin
US Forest Service (USFS)
AirFire

Karoline (Johnson) Barkjohn
US Environmental Protection Agency (EPA)
Office of Research and Developement

ASIC Webinar Series
April 1, 2021

With many others

EPA Office of Air Quality Planning and Standards

- Ron Evans
- John White
- Lourdes Morales
- Michelle Wayland
- Rob Wildermann
- Alison Davis
- Susan Stone
- Kristen Benedict

EPA Office of Research and Developement

- Amara Holder
- Andrea L. Clements

USFS AirFire

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

USFS

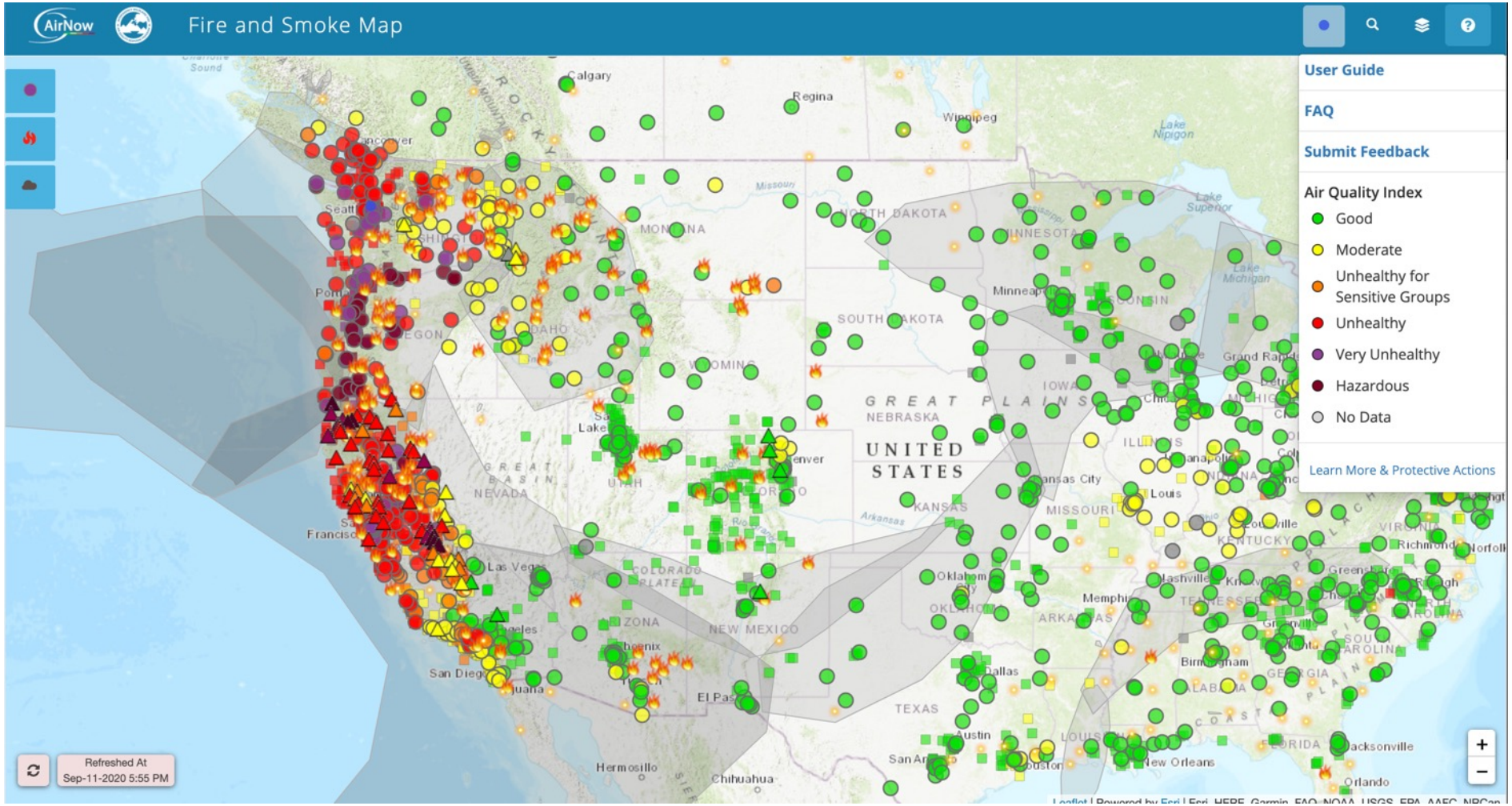
- Pete Lahm

Fire and Smoke Map v1 (2020)

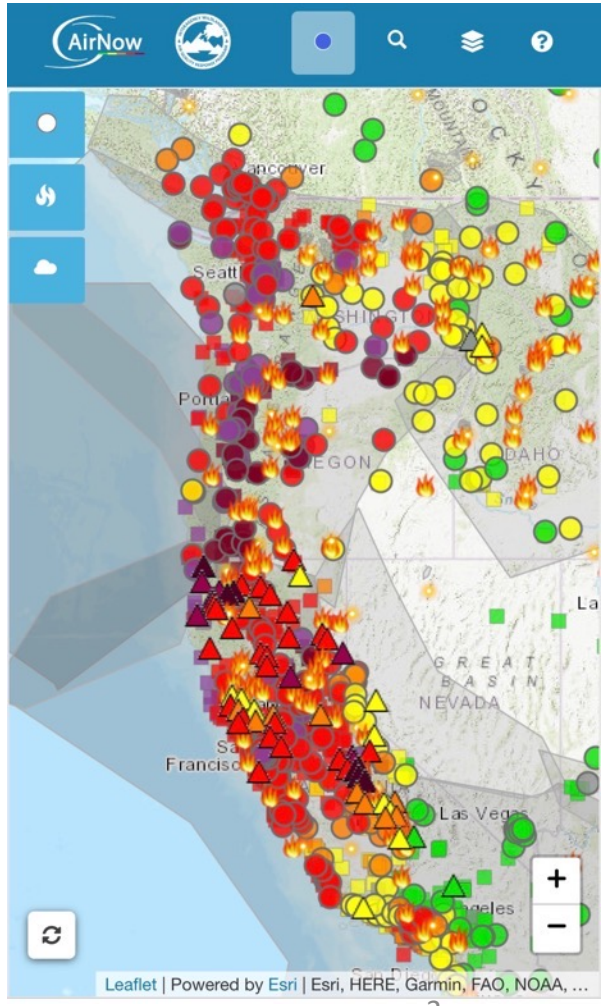
https://fire.airnow.gov

September 11, 2020 shown

Desktop:



Mobile:



Objectives

- Provide enhanced air quality information critical during periods of wildland fires and smoke

- Pilot the inclusion of air quality measurements from low-cost sensors in a consistent manner

Photo: NCSU

EPA AirNow

- Year-round 24/7 coverage
- Delivers near real-time data (ozone & particles)
- Next-day Air Quality Index (AQI) forecasts for nearly 500 cities
- State-of-the-science information about air pollution health effects for the public, media, and stakeholders

U.S. Forest Service

Interagency Wildland Fire Air Quality Response Program

- Enhanced smoke monitoring, modeling, messaging, and interagency coordination during wildfires
- Trained smoke specialists (Air Resource Advisors) on wildland fire incidents
- Smoke Outlooks and other products (transportation, safety)

The pilot met a public need during one of the worst fire seasons in U.S. history

- Over 7.4 million page views over about 3 months
- Numerous comments from public and government agencies welcoming the new information
  - “The EPA website change allows lower quality sensors to provide information that helps real people decide how to live their lives in a city threatened by smoke and catastrophic fires. It was a positive and very useful step”
  - “I have asthma and the information on this site has helped me to make critical decisions about how to protect myself during the wildfires in Sonoma County this month August 2020. ……Overall, I give this an A grade for information in real time to the public”

Data Layers

Air Quality Observations ($PM_{2.5}$)

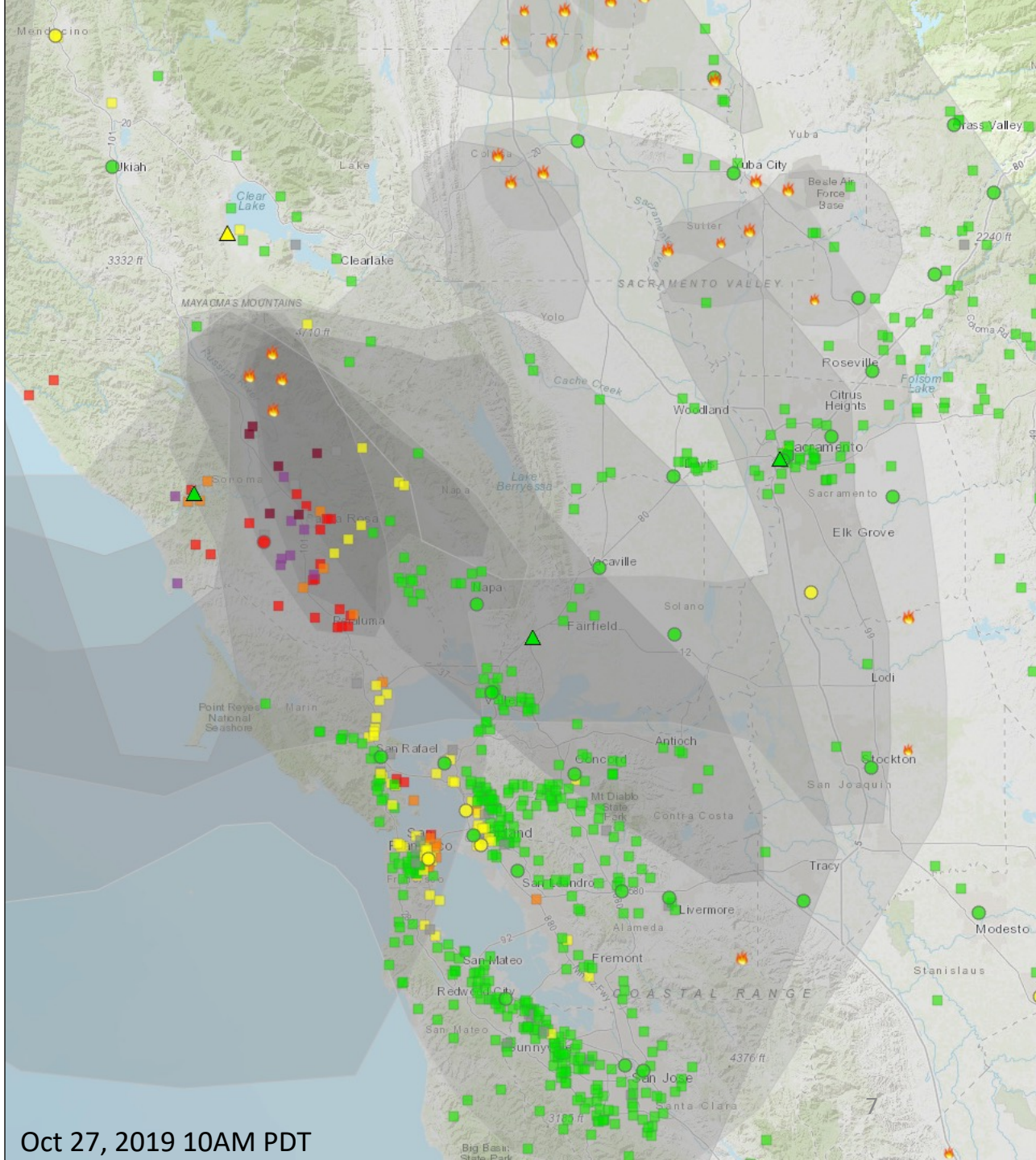
- Permanent Monitors
- Temporary Monitors
- Low-Cost Sensors

Fire Information

- (Wildland) Fire Incident Reports
- Satellite Detections

Smoke Plume Extent

- Satellite Plume Extents



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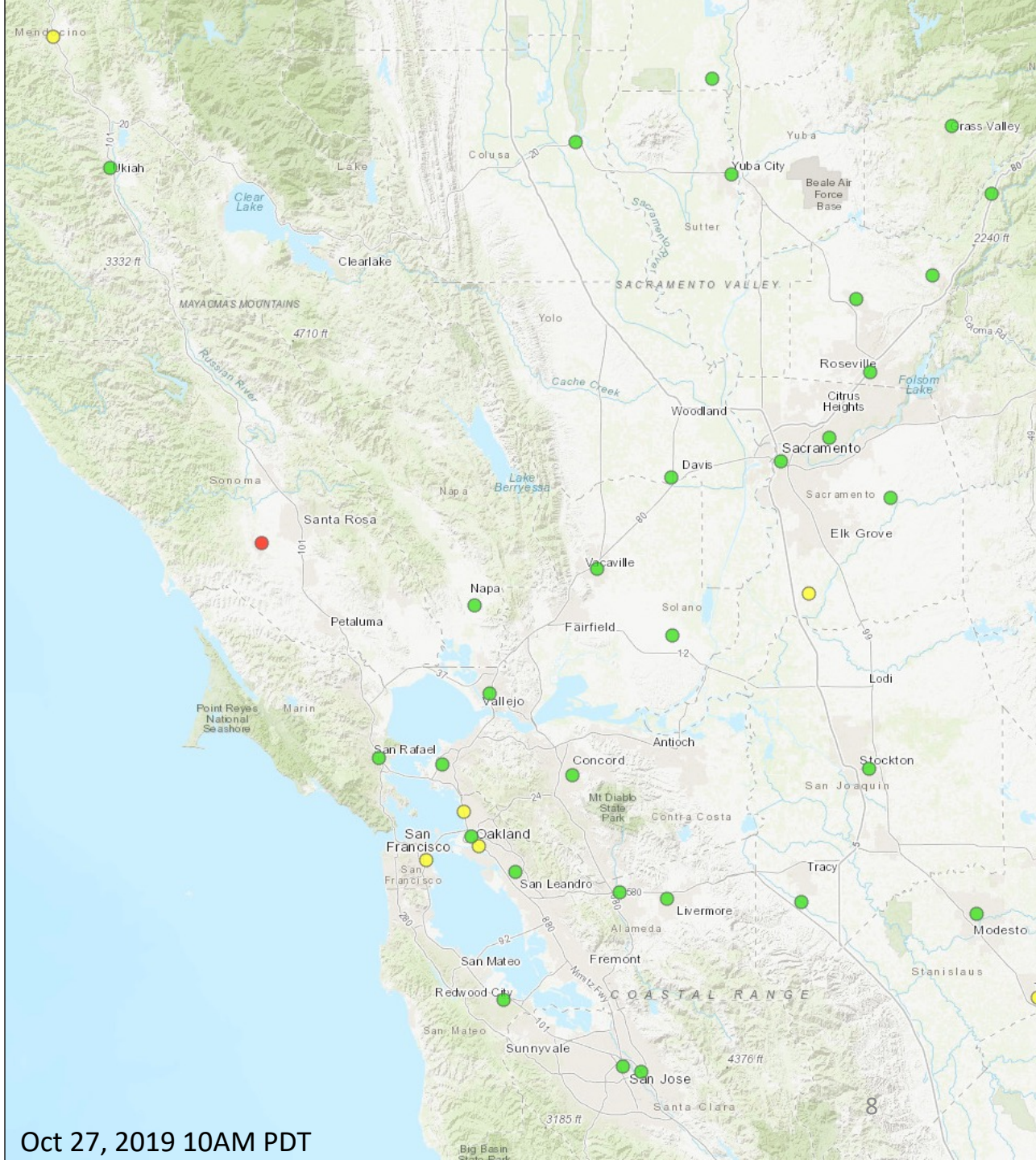
Permanent Monitors

Fire Information

Smoke Plume Extent



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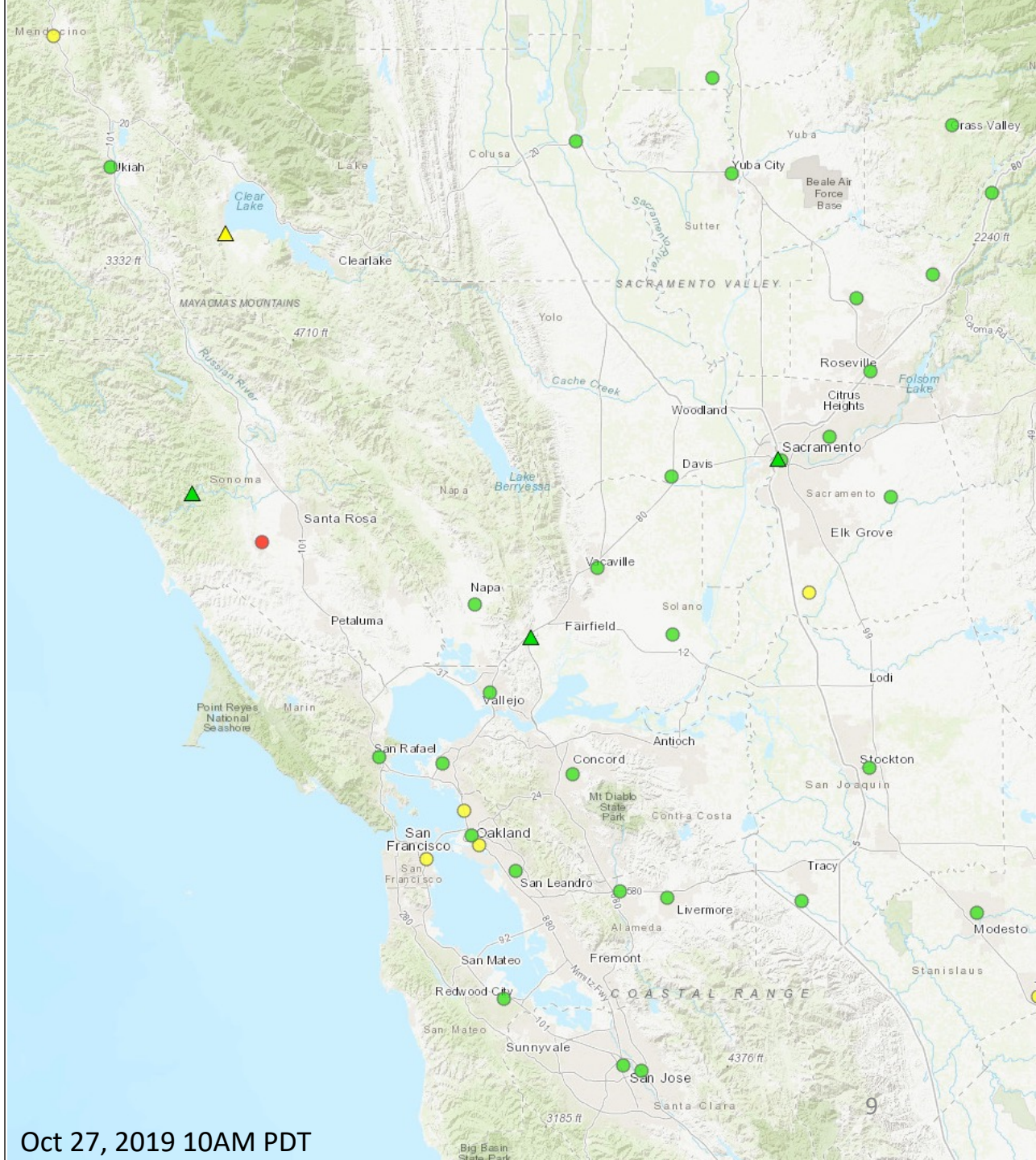

Oct 27, 2019 10AM PDT

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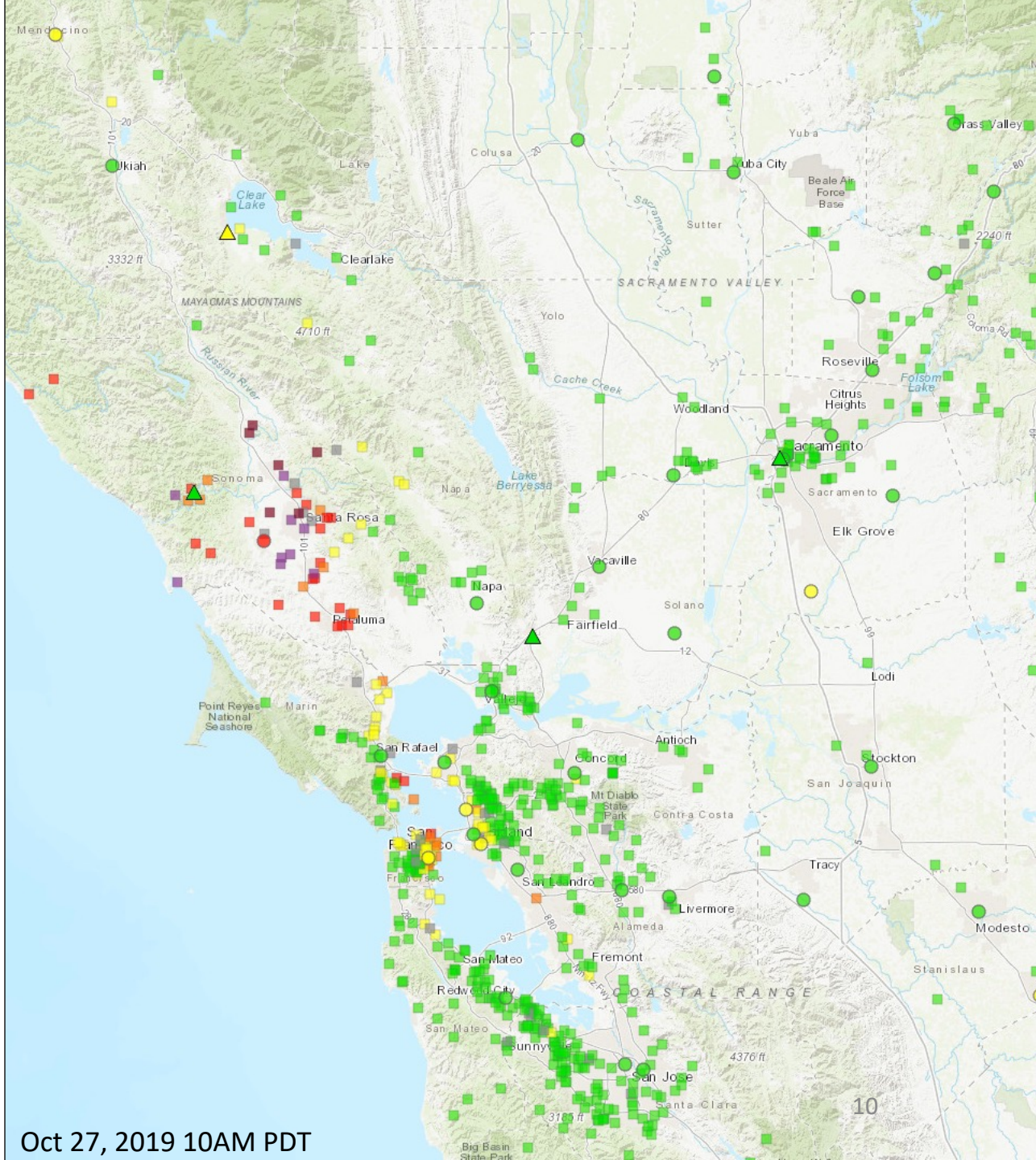
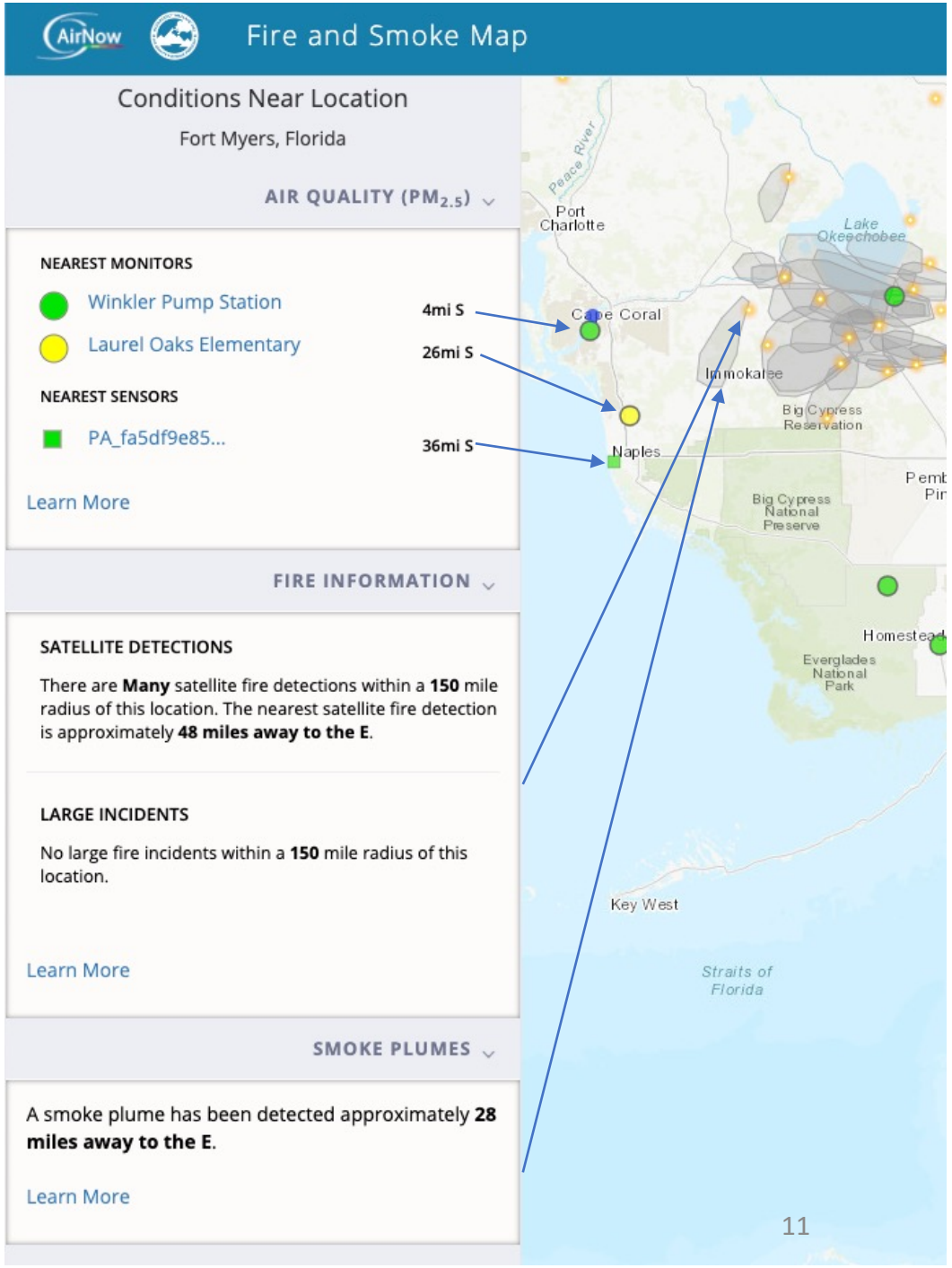


Oct 27, 2019 10AM PDT

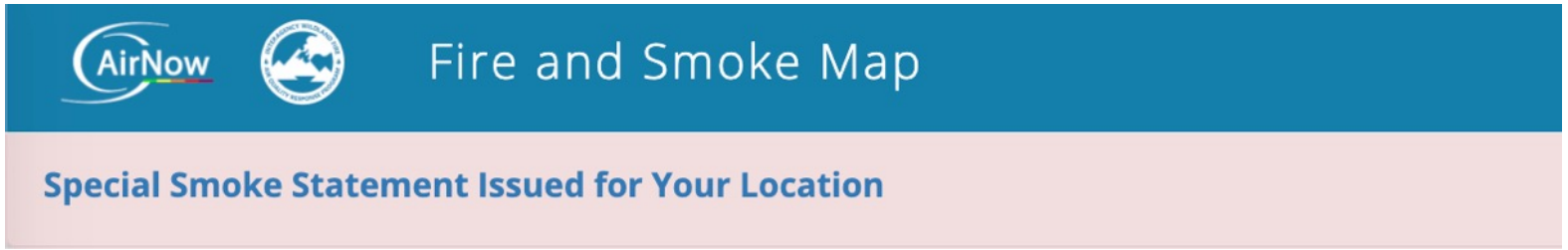
In Your Area

- Geolocated relevant information
- Direct access to incident-issued Special Smoke Statements

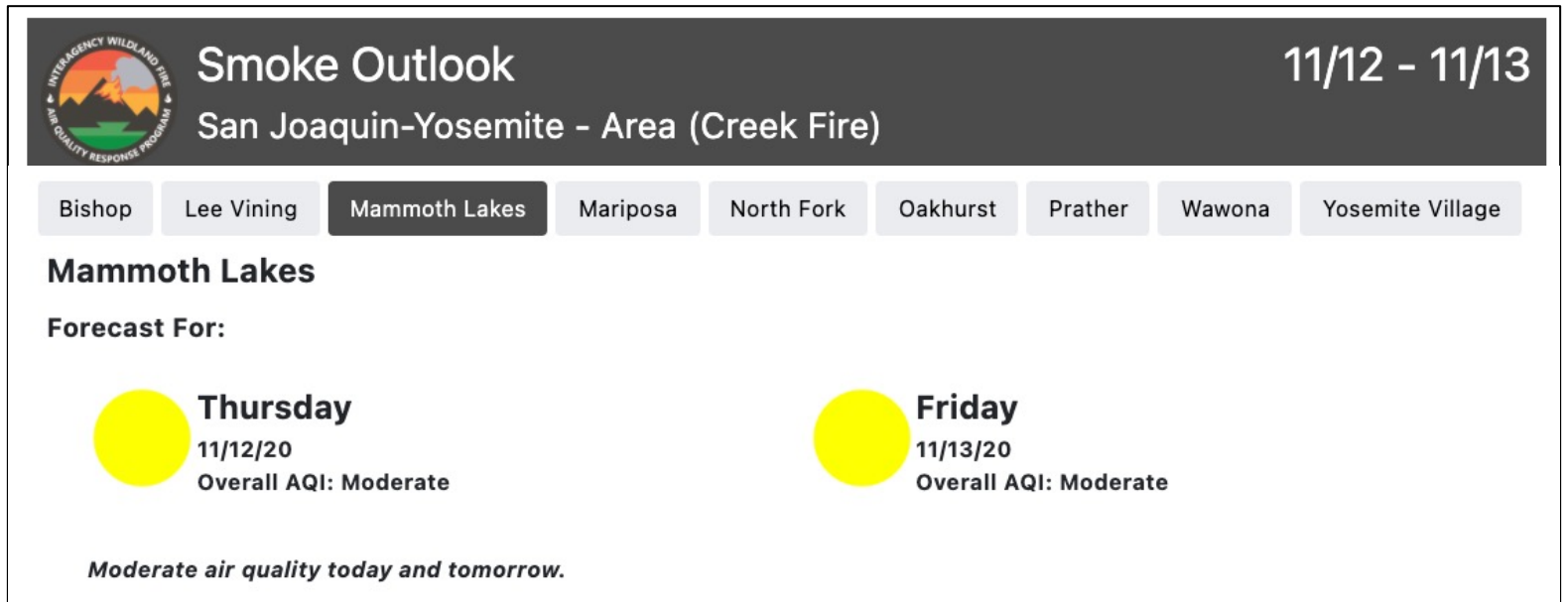


Special Smoke Statements

- If applicable to your location, alert will appear:



- Accesses outlooks created by specialists with info on fires, smoke:



Data Considerations / Challenges

Timeliness:

- Different monitors and sensors have different lag times before the data is available

Time Averaging:

- There is a tradeoff and tension between displaying rapidly changing shorter time averages and having longer time averages that are better related to health impacts

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Time Averaging:

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Consistency:

- Low-cost sensors are more likely to be moved, turned off, or have other inconsistencies
- Quality assurance and correction required for sensor data to match permanent / temporary monitors

Air Quality Observation Colors

(symbols are filled in with the appropriate color)

- We show colors based on the measured NowCast AQI level
  - NowCast is a time average
- Levels relate to the Air Quality Index (AQI) color scale:

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Gray indicates data is missing (or failed quality assurance steps)

More details: https://www.airnow.gov/aqi/aqi-basics/using-air-quality-index/

Symbology of Air Quality Observations

(based on type of device)

PERMANENT MONITOR
(circle)

Example: Permanent Site
(Jefferson Co., AL)

TEMP MONITOR
(triangle)

~6ft

Example: E-BAMS

~4in

Example: Purple Air PA-II

LOW-COST SENSOR
(square)

Photos: Jefferson County Public Health, MetOne, Purple Air

Symbology of Air Quality Observations

(based on type of device)

PERMANENT MONITOR
(circle)

+ Higher quality
+ Professionally sited
+ Professionally maintained

- Higher cost
- Limited in number
- May be slow to report

TEMP MONITOR
(triangle)

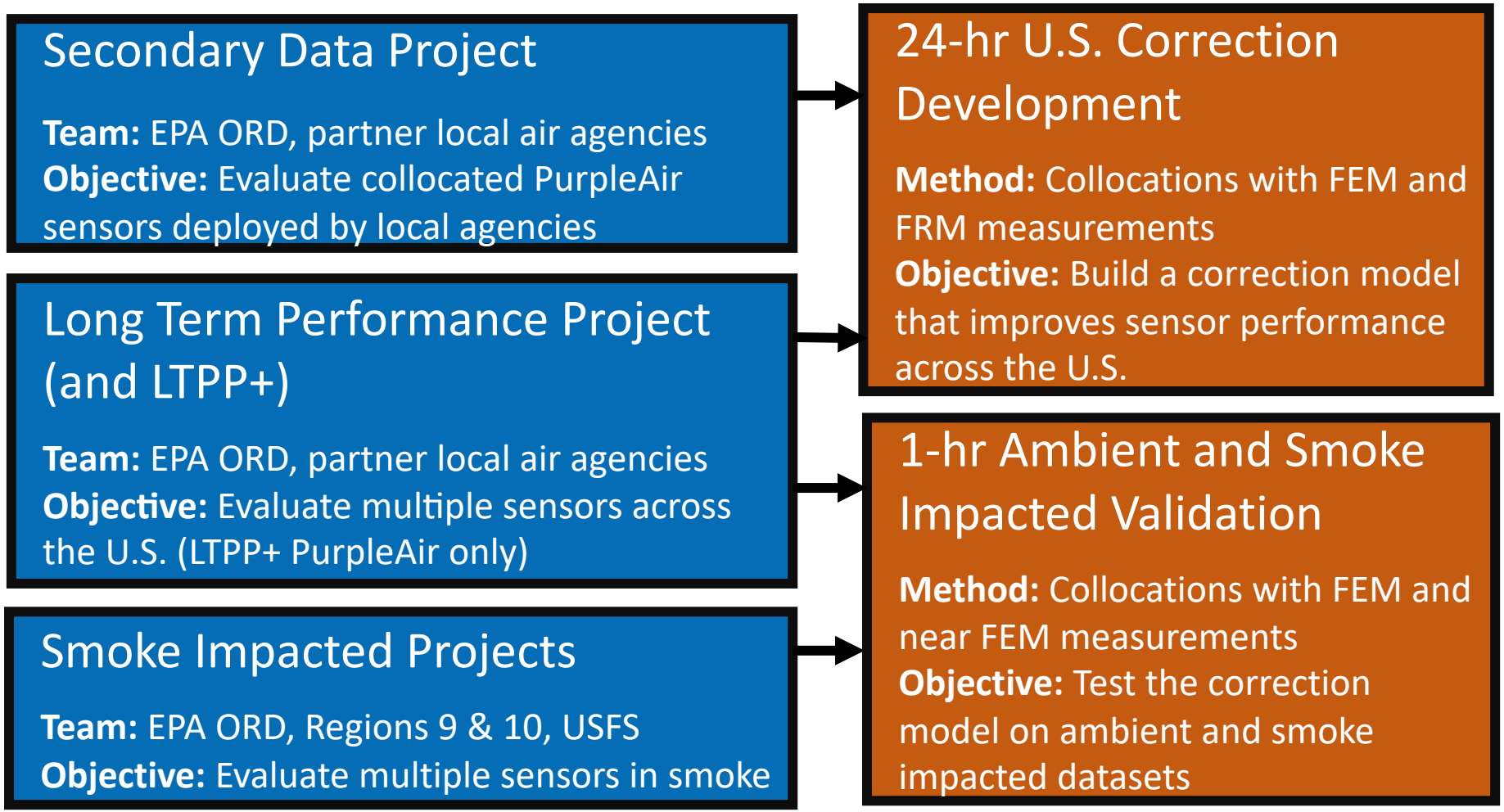
LOW-COST SENSOR
(square)

+ Lower cost
+ 7x number of permanent sites
+ Reports quickly

- Unknown siting
- Unknown maintenance
- Need for more data qa/qc

Steps to Quality Assure and Correct PurpleAir data

Research Efforts enabling the sensor data correction AirNow sensor data pilot



FEM=Federal Equivalent Method
FRM=Federal Reference Method

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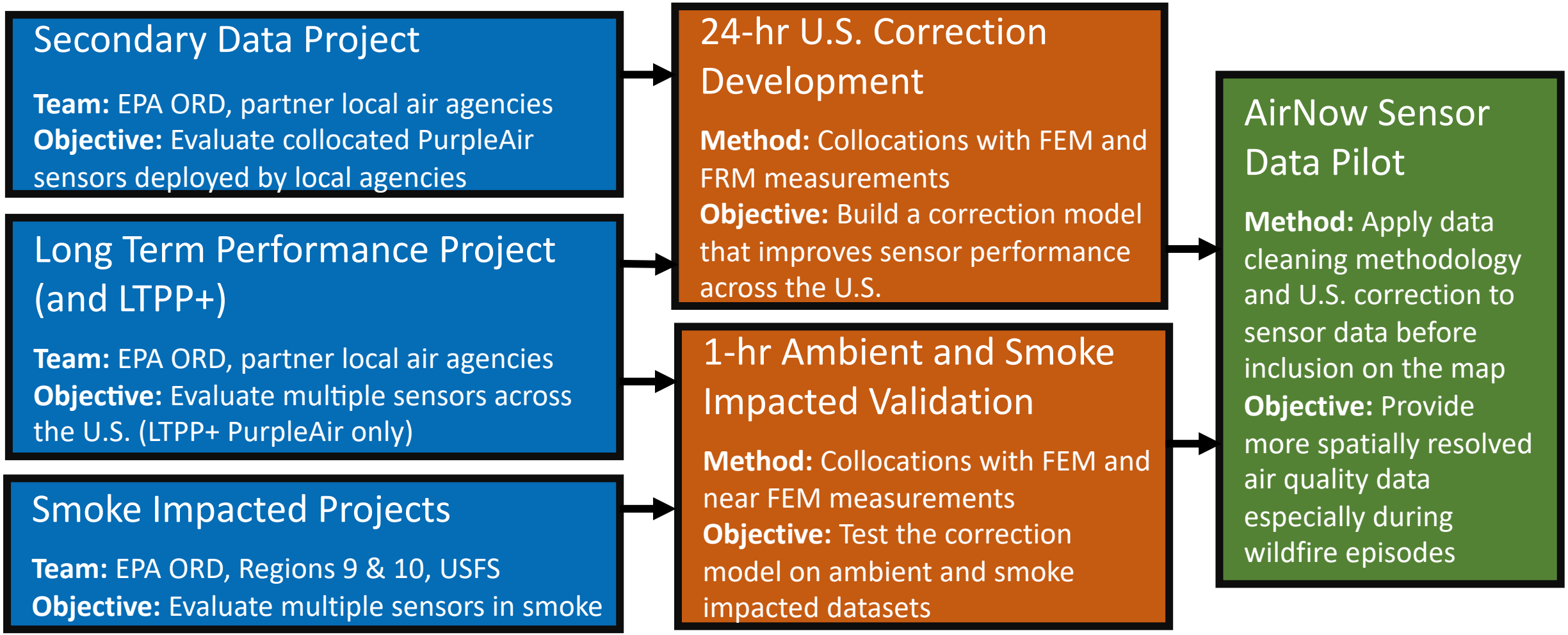
Research Efforts enabling the sensor data correction AirNow sensor data pilot



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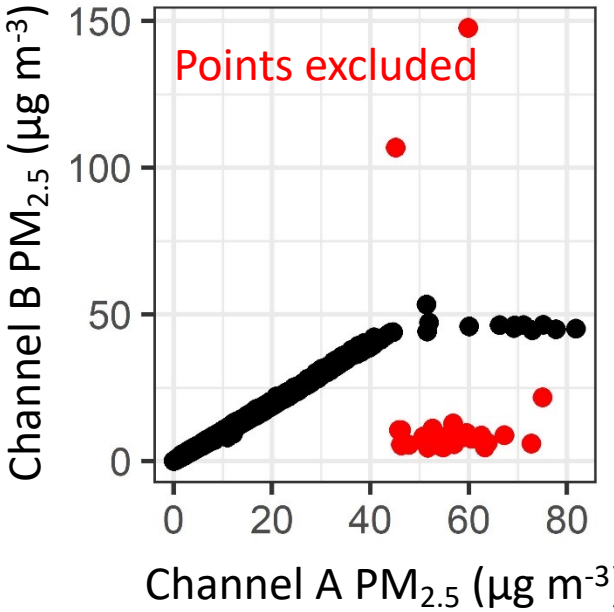
Steps to display PurpleAir data on the Pilot

Cleaning steps

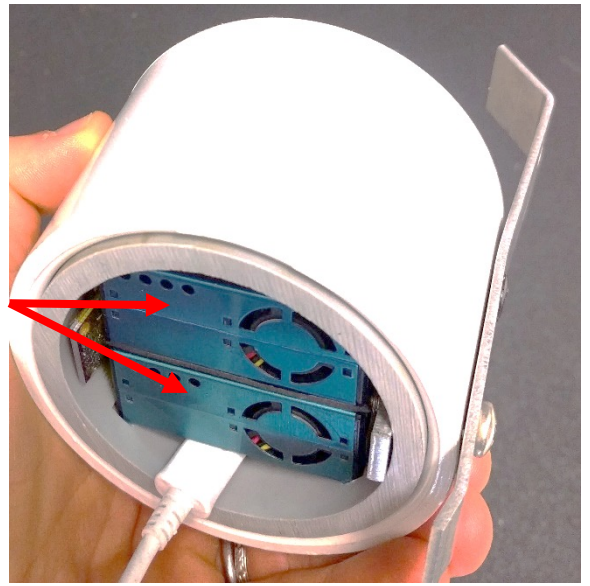
1. Only outdoor sensors selected
2. Average PurpleAir $PM_{2.5}$ and RH data to 1-hour
3. Clean the data; Remove data when channels differ by ≥ ± 5 µg m^{-3} and ≥ ± 70%

Hourly data with sensor failure



70% is a compromise removing the worst offending points but leaving some questionable increasing data availability

A & B channels



PurpleAir underside view

Steps to display PurpleAir data on the Pilot

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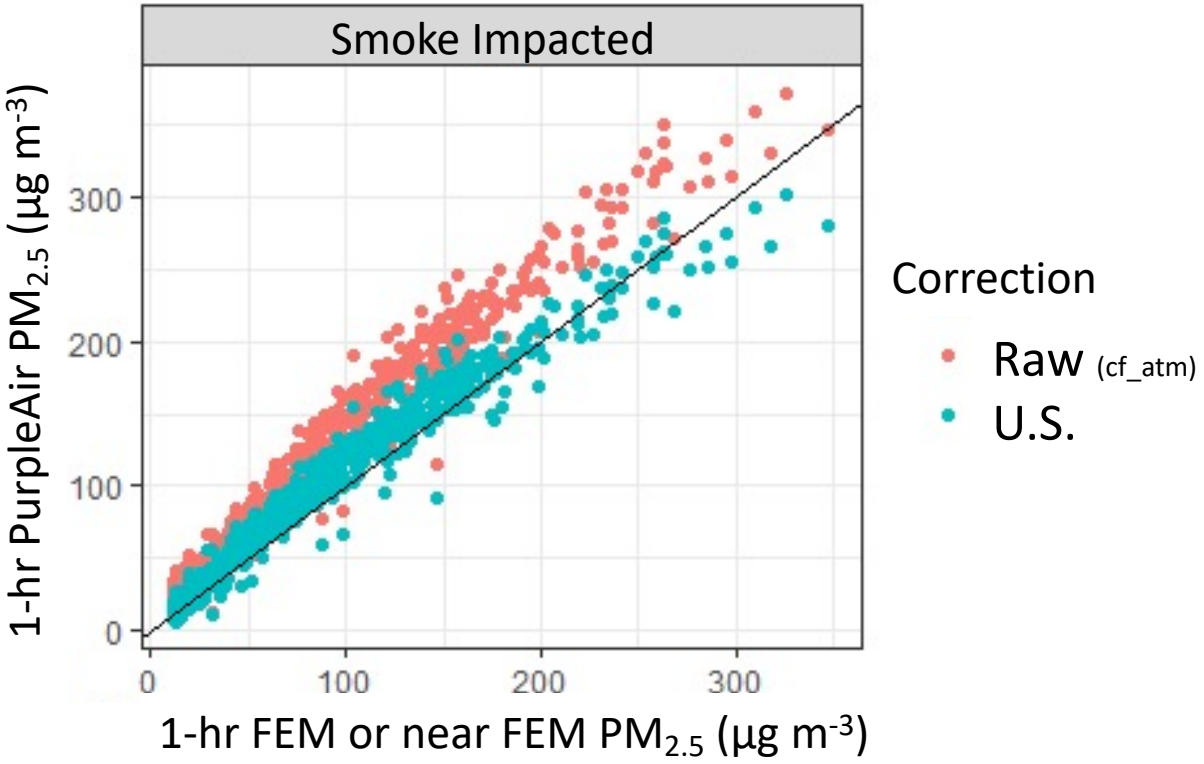
4. Average A & B channels
5. RH removed if outside 0-100%, if removed or missing replace with 50%
6. Apply U.S.-wide correction equation to **1-hr data**



$PM_{2.5}$ corrected=
$0.524*[PurpleAir_{CF=1;\ avgAB}] - 0.0852*RH + 5.72$

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6. Apply U.S.-wide correction equation to **1-hr data**
7. **Calculate the NowCast AQI**

The Air Quality Index	
Index Values	AQI Category
0 - 50	Good
51 - 100	Moderate
101 – 150	Unhealthy for Sensitive Groups
151 – 200	Unhealthy
201 – 300	Very Unhealthy
301 –500	Hazardous

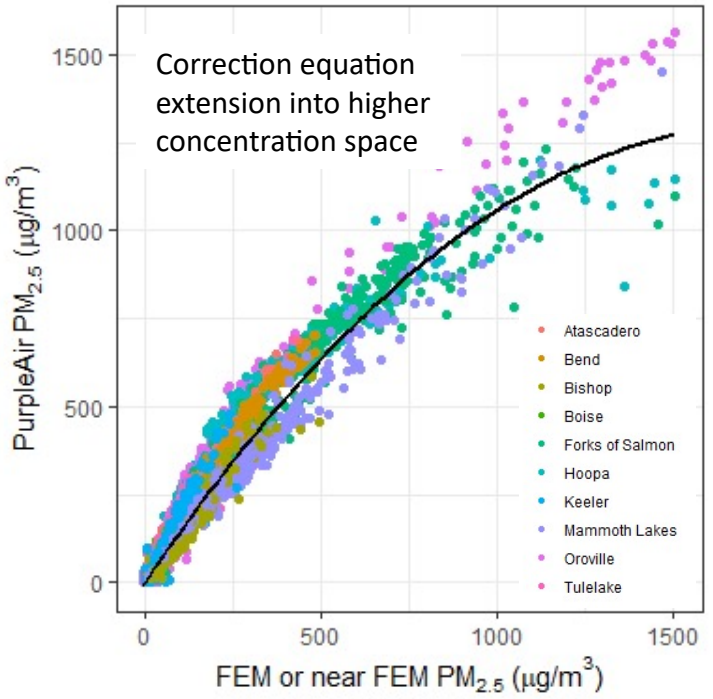
Traditional AQI: 24-hr averages
NowCast: Weighted 12-hr rolling average

- Heavily weighted to recent hours under rapidly changing conditions
- Balances:
  - Need for real-time data
  - Measurement uncertainty
  - Uncertainty in health effects

Image: Airnow.gov

Next steps

- **Finalize and apply an updated correction equation** to extend the applicable concentration range using newly available data
  - During 2020 wildfires, new *very high* concentration collocation data from CA and OR was collected



Resources

Additional resources and details about EPA's work with air sensors
(including webinars/presentations/conference presentations on this effort)

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

AirNow Fire and Smoke Map:

https://fire.airnow.gov/

Project Publications:

- Holder, A., A. Mebust, L. Maghran, M. McGown, K. Steward, D. Vallano, R. Elleman, and K. Baker, 2020. 'Field Evaluation of Low-Cost Particulate Matter Sensors for Measuring Wildfire Smoke', Sensors. https://www.mdpi.com/1424-8220/20/17/4796
- Barkjohn (Johnson), K, B. Gantt, A. Clements, 2020 'Development of a United States Wide Correction for PM2.5 Data Collected with the PurpleAir Sensor', Atmospheric Measurement Techniques Discussion. https://doi.org/10.5194/amt-2020-413
- Barkjohn (Johnson), K, A. Holder, S. Frederick, A. Clements, (in preparation) 'PurpleAir PM2.5 U.S. Correction and Performance During Smoke Events'.

Thank you!

More Information:

Karoline (Johnson) Barkjohn
johnson.karoline@epa.gov

Sim Larkin
sim_larkin@firenet.gov