July 29, 2024

AirNow Fire & Smoke Map: Building Trust in Air Quality Sensors
National Ambient Air Monitoring Conf.   August 2024

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Building Public and Government Agency Familiarity & Trust in Air Quality Sensors

- A decade ago, air quality sensors did not have much of a track record and there were many questions about their potential

- Now, the AirNow Fire & Smoke Map (FASM) has roughly 15,000 $PM_{2.5}$ air quality sensors
  - They provide additional $PM_{2.5}$ air quality information for the public to use to protect their health during wildfire and smoke events in near-real time
  - For this non-regulatory purpose, we treat them as being supplemental sources of air quality information to permanent monitors for the public to use

- The number of $PM_{2.5}$ sensors reporting data on FASM more than doubled since its release in August 2020

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Review purpose of AirNow Fire and Smoke Map

- Two primary goals:
  - Provide additional $PM_{2.5}$ air quality information for the public to use to protect their health during fire and smoke events in near-real time

  - Provide greater spatial coverage of observations by including data from permanent monitors, temporary monitors, and sensors in a consistent, scientifically-based format ("apples-to-apples" comparison)
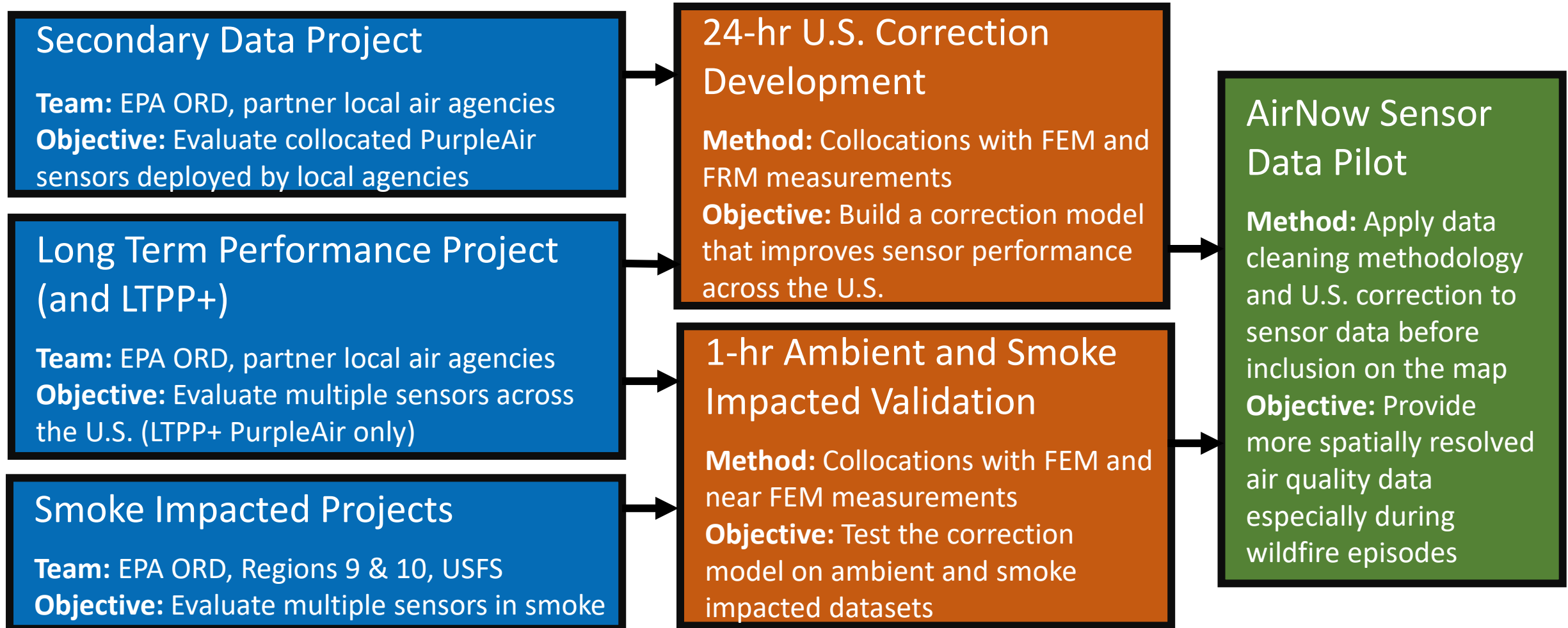
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Usage since release in August 2020

- Heavy usage
  - Nearly 53 million page views since initial release
    - Roughly 8 to 10% viewed on AirNow app
  - Over 13 million June through August 2023
- Significant increase in number of sensors
  - Roughly 7,500 for initial release
  - roughly 15,000 currently, including 1,000 in Canada
- Spanish version
  - Released in September 2022
  - plan to increase outreach with release of Version 4 final

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Building familiarity and trust is a process

- Key design principle:
  - Provide greater spatial coverage of air quality observations by including data from permanent monitors, temporary monitors, and sensors in a consistent, scientifically-based format ("apples-to-apples" comparison)
- Before release of the map:
  - EPA ORD worked with air agency partners to collocate sensors for performance testing and to develop a data correction approach
  - EPA ORD established a collaborative agreement with PurpleAir to support Agency use of public-facing data for research and applications
  - EPA and USFS worked closely with State, Local and Tribal agencies to provide them with the time to review and provide comments on the design of FASM

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Research Efforts enabling the sensor data correction AirNow sensor data pilot

Secondary Data Project

Team: EPA ORD, partner local air agencies
Objective: Evaluate collocated PurpleAir sensors deployed by local agencies

Long Term Performance Project (and LTPP+)

Team: EPA ORD, partner local air agencies
Objective: Evaluate multiple sensors across the U.S. (LTPP+ PurpleAir only)

Smoke Impacted Projects

Team: EPA ORD, Regions 9 & 10, USFS
Objective: Evaluate multiple sensors in smoke

24-hr U.S. Correction Development

Method: Collocations with FEM and FRM measurements
Objective: Build a correction model that improves sensor performance across the U.S.

1-hr Ambient and Smoke Impacted Validation

Method: Collocations with FEM and near FEM measurements
Objective: Test the correction model on ambient and smoke impacted datasets

AirNow Sensor Data Pilot

Method: Apply data cleaning methodology and U.S. correction to sensor data before inclusion on the map
Objective: Provide more spatially resolved air quality data especially during wildfire episodes

FEM=Federal Equivalent Method
FRM=Federal Reference Method

Prior to PurpleAir sensor data appearing on FASM several QA steps happen

- FASM team gets sensor manufacturer QA'ed data stream via a PurpleAir API
- Prior to the data appearing on FASM, it goes thru several cleaning steps

Cleaning steps

1. Only outdoor sensors selected
2. Average PurpleAir $PM_{2.5}$ and Relative Humidity (RH) data to 1-hour
3. Clean the data; Remove data when channels differ by $\geq \pm 5$ µg m^{-3} and $\geq \pm 70\%$
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 (has been updated since initial FASM release)

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FASM has been updated and upgraded since 2020

- We released FASM as a pilot in August 2020, not knowing what the acceptance would be.

- As previously indicated, it is recognized as the go to resource for the public for wildfire smoke air quality information and recommendations on how to protect their health based on the EPA Air Quality Index (AQI) and AirNow program

- Over the past few years, we have released 2 other FASM versions, each time improving the clarity and quality of the air sensor data. For example:
    - A few updates to the correction equation
    - Improvements to the user interface
    - Adding a Spanish language version
    - Adding a color assist button to improve the readability of the map for color-blind individuals

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Updates

- Version 4 has an updated look and feel, English and Spanish editions
- Beta released to public on July 17th, about a quarter of total views are beta version currently
- More "at a glance" information about your location
  - A consistent approach whether you are on a computer or mobile device
- Some new and updated features
  - Much faster loading
  - An indication when ozone or PM10 are the controlling pollutant
  - More explanatory information when a user digs down
  - Better fire information display
- Other underlying features (e.g. correction equation) remain unchanged

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Re-styled monitor and sensor symbology

12 Permanent Monitors

T Temporary Monitors

Air Sensors

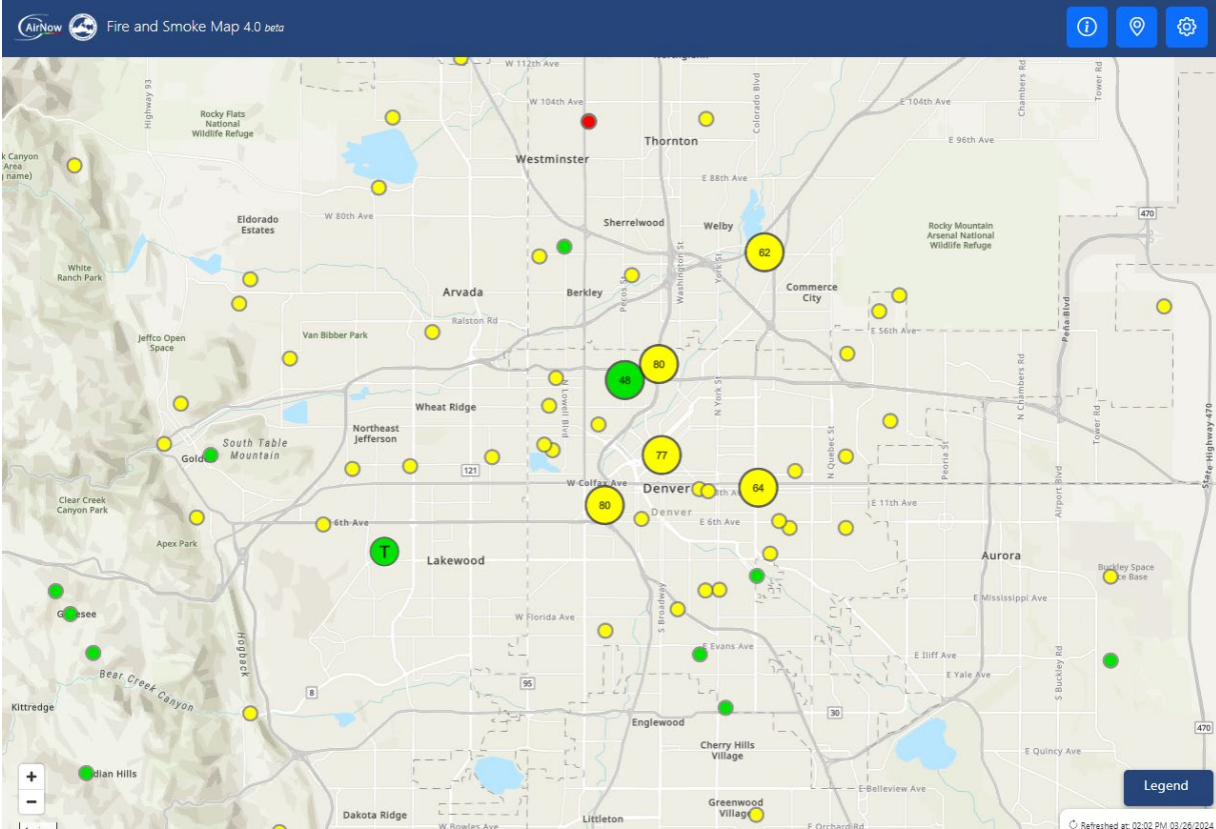Number one comment on beta,
bring back Circles, Triangles and
Squares.
O   technical challenge
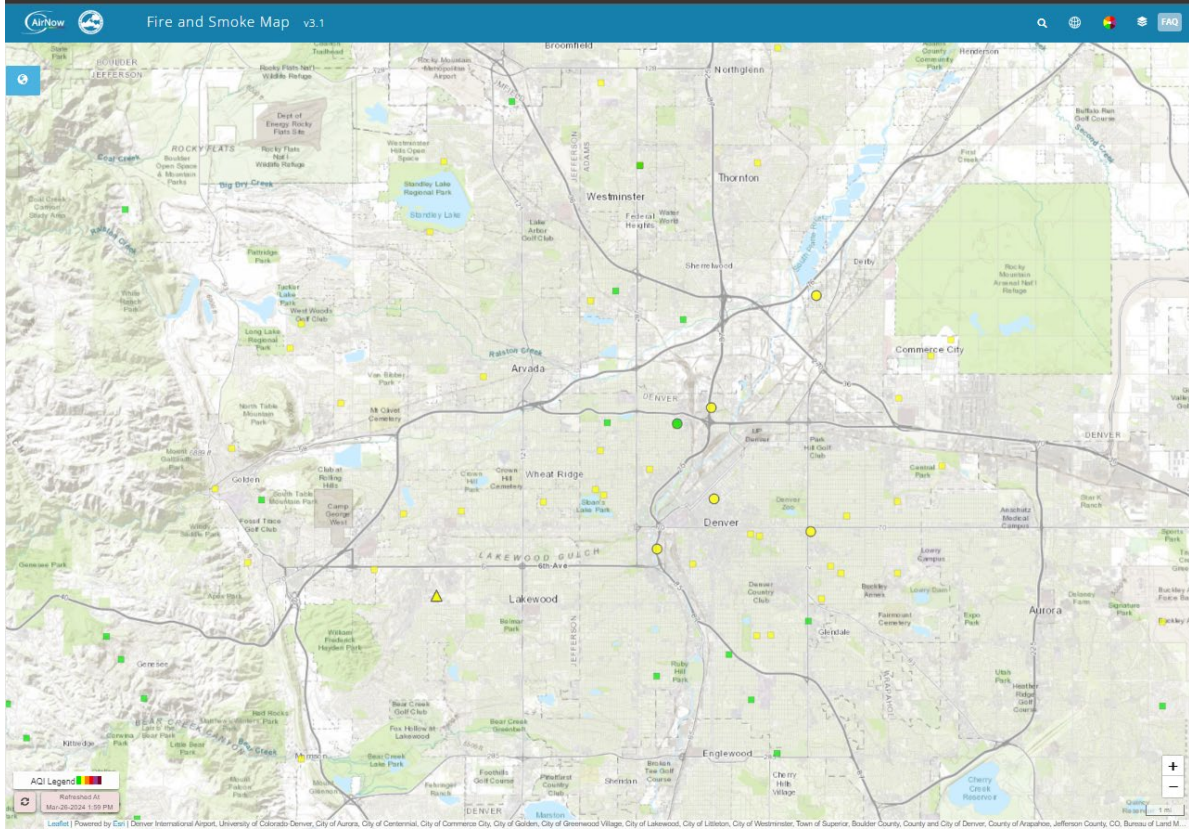O   policy considerations
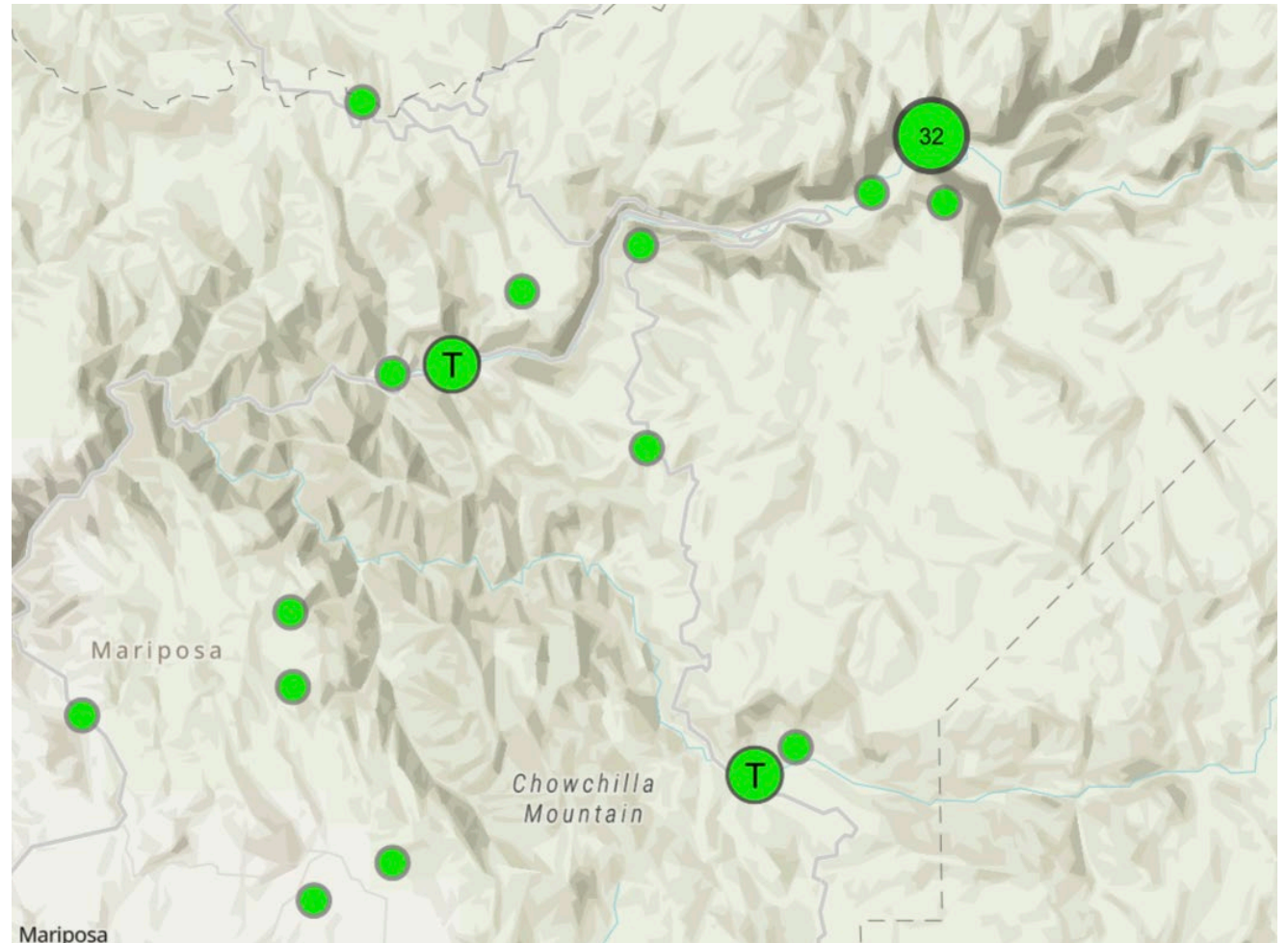
Comparison of FASM Version 4 and Version 3: Denver CO March 26, 2024

Version 4
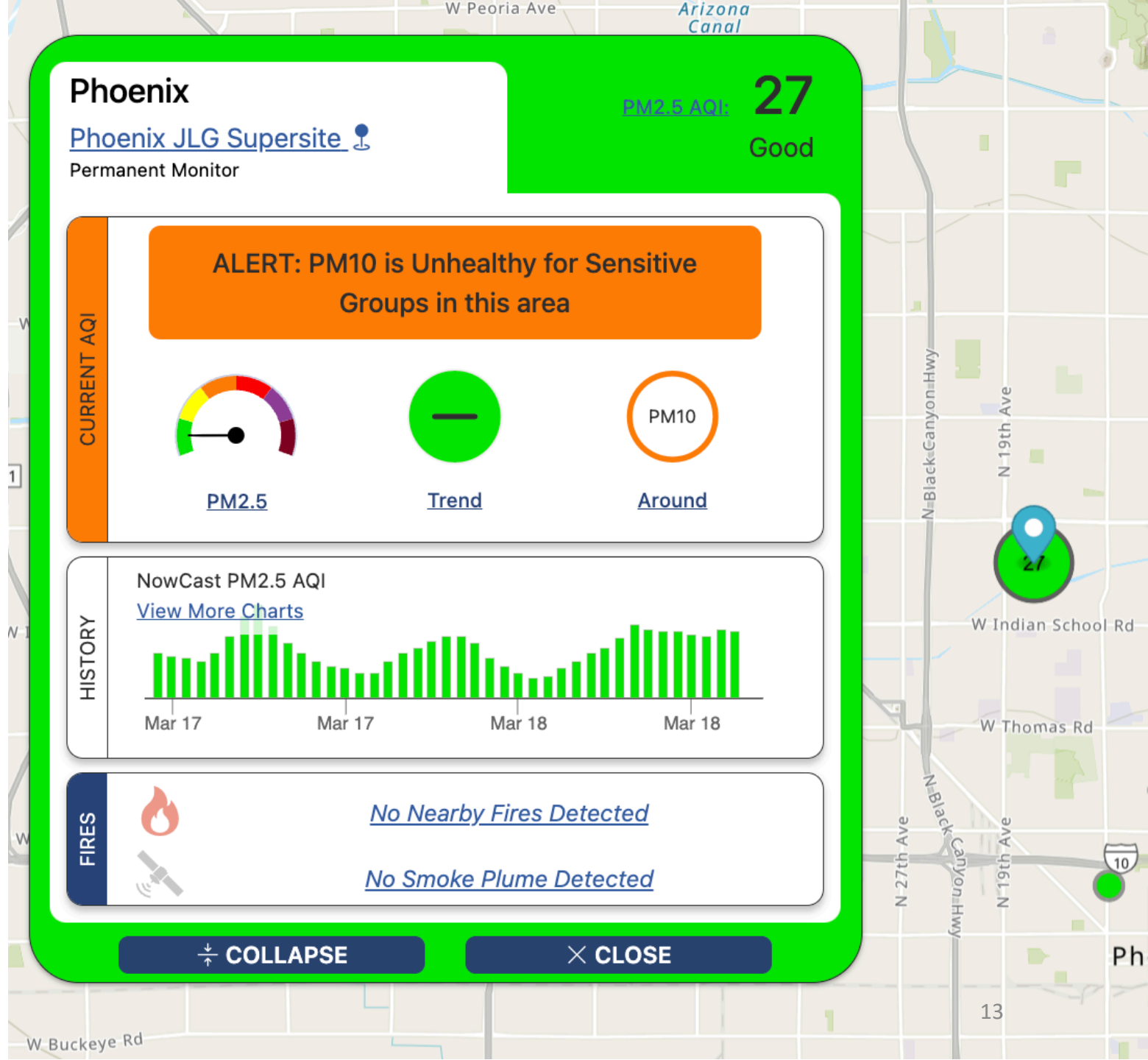
Version 3

zoom level 1 mile

New Features in v4

- Canadian sensor coverage expansion, added about 1,000
- *Around* function
  - Other nearby PM2.5 measurements
  - PM10 / Ozone impacted locations
- Sensor Outlier detection
- Heat*
  - Excessive Heat Warning / Heat Watch locations

*coming soon

Around function and Alert for O3/PM10 Example

(PM10 shown)

Updating and Improving the Quality

- Underlying science features (e.g., correction equation) remain unchanged

- Beginning in Version 3 we started including steps to remove sensors which were clearly problematic (e.g., $PM_{2.5}$ levels remained constant over hours or days)

- Version 4 will start testing approaches to automatically detect potentially malfunctioning or mislocated sensors . However, since $PM_{2.5}$ levels can vary significantly over a small distance we will proceed cautiously their implementation

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Success in building familiarity & trust in air quality sensors

- Through a variety of ways, air quality sensors, in particular for $PM_{2.5}$, have gained familiarity and trust by the public and government agencies

- FASM was considered and released to provide a forum for sharing air quality sensor and monitor data side by side

- For this non-regulatory purpose, we treat them as being supplemental sources of air quality information to permanent monitors for the public to use to protect their health during wildfire smoke events

- Scientific credibility & transparency are paramount for familiarity and trust

- We will continue to update and improve FASM
  - For example, we are running a pilot process on how to qualify sensors from other manufacturers to FASM including transparent criteria and rationale

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Thank you!

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