U.S. EPA STAR Grant

Engage, Educate and Empower California Communities
on the Use and Applications of Low-cost Air Monitoring Sensors

During-the-Deployment Workshop

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

(Conducted December 2018 – April 2019)

Main Objective

Provide communities across California with the knowledge necessary to <u>appropriately</u> select, use, and maintain “low-cost” sensors and to correctly interpret the collected data

Specific Aim #1

Develop new methods to engage, educate, and empower local communities on the use and applications of "low-cost" sensors

Best practices for…

- Sensor deployments
- Data collection
- Data analysis and interpretation
- Next steps: communicating results, planning outreach, developing mitigation strategies

Recruit local communities to help inform toolkit materials through in-person meetings as well as survey on their knowledge and perception of sensors

↓

Draft guidebook, training videos, and data collection checklist

↓

Share draft toolkit with community members and survey them regarding sensor use to assess if their interaction and perception of sensors has changed

↓

Revise toolkit materials based on community feedback

Specific Aim #2

Conduct field and laboratory testing to characterize the performance of commercially-available "low-cost" sensors and to identify candidates for field deployment

- Field Testing:
  - Sensor tested in triplicates
  - Two months deployment
  - Comparison with FRM/FEM instruments
  - Testing performed at a fixed monitoring station

- Laboratory Testing:
  - State-of-the-art characterization chamber
  - Particle and gas testing
  - T and RH controlled conditions

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Specific Aim #3

Deploy the selected sensors in multiple California communities and perform a thorough validation and interpretation of the collected data

Specific Aim #4

Communicate the lessons learned to the public and organize outreach activities

Disseminate study results and help answer these key questions:

- ✓ Which tools will be most successful in educating communities to effectively use air monitoring sensors and to engage them in using sensor data?
- ✓ Will a community more likely take action to reduce air pollution exposure when sensors and sensor data are made readily available?
- ✓ Which sensors are the most suitable for community use?
- ✓ How does sensor data quality change with time after sustained use by communities under “real-world” conditions?
- ✓ How do sensor data compare (spatially and temporally) to that of existing monitoring networks?
- ✓ What value is added by these sensors that we are not getting with current network data?

PurpleAir Sensors & Feedback

Example Community PM Sensor Network

- 28 sensors installed

Any Feedback on the Following…

- Issues installing or running the sensors?
- Issues accessing/understanding the data?
- Is there any information/training that you feel would help you to make better use of the sensors?
- Are there any questions they would like to know how to answer using the sensors? Or would like to try to answer using sensor data?

Sensor Installation/Non-Installation e-Survey

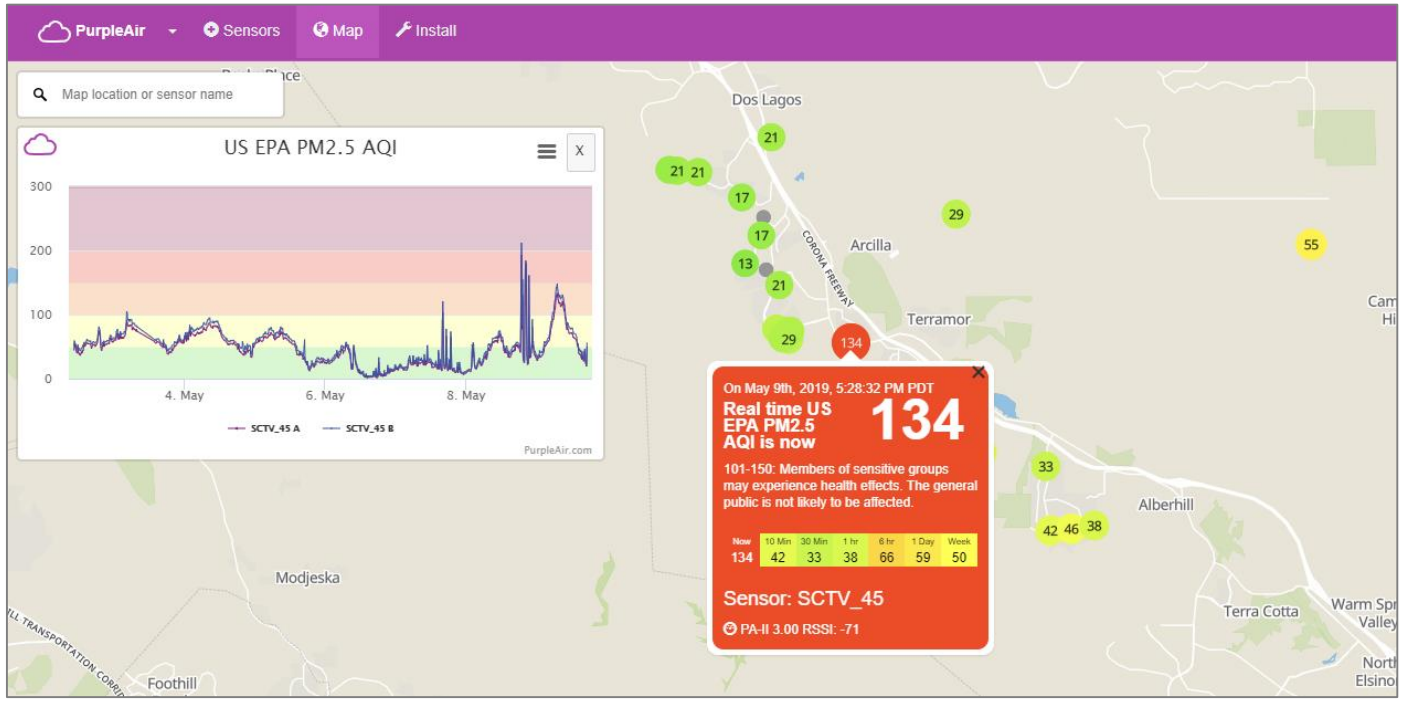
The Science To Achieve Results (STAR) Grant team at the South Coast AQMD would like to thank you for your participation in the project entitled, " Engage, Educate and Empower California Communities on the Use and Applications of "Low-cost" Air Monitoring Sensors" and to invite you to participate in this very brief online survey about your sensor installation location. Completing this survey with a smart device with a camera will allow you to easily submit a picture.

Installation Survey

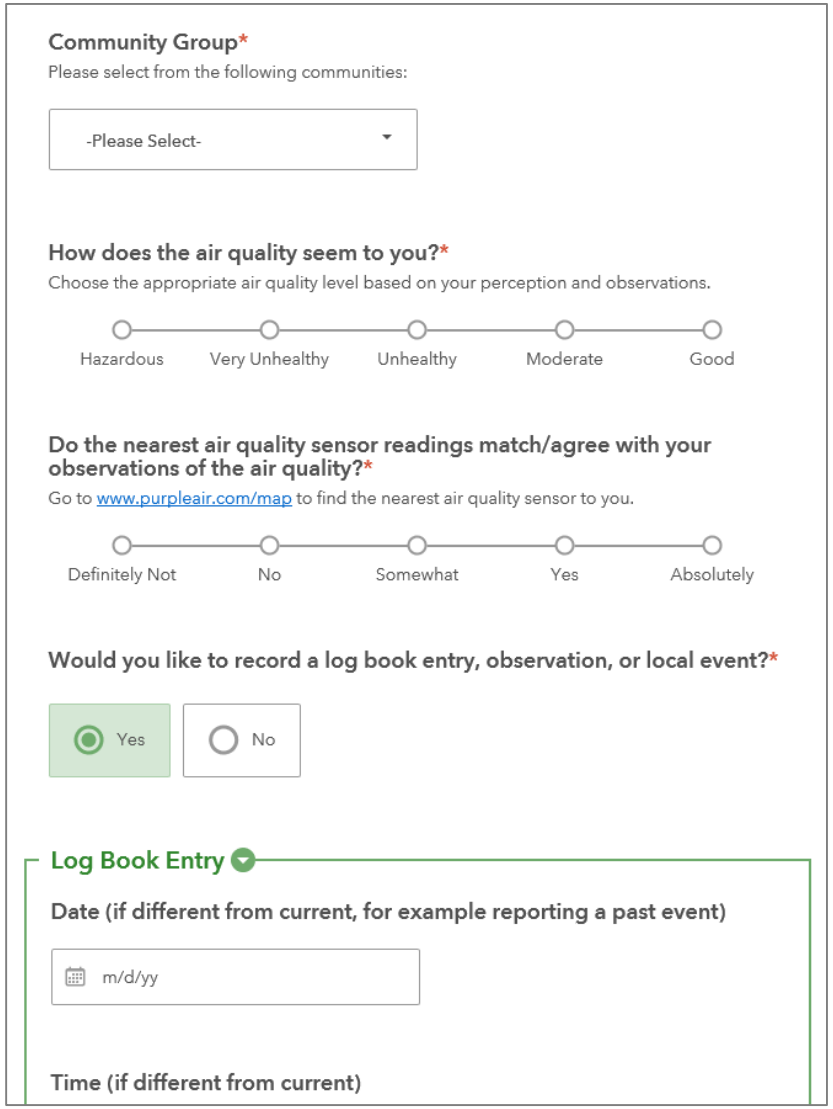
Moving forward, please keep an eye out for upcoming community group meetings, an email containing the electronic log note entry form, and changes for end user data visualization and accessibility!

Log-book e-Survey – Adding Context to the Data

[Purple Air Map Link]



(also available as a hard copy)



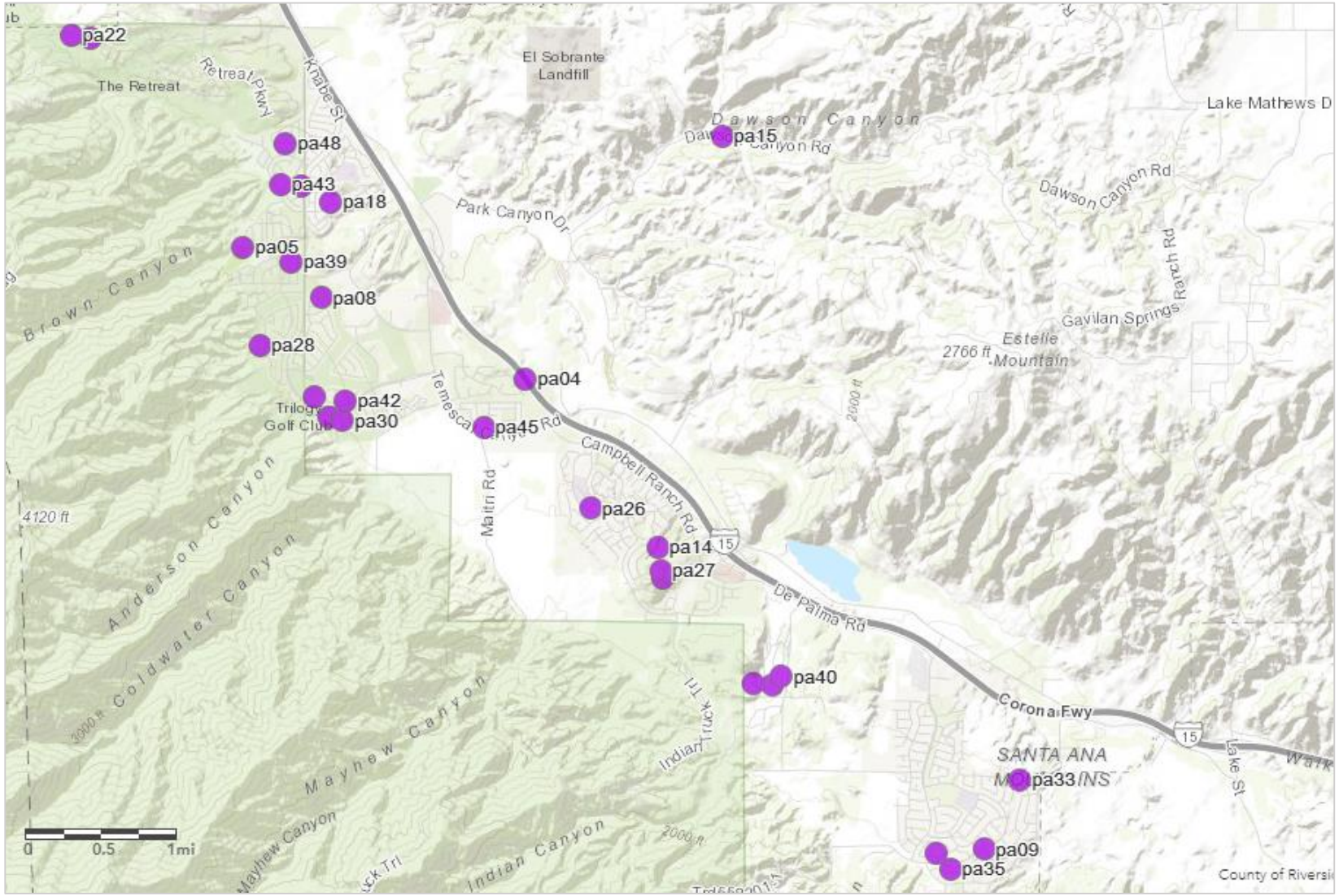
Any observations by the community?

Sensor Data

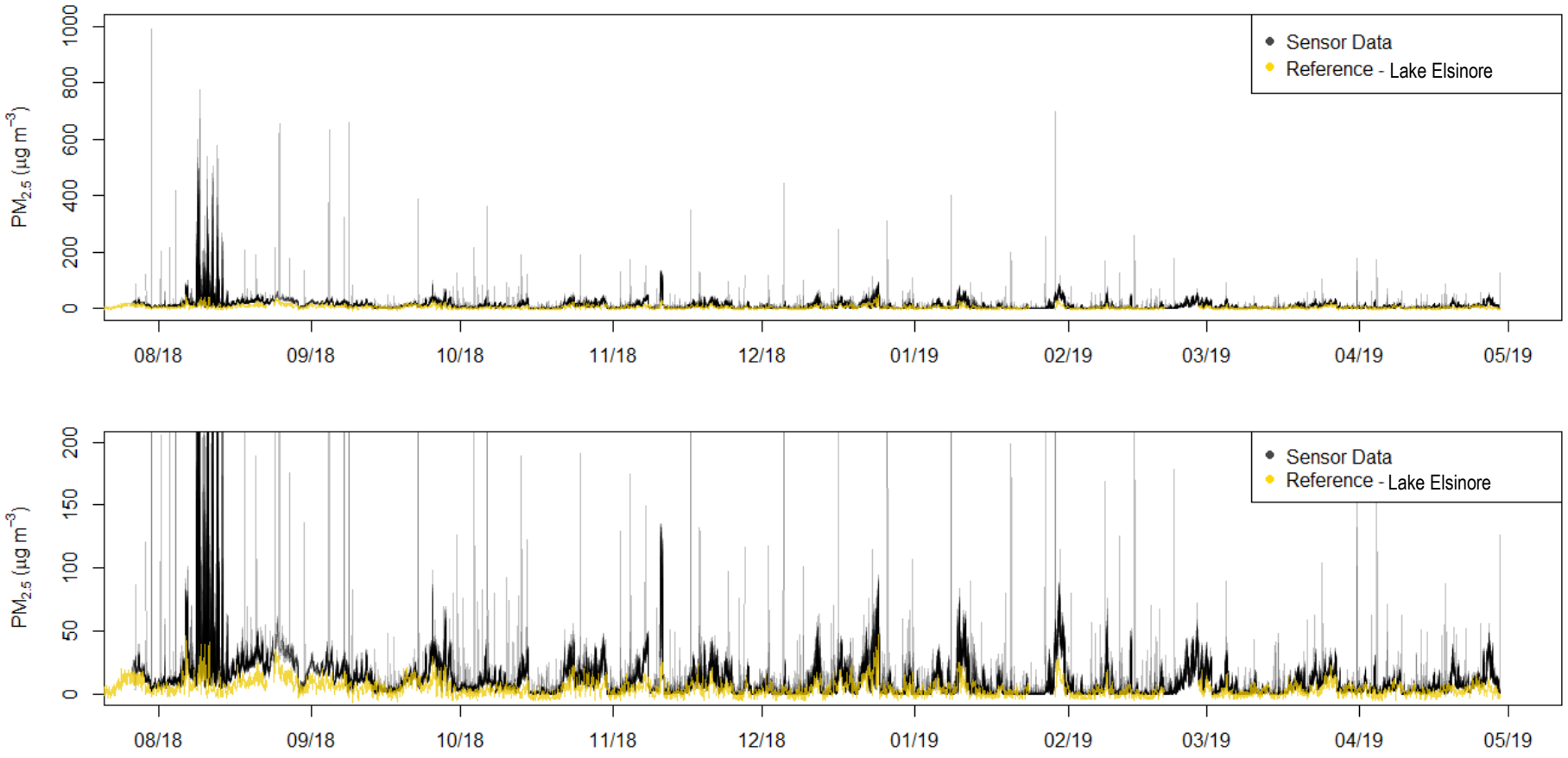
What can we do with this data?

- Assess spatial and temporal variability
- Compare regional and local trends across network
- Evaluate impact of wind speed & wind direction
- Determine when particle or gas pollution is high/low
- Identify potential nearby pollution sources

Map of Sensor Locations



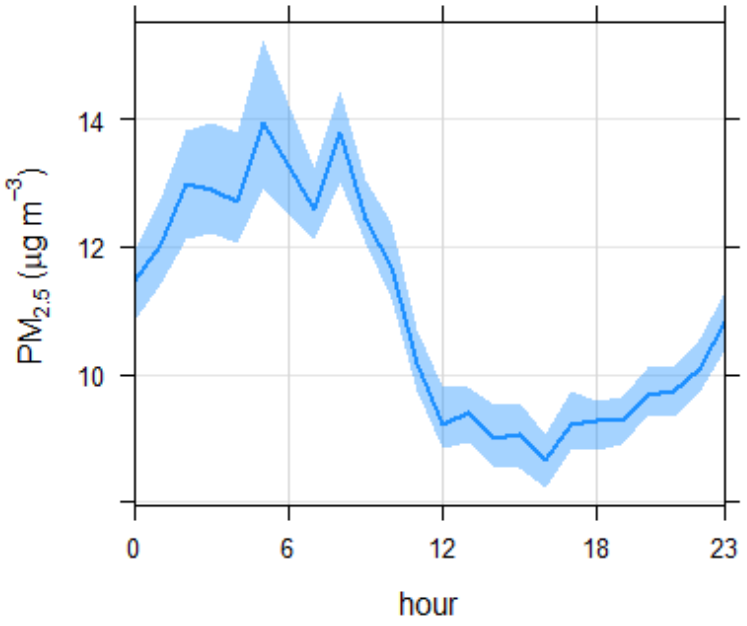
Example Analysis – Complete Sensor Data

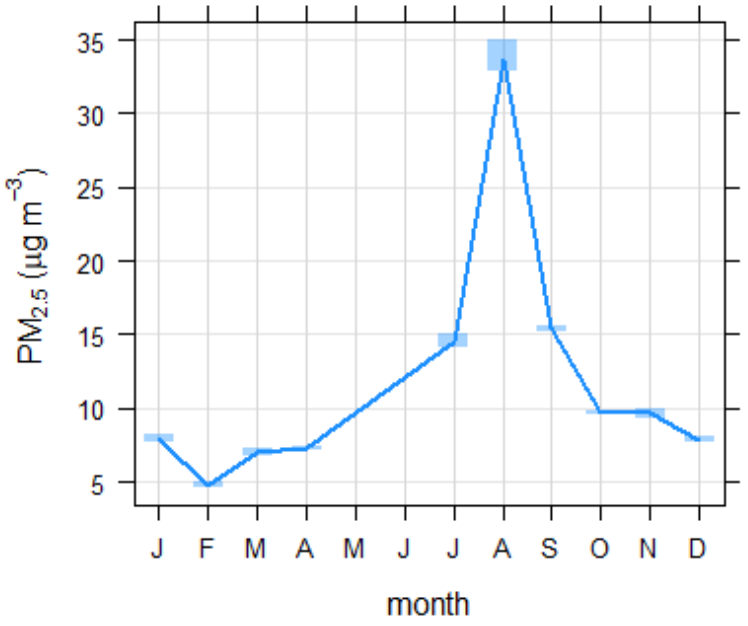


- All sensors plotted together
- Darker indicates overlapping, lighter indicates a single sensor signal

Example Analysis – Temporal Trends

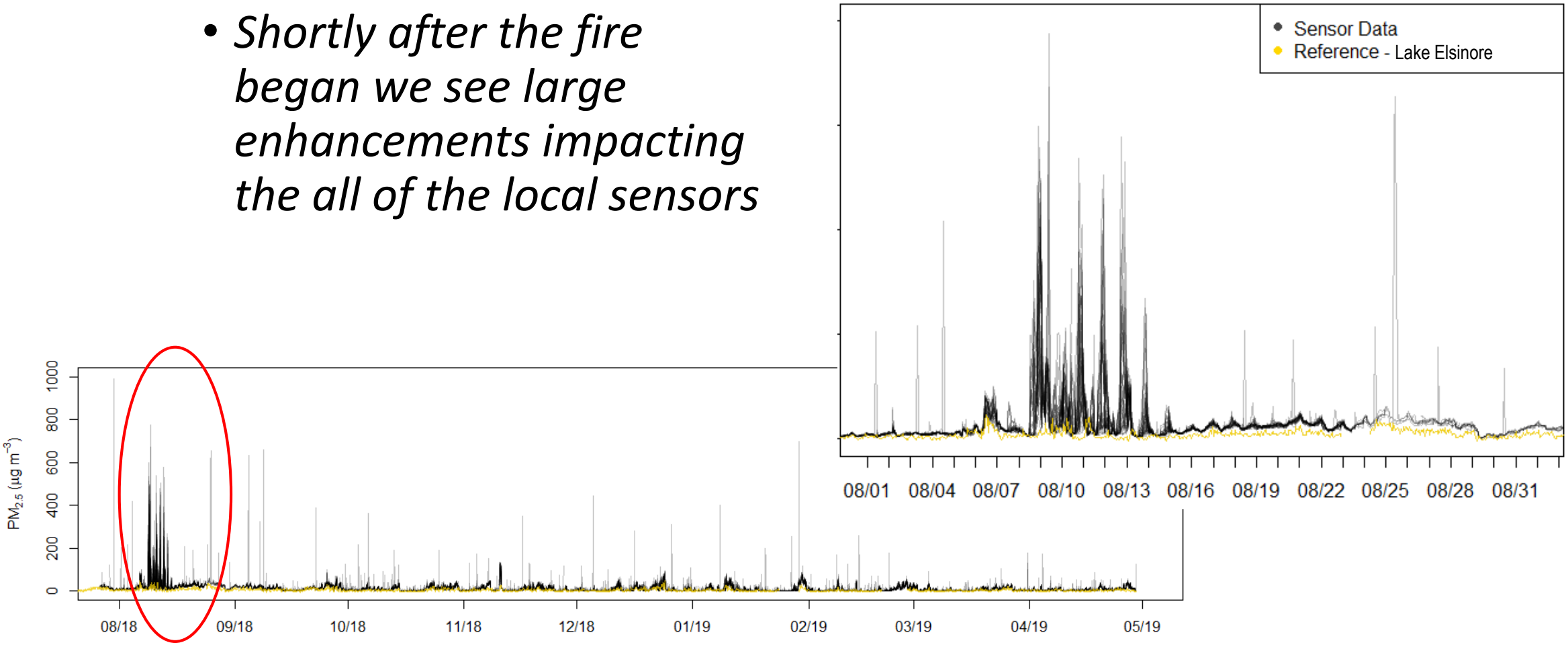
- On average, higher PM at night and lower during the day
  - Expected trend – driven by daily fluctuations of the “planetary boundary layer”
- Also, the averages for each month are similar, with the exception of August where it is much higher average





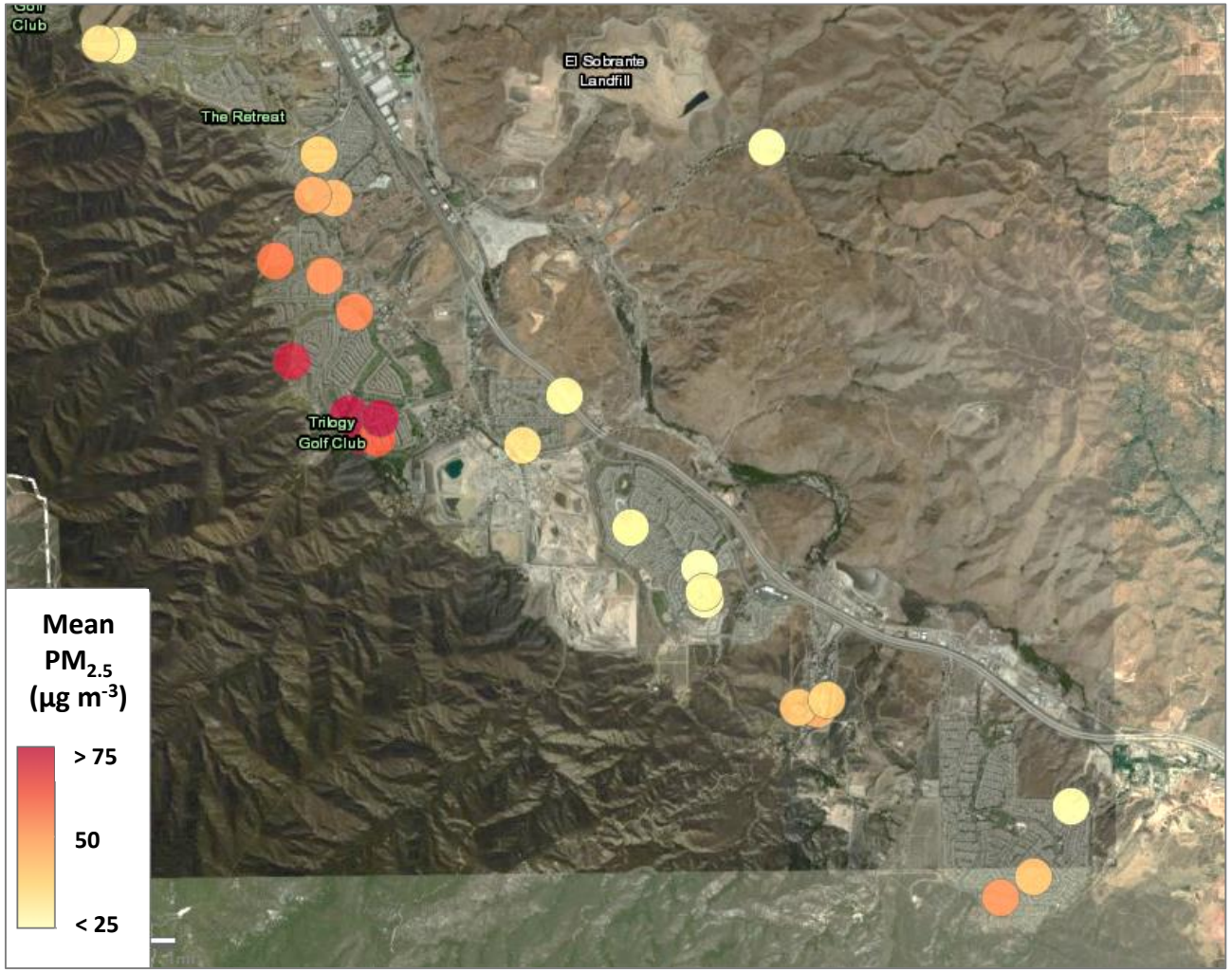
Example Analysis – Impacts from a Nearby Wildfire

- *Shortly after the fire began we see large enhancements impacting the all of the local sensors*



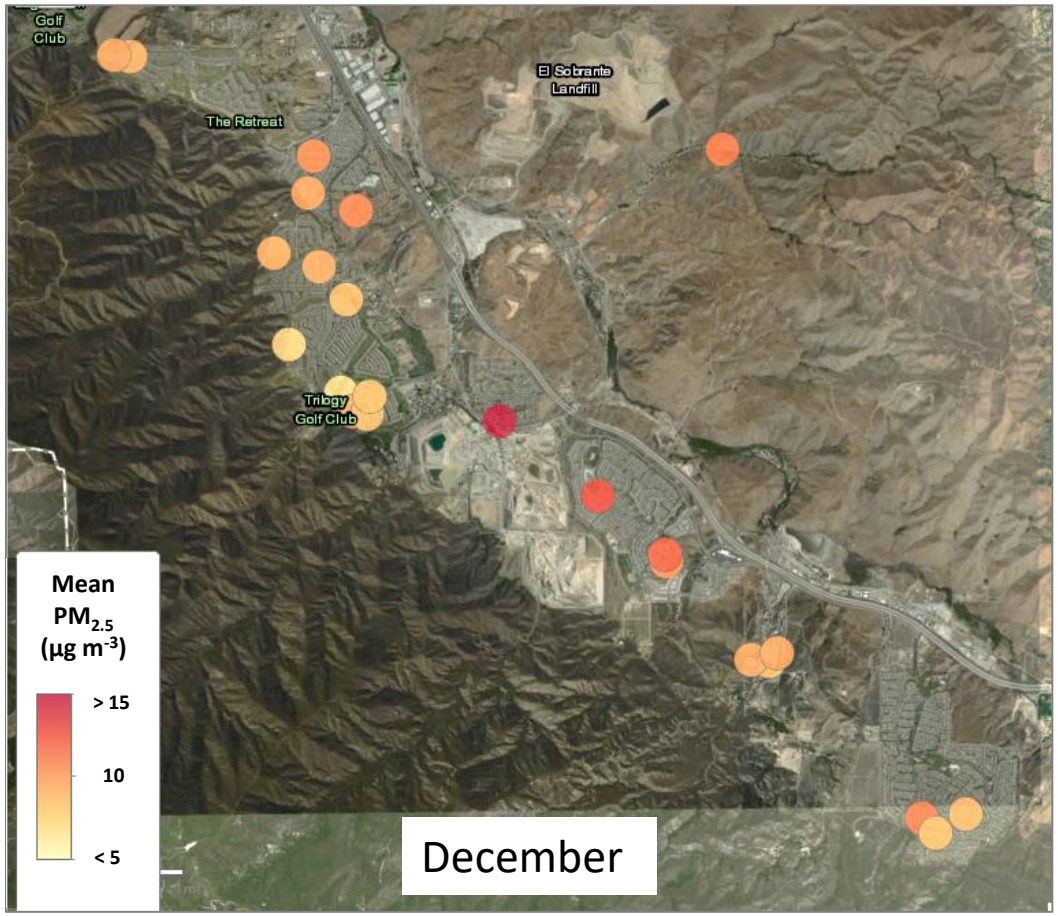
Example Analysis – Impacts from a Nearby Wildfire

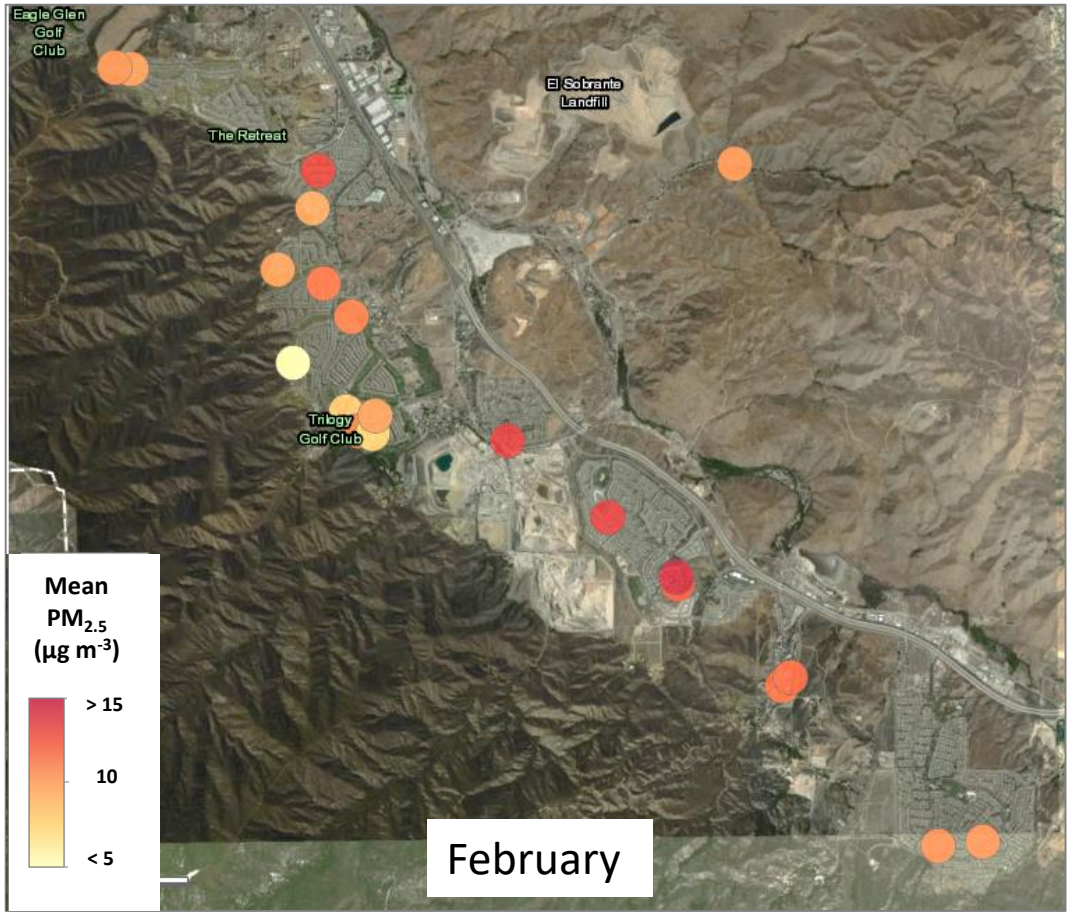
- Average for each site from 8/8/18 – 8/15/18
- Average for all sites is relatively high
- There is also a clear gradient with some sites seeing higher peaks than others



Example Analysis – Comparisons

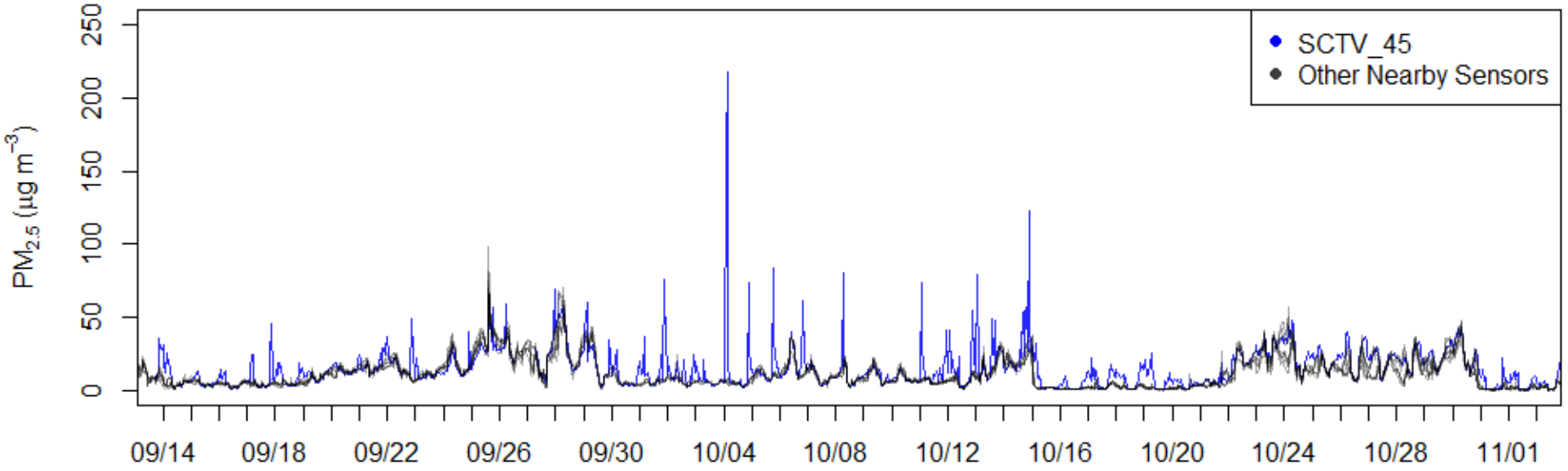
- By comparison, the averages for other months are much lower (Aug: 15 – 76 µg m^{-3})
- The spatial trends also differ from what was seen during the fire





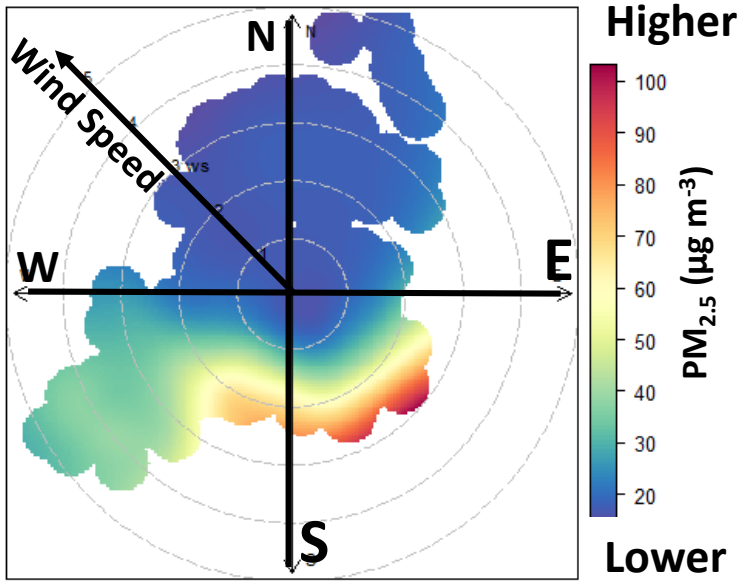
Example – Studying Potential Local Sources

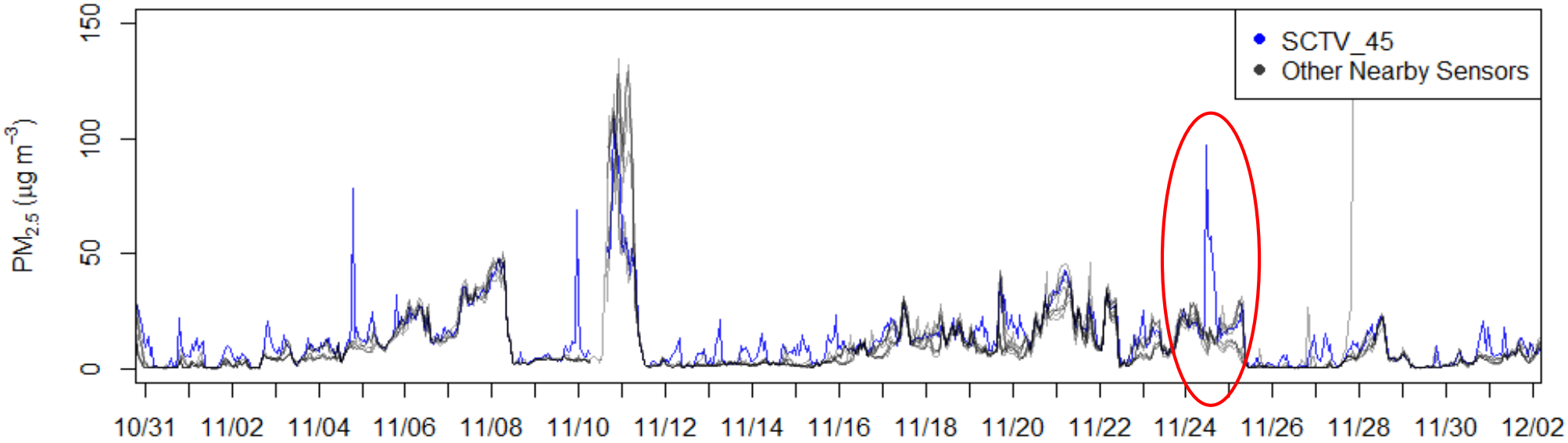
- In the fall, there are repeated short-term enhancements at one site
- This may be an indication of a local source impacting a sensor – though it would be important to verify that these “events” are not an issue with the sensor



Example – Studying Potential Local Sources

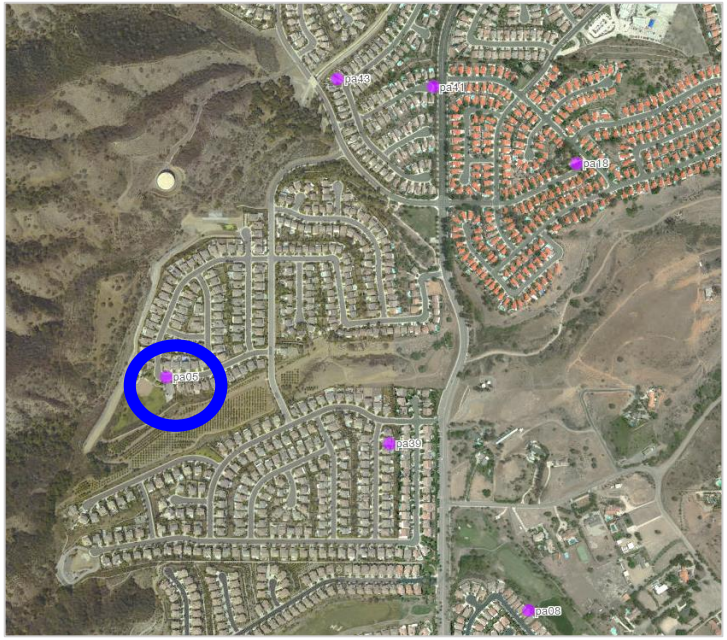
- Assuming these are events driven by a source, supplemental data (e.g., wind speed and direction) can help us to learn more about the location of the potential source

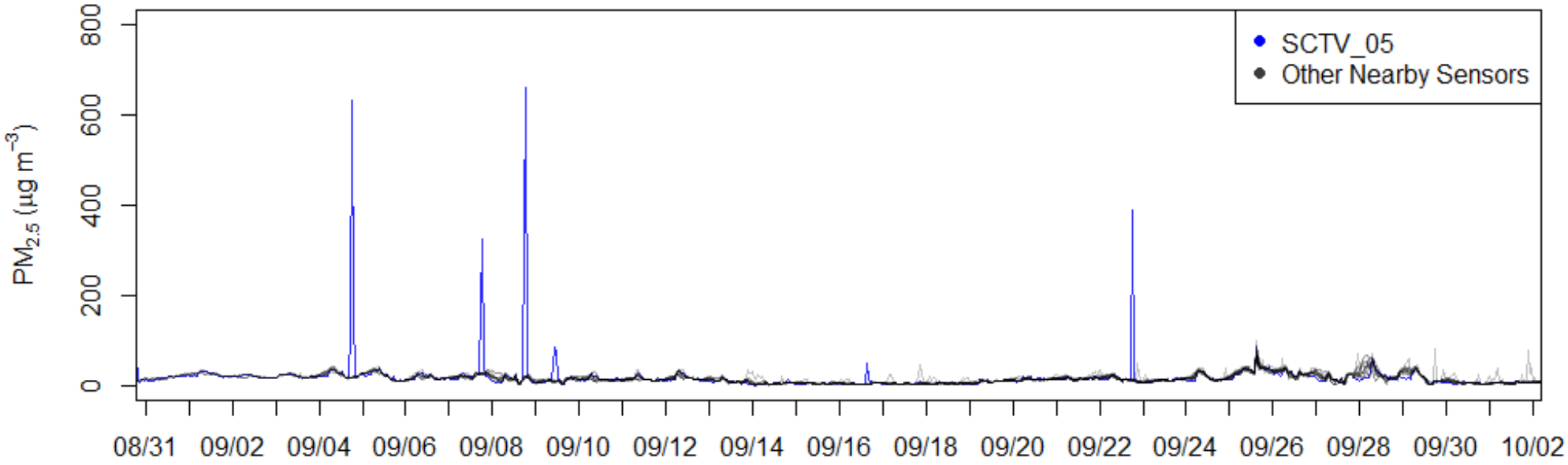




Example – Studying Potential Local Sources

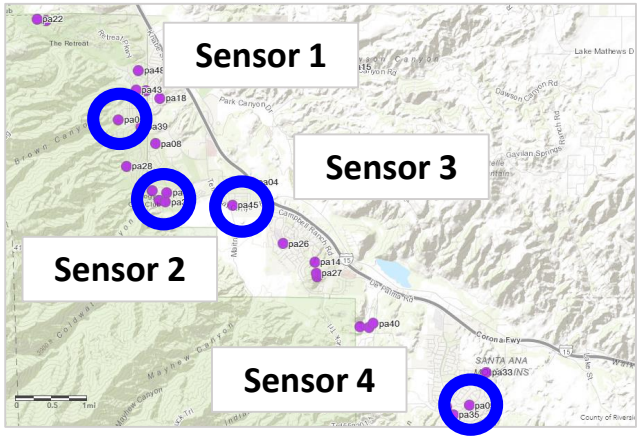
- Data from another site at which there were also fairly substantial short-term enhancements
- An enhancement like this may be due to local activities, such as cooking or grilling

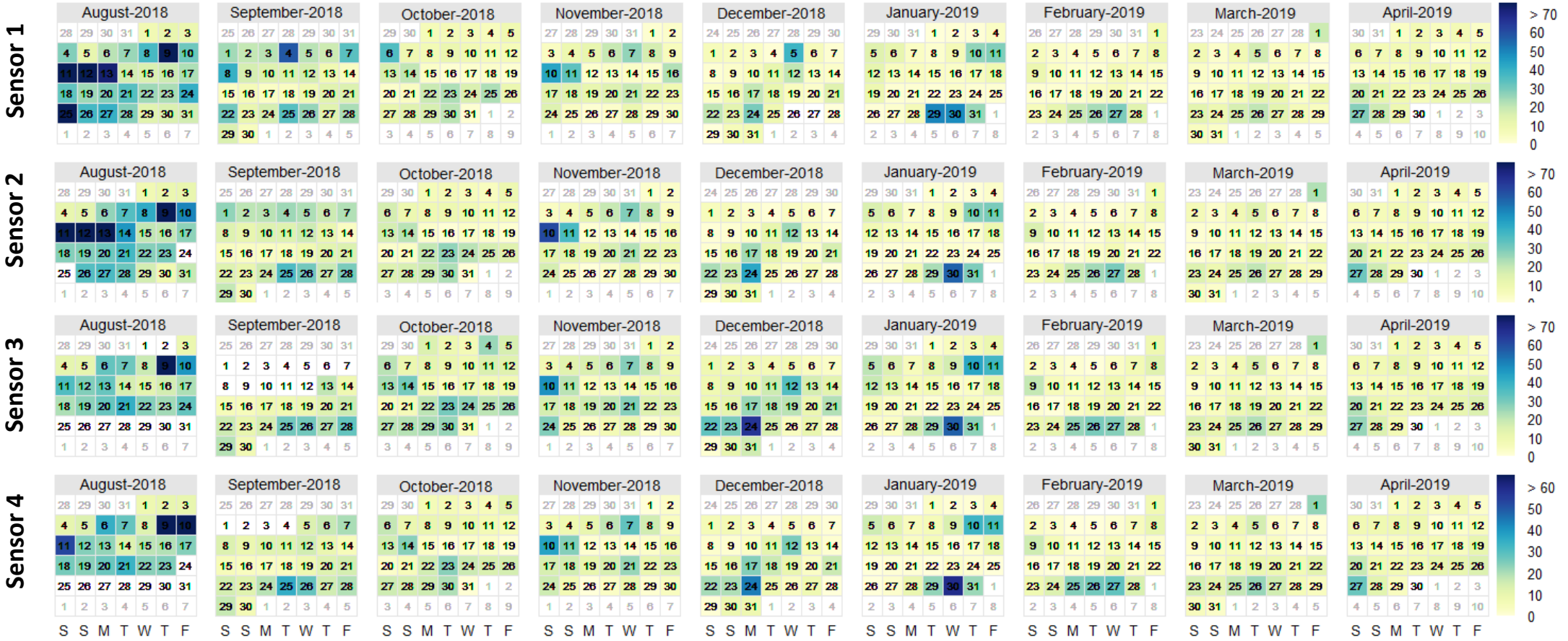




Summarizing the Data

- Daily average throughout the year
- Short-term events may have a slight impact on averages
- Wildfire impacts from August still stand out as a major event





One Final Example

- Data: May 7th – May 9th 2019
- *Sensors seem well suited to provide real-time, localized information*


NEWS › CRIME + PUBLIC SAFETY

Chino dairy hay fire continues to burn; warning about smoke issued

As cows stand a safe distance away, smoke and flames from burning hay bales continue to burn at a dairy farm in the 8300 block of Pine Avenue in Chino on Wednesday morning, May 8, 2018. The fire began Tuesday night just after 9 p.m. (Photo by Mark Rightmire, Orange County Register/SCNG)

By BEATRIZ E. VALENZUELA | bvalenzuela@scng.com and BRIAN ROKOS | brokos@scng.com | San Bernardino Sun

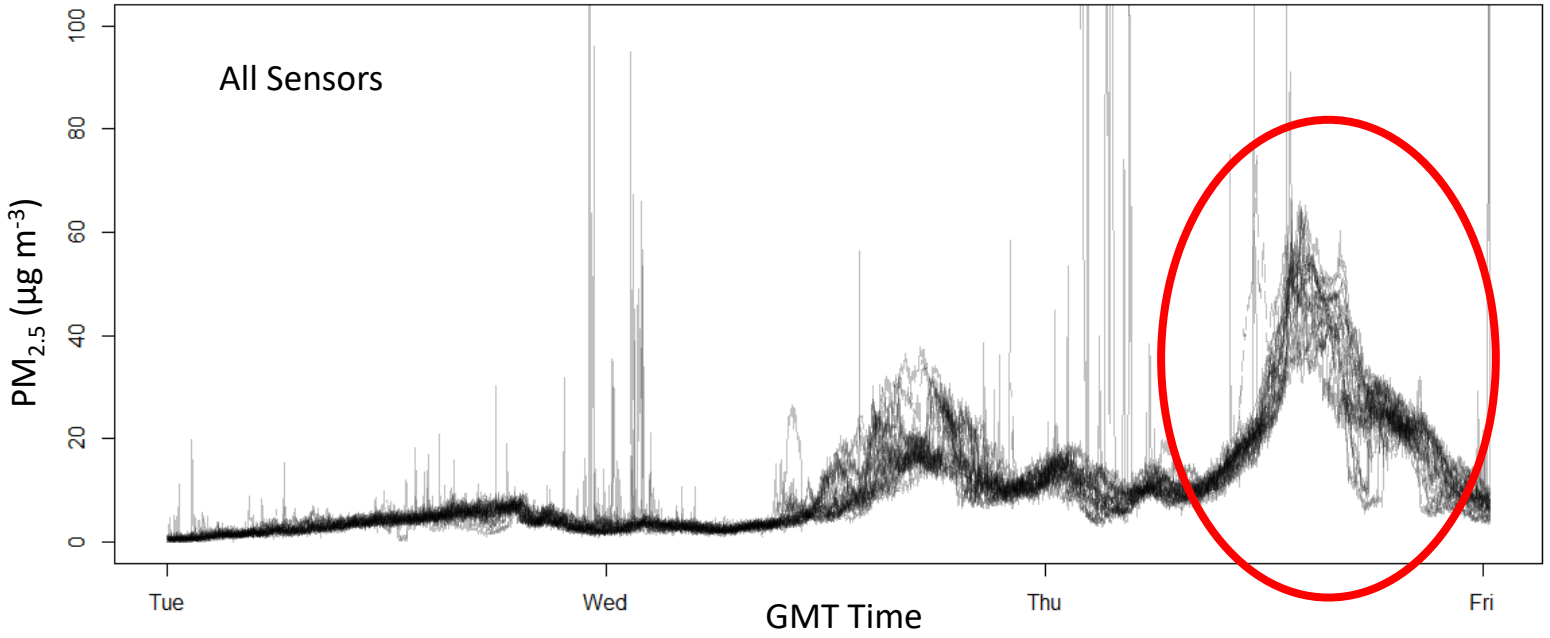
PUBLISHED: May 8, 2019 at 6:45 am | UPDATED: May 9, 2019 at 2:23 pm

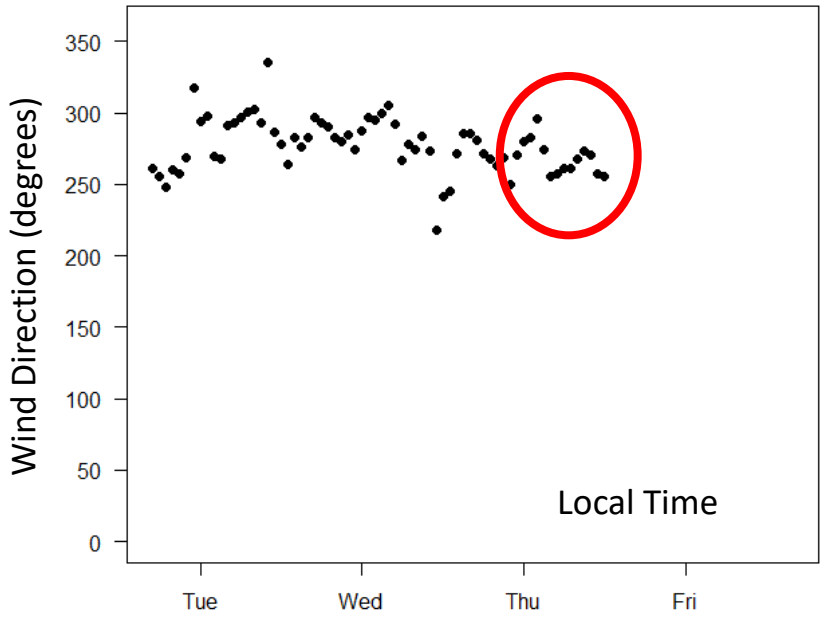
MOST POPULAR

1 Community rallies Rancho Cucamong teacher who broug on campus

2 Disneyland's new F pass requires reser roll out ahead of St Galaxy's Edge debu

3 Pomona police to h checkpoint and bri breathalyzers to ba





Conclusions

- *The low-cost sensors reflect expected air quality trends*
- *These sensors reveal interesting trends across the network and help to track major events*
- *It seems there is also potential to use these sensors to learn more about local sources*

Any Final Thoughts?

(1) What result that was presented did you find most interesting or unexpected? Why?

(2) What result was the most actionable, or the most relevant to your concerns? Would you change your behavior based on this results or did it give you any ideas of how we may be able to improve air quality using sensors?

(3) Was there a particular plot, or visual, or story regarding the data that you found most easy to connect with? In other words, what way of presenting data do find most effective?

Next Steps

Develop a cloud-based computing platform to ingest, store, analyze, and display sensor data

Data analysis workloads larger than typical tools can handle

Fence-line monitoring: ~15 million rows of data

Regional monitoring network: ~40 million rows of data

STAR Grant: ~50 million rows of data

South Coast AQMD R1180: XX million rows of data

CA AB617: X billion rows of data

Specific Aim #4

Communicate the lessons learned to the public and organize outreach activities

Disseminate study results and help answer these key questions:

- ✓ Which tools will be most successful in educating communities to effectively use air monitoring sensors and to engage them in using sensor data?
- ✓ Will a community more likely take action to reduce air pollution exposure when sensors and sensor data are made readily available?
- ✓ Which sensors are the most suitable for community use?
- ✓ How does sensor data quality change with time after sustained use by communities under “real-world” conditions?
- ✓ How do sensor data compare (spatially and temporally) to that of existing monitoring networks?
- ✓ What value is added by these sensors that we are not getting with current network data?

Thank you!