NC STATE UNIVERSITY

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Expanding stationary and mobile $PM_{2.5}$ measurement capabilities near fires

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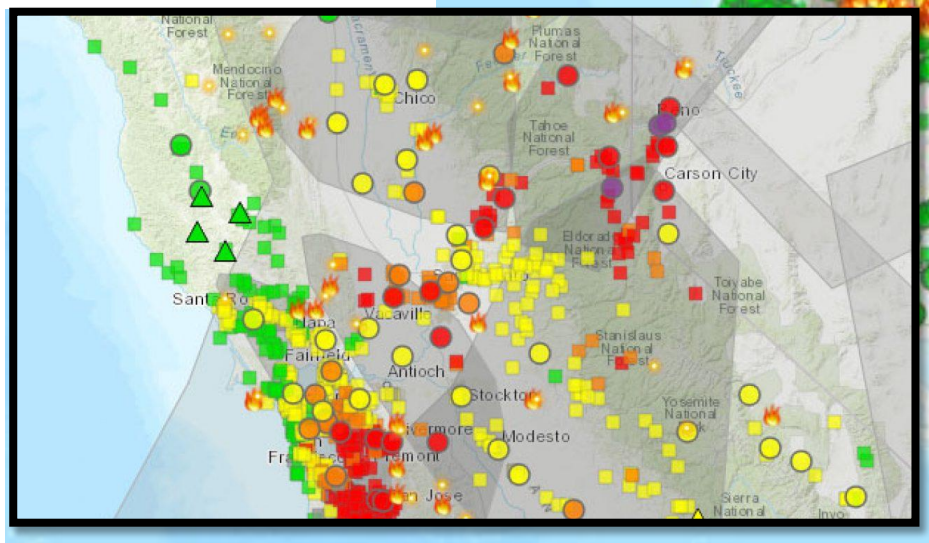
Air Sensors International Conference

Pasadena, CA, USA

May 13, 2022

Fires are key contributors to ambient PM

August 2020



Daily AQI Color	Levels of Concern	Values of Index
Green	Good	0 to 50
Yellow	Moderate	51 to 100
Orange	Unhealthy for Sensitive Groups	101 to 150
Red	Unhealthy	151 to 200
Purple	Very Unhealthy	201 to 300
Maroon	Hazardous	301 and higher

● Permanent

▲ Temporary

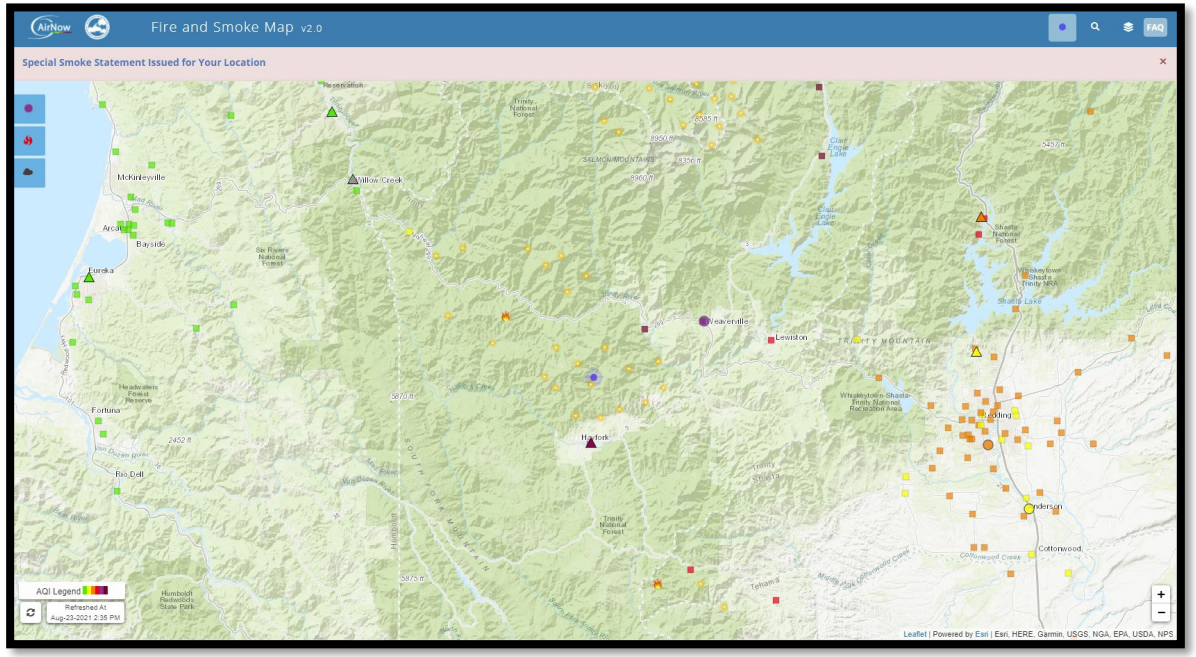
■ Low cost sensors

Accessed: https://southernfireexchange.org/updated-airnow-fire-and-smoke-map/
Inset: https://www.mymotherlode.com/news/local/1202848/wildfires-impacting-mother-lode-air-quality.html

https://fire.airnow.gov/

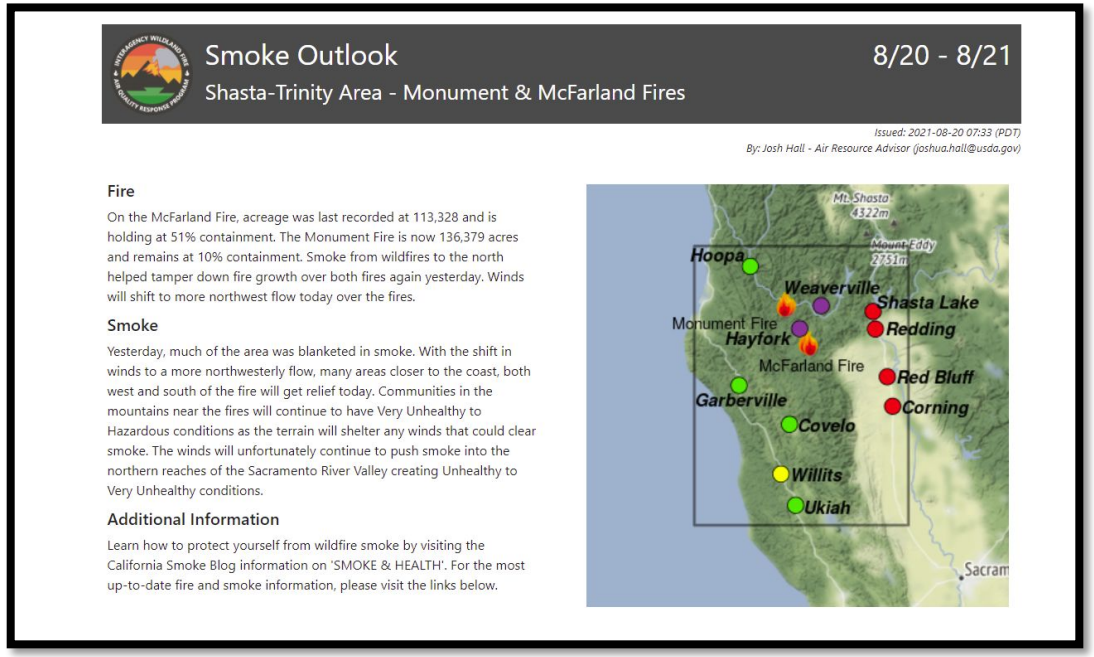
Impacted areas need real-time updates

Current Air Quality Index (AQI) map



Fire and Smoke Map:
https://fire.airnow.gov/

Daily Smoke Outlook report



Incident Information:
https://inciweb.nwcg.gov/

Exposure varies across space and time

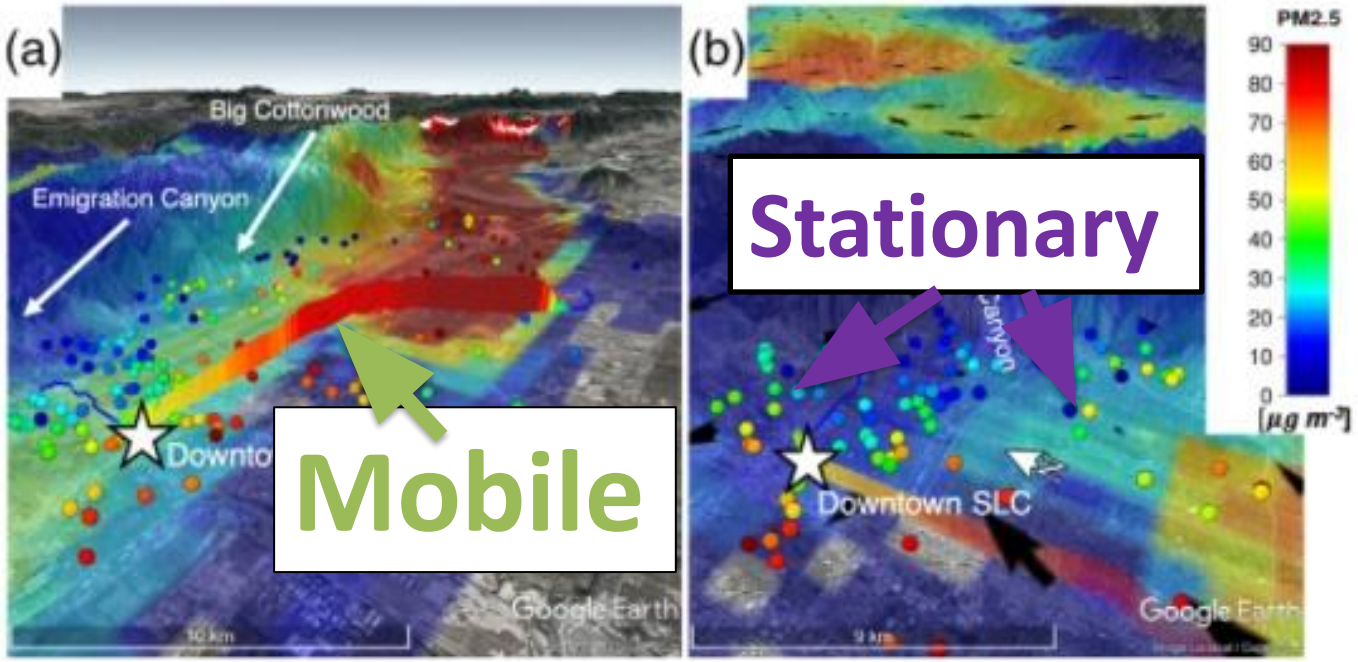


Figure 10. A 3-D model-observation comparison for 15 September 2018 at 8:30 LST. Panel (a) is looking southeast while panel (b) is looking east. Both panels show AQ&U observations (color-filled circles), TRAX measurements (color-filled vertical bars), and WRFSFC predicted $PM_{2.5}$ concentrations (color-filled contours). Modeled wind vectors (black arrows) were added to panel (b) to emphasize the drainage flow coming from Emigration Canyon.

Mobile monitoring

↑ **Spatial info**

Stationary network

↑ **Temporal info**

*Mallia, D. V., Kochanski, A. K., Kelly, K. E., Whitaker, R., Xing, W., Mitchell, L. E., Jacques, A., Farguell, A., Mandel, J., Gaillardon, P.-E., Becnel, T., and Krueger, S. K.: **Evaluating Wildfire Smoke Transport Within a Coupled Fire-Atmosphere Model Using a High-Density Observation Network for an Episodic Smoke Event Along Utah's Wasatch Front**, 125, e2020JD032712, https://doi.org/10.1029/2020JD032712, 2020.*

Affordable sensors can meet these needs

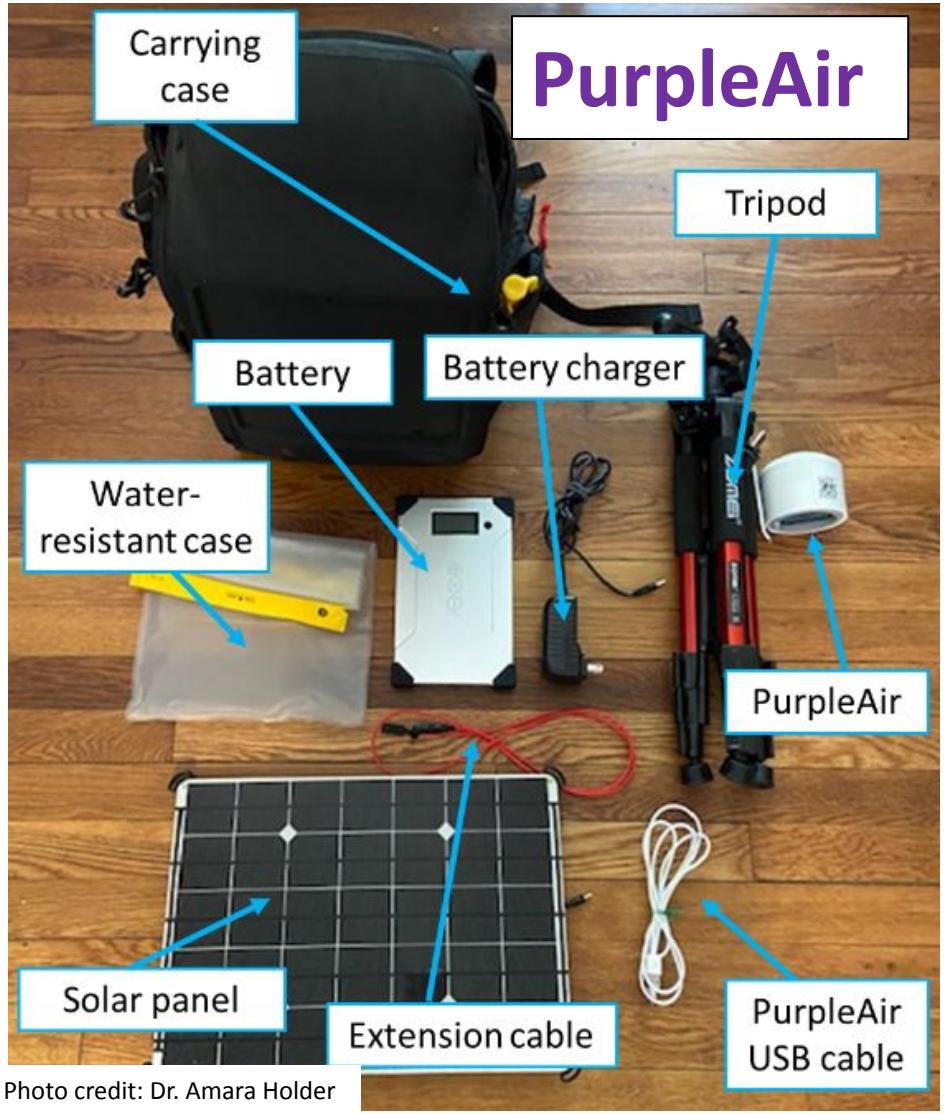


Photo credit: Dr. Amara Holder

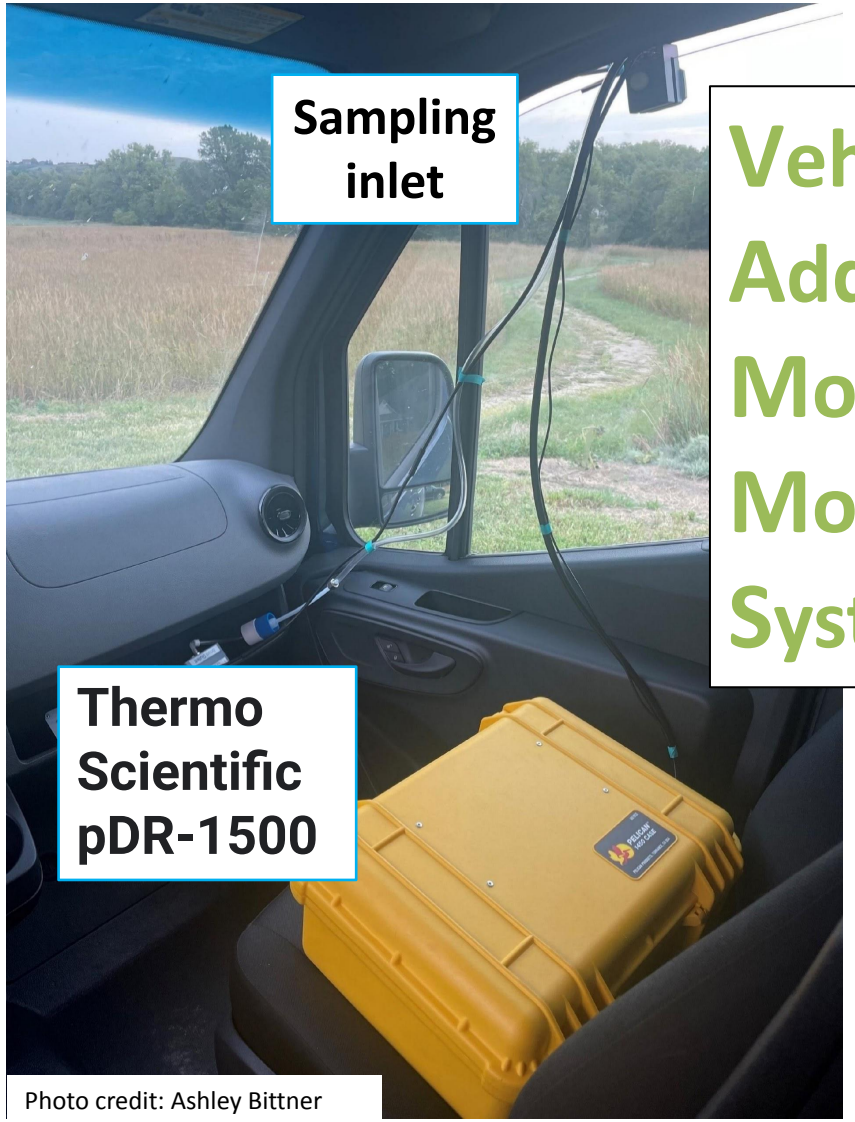


Photo credit: Ashley Bittner

Vehicle Add-on Mobile Monitoring System

Data processing steps for quality assurance

If difference of A and B channels < 70% or 5 µg m^{-3}, take average A and B cf_1 channels

ONGOING WORK

- Smoke-specific corrections (Holder et al. 2020)
- U.S.-wide piecewise correction (BarkJohn et al. 2021) https://fire.airnow.gov/#correction-equation

Velocity and distance from GPS

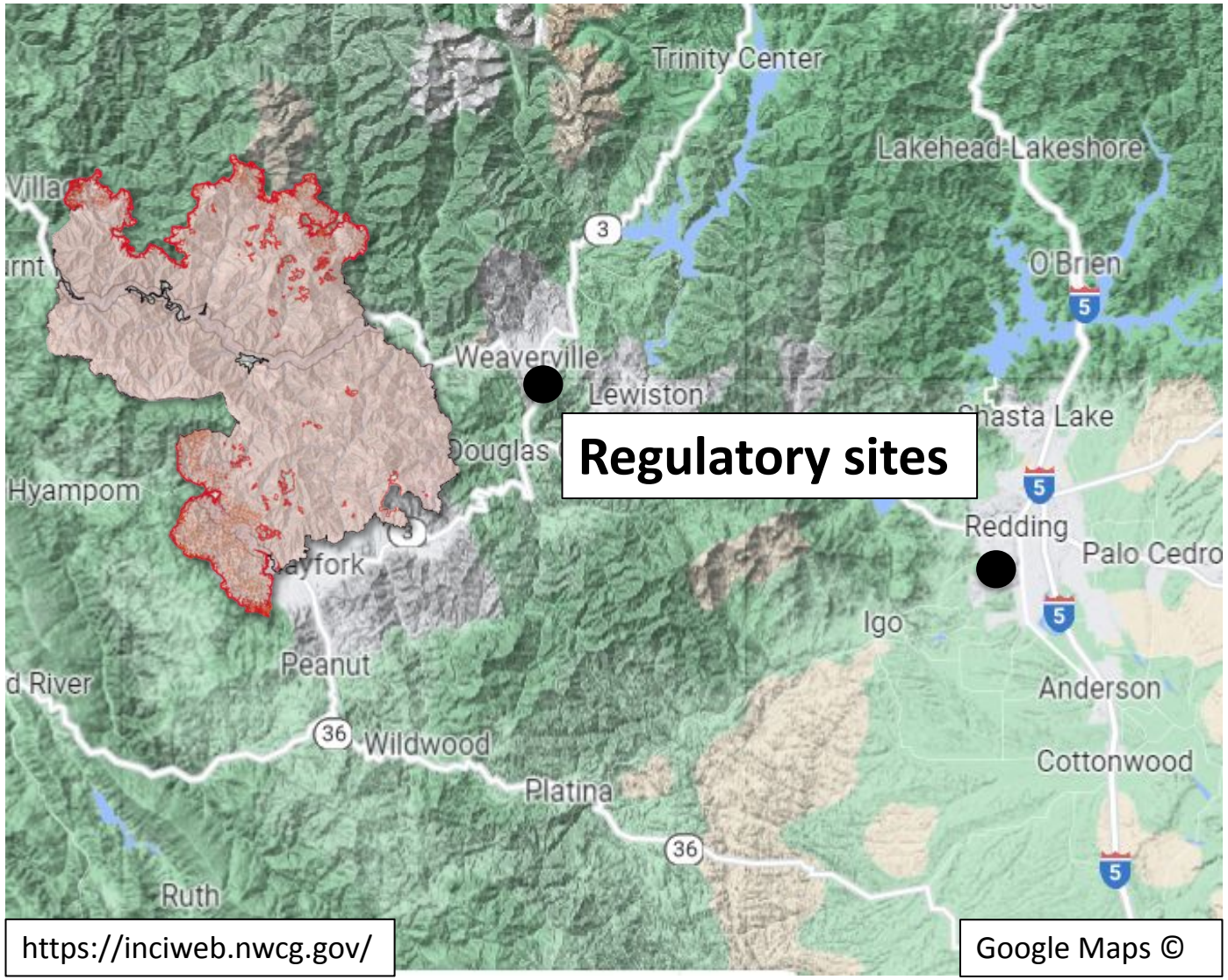
Temporal smoothing (1-min)

ONGOING WORK

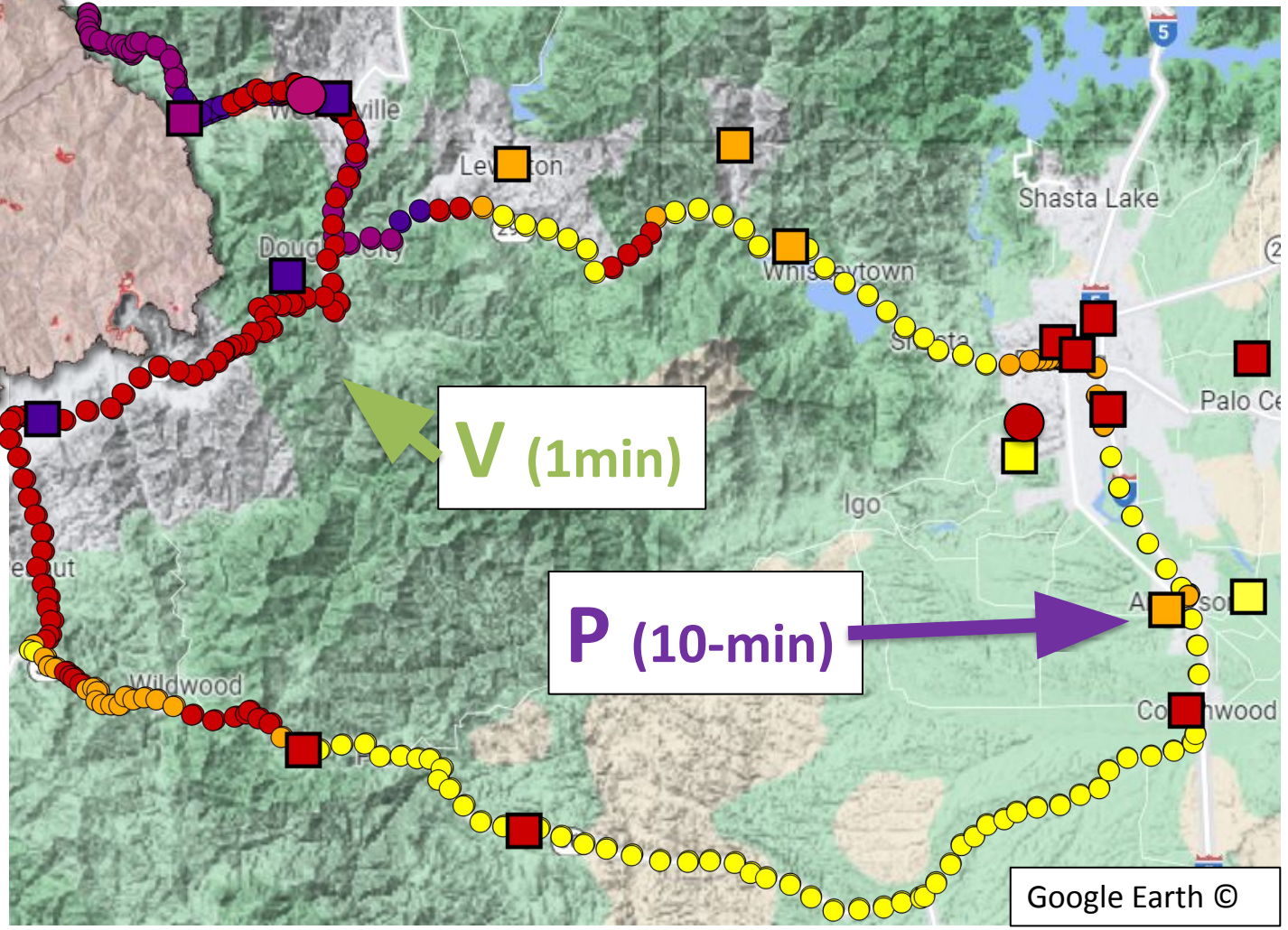
- Source subtraction via COV method (Hagler et al. 2012)
- Background estimation/subtraction
- Spatial smoothing (10-50 m)

Supplemental air monitoring in wildfire areas

Photo, data credit: Ali Kamal, Joshua Hall, Air Resource Advisors, Weaverville, CA. Aug 2021



Supplemental air monitoring in wildfire areas

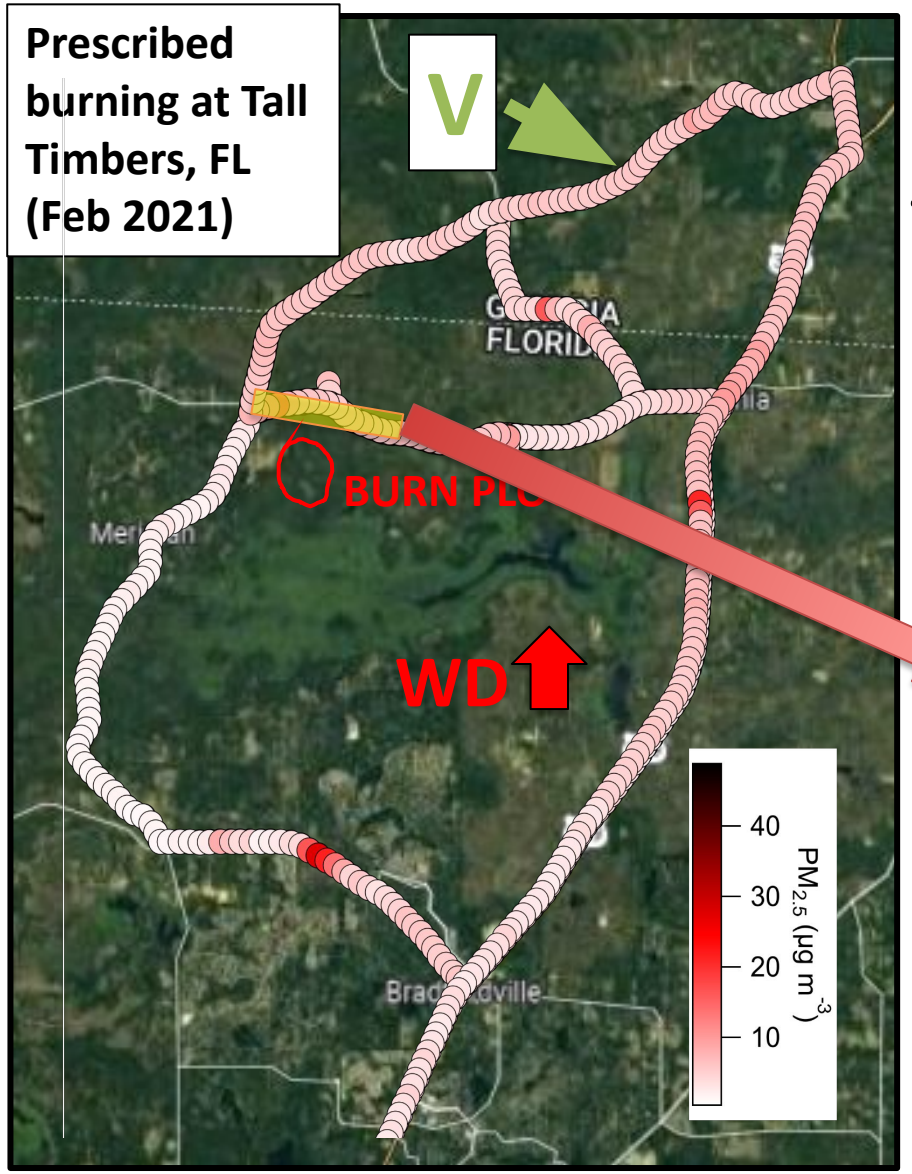


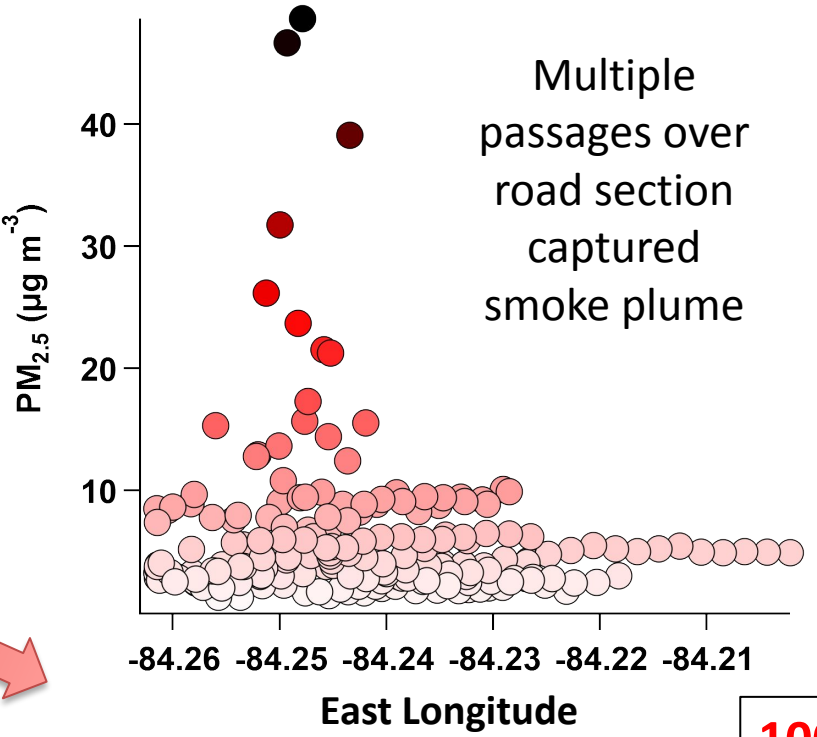
Main findings

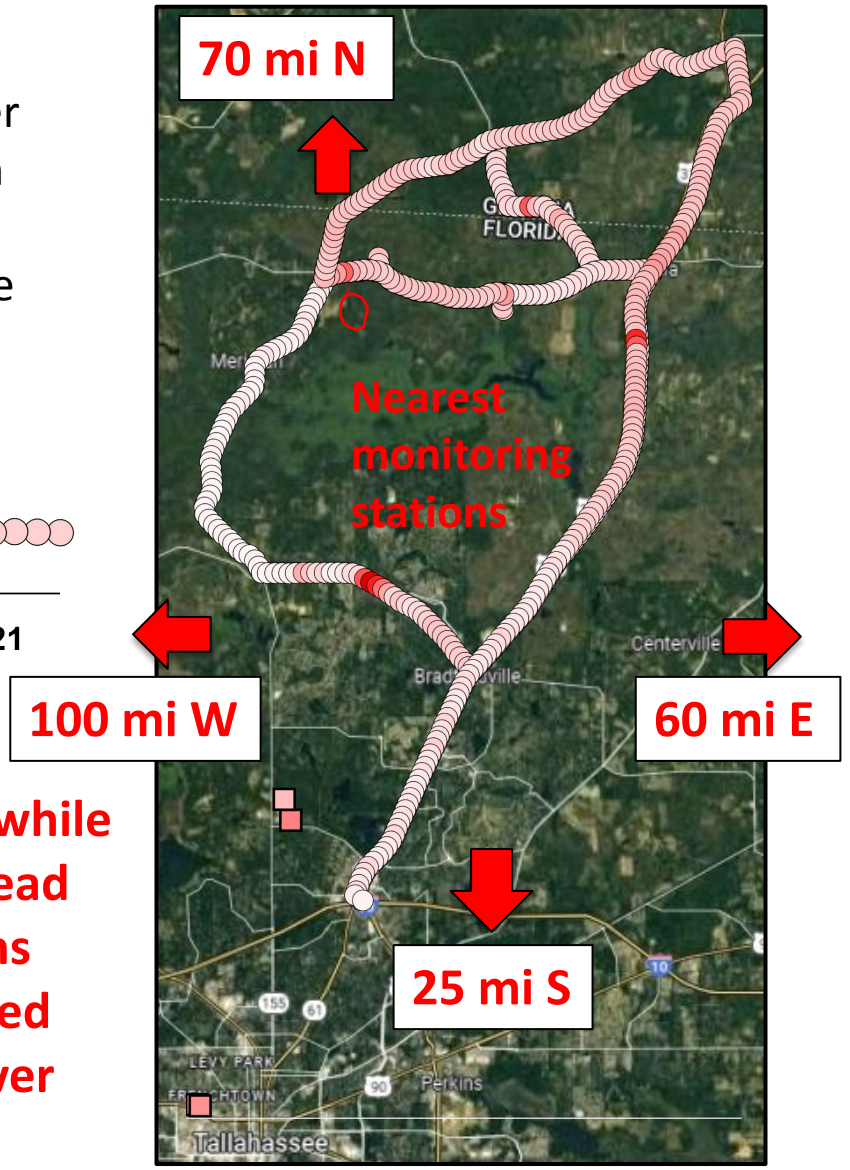
- Mtn terrain may have reduced transport, keeping highest exposures W of Shasta
- VAMMS & PurpleAir (web) were consistent, but PA were often 1 AQI level higher, likely due to diff. avg. interval

Support areas with data coverage gaps

Prescribed burning at Tall Timbers, FL (Feb 2021)







Main findings

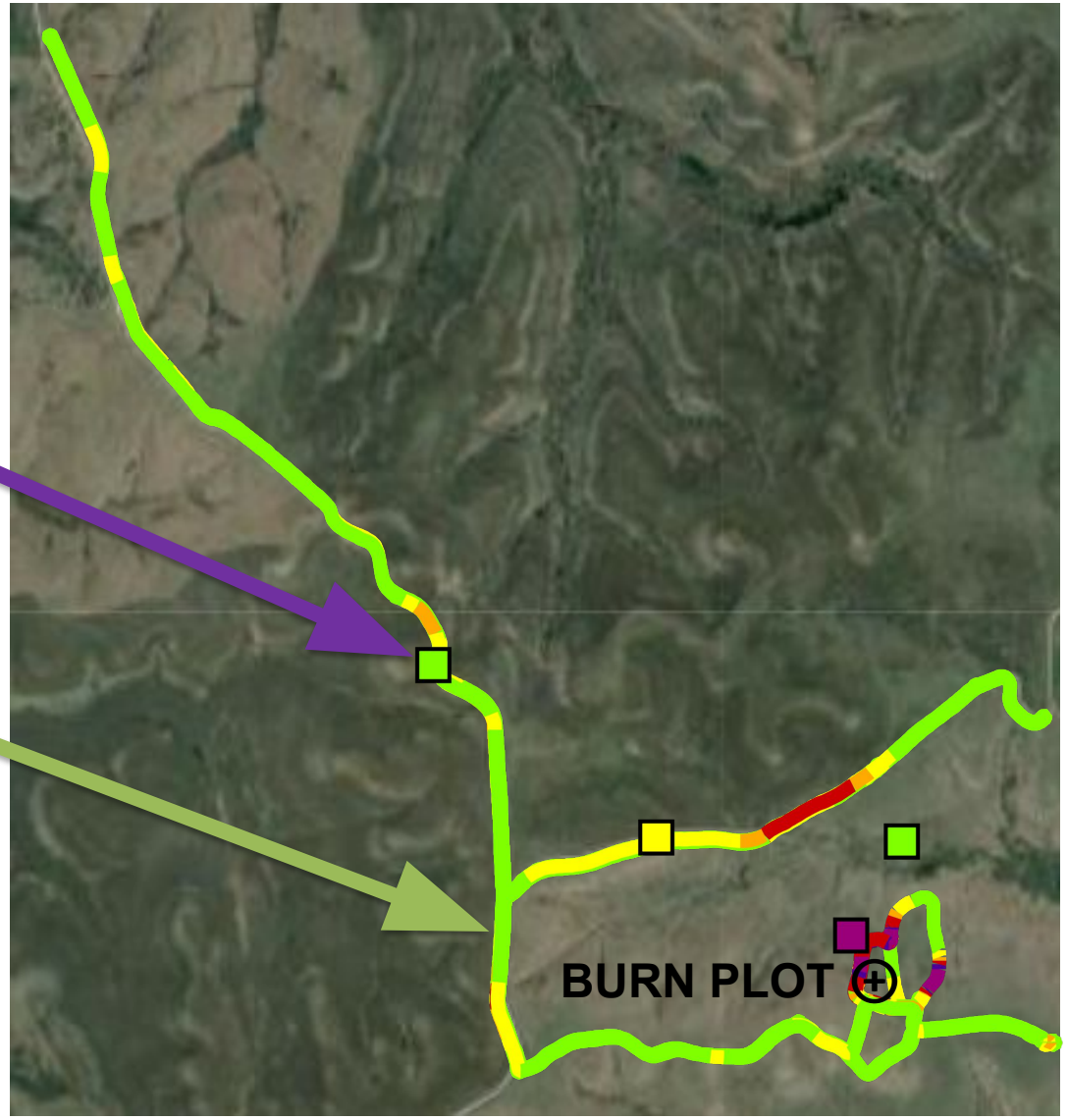
- Fires have localized impacts while also contributing to widespread elevated $PM_{2.5}$ concentrations
- VAMMS offers vastly increased spatiotemporal resolution over regulatory monitoring sites

Evaluate commonly used dispersion models

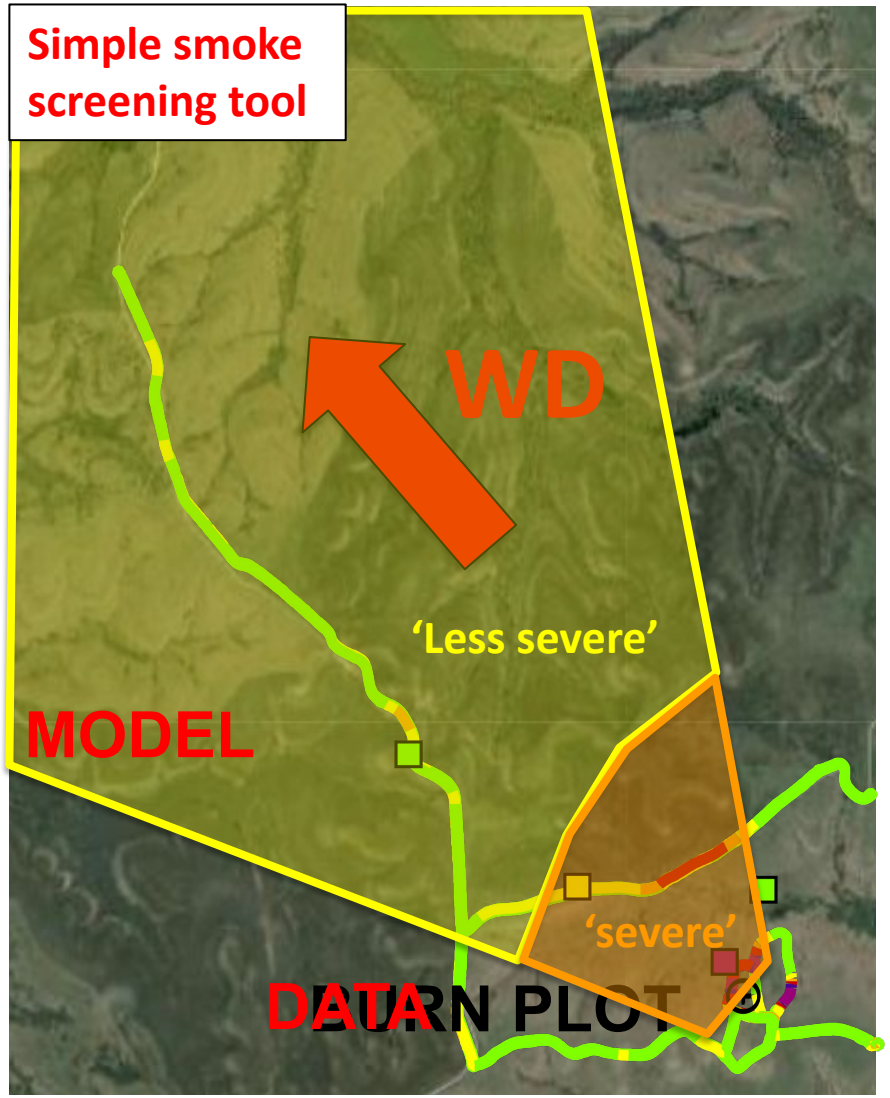
Konza Prairie Biological Station, Manhattan, KS, Sept 2021.

P

V



Evaluate commonly used dispersion models

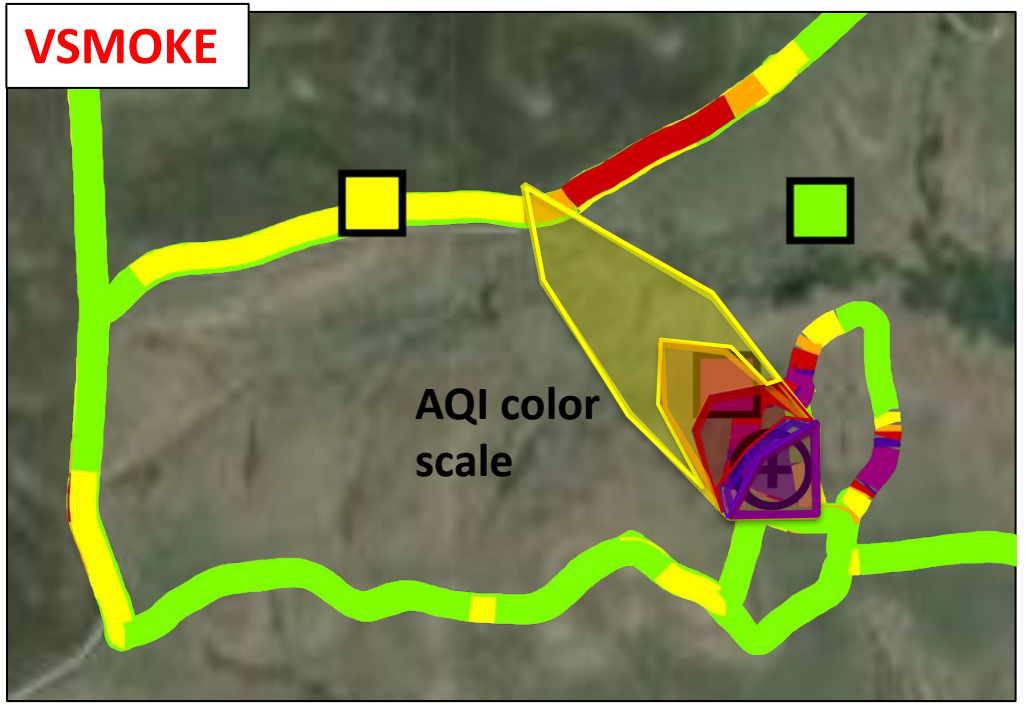


Simple Smoke

- Identified primary direction & plume span
- 'Less severe' region may be overly conservative

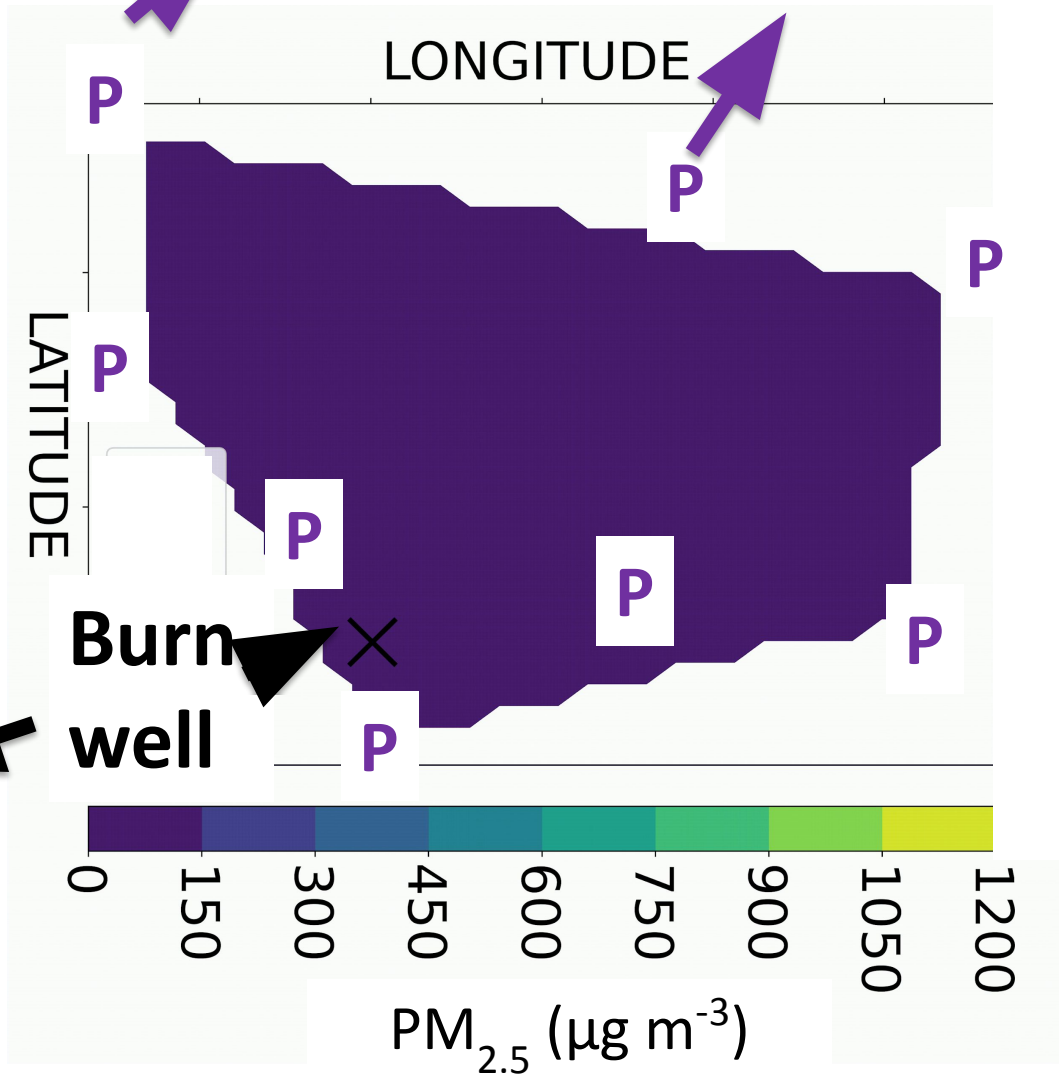
VSMOKE

- Identified primary direction and most impacted region
- Underestimated max. AQI & plume span



Detect hotspots and map plumes

Cold Regions Research and Engineering Laboratory, Hanover, NH, Oct 2021.



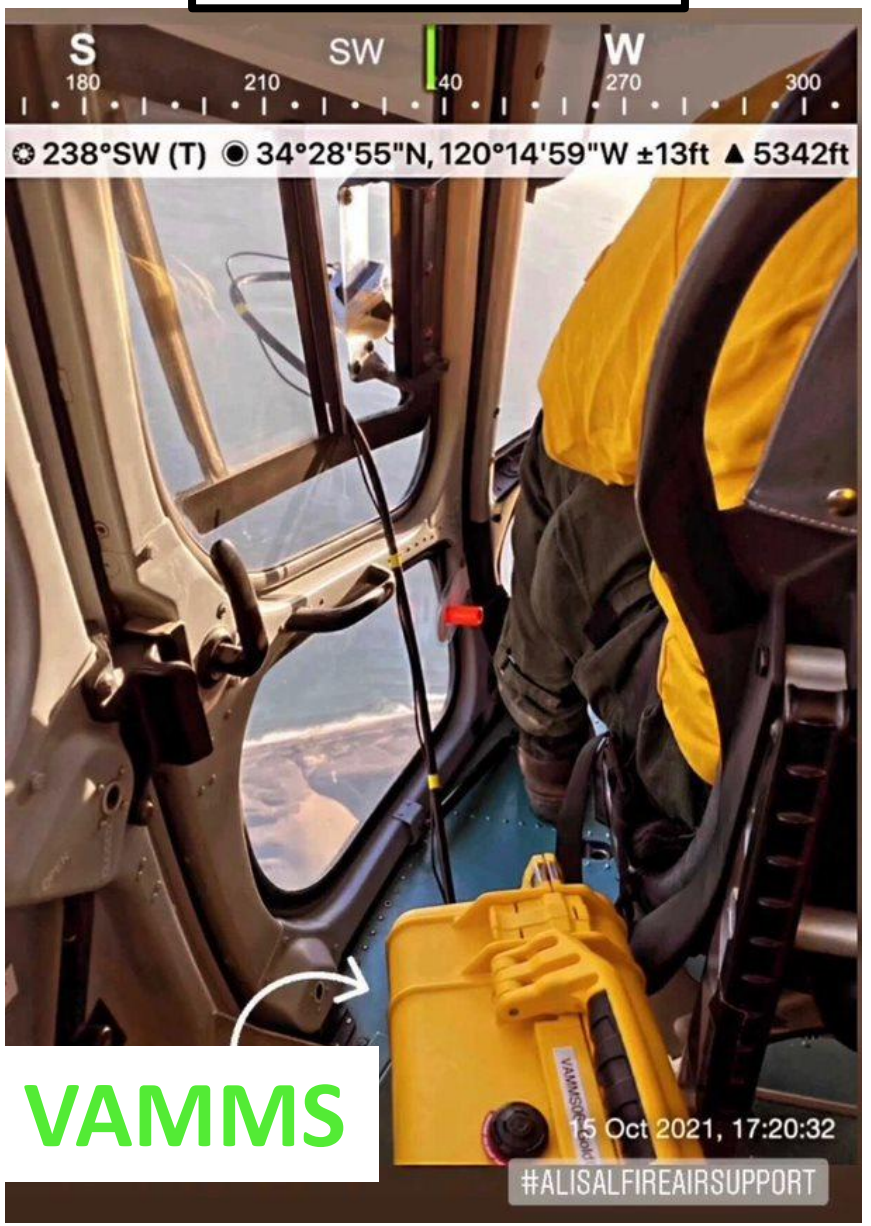
Main findings

- Flexible PurpleAir network requires minutes to set up
- Potential to map plumes in real time to inform mitigation strategy

Future (& Exploratory) Work

- Emergency response applications: deployments on ATVs and helicopters
- Meaningful quantitative comparisons (e.g., to PurpleAir network and model predictions)
- A mobile monitoring data Shiny App and improved visualizations (your comments are welcome!)

Photo credit: Amber Ortega



Questions?

For more information on this project, please see the U.S. EPA Wildfire Smoke Air Monitoring Response Technology (WSMART) Pilot program:

https://www.epa.gov/air-sensor-toolbox/wildfire-smoke-air-monitoring-response-technology-wsmart-pilot

References

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