

# Atlanta Rail and Port Sensor (RAPS) Project:

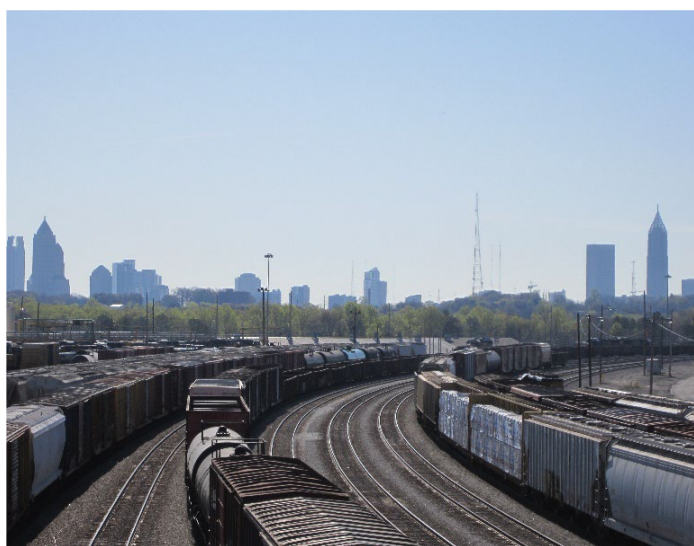
## An Air Quality Pilot Study - Results and Lessons Learned

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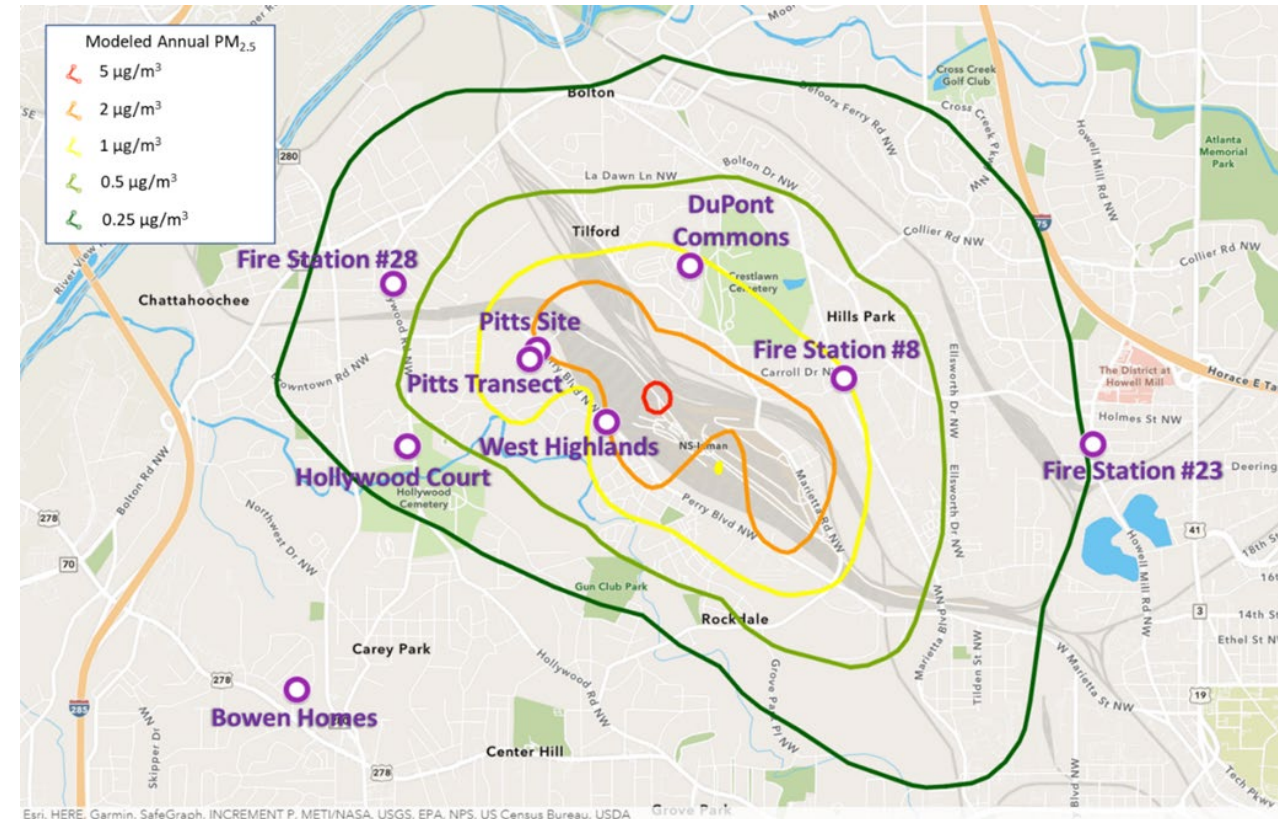
# Atlanta RAPS Project: Overview and Objectives

- Collaboration between EPA Region 4 and the Georgia Environmental Protection Division (GA EPD)
- Objectives:
  - Conduct a pilot-scale air quality study in a port-like area, partnering with GA EPD.
  - Evaluate the utility of lower-cost air sensor technology in understanding near-source exposures from a port.
- Timeline: Sensor field deployment from May 2018 – December 2020
- Final report to be published Fall 2022.



# Study Design

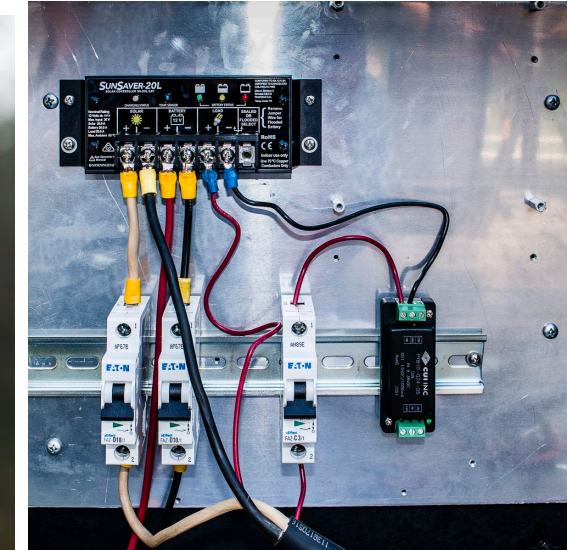
- PM sensors installed at 9 sites near the Inman Railyard in NW Atlanta for approximately 1 year.
- Variety of monitoring site objectives:
  - Expected higher PM<sub>2.5</sub> concentration areas
  - Populated areas
  - Background concentrations
  - Spatial representativeness
- Collocation with regulatory monitors
  - GA EPD South DeKalb NCore site before and after deployment (hourly)
  - GA EPD Fire Station 8 site during study (24-hr filter-based)



Site locations and modeled annual avg. PM<sub>2.5</sub> gradient

# Materials and Methods

- Solar-powered PM sensor pods:
  - PurpleAir PA-II-SD
  - Manual data download from SD cards
- Aethlabs MA350 Black Carbon Sensors
- Data retrieved, cleaned, and analyzed using custom R and Python code



# Example Atlanta RAPS Sensor Evaluation

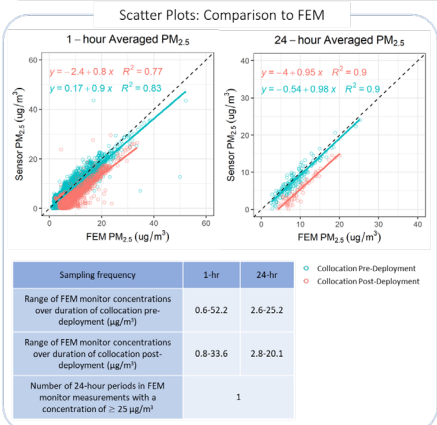
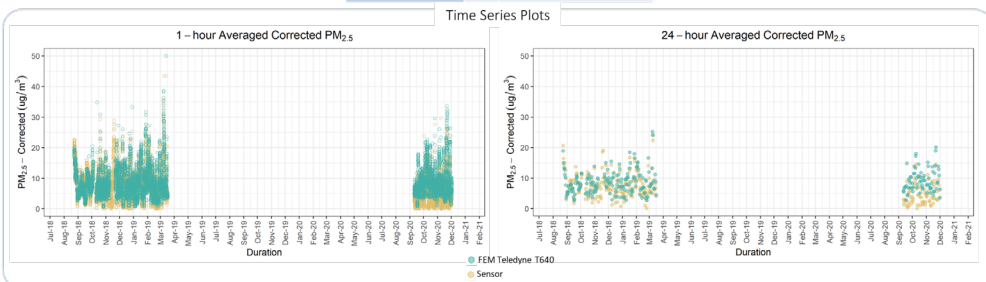
Used sensor evaluation templates in *EPA Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors*<sup>2</sup>

PM<sub>2.5</sub> Field Collocation Report  
PurpleAir PA-II-SD; Project Sensor ID 2

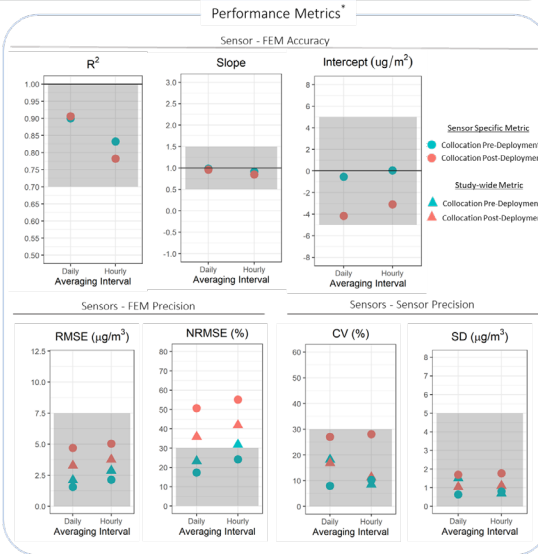
Atlanta Rail and Port Sensor (RAPS) Project  
US EPA Region 4 and Georgia EPD  
August 2018 – December 2020



Testing Organization and Site Information		Sensor Information		FEM Monitor Information	
Testing organization (Name, Organization Type, Contact website / phone number / email)	US Environmental Protection Agency (EPA), Region 4 and Georgia Environmental Protection Division (EPD)	Manufacturer, model	PurpleAir, PA-II-SD	Manufacturer, model	Teledyne API – T640
Testing location (City, State, Latitude & Longitude)	South DeKalb Decatur, GA 33.68797, -84.2904	Device firmware version	4.0240i, 3+0i, 0+2.5i	Sampling time interval	1-hour
AQS site ID	13-089-0002	Sampling time interval	1-hour	Date of calibration	As required by 40 CFR Part 58 and GA EPD QAPP
Sampling timeframe	August 2018-December 2020	Sensor serial number	Mac address: 2c:3a:e8:34:ff:80	Date of flowrate verification check	Monthly, as required by 40 CFR Part 58 Appendix A
		Issues encountered during deployment?	<input type="checkbox"/>	Description, date(s) of maintenance activities	



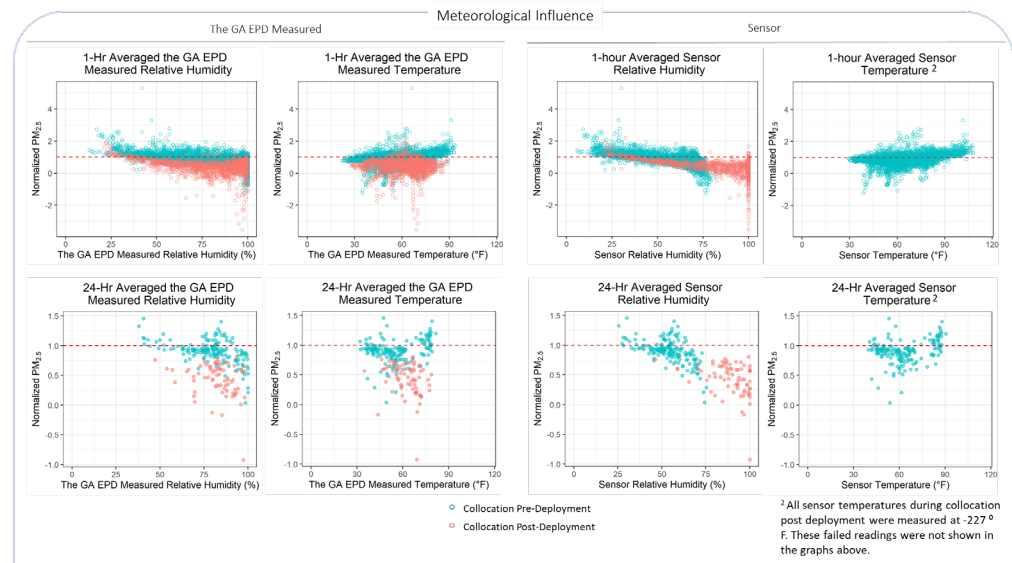
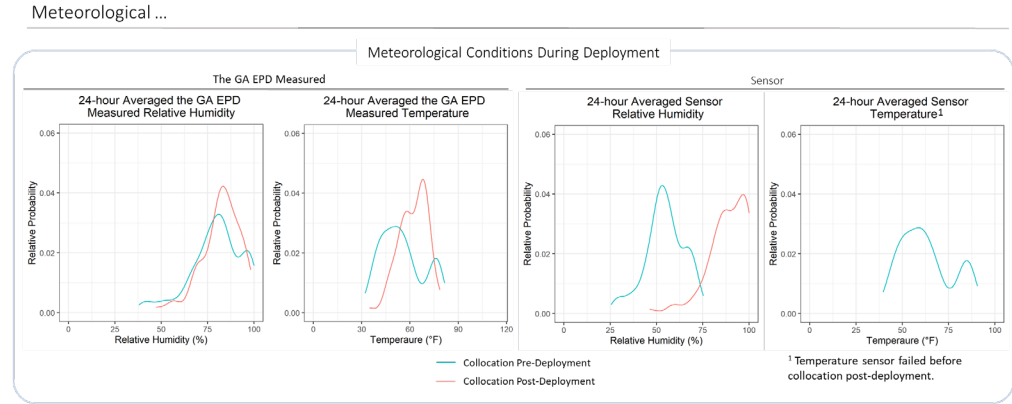
2. Duvall, R., A. Clements, G. Hagler, A. Kamal, Vasu Kilaru, L. Goodman, S. Frederick, K. Johnson Barkjohn, I. VonWald, D. Greene, and T. Dye. *Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors: Use in Ambient, Outdoor, Fixed Site, Non-Regulatory Supplemental and Informational Monitoring Applications*. U.S. EPA Office of Research and Development, Washington, DC, EPA/600/R-20/280, 2021. URL



PM<sub>2.5</sub> Field Collocation Report  
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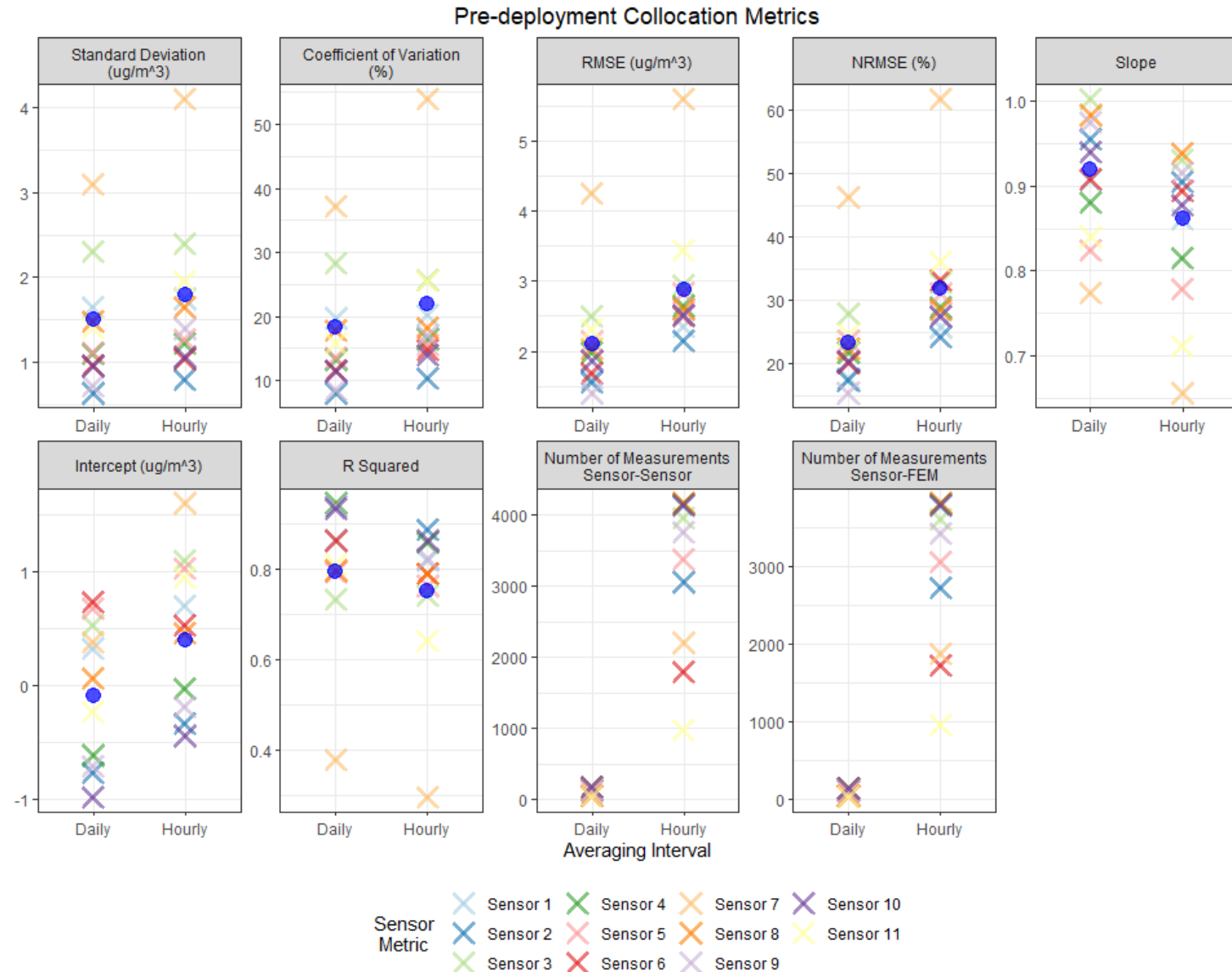


Sampling Frequency	1-hr	24-hr
Number of paired, normalized concentration and GA EPD measured temperature values over duration of collocation pre-deployment	4348	165
Number of paired, normalized concentration and GA EPD measured relative humidity values over duration of collocation pre-deployment	4348	165
Number of paired, normalized concentration and sensor temperature values over duration of collocation post-deployment	1955	73
Number of paired, normalized concentration and GA EPD measured relative humidity values over duration of collocation post-deployment	1955	73

Sampling Frequency	1-hr	24-hr
Number of paired, normalized concentration and sensor temperature values over duration of collocation pre-deployment	4358	171
Number of paired, normalized concentration and sensor relative humidity values over duration of collocation pre-deployment	4358	171
Number of paired, normalized concentration and sensor temperature values over duration of collocation post-deployment	1956	74
Number of paired, normalized concentration and sensor relative humidity values over duration of collocation post-deployment	1956	74

# RAPS PM<sub>2.5</sub> Sensor Performance

- Applied US-wide EPA correction equation<sup>1</sup> to PurpleAir sensor data.
- Most performance targets<sup>2</sup> met after sensor data was corrected.
  - Humidity sensor drift may have contributed to lower accuracy in certain sensors
- Sensor accuracy generally:
  - < ±20%, ±2 µg/m<sup>3</sup> sensor to sensor (CV and standard deviation)
  - < ±30%, ±3 µg/m<sup>3</sup> sensor to regulatory monitor (NRMSE, RMSE)

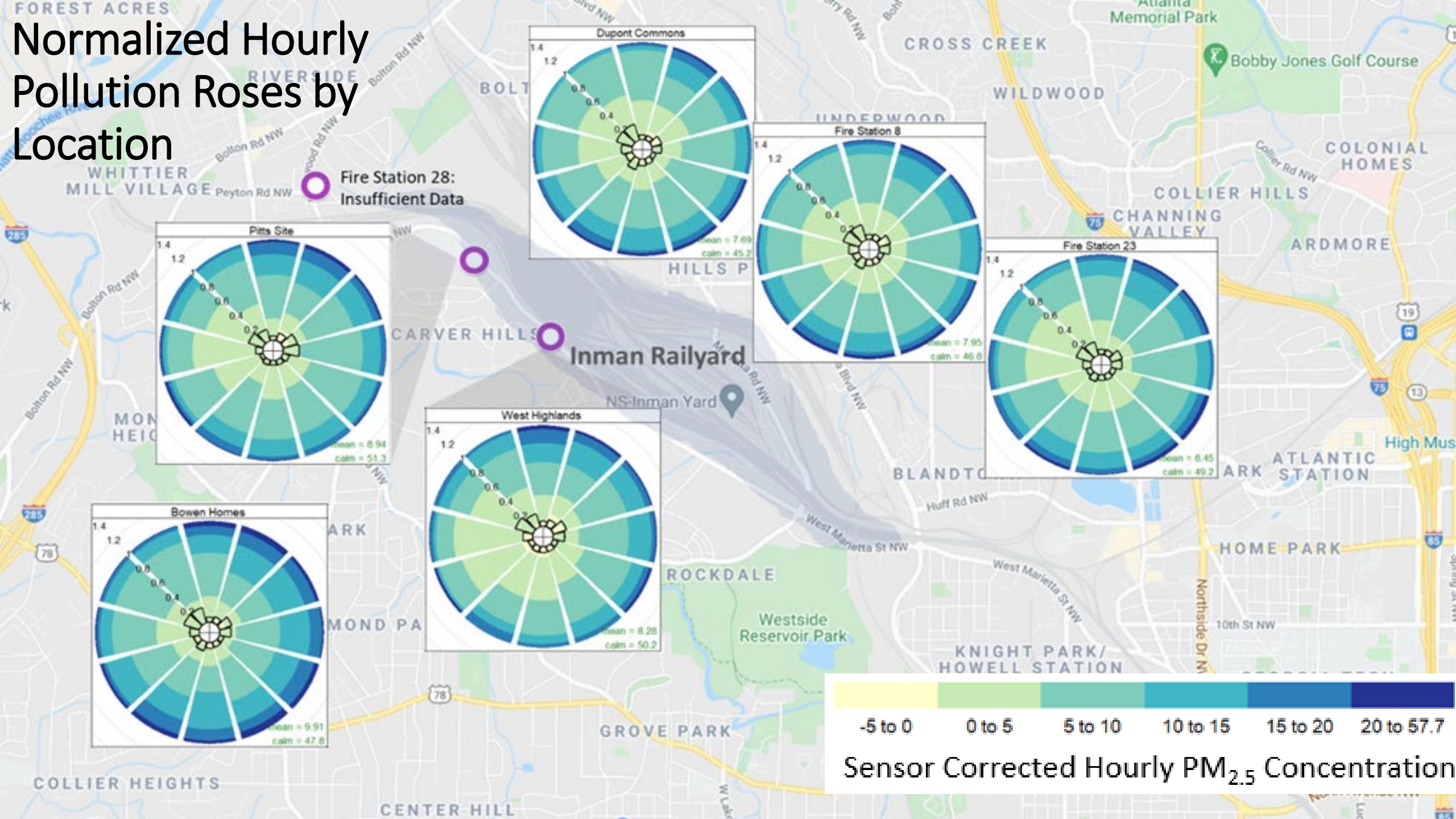


1. Barkjohn, K. K., Gantt, B., and Clements, A. L.: *Development and application of a United States wide correction for PM<sub>2.5</sub> data collected with the PurpleAir sensor*, Atmos. Meas. Tech., 14, 4617–4637, <https://doi.org/10.5194/amt-14-4617-2021>, 2021.

# Results and Conclusions

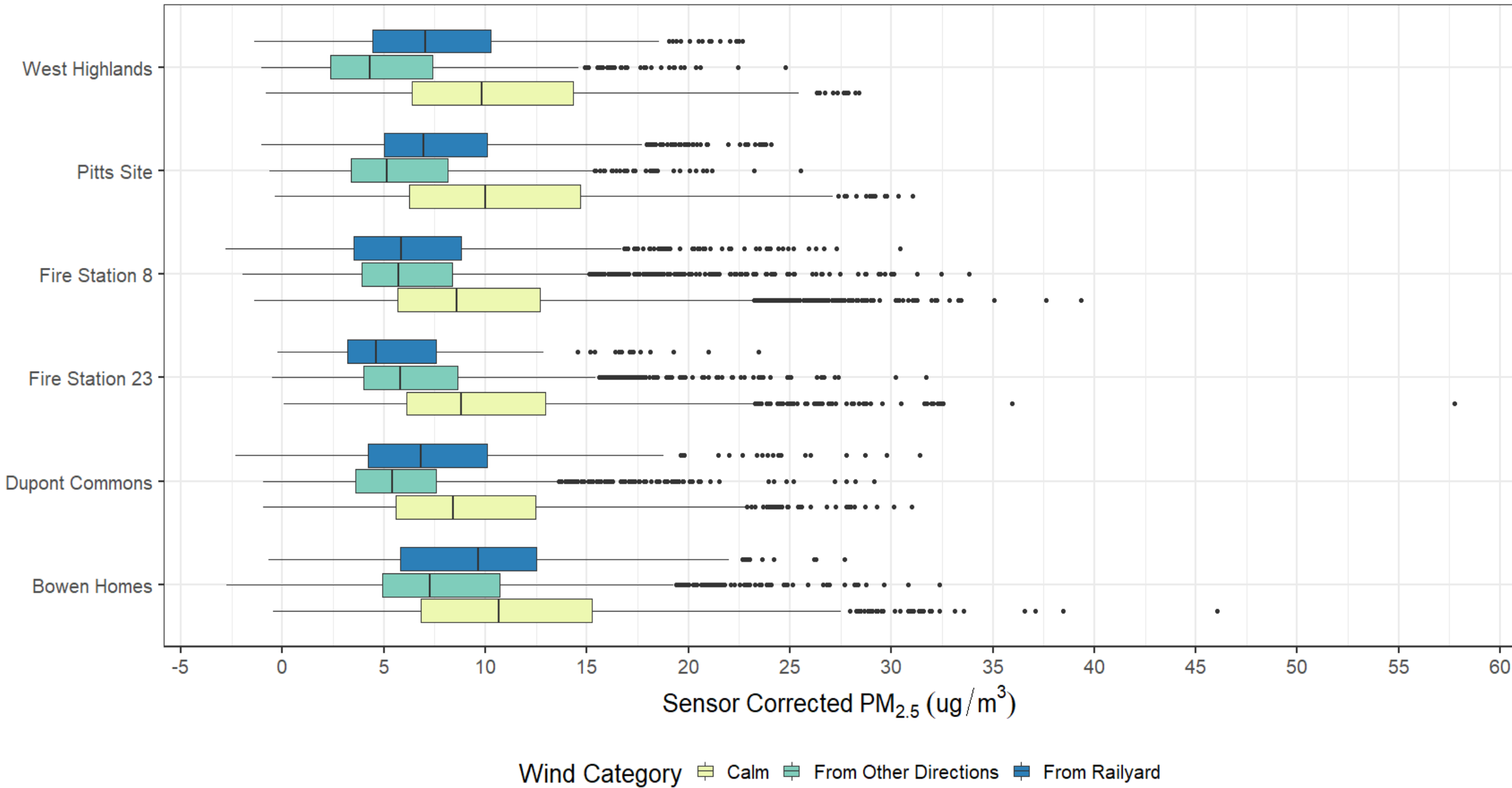
- Some sensors indicated a small PM<sub>2.5</sub> contribution from railyard emissions.
- Other factors (local meteorology and other urban sources) also contributed to hourly PM<sub>2.5</sub> variations between sites.
- Hourly PM<sub>2.5</sub> sensor data showed the expected 24-hour pattern (higher concentrations at night, lower during the day)
- Data quality likely sufficient to quantify impacts from significant, local PM<sub>2.5</sub> sources.
- Quality assured and corrected sensor measurements indicate that railyard contributions at some sites were potentially smaller than other influences on the PM<sub>2.5</sub> concentrations (meteorology and other urban sources).

# Normalized Hourly Pollution Roses by Location

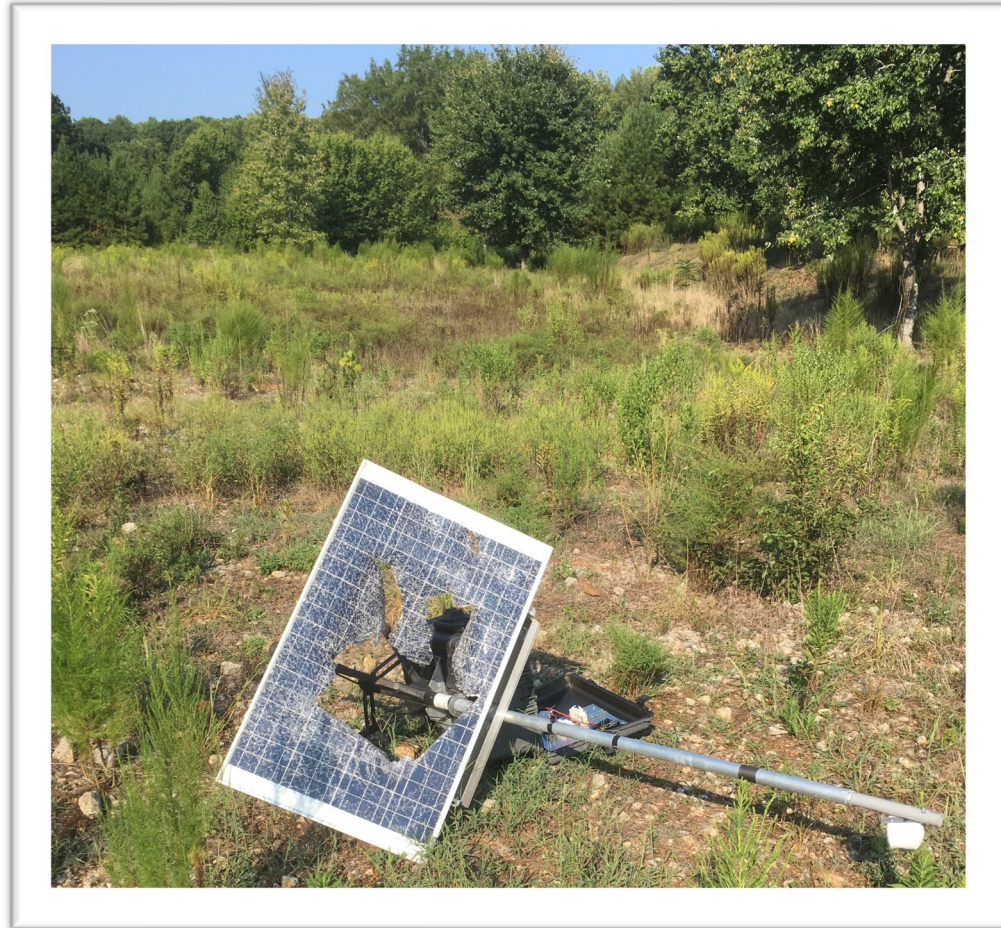
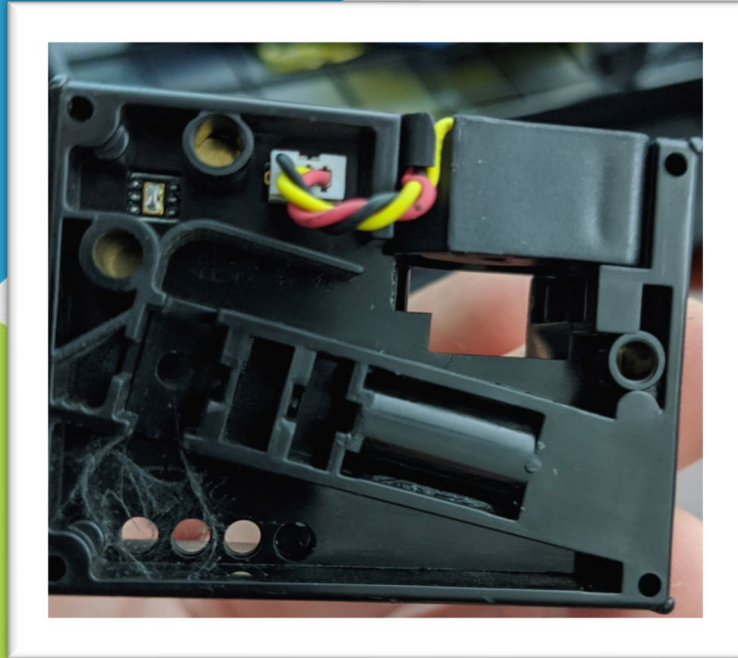
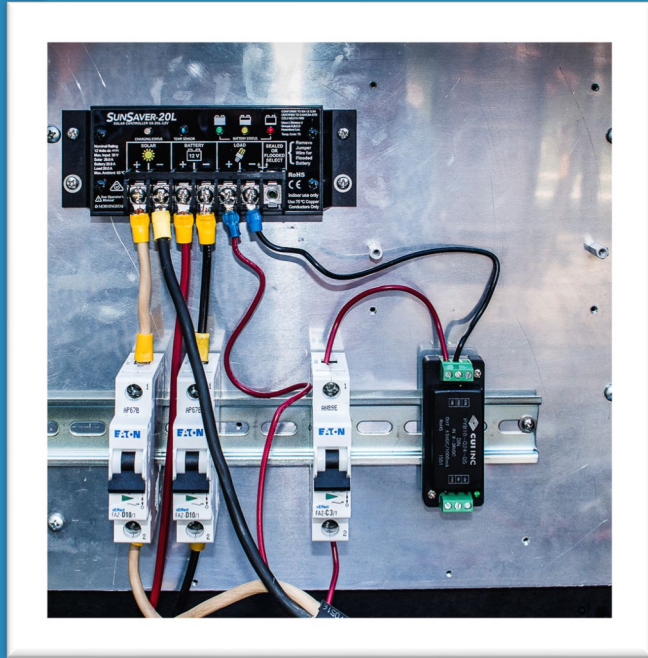




# PM<sub>2.5</sub> Concentrations by Wind Direction Group and Location



# Lessons Learned





LESSONS LEARNED:

## Study Planning

- Allow several months for negotiating site access agreements
- Present project fact sheets and access agreement forms to property owners
- Conduct additional public/community outreach about future projects before monitoring
  - May help facilitate more opportunities to obtain site access from a wider variety of stakeholders



LESSONS LEARNED:

## Fieldwork and Data Collection

- Consider wireless data transmittal for future projects (WiFi or cellular)
- Use grid power or commercially available solar power if possible
- If using custom-built power supply, test extensively before deployment

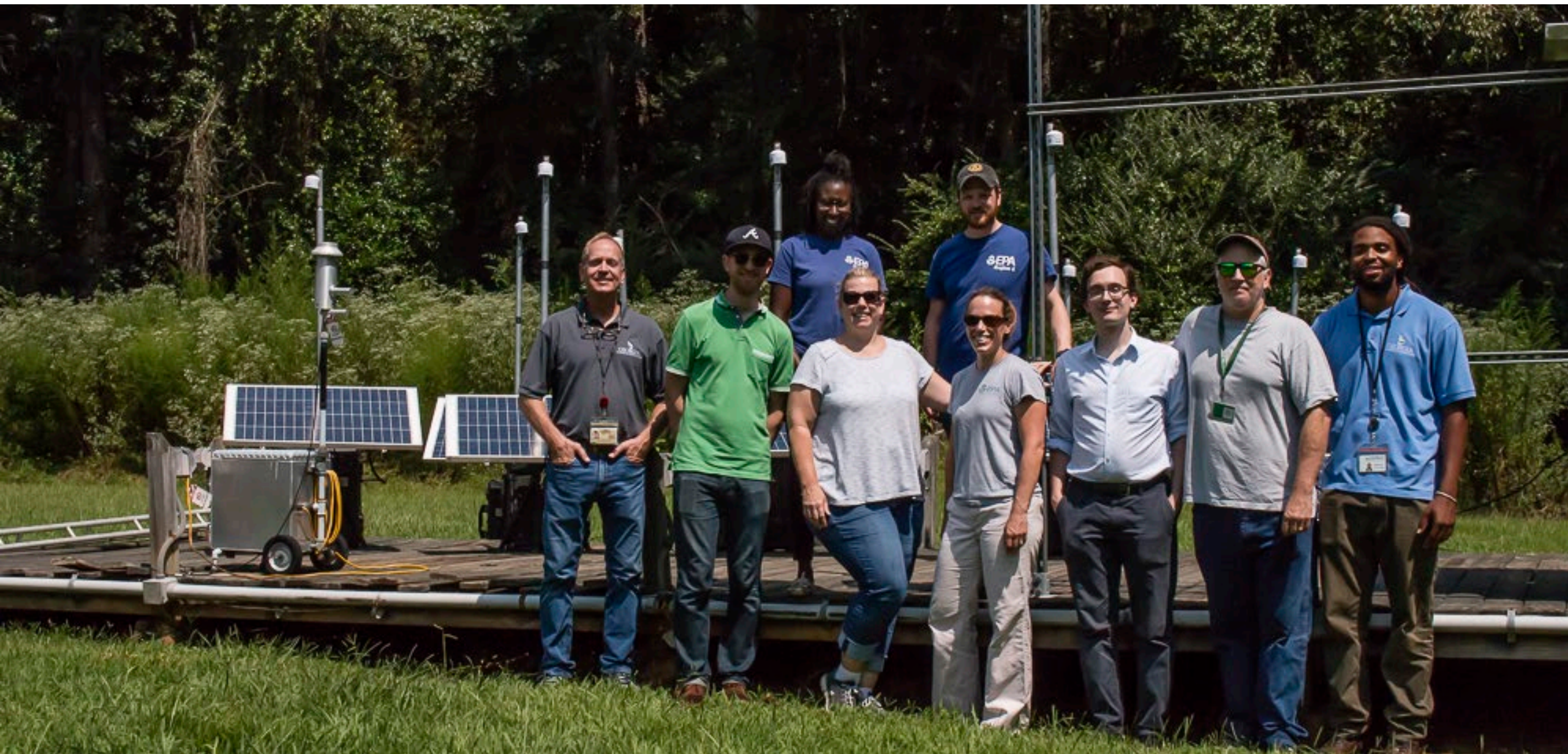


## LESSONS LEARNED:

# Data Management & Analysis

- Plan data storage and analysis procedures and roles early in the project
- Attempt to use existing tools
  - Air sensor toolbox
  - Sensor manufacturer
- Consider partnering with academia or an air pollution agency for customized data analysis
- Consider using an existing weather station (e.g. airport, NOAA) if representative of the project area
- Recommend using the EPA national correction equation or developing a sensor-specific correction equation
- Check for humidity drift, since if undetected it could affect the final data interpretation

# Questions?



# References

1. Barkjohn, K. K., Gantt, B., and Clements, A. L.: *Development and application of a United States-wide correction for PM<sub>2.5</sub> data collected with the PurpleAir sensor*, *Atmos. Meas. Tech.*, 14, 4617–4637, <https://doi.org/10.5194/amt-14-4617-2021>, 2021.
2. Duvall, R., A. Clements, G. Hagler, A. Kamal, Vasu Kilaru, L. Goodman, S. Frederick, K. Johnson Barkjohn, I. VonWald, D. Greene, and T. Dye. *Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors: Use in Ambient, Outdoor, Fixed Site, Non-Regulatory Supplemental and Informational Monitoring Applications*. U.S. EPA Office of Research and Development, Washington, DC, EPA/600/R-20/280, 2021. URL [https://cfpub.epa.gov/si/si\\_public\\_record\\_Report.cfm?dirEntryId=350785&Lab=CEMM](https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=350785&Lab=CEMM)