QA for specific gas and PM sensor applications: device siting

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Monitor Siting

USEPA provides…

- Extensive *location* criteria for air monitoring stations
- Criteria for monitor probe and sampler placement

- **How do existing criteria map onto low-cost sensor (LCS) devices?**
- Today's presentation
  - Case studies
  - Reflections rather than answers

EPA Siting Criteria – Regulatory Context

40 CFR Appendix E to Part 58
Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

1. Introduction
2. Horizontal and Vertical Placement
3. Spacing from Minor Sources
4. Spacing From Obstructions
5. Spacing From Trees
6. Spacing From Roadways
7. Cumulative Interferences on a Monitoring Path
8. Maximum Monitoring Path Length
9. Probe Material and Pollutant Sample Residence Time
10. Waiver Provisions
11. Summary
12. References

Recommended reading!

- **Good orientation to general concerns and considerations**
  - **e.g., gas scavenging by nearby surfaces, obstructions affecting airflow**

Case Study #1 – Obstructions at Residential setting

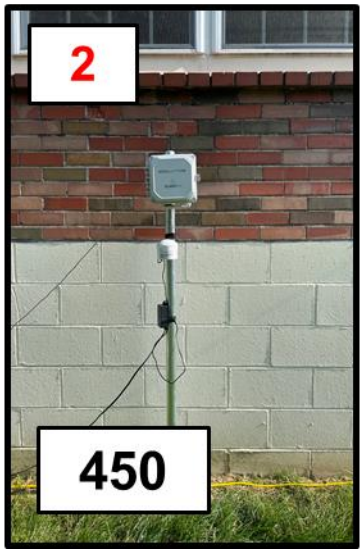
PM monitoring in residential area

far from local sources

- 6/01/2023 – 7/09/2023
- **QuantAQ Modulair-PM**
- PurpleAir

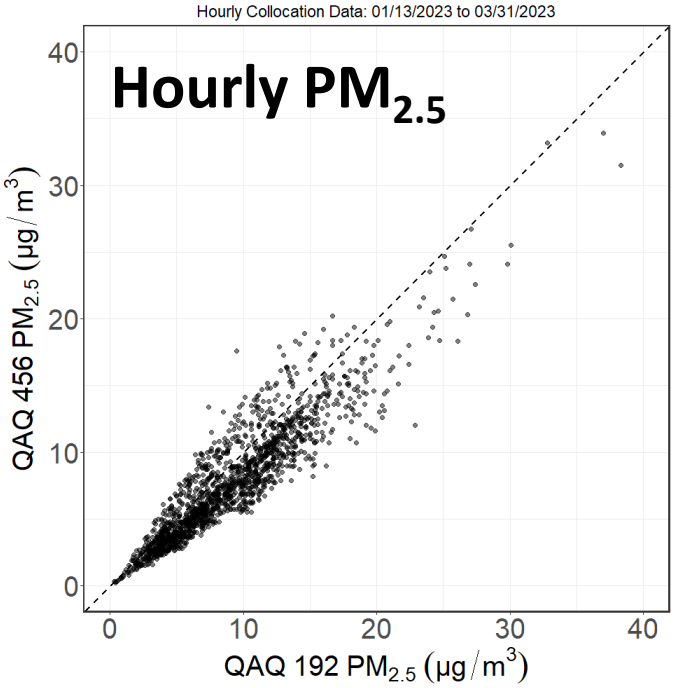
Probe height ~1.5m

Wall-monitor gap < 20cm

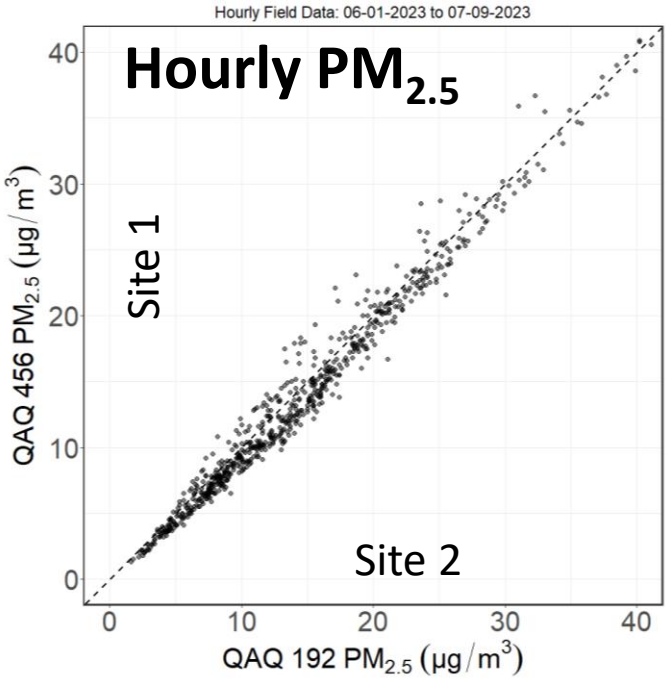


Data tighter at residence than collocation site!

Collocation: 1/13/2023 – 3/31/2023

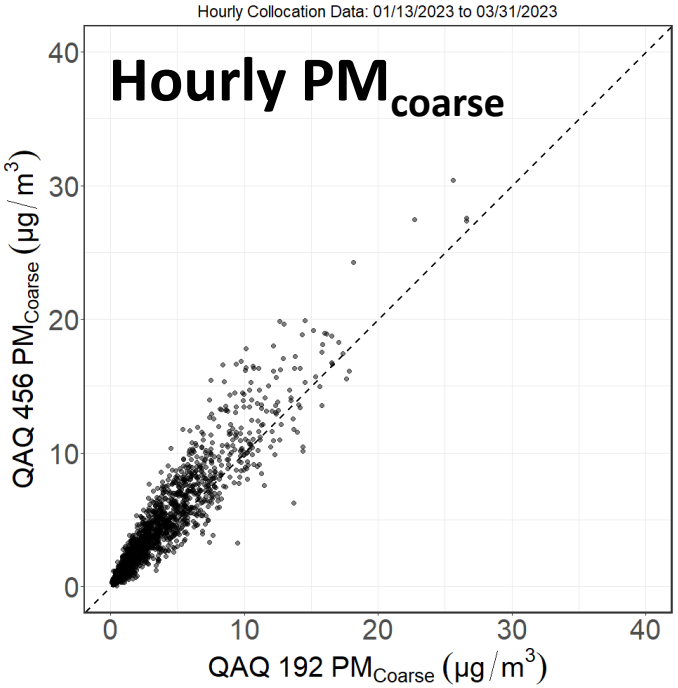


Residential Monitoring: 6/28/2023-7/7/2023

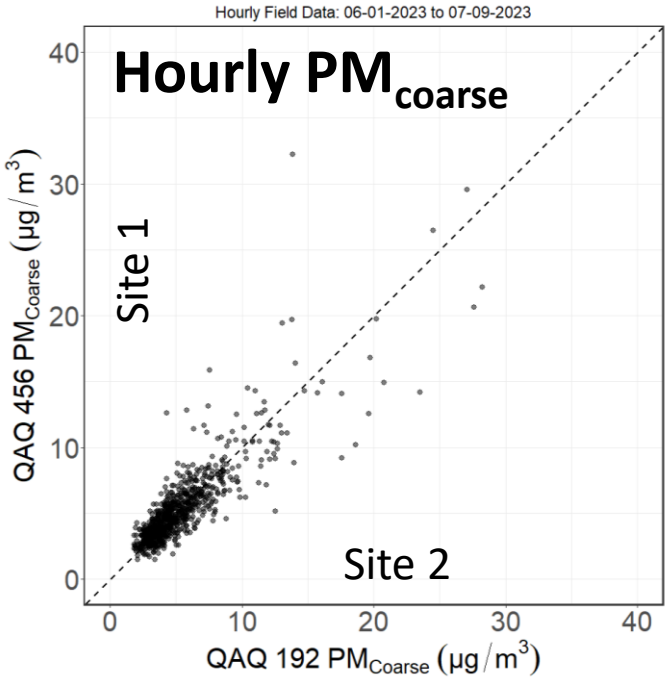


Coarse PM shows comparable patterns

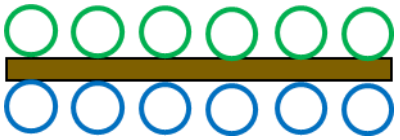
Collocation: 1/13/2023 – 3/31/2023



Residential Monitoring: 6/28/2023-7/7/2023



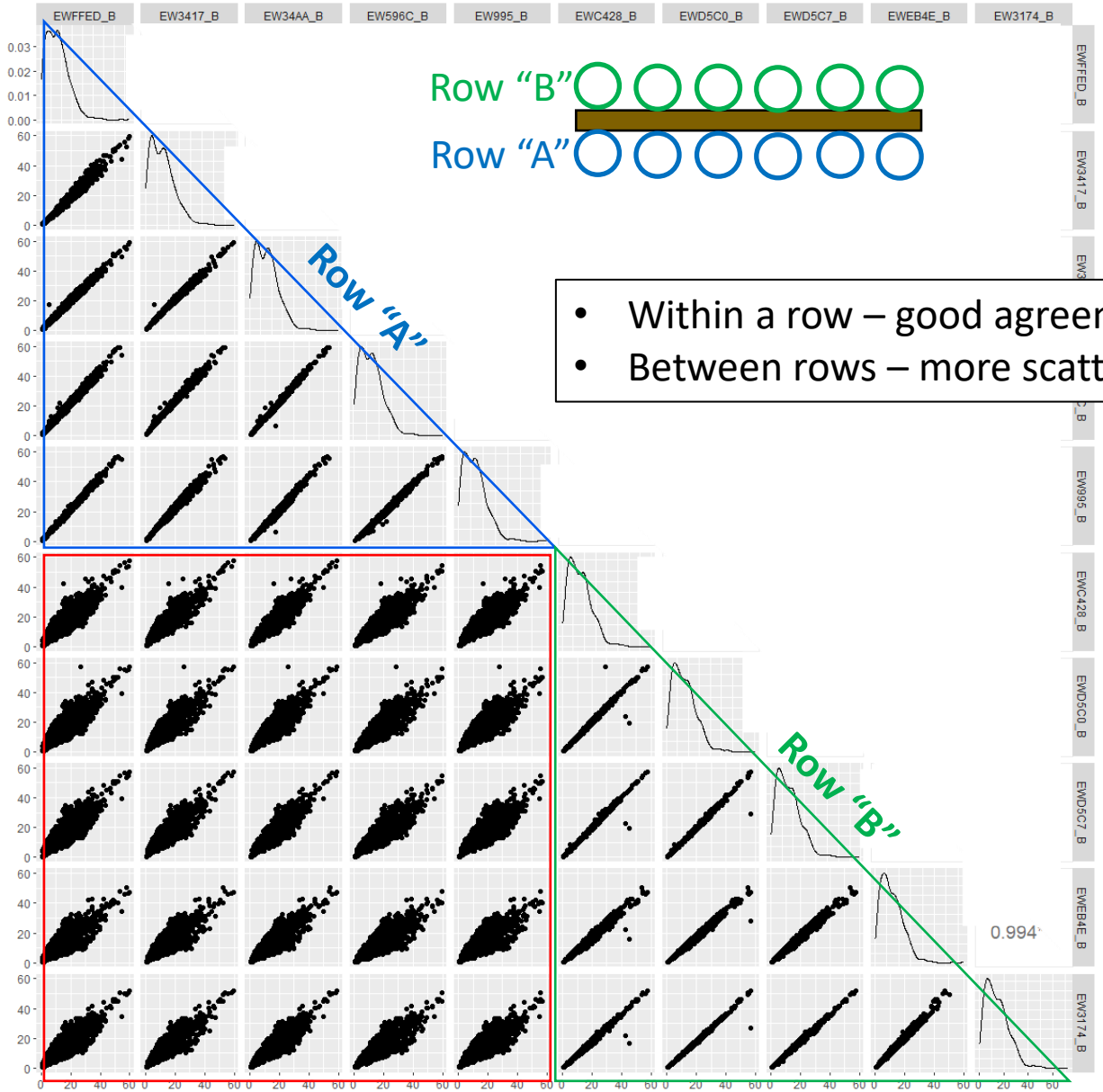
Case Study #2 – Collocated LCS Devices



TOP VIEW

- PurpleAir LCS devices
- Missouri DNR Ncore station, St. Louis, MO
- 1/22/2021 – 3/14/2021
- Show data only for the ten devices later moved to Louisville, KY

PurpleAir 1-Hour $PM_{2.5}$, axis ranges 0-60 µg/m³

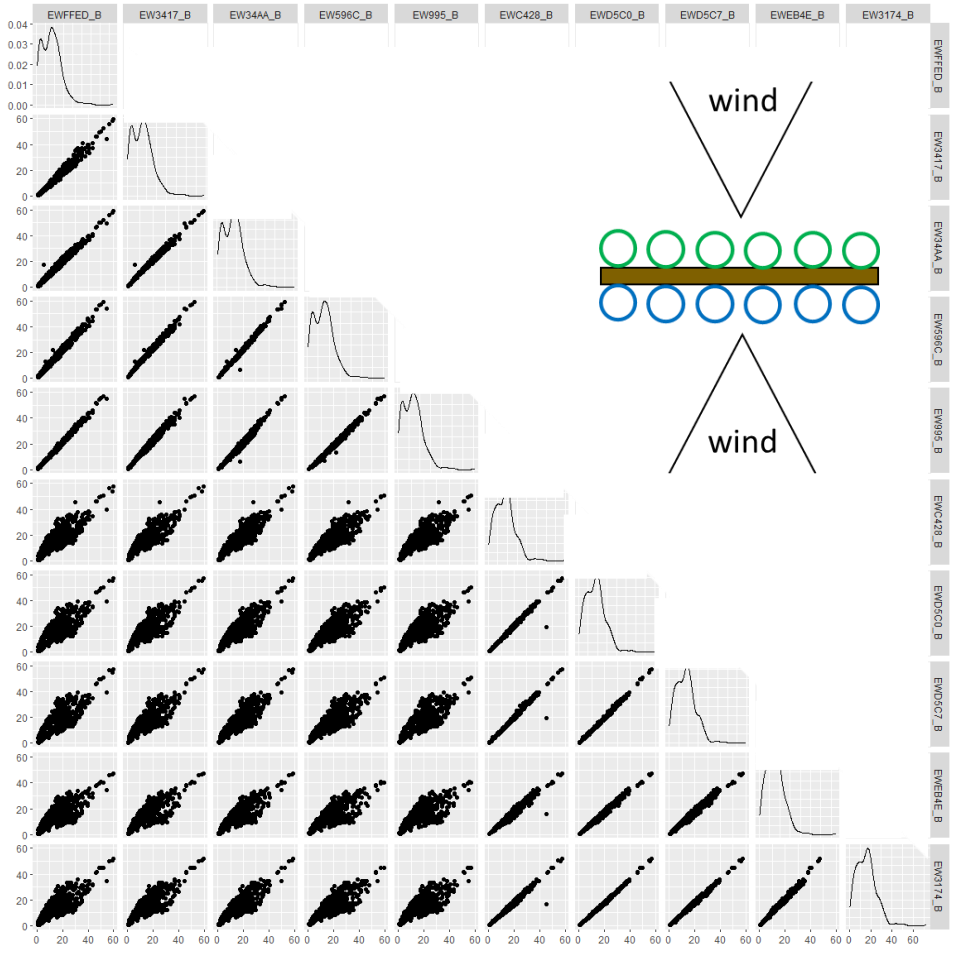


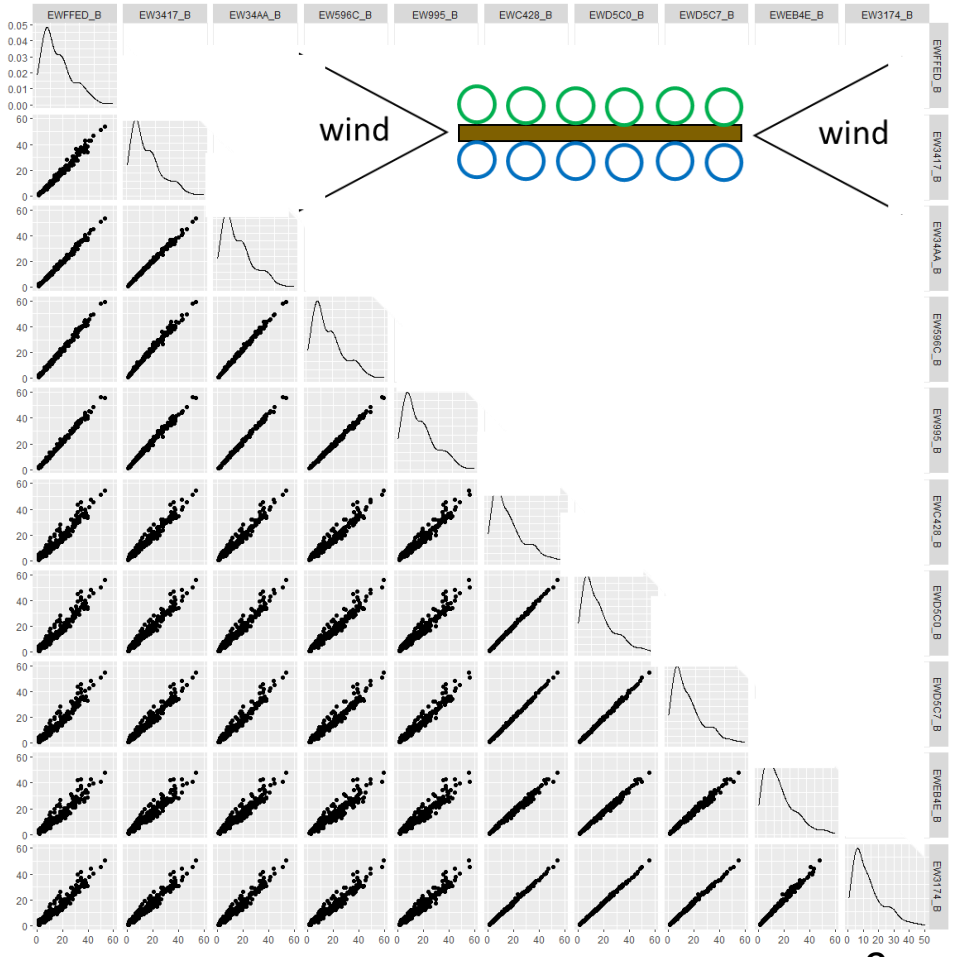
- Within a row – good agreement
- Between rows – more scatter

Row "A"
-vs-
Row "B"

PurpleAir 1-Hour $PM_{2.5}$ stratified by wind direction

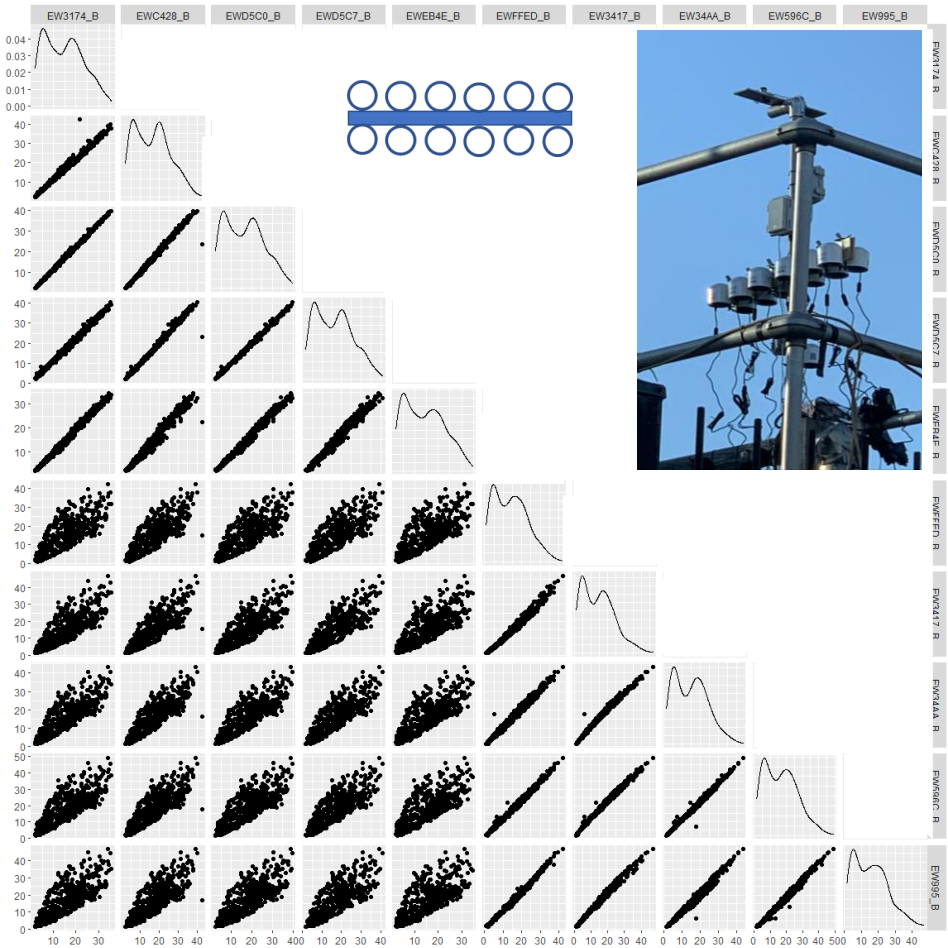
- Collocated precision sensitive to layout-to-wind orientation





PurpleAir 1-Hour $PM_{2.5}$ for different device layouts

Saint Louis, MO* (1/22/2021 – 3/14/2021)



Louisville, KY** (4/13/2021 – 6/2/2021)

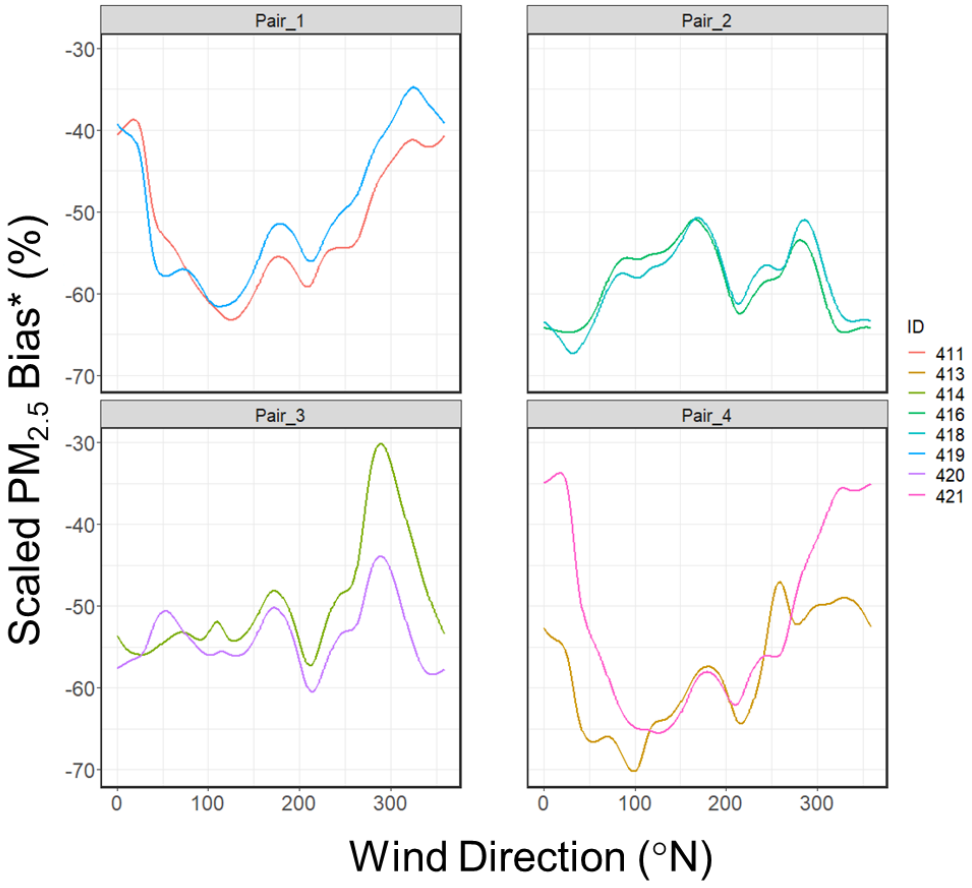
* axes ranges (0-40 μg/m^3) zoomed in compared to previous sides (0-60 μg/m^3)

** Louisville Metro APCD NCore Station

Case Study #3 – Collocated LCS Devices

- QuantAQ Modulair-PM
- Deployed in pairs with different orientations
- Bias grouped into pairs with wind direction dependence!

Hourly $PM_{2.5}$ Pollution Rose* as Cartesian Plot



* scaled bias with respect to reference monitor (devices to be recalibrated)
** nonparametric wind regression

Summary

From the case studies (do not extrapolate results!)

- PM monitoring at residential site far from sources
  - Data quality insensitive to obstructions (*location* criteria)
- Device mounting, at least in more complex environments, can lead to PM measurement biases

Next Steps

- More comprehensive examination of existing data
- Location criteria studies in a source-oriented environment
- GIS based approach to ranking conformance with location criteria
- Testing of additional device mounting layouts
- Eventually lead to guidance/heuristics?

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