Pairing high- and low-cost sensing technologies to understand cumulative health impacts for fenceline communities

Chester HAP Monitoring and Assessment Project (HAP-MAP)

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- **JHU Measurements Team:** *Ellis Robinson, Mina Tehrani*, Kirsten Koehler, Roger Sheu, Peter DeCarlo
- **JHU Risk Team:** Carolyn Gigot, Andrea Chiger, Keeve Nachman, Tom Burke
- **ARI Mobile Lab Team:** Tara Yacovitch, Ed Fortner, Conner Daube, Megan Claflin, Ben Werden, Kenji Lizardo - and more to come
- **Widener University Host:** Scott Van Bremer
- **Community Partners:** CRCQL, Clean Air Council, Energy Justice, CEP
- **Regulatory Groups:** PA DEP, NJ DEP

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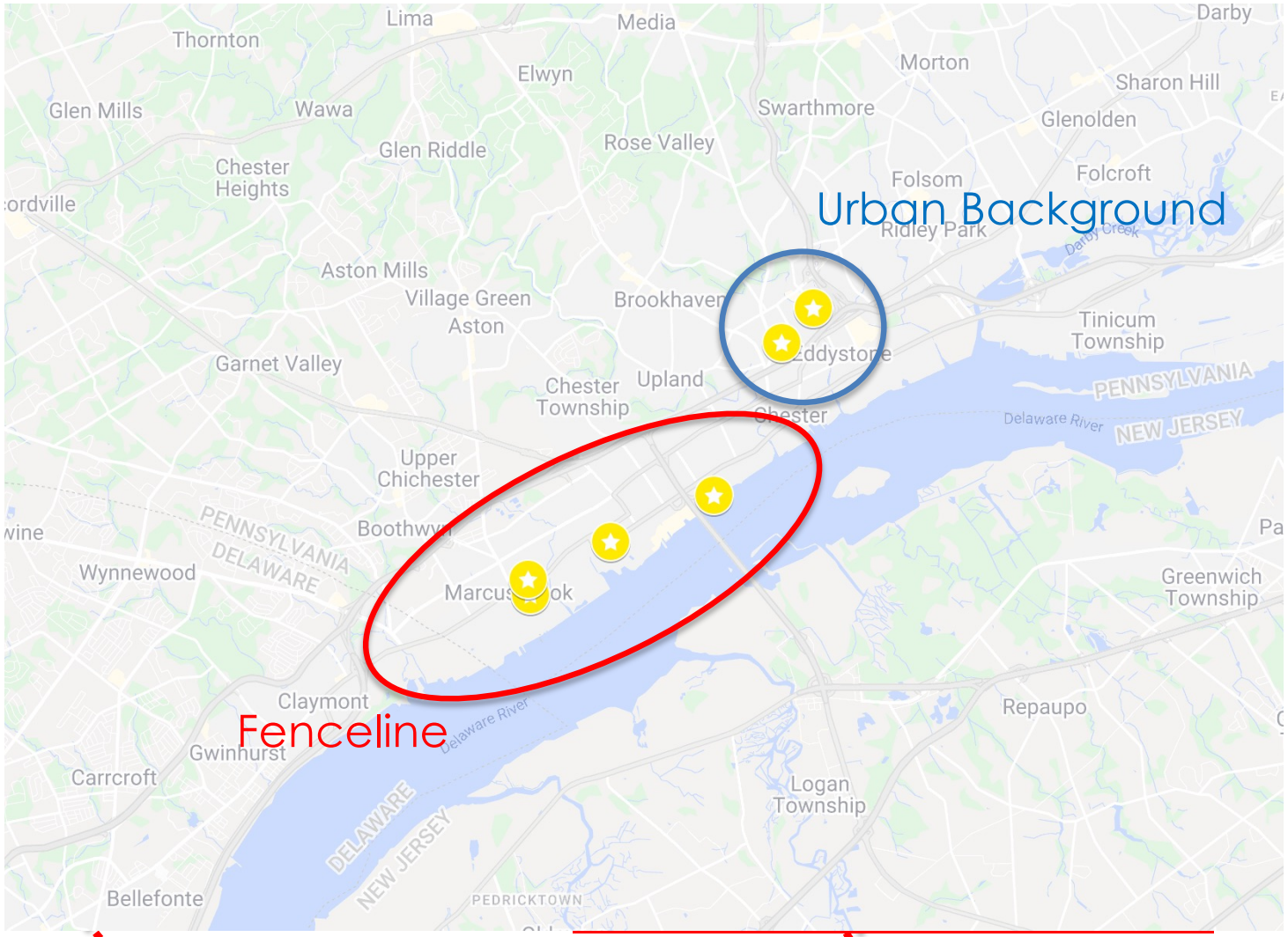
Bloomberg
Philanthropies



Study Area

- Chester, Trainer, Marcus Hook, PA
- Industrial history with booms during WW1/WW2
- Racial segregation from these booms still exists in modern Chester.
- Industry centered around Delaware River waterfront.
- Sensors:
- 2 @ Widener University
- 2 @ PA DEP locations
- 2 @ resident homes

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https://www.google.com/maps/d/viewer?mid=1XTFS8fDM8EDT3lPYc7d1KhvNFtZwP6_v&ll=39.786769259044696%2C-75.42114611200944&z=12

Quant-AQ MODULAIR-PM overview

Key: Combines Nephelometry with OPC for sub and supermicron particle measurements

Data upload through LTE network

Currently on Solar power

MODULAIR™-PM

MODULAIR™-PM provides real-time estimates of particulate matter concentrations (PM_1, $PM_{2.5}$, PM_{10}) and particle size distribution using a novel combination of multiple light scattering-based particle sensors (patent pending). Each unit is internet connected and paired with the QuantAQ Cloud™ to provide real-time data visualization and data access, team management tools, and fleet-wide sensor health diagnostics. MODULAIR™-PM is designed to be used indoors or outdoors and is easily deployed as a standalone unit or as part of a distributed air quality sensor network.

AIR QUALITY MEASUREMENTS

PARAMETER	RANGE	ACCURACY
PM_1, $PM_{2.5}$, PM_{10}	0 to 2,000 $\mu g m^{-3}$	See page 2.
Particle size distribution	0.35 to 40.0 µm (24 bins)	Not yet determined
Temperature	-40 to 85 °C	±0.2°C
Relative Humidity	0 to 100 %	±2 %

FEATURES

- ✓ 2+ years on-board data storage
- ✓ Full access to raw particle sensor data
- ✓ No user-intervention or maintenance required
- ✓ 1min time resolution (cloud), 5s (on-board)

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PM sensors

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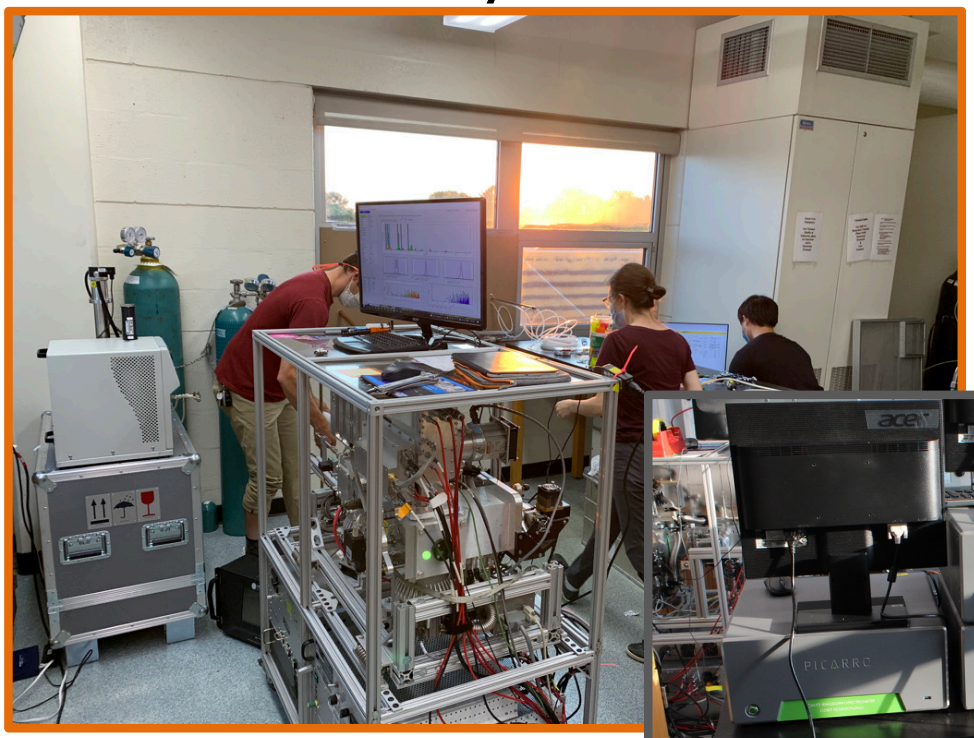
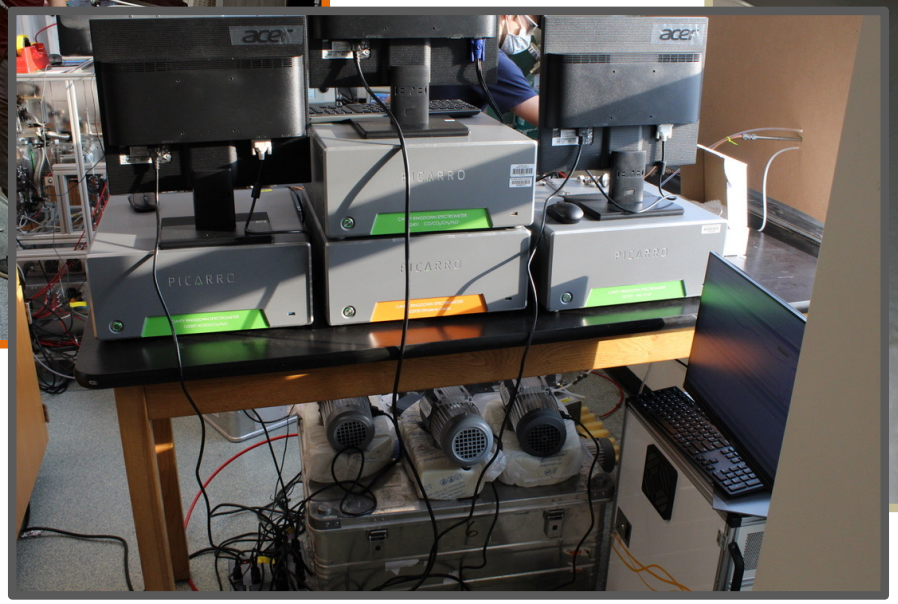
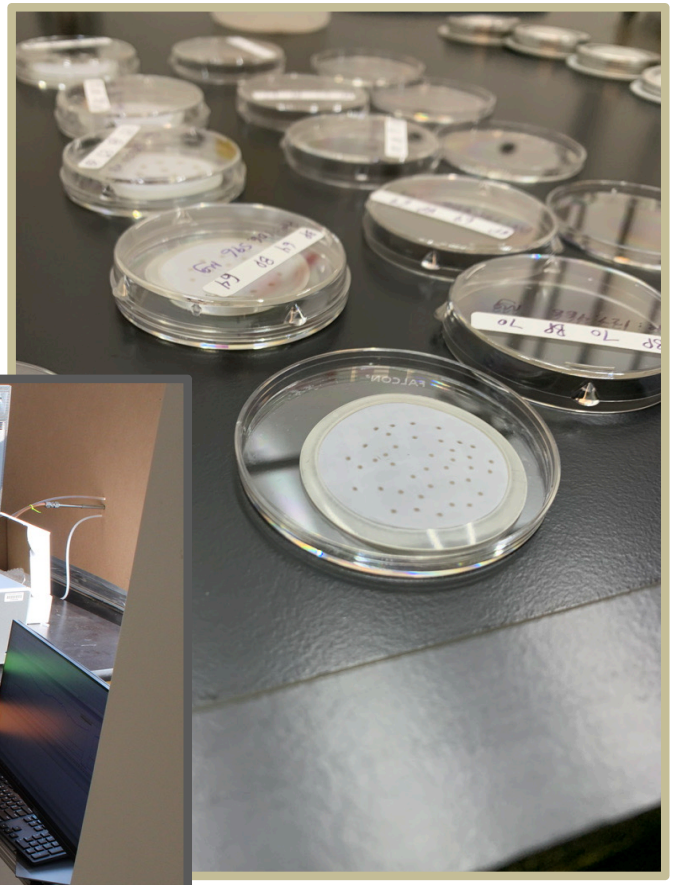
Stationary Site Measurements (Widener U)







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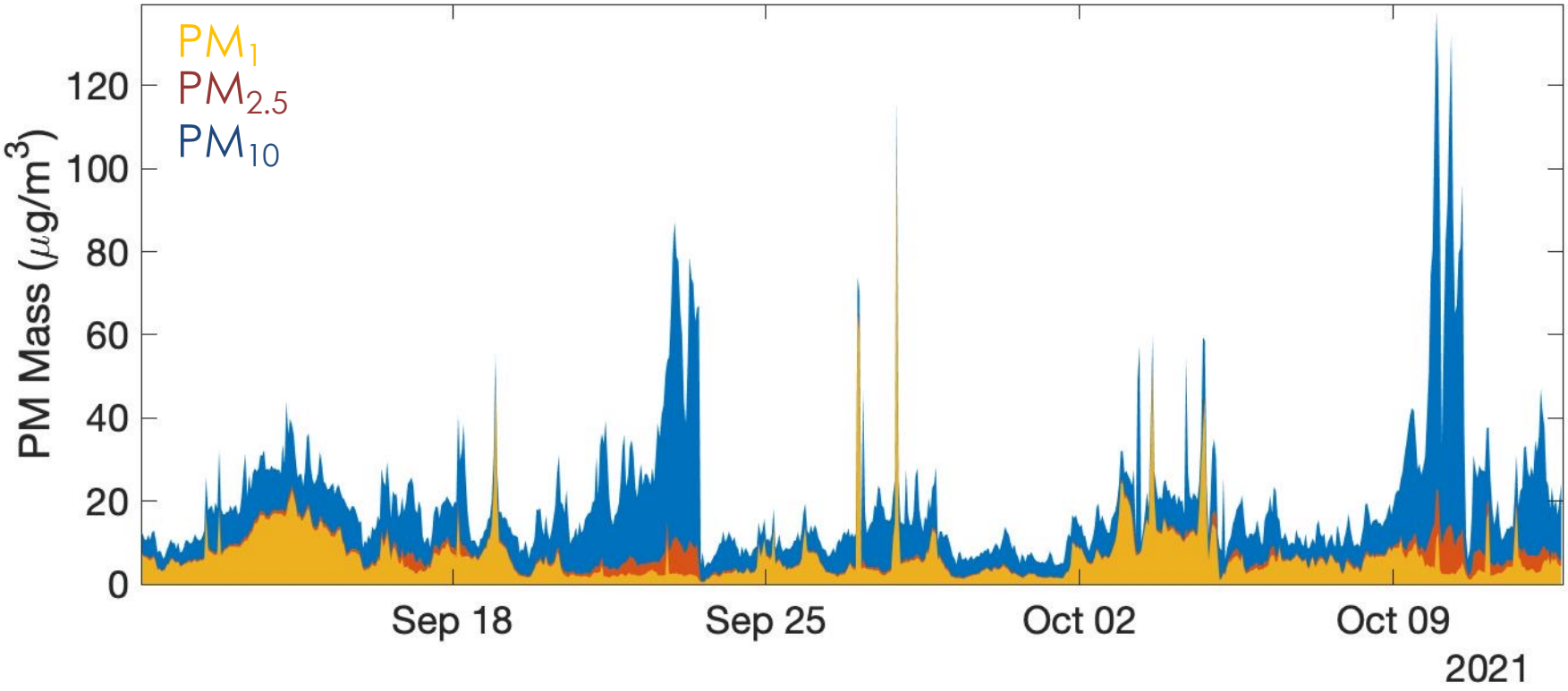
Mobile Measurements

- Plume finding
- Neighborhood Mapping
- Can respond to community complaints quickly
- Will find highest concentrations

Aerodyne Research Mobile Laboratory: Tara Yacovitch (AML PI)

Modulair-PM example data



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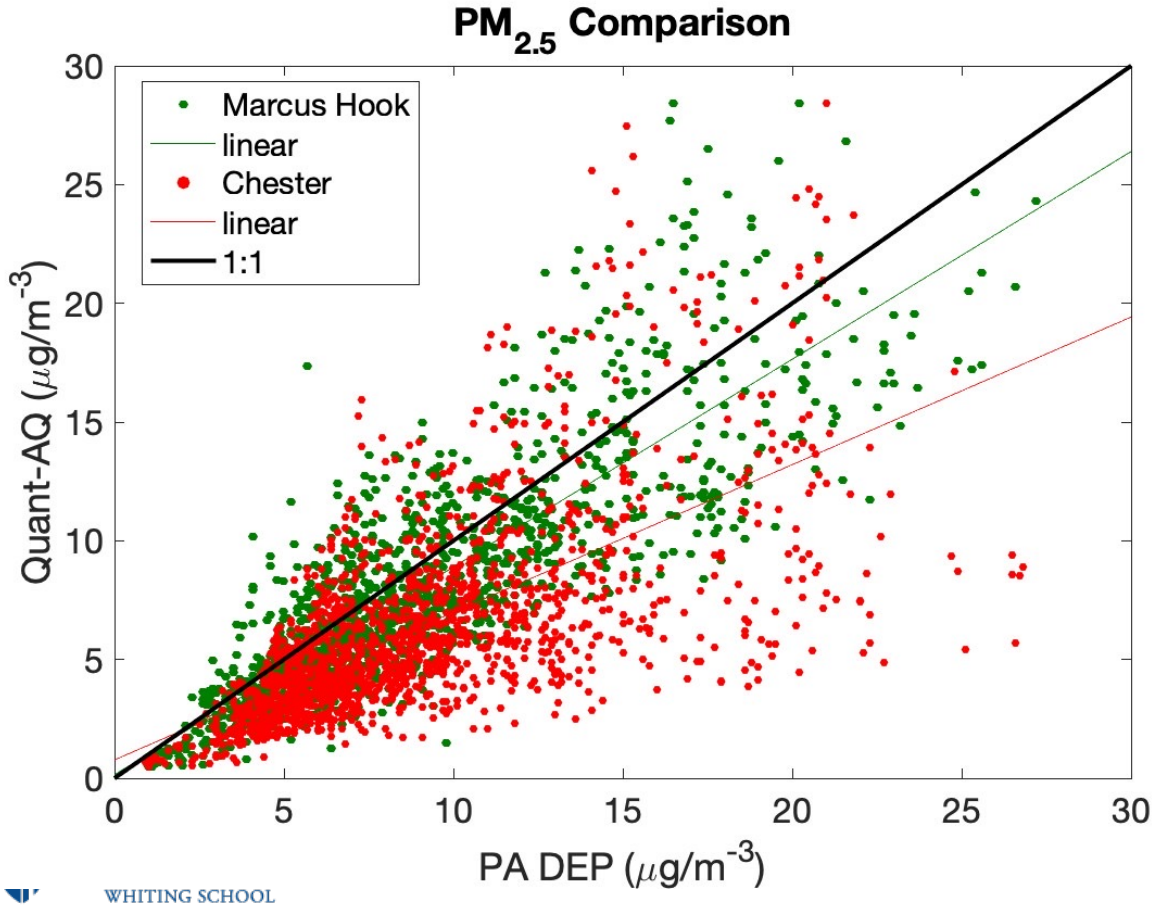
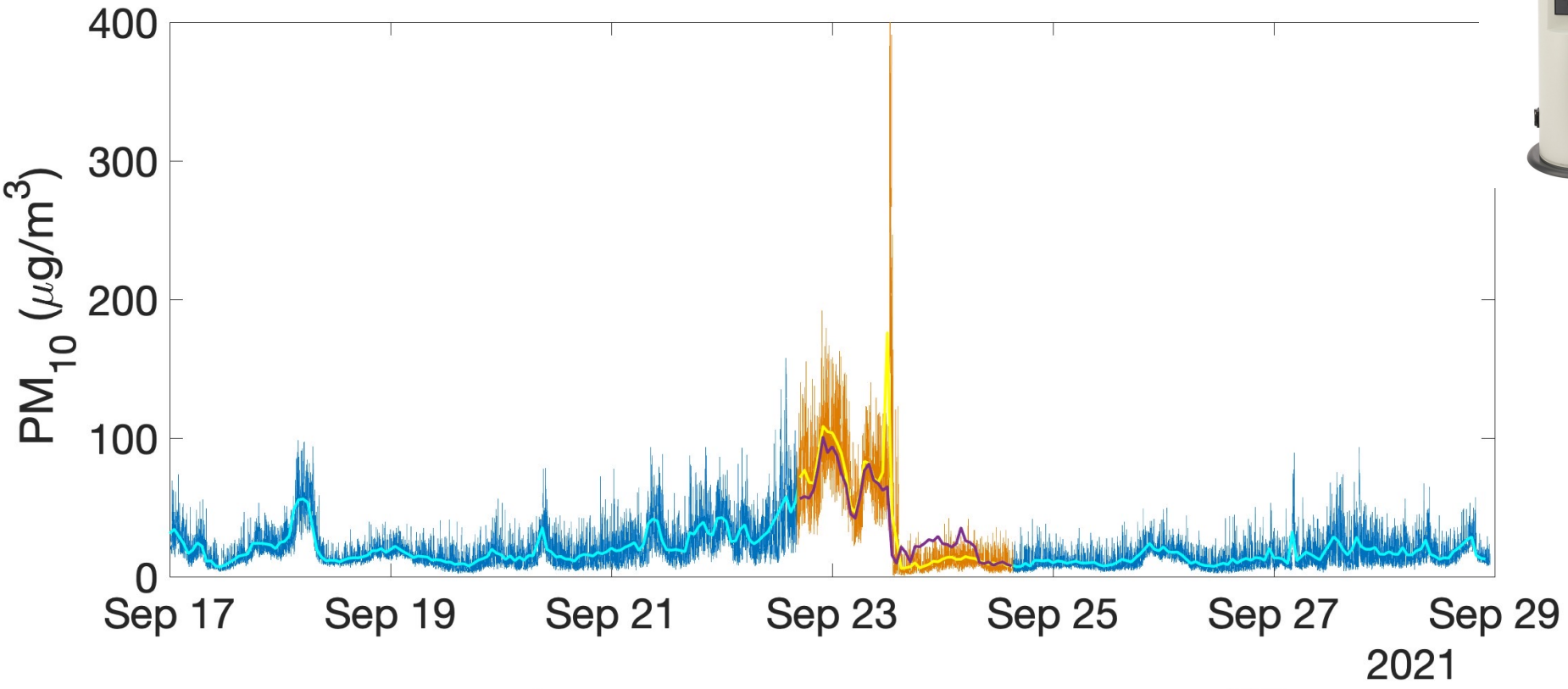
Good agreement for $PM_{2.5}$ with nearby regulatory measurements



RMSE (9/11/21 – 12/08/21):
Chester = 3.53 μg/m^3
Marcus Hook = 2.66 μg/m^3

Good agreement with Gravimetric Samples



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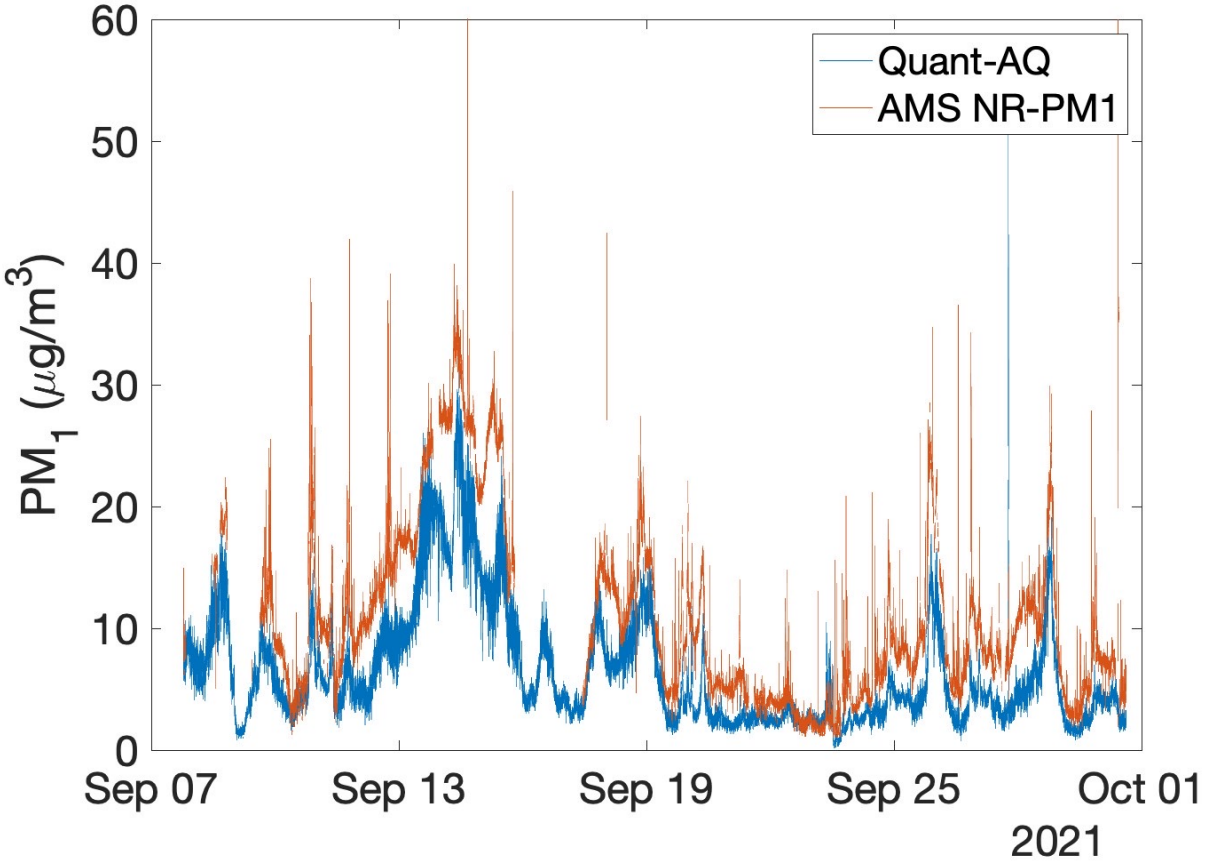
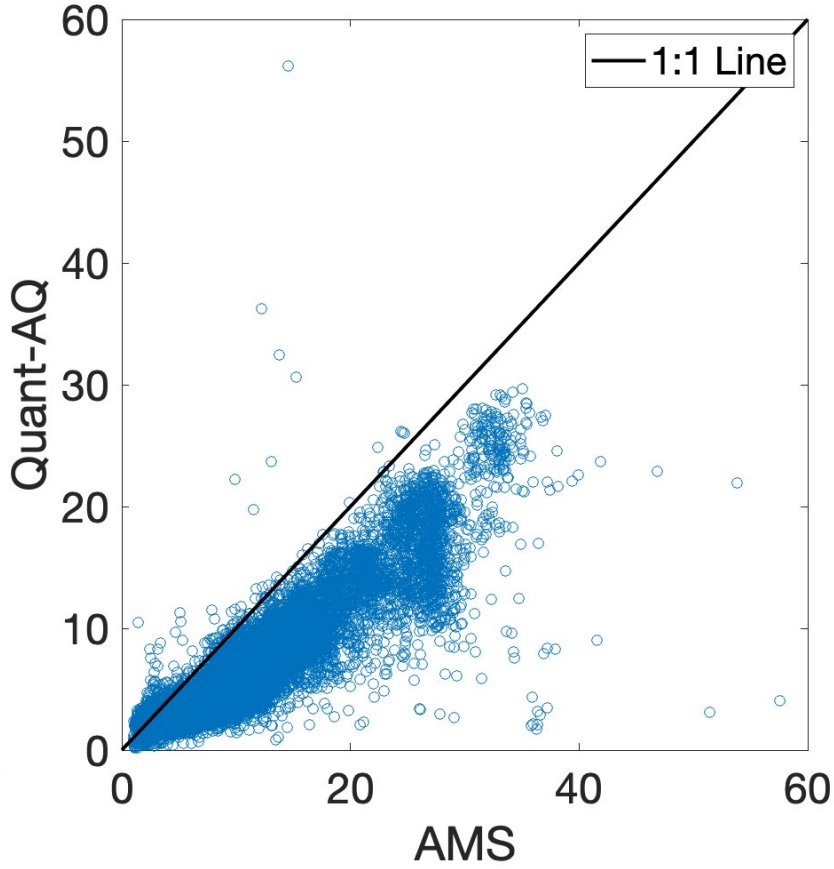
AMS (fixed Site)





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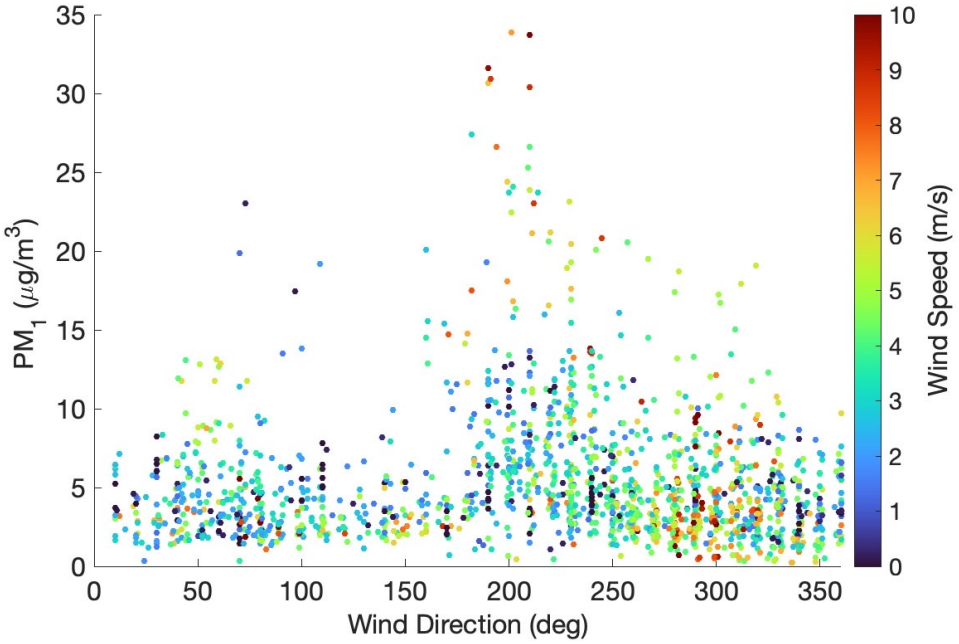
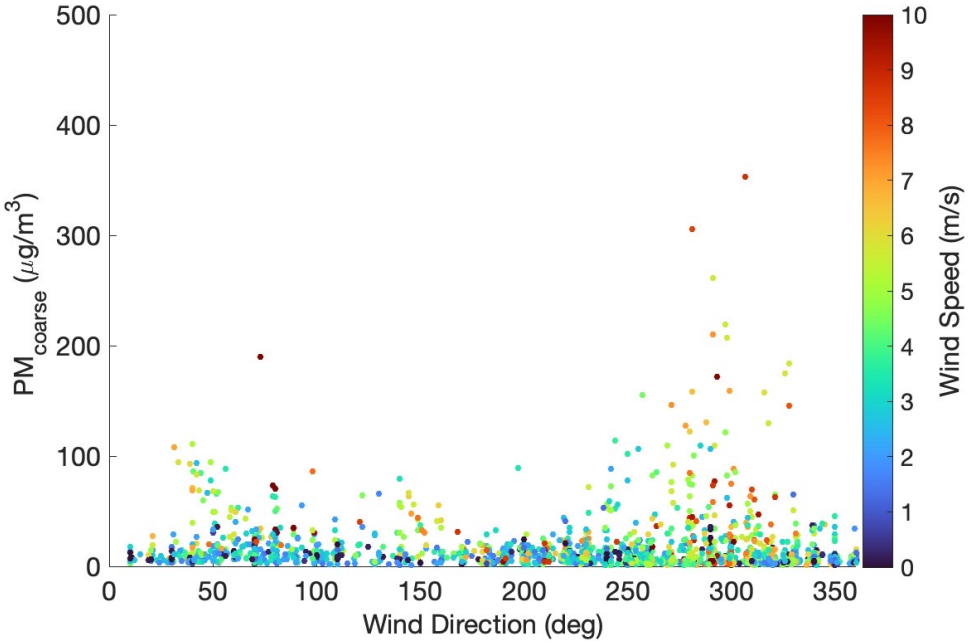
Sensors Identify Peaks from Directions of Sources

PM_1



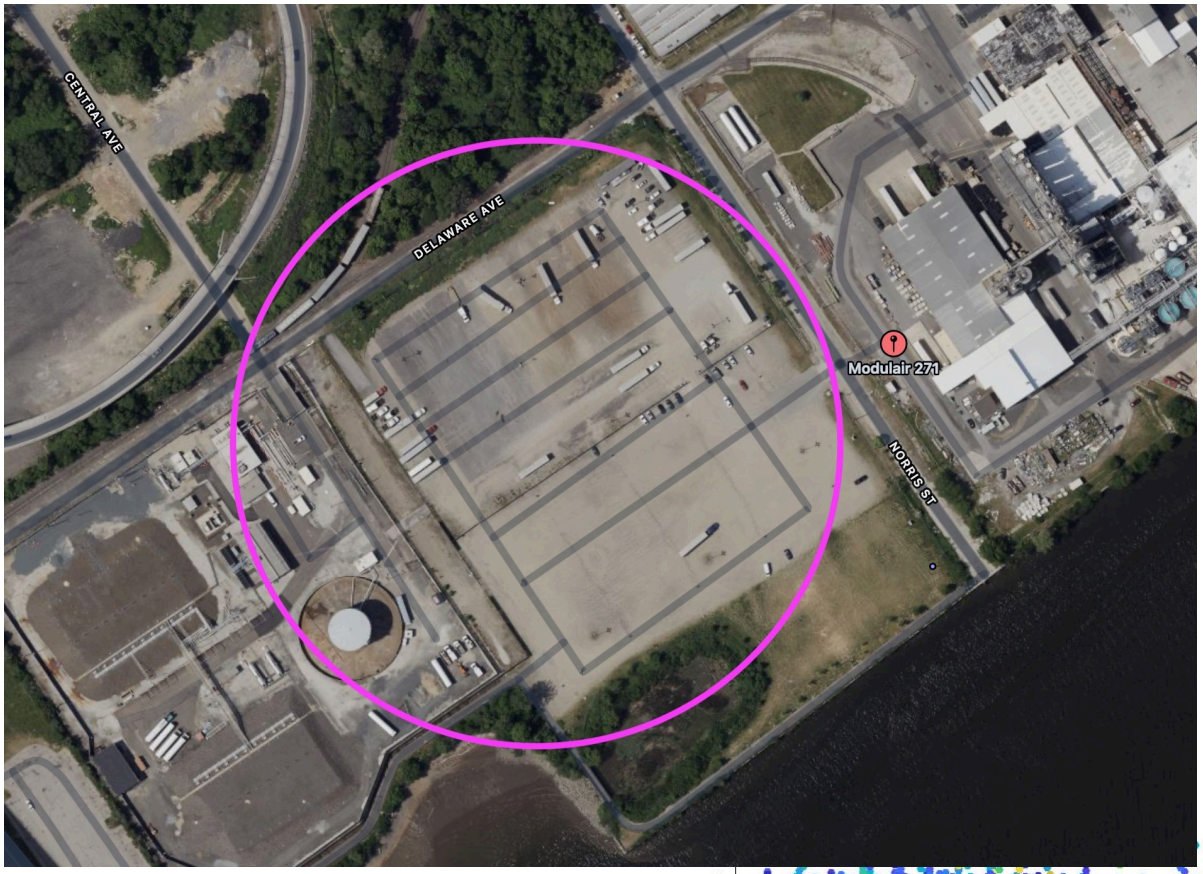
PM_{coarse}

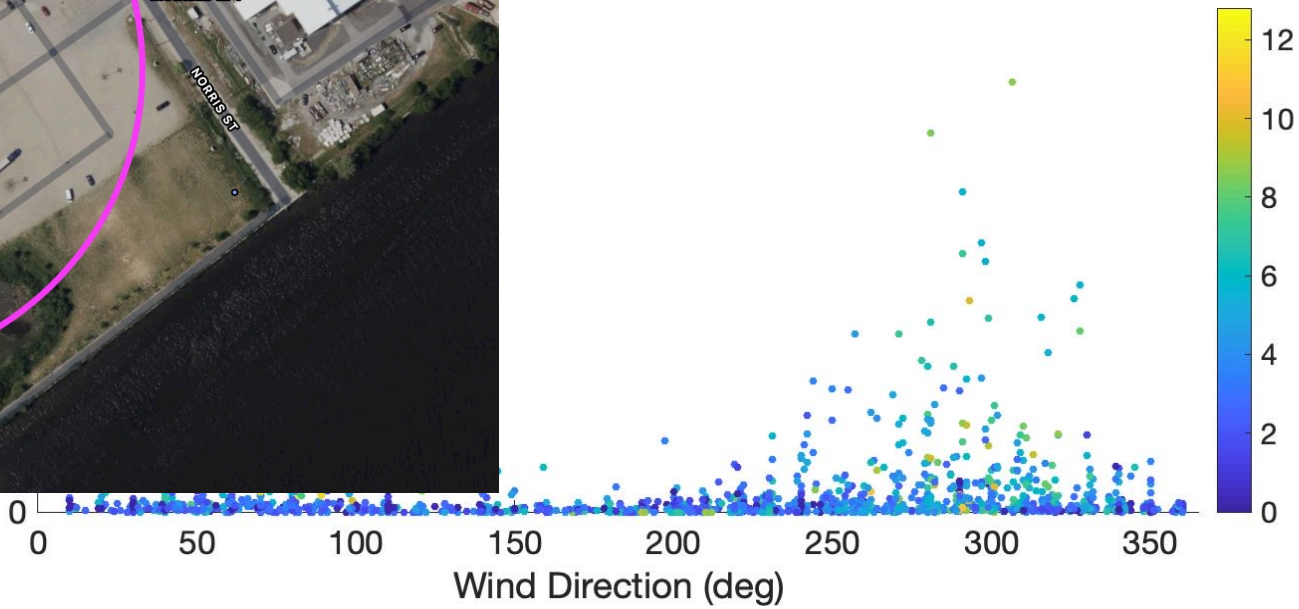


9/11/21 – 12/8/21

Larger particles – sources from NE and W

Chester DEP site – Coarse PM





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Conclusions (to date)

- We are still looking at a lot of data from the fixed site and mobile laboratory datasets
- Quant-AQ shows promising results for measuring coarse PM associated with some industrial operations.
- Low-cost data able to distinguish peaks in times wind comes from prominent sources.