Combining Low-cost Air Quality Sensors with a Micronet for Fine-scale Monitoring in NYC

Ellie Hojeily, JANIE SCHWAB, Jason Covert, Kit Moore,
Matthew Brooking, Sarah Lu, Md. Aynul Bari, Scott Miller

University at Albany, State University of New York

Motivation

Create a high-density air quality monitoring network in the New York City (NYC) Metro Area using low-cost sensors and the New York State Mesonet (NYSM) and NYC Micronet (NYCM)

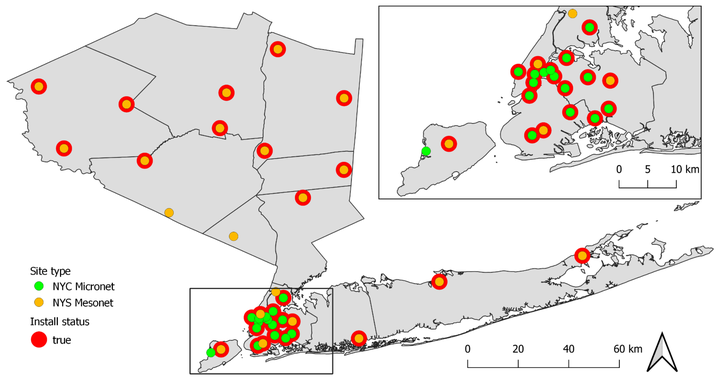

Figure 1. Map NYSM (yellow) and NYCM (green) sites outfitted with low-cost air quality packages. A red outline indicates the package currently has a package deployed

Objectives

1. Design a low-cost sensor package capable of measuring $PM_{2.5}$, CO, NO, NO_2, and O_3
2. Field calibrate low-cost sensors by co-locating with reference instruments located at the Queens College DEC Monitoring Station
3. Deploy sensor packages at 37 sites (22 NYSM and 15 NYCM)

Low-Cost Sensor Package Design

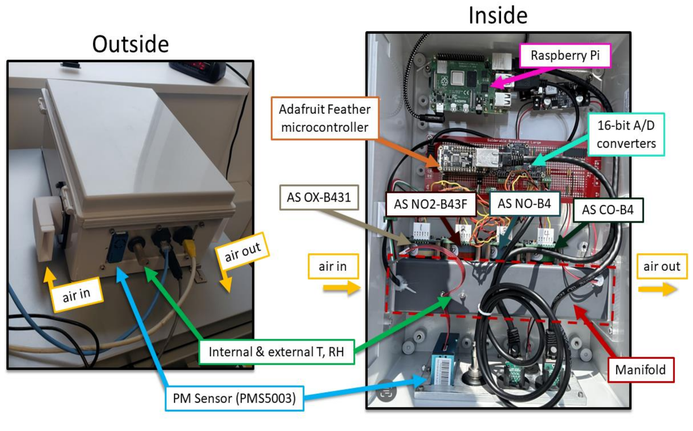

Figure 2. Sensor package design and components. AS indicates AlphaSense.

Calibration

1. Co-locate with reference instruments at Queens College for ~1 month
2. Develop calibration model using multiple linear regression

$$\text{Ref } PM_{25} = \beta_0 + \beta_1 * \text{PM25\_sensor} + \beta_2 * T + \beta_3 * RH$$

3. Evaluate model performance

Table 1. Average Testing Period Performance (34 packages)

Pollutant	This study (2023)		Buehler et al. (2020)	
	R^2	RMSE	R^2	RMSE
$PM_{2.5}$	0.80	2.95 µg/m³	0.82	4.3 µg/m³
CO	0.83	43.3 ppb	0.92	43.0 ppb
NO	0.61	2.2 ppb	0.54	16.0 ppb
NO_2	0.78	4.5 ppb	0.77	5.3 ppb
O_3	0.95	3.9 ppb	0.96	2.9 ppb

Network Monitoring

Daily and hourly heatmaps are used to identify sensor outages

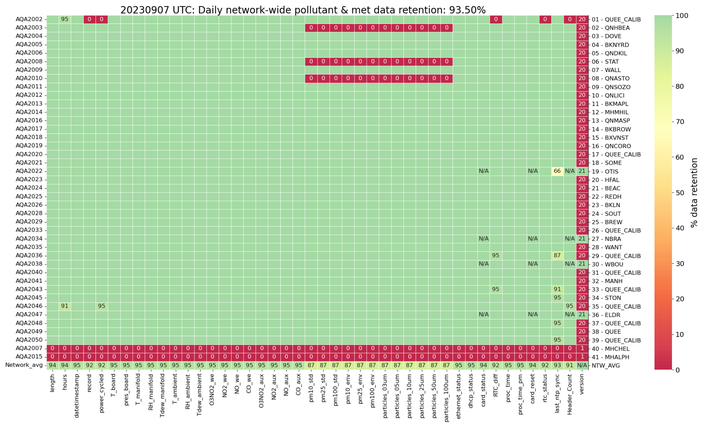

Figure 3. Sample daily network heatmap.

Sample Deployment Sites

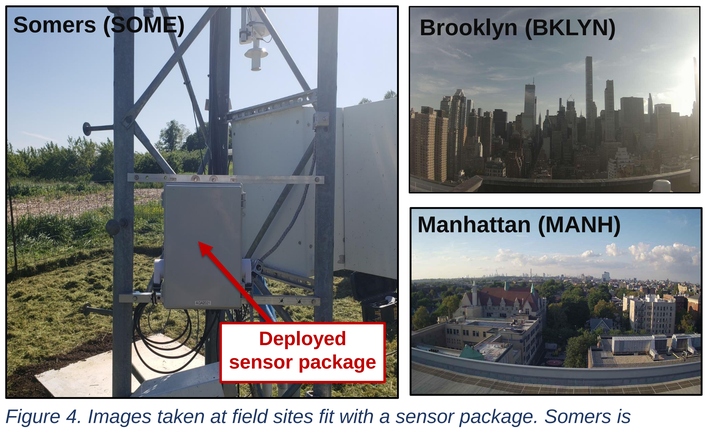

Figure 4. Images taken at field sites fit with a sensor package. Somers is located north of NYC in a rural location. Manhattan and Brooklyn are urban sites located within NYC.

Network Capabilities

All $PM_{2.5}$ Network Observations

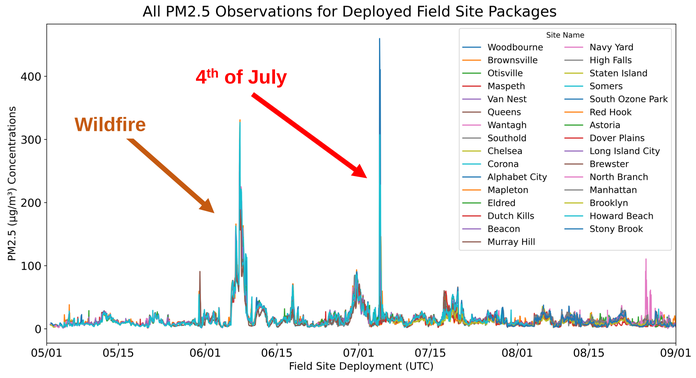

Figure 5. All $PM_{2.5}$ field site observations in 2023.

Sample Ozone Spatial Analysis

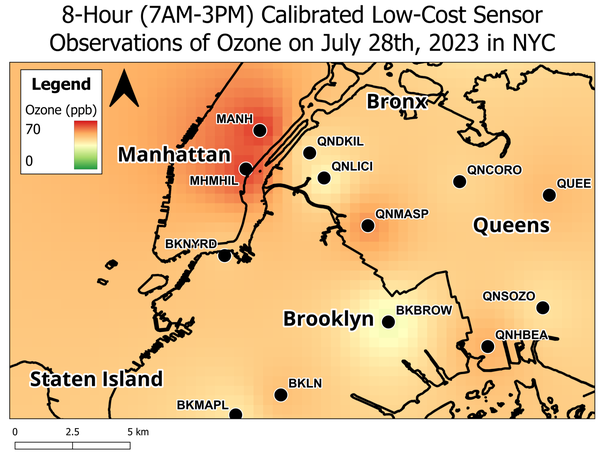

Figure 6. Map of 8-hour averaged calibrated ozone observations.

Canadian Wildfire Observations

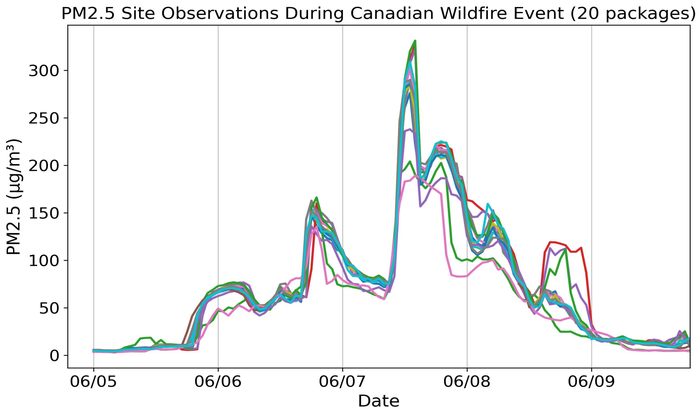

Figure 7. Time-series of calibrated PM2.5 observations during June 6-9 Canadian Wildfire smoke event. Each line is uniquely colored and is representative of data from a single package.

Next Steps

1. Characterize temporal and spatial variation of pollutants and identify sources
2. Fuse observations with a high-res air quality forecast model output

Contact: Ellie Hojeily (ehojeily@albany.edu)

References

Buehler, C., and Coauthors, 2020: Stationary and portable multipollutant monitors for high spatiotemporal resolution air quality studies including online calibration. *Atmospheric Measurement Techniques Discussions*, 1–28, doi:10.5194/amt-2020-217.

Acknowledgements This work was supported by the New York State Energy Research and Development Authority (NYSERDA), [contract number 156228]. NYSERDA has not reviewed the information contained herein, and the opinions expressed in this report do not necessarily reflect those of NYSERDA or the State of New York. Special thanks to the New York State Department of Environmental Conservation. Thanks to Lee Brittle of the NYSM.