Combining Low-Cost Air Quality Sensors with the New York State Mesonet for Fine-Scale Monitoring in New York City

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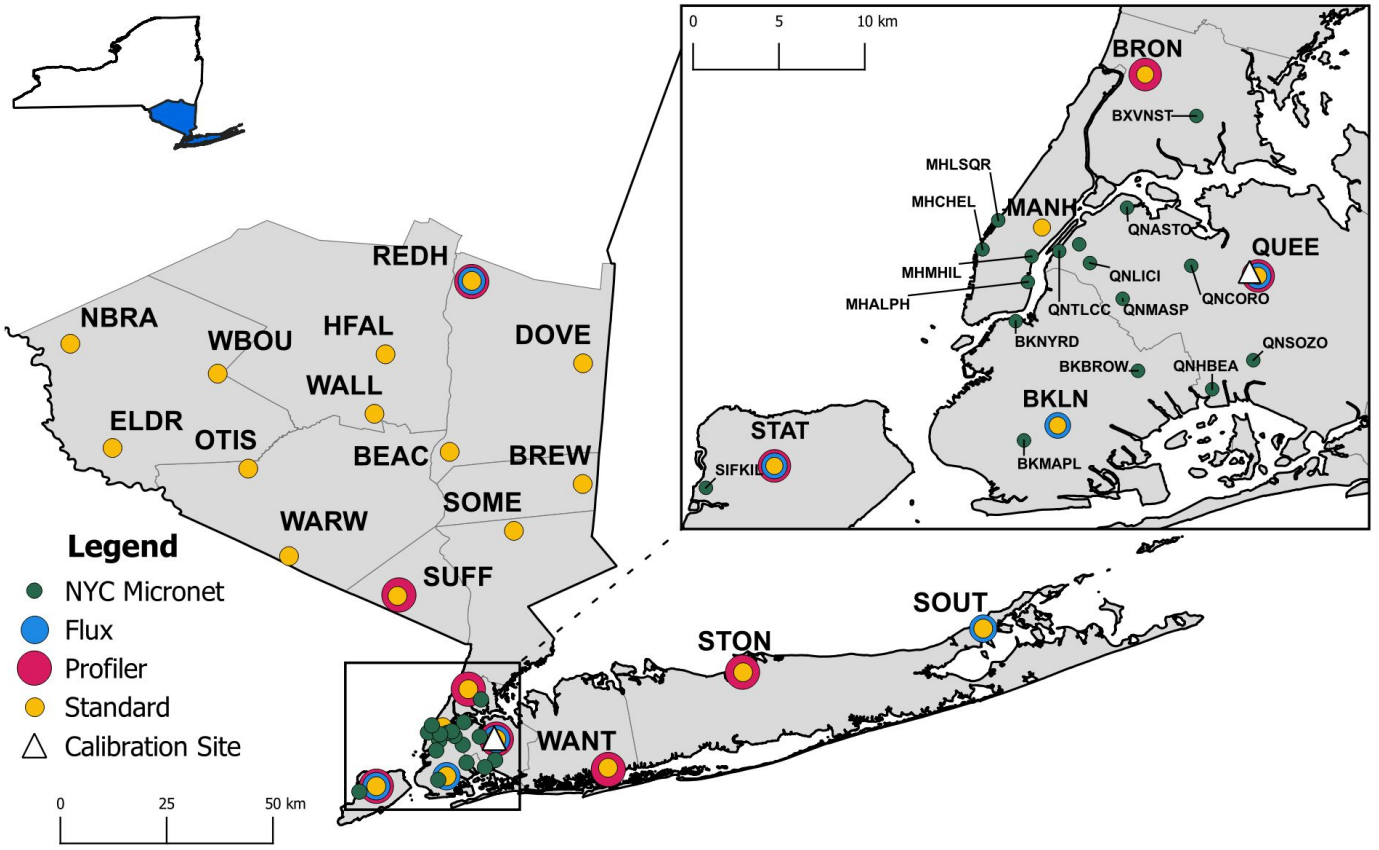
NYS Mesonet

NEW YORK STATE NYSERDA Supported

Objectives

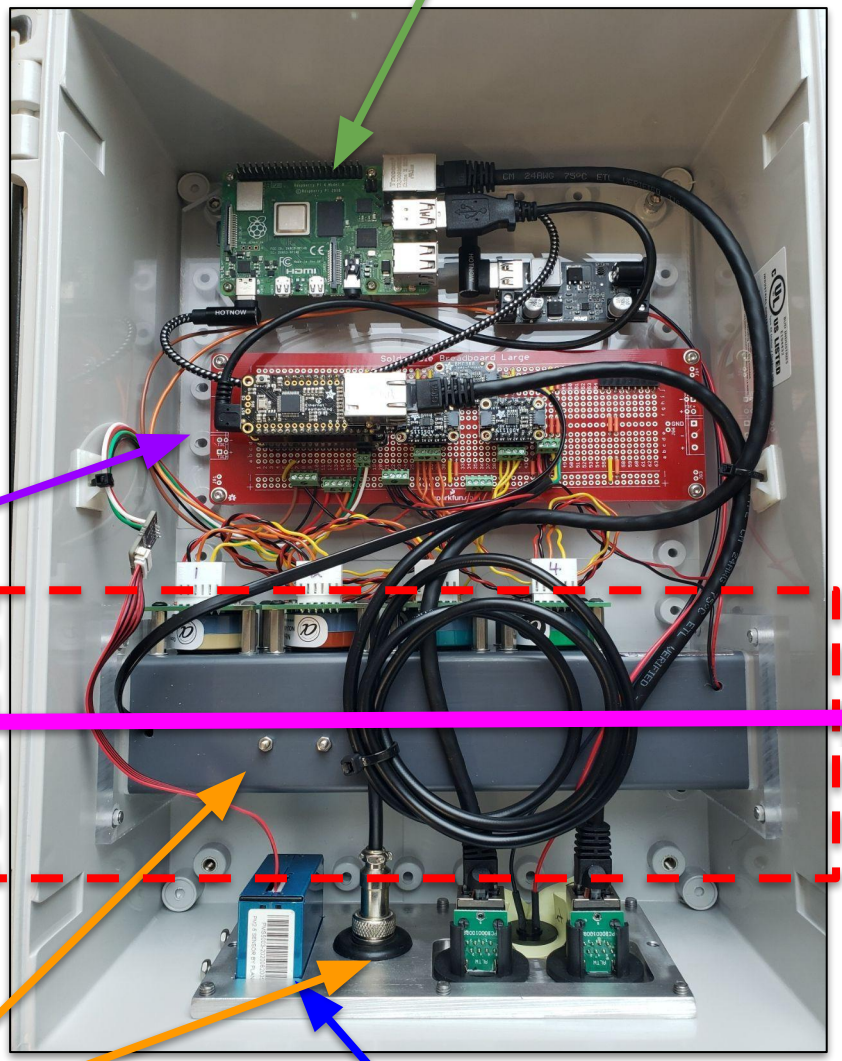
1. **Build** low-cost sensor packages ($PM_{2.5}$, O_3, NO, NO_2, CO)
2. **Calibrate** the low-cost sensors
3. **Deploy** at 38 NYSM field sites in NYC Metro area
   - **21 NYSM (6 Flux, 8 Profiler), 17 NYC Micronet**

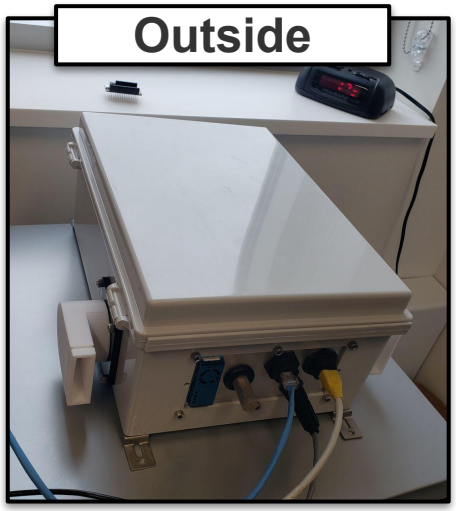


The UAlbany Sensor Package (~$1500)

Variable	Alphasense Sensor
CO	CO-B4
NO	NO-B4
NO_2	NO2-B43F
*O_3 + NO_2	OX-B431

*Estimate O_3 using OX-B431-NO2-B43F





Network Workflow

Recalibrate after 4-12 months

Repair broken packages

UAlbany Lab
Design + produce packages

CALIBRATION SITE
DEC (Queens College)
~30 days

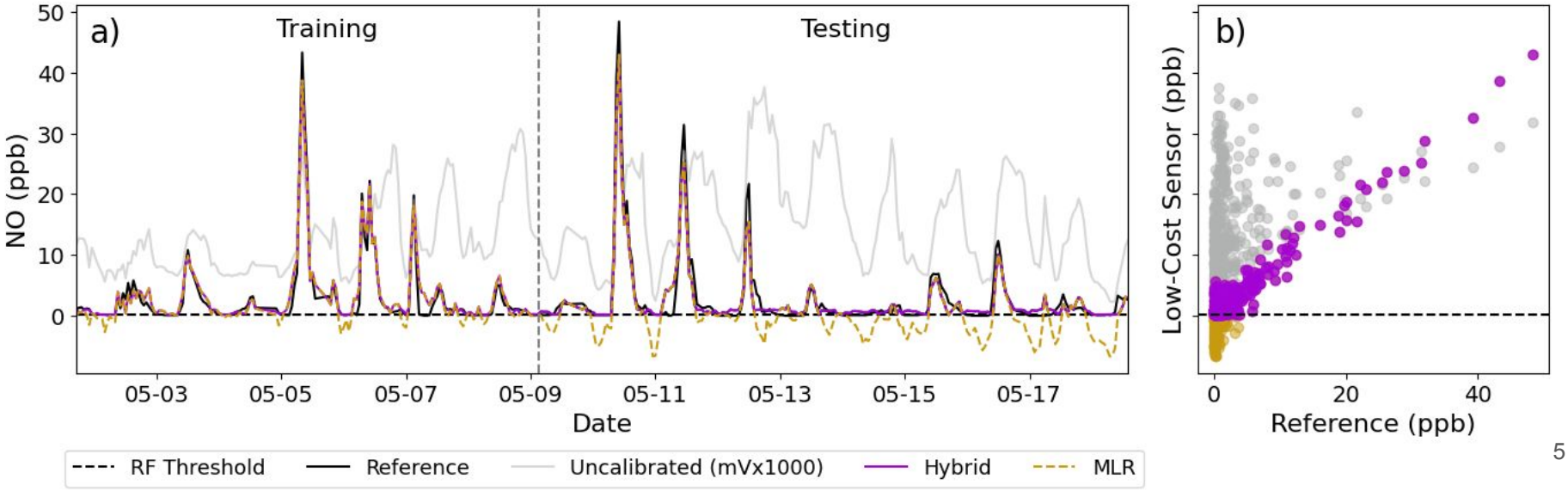
FIELD SITES
4-12+ months

Queens College Calibration Site
20 package capacity

Example Field Site
NYSM - Somers

Why and how do we calibrate low-cost sensors?

- **We calibrate the sensors to account for environmental sensitivities (i.e., meteorology, other pollutants, drift)**
- Field calibration steps:
  - Collect *simultaneous* observations between low-cost sensor and reference instrument
  - Fit calibration model (MLR, Random Forest, hybrid) where the reference concentration is predicted using the low-cost sensor



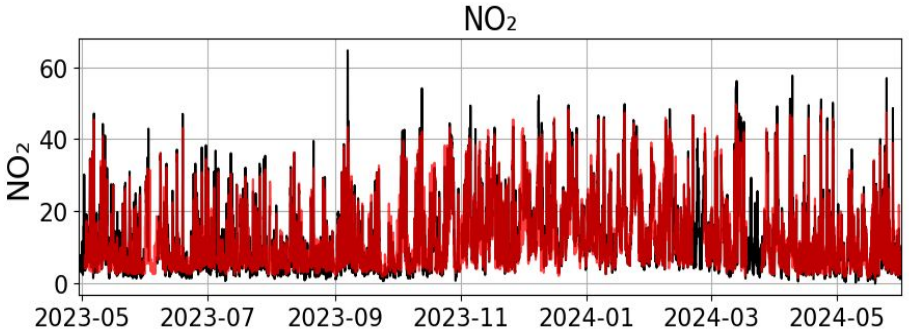
Calibration

- Developed a *single model per pollutant* (“Network” model)

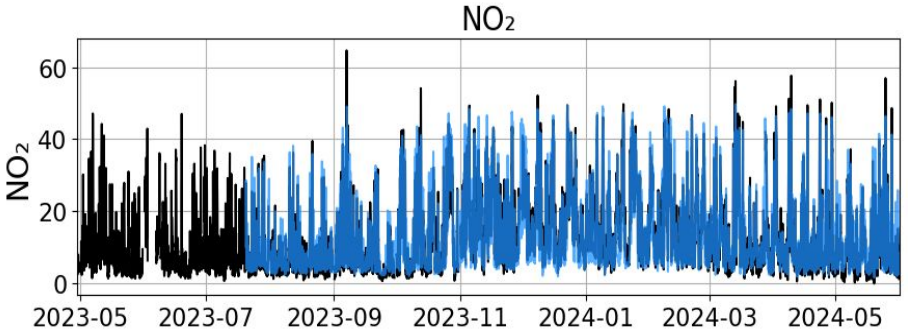
- Trained calibration models on **13+ months of continuous data** from 2 packages permanently installed at Queens College calibration site

- Trained on broader range of environmental conditions + drifted data resulted in better long-term accuracy
  - Hybrid RF-MLR models used for all pollutants except CO

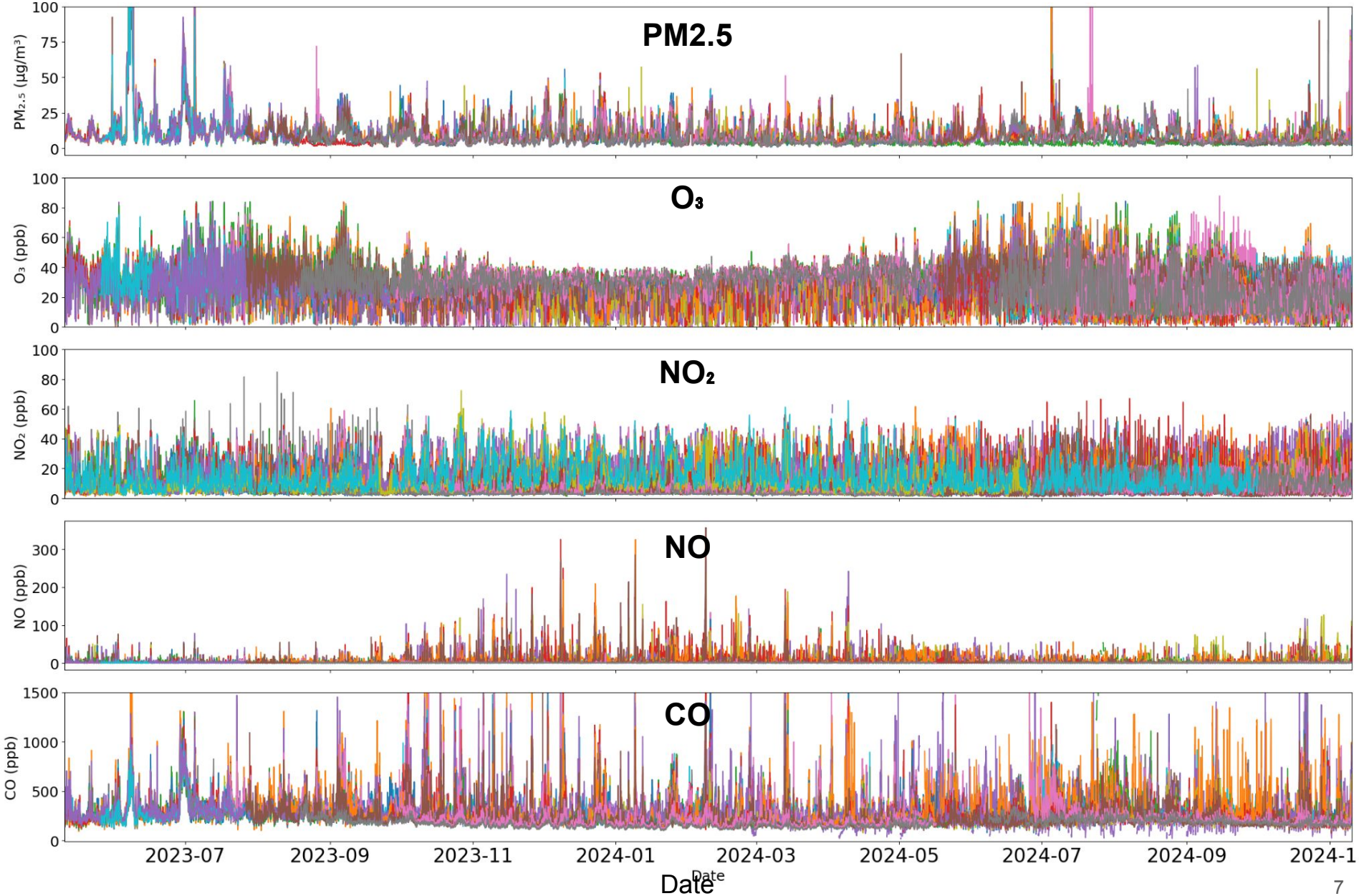
AQA2020 (Training)



Queens NYSM

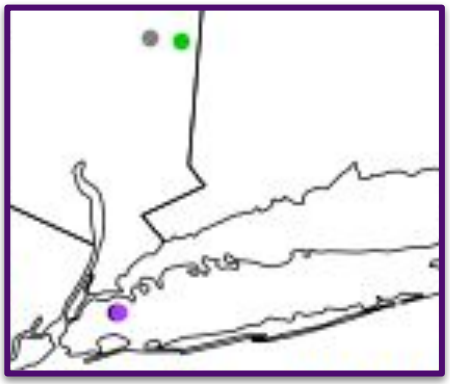


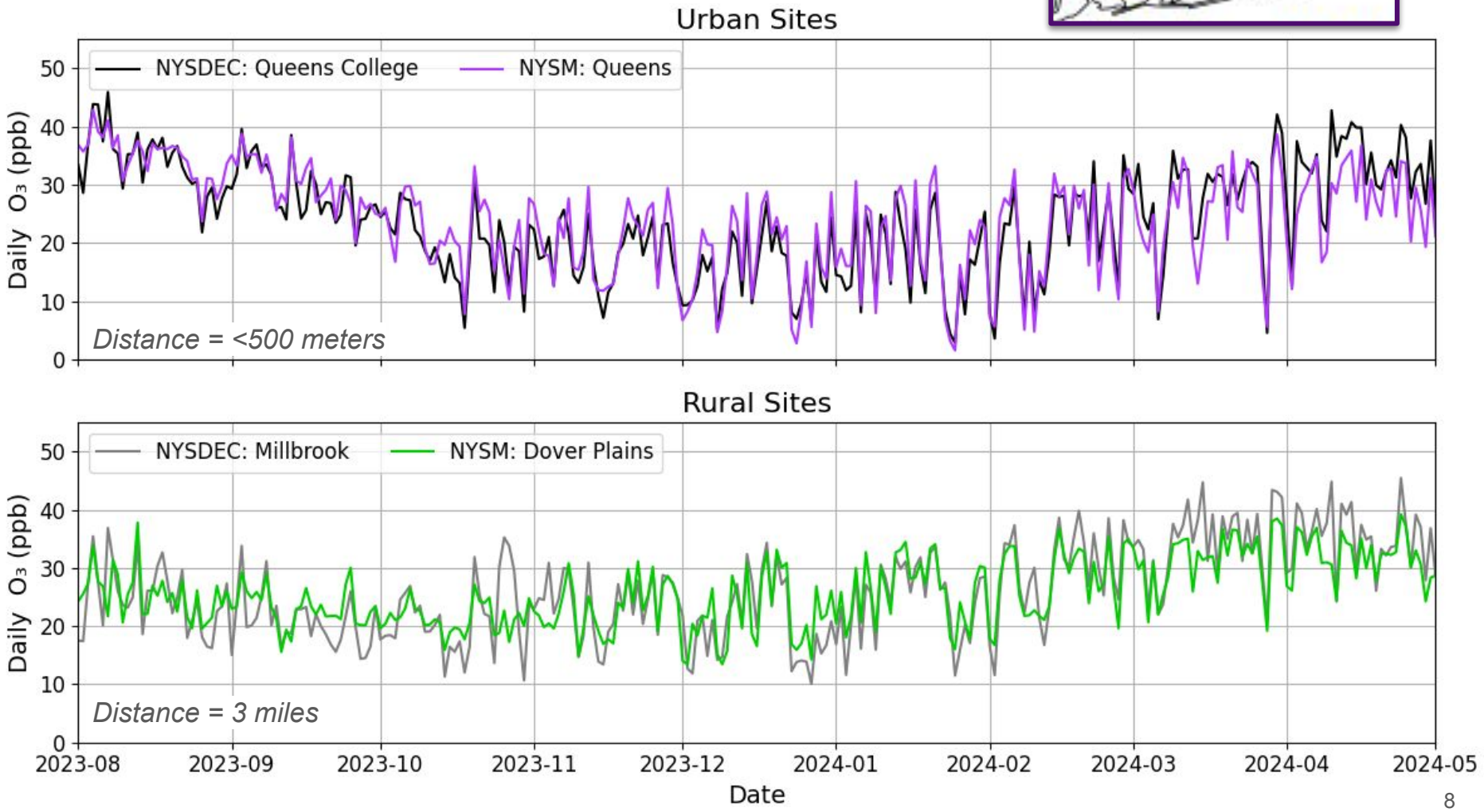
NYSM Field Site Observations



Field Site Evaluation

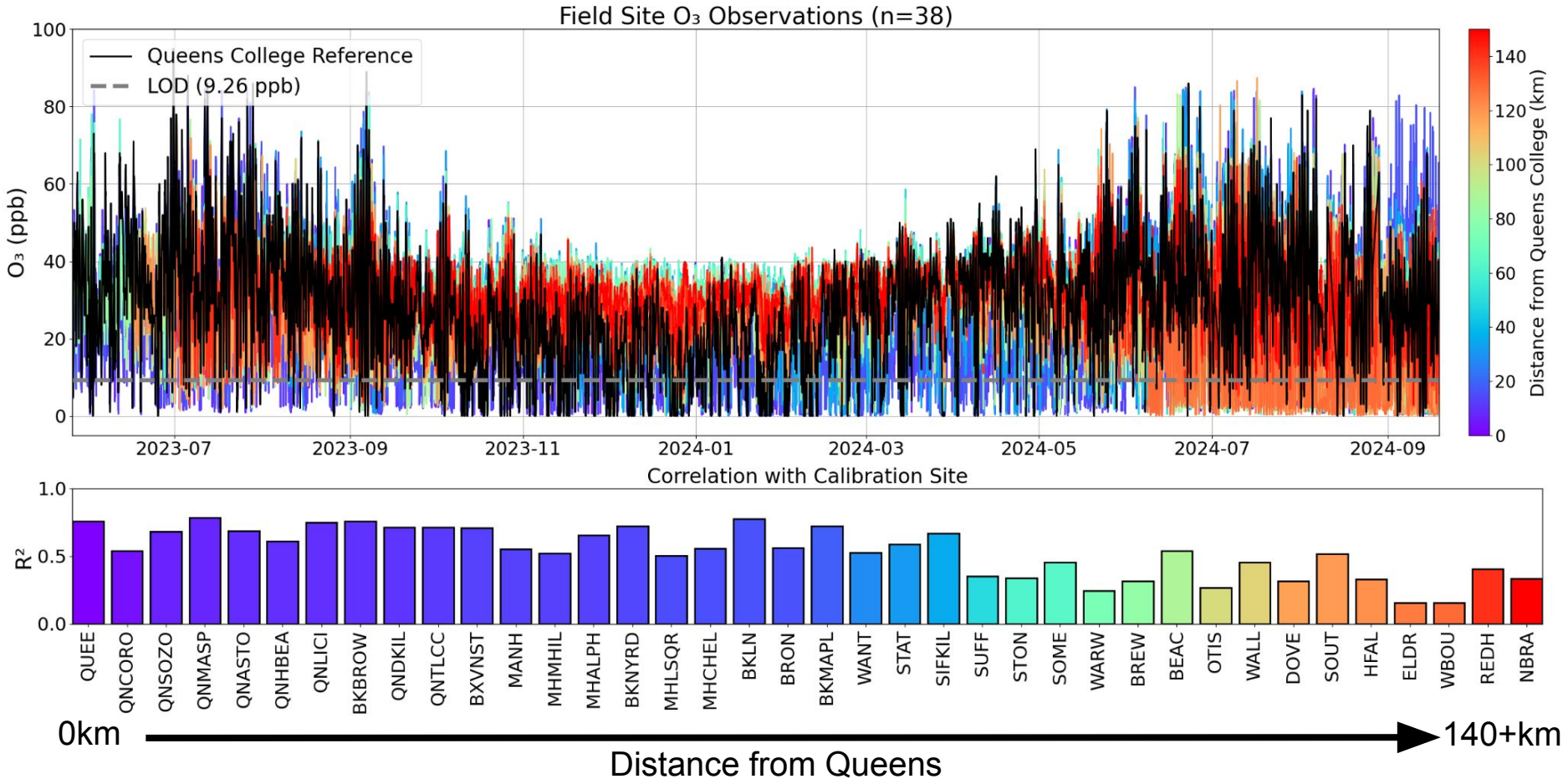
- Performance retained at rural site, model not overfit to urban conditions!





NYSDEC: reference grade site

Network O_3 Observations

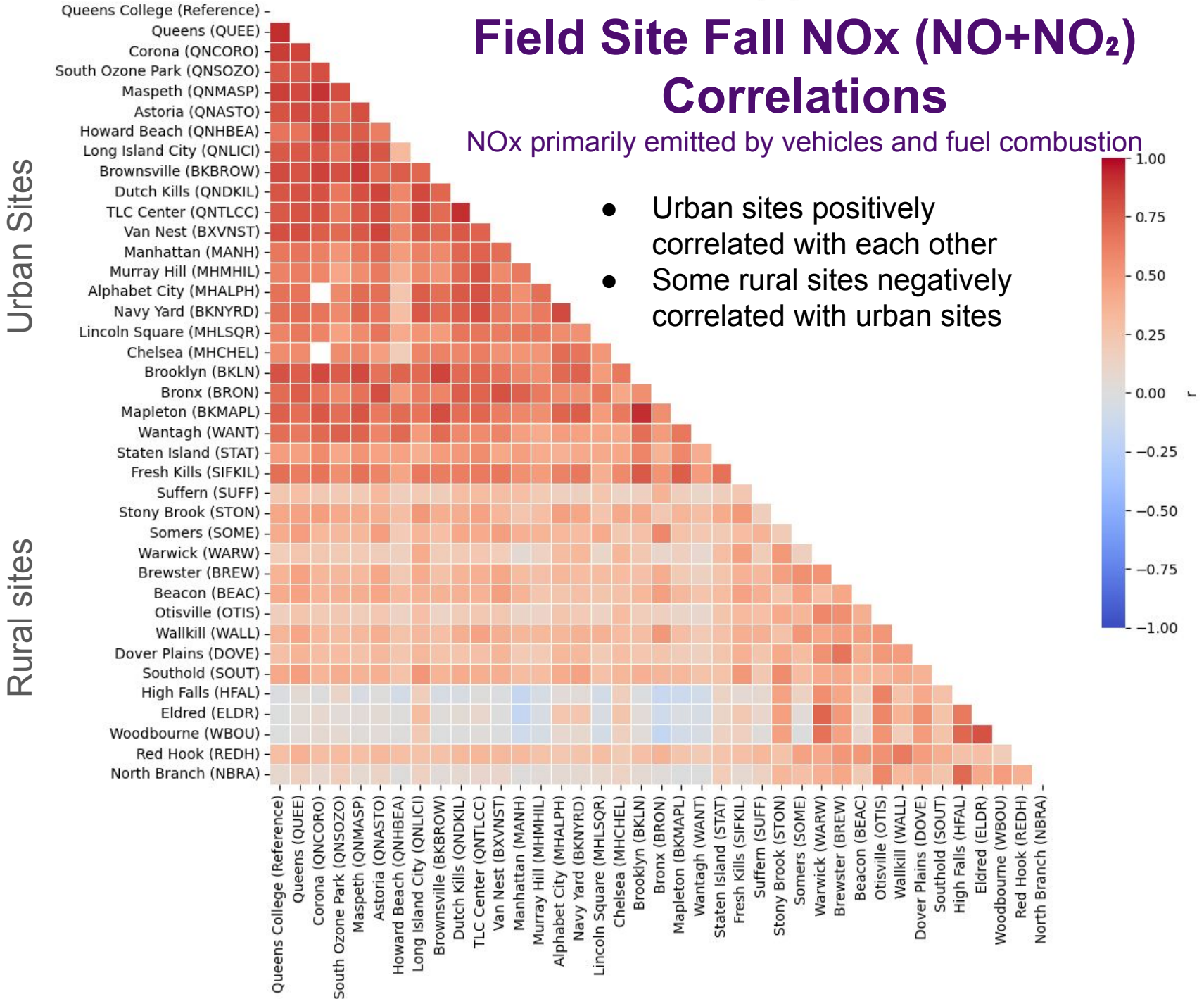


- Sites far from Queens are less correlated with Queens College reference site
- Successfully capturing seasonal variability

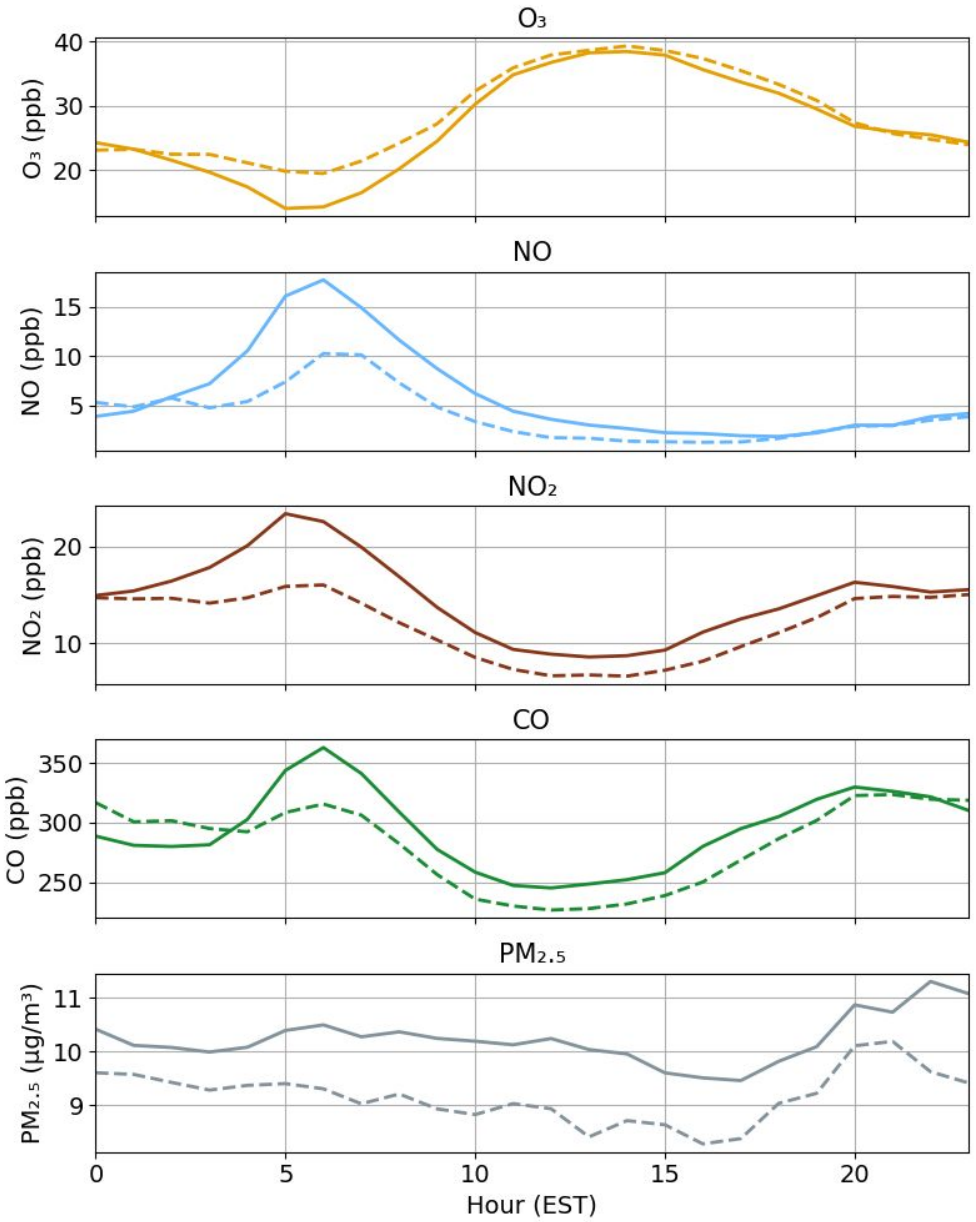
Field Site Fall NOx ($NO+NO_2$) Correlations

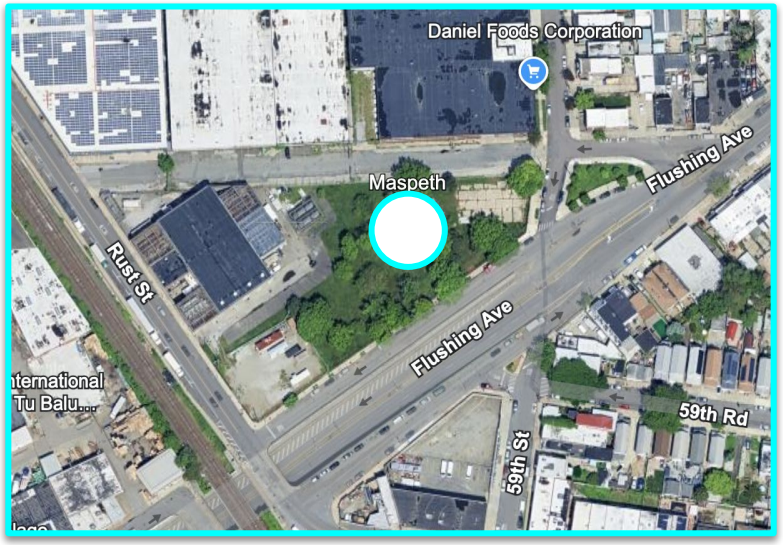
NOx primarily emitted by vehicles and fuel combustion

- Urban sites positively correlated with each other
- Some rural sites negatively correlated with urban sites



Urban Road Site, Maspeth, Observations

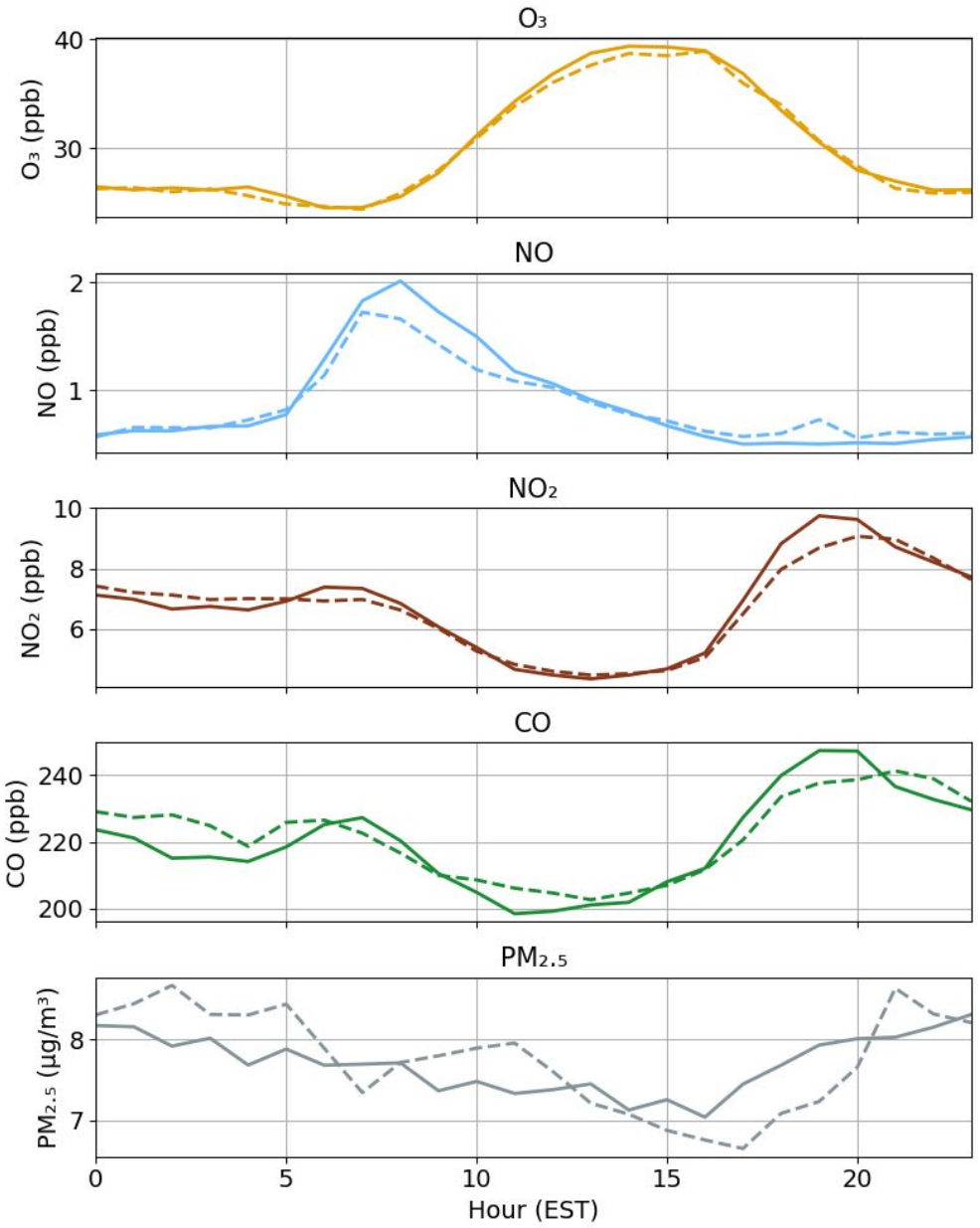


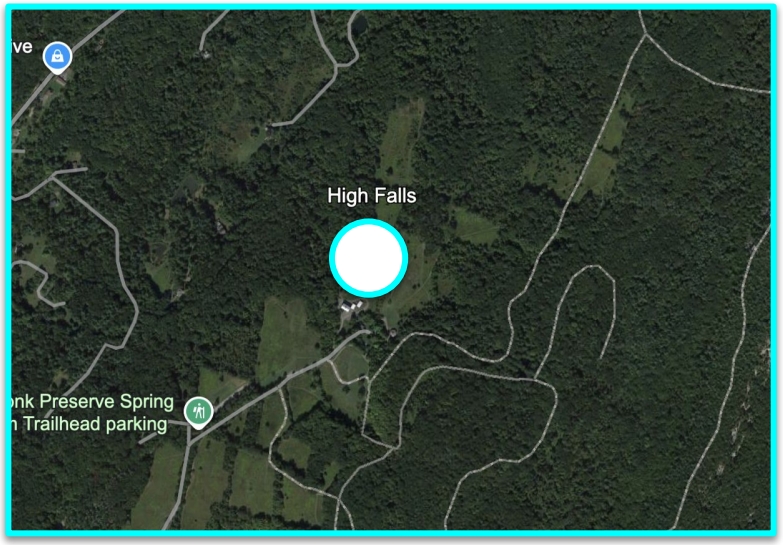


— Weekday observations
- - Weekend observations

- Higher NOx, CO, and PM2.5 concentrations on weekdays
- O_3 concentrations higher on weekends

Rural Site, High Falls, Observations





— Weekday observations
- - Weekend observations

- Minimal weekday-weekend variability
- Besides O_3 and PM2.5, significantly lower concentrations (note max NO of only 2 ppb compared to 17 ppn at urban site!)

Summary

- Integrated a low-cost sensor package to 38 NYSM sites
- Successfully calibrated the low-cost sensor network
- Network captures spatial variability across NYCMA
- Support for network maintenance ended in August 2024

Example deployment at **Van Nest** Micronet site
Photo from Lee Brittle

Future Work

- Next steps… *use* the data!
  - **Characterize air quality in NYC and identify emission sources - led by Dr. Aynul Bari**
  - **Using data from the network to support air quality models - led by Dr. Sarah Lu**
- Final datasets will be publicly available in the future

Contact:

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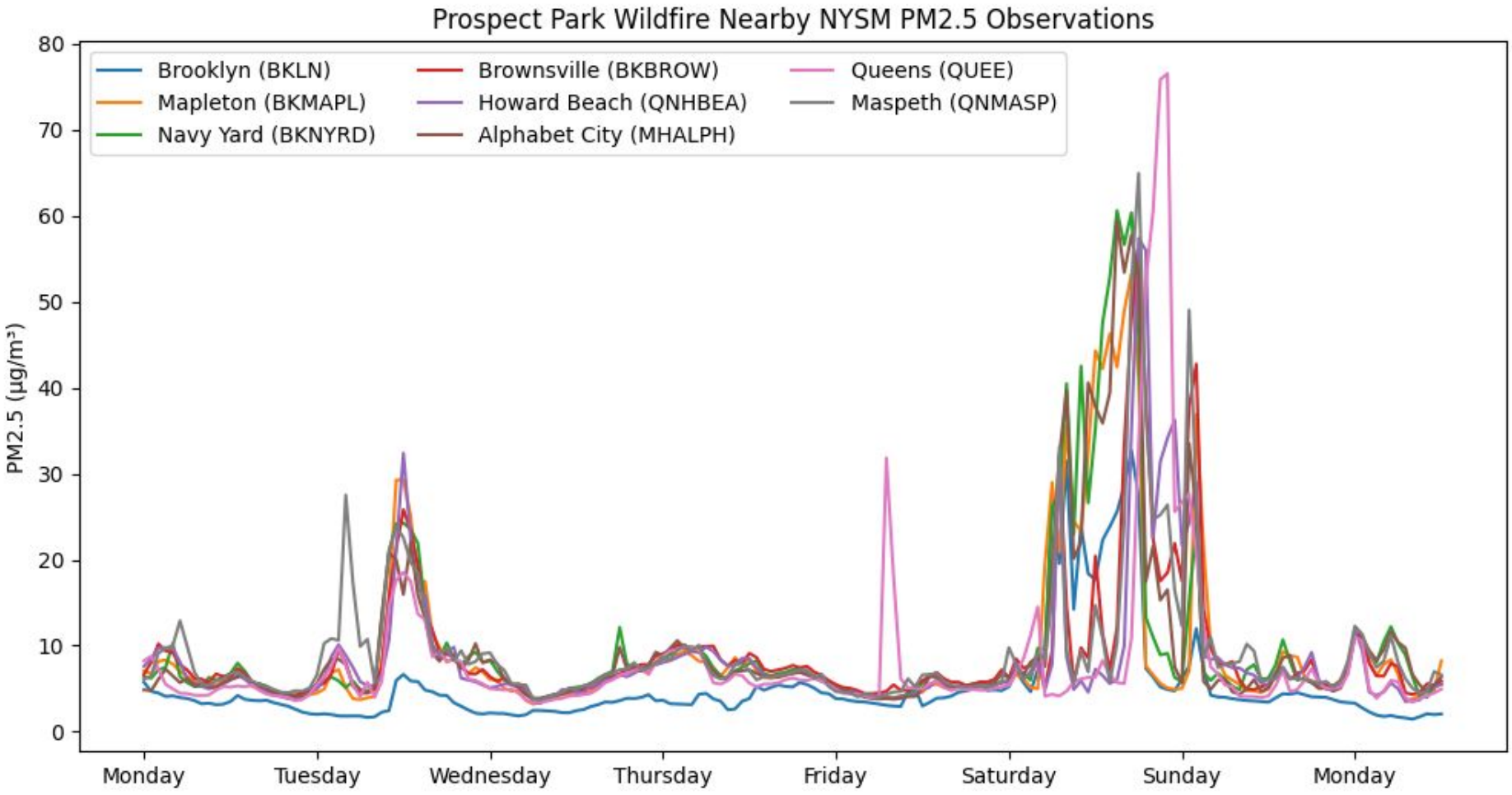
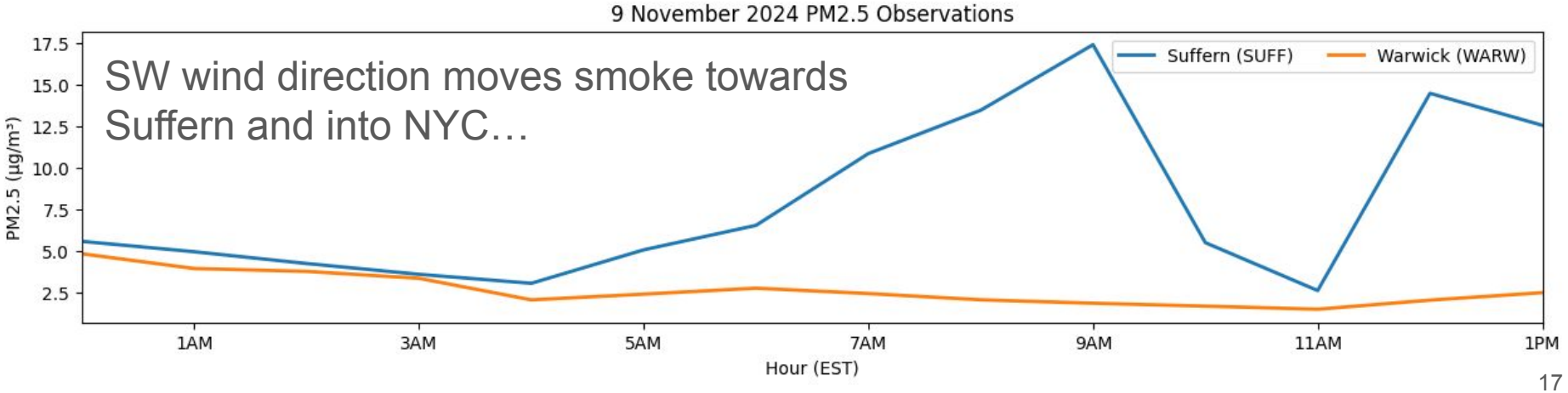
Extra Slides

Prospect Park Wildfire Observations

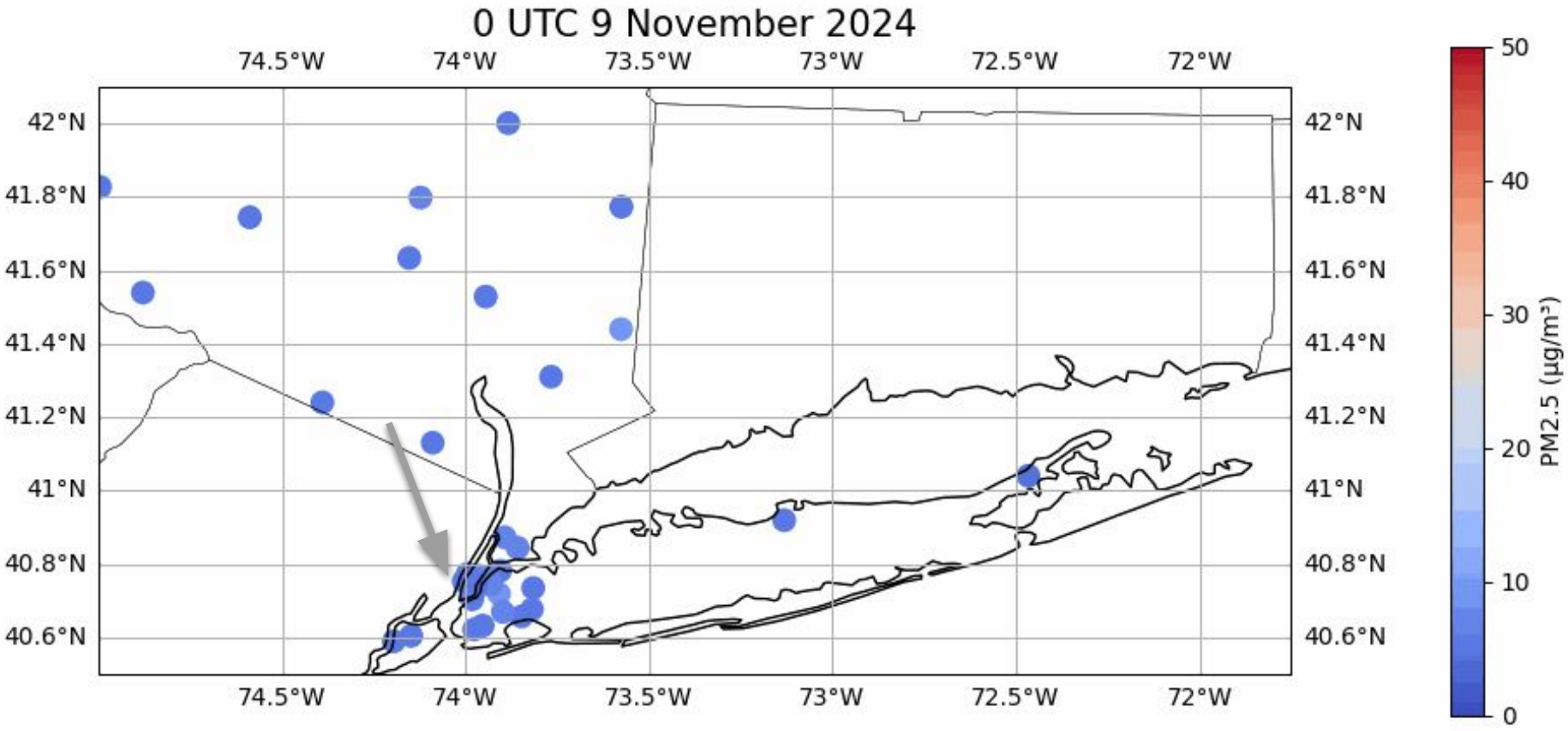


Week of November 4 - 11

NJ Wildfire Smoke Impacting NYC



NJ Wildfire Smoke Impacting NYC



- Wind carries the smoke plume into the core of NYC, causing localized hotspots of PM2.5 in Manhattan, Queens, the Bronx, and Brooklyn