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Understanding ambient air quality at underserved neighborhoods in New York State through low-cost monitoring techniques and community engagement

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Introduction

In the United States, current ambient air quality observation networks are limited in characterizing the diverse group of air pollutants including climate-driven pollutants black carbon (BC) and brown carbon (BrC) that affect exposure across regional to neighborhood scales.

Key hypotheses are, ambient and near-field outdoor concentrations of air pollutants can vary spatially and temporally and have strong localized signals by nearby sources.

The use of cost-effective measurement techniques offers an opportunity to complement conventional sparse air quality monitoring systems to transform the ability of communities to understand air pollution exposure, identify source impacts and disparities, and raise awareness among community neighborhoods about air quality problems.

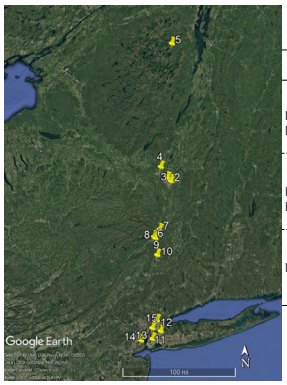
Objectives

- Harness Internet of Things (IoT)-driven low-cost sensor monitoring to determine ambient air quality at underserved communities in NYS.
- Engage and empower community stakeholders to establish a foundation of trusting relationship.

Methodology

Study areas

- New York State Capital Region
- Hudson Valley Region
- New York City



Location	Site #	Site information
NYS Capital and North Country	1	Albany (ETEC, UAlbany, urban)
	2	Rensselaer (Rensselaer City School, urban)
	3	Slingerlands (home, suburban)
	4	Schenectady
	5	Whiteface Mountain Base (reference, rural)
Hudson Valley Region	6	Kingston downtown (urban)
	7	Bard College (rural)
	8	Saugerties (library, suburban)
	9	Poughkeepsie (library, mixed suburban)
	10	City of New Windsor (suburban)
New York City	11	Queens College (Reference, urban)
	12	Brooklyn (Mesonet, urban)
	13	Bronx (Mesonet, urban)
	14	Staten Island (Mesonet, urban)
	15	Harlem, Manhattan (CUNY, urban)

Sampling strategies

- Scope of pollutants

Key pollutants	Low-cost sensors/equipment	No. of units
Black carbon (BC), Brown carbon (BrC)	C-12 Carbon monitor (Met One)	15
Total volatile organic compounds (TVOC), CO_2, $PM_{2.5}$	Duet (TelosAir)	10
$PM_{2.5}$	PurpleAir	15

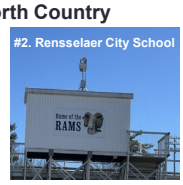
- Measurement started from April 2025
- Short-term co-located measurements for BC/BrC with aethalometer and for multipollutant sensors in Queens College (Nov-Dec 2024).
- For long-term performance, ongoing co-located measurements at urban (Queens College) and rural (Whiteface Mountain Base) reference sites.

Data analysis

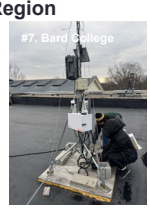
- Several statistical approaches e.g., Kruskal-Wallis test, and coefficient of divergence (COD) were applied to determine temporal variation and spatial heterogeneity.
- Conditional bivariate probability function (CBPF): possible local source impacts.
- NOAA HYSPLIT model to show backward air mass trajectories.

Ambient Air Quality Monitoring Sites in NYS

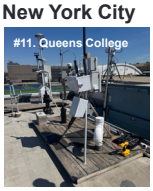
NYS Capital/North Country



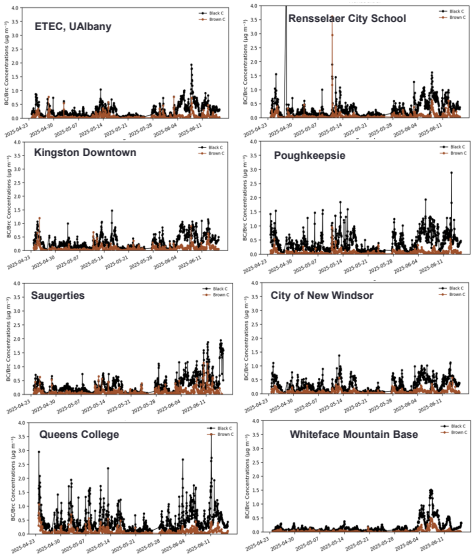
Hudson Valley Region



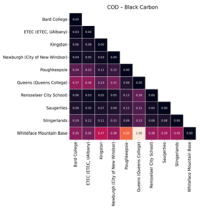
New York City

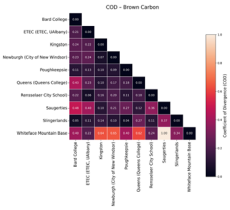


Preliminary Results- BC/BrC Profiles

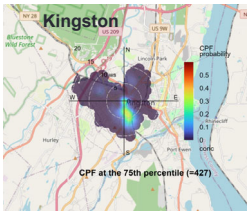


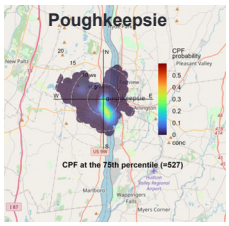
Spatial Variability in BC and BrC



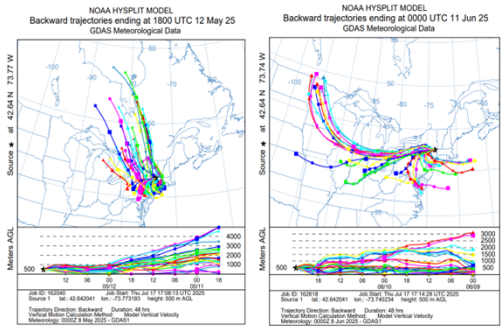


Potential local source impacts





Impact of Canadian Wildfires and Saharan Dust on Air Quality in NYS



Conclusion and Future Work

- ❑ Notable variations of BC and BrC concentrations between urban and rural neighborhoods in NYS.
- ❑ The BC/BrC measurement network can detect impacts of wildfires and Saharan dust on air quality across neighborhoods.
- ❑ Future long-term (at least 1-year) co-location measurements for BC, BrC, TVOC, and criteria air pollutants.

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