EDGE 2026 Symposium

Mobile Monitoring

Diverse and Tailored Applications

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2026-06-10

ENVIRONMENTAL & OCCUPATIONAL HEALTH SCIENCES
UNIVERSITY of WASHINGTON | SCHOOL OF PUBLIC HEALTH

What is Mobile Monitoring?

> ***Mobile Monitoring*** *-- the collection of real-time air quality measurements while in motion is currently conducted worldwide to evaluate in situ emissions, local air quality trends, and air pollutant exposure*

Brantley, et al., 2014 AMT

> *Air quality research has been revolutionized in recent years by the development and application of mobile platforms capable of resolving air pollutant concentrations in real time. These platforms including instrumented cars, vans, bicycles, and handheld devices*

Wearable Air Quality Monitor

Applications

Three main types:

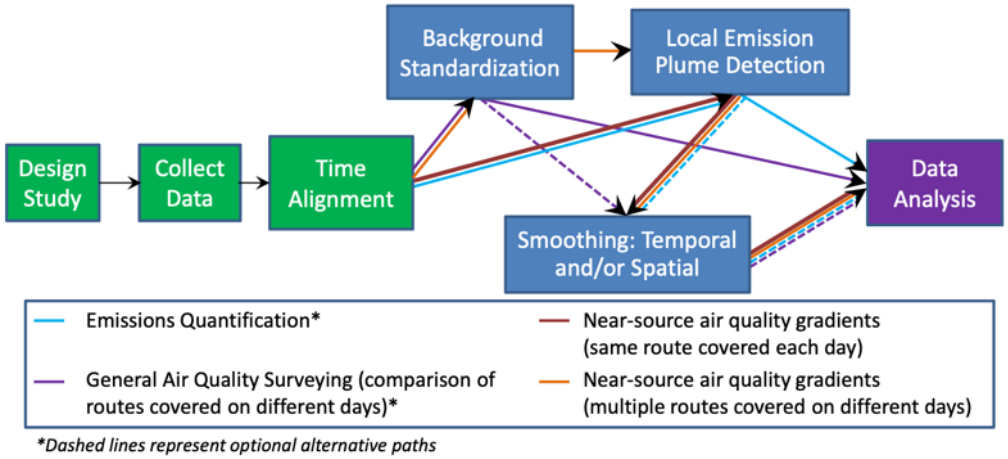
- Emissions quantification
- Near-source gradients
- General air quality surveying

Atmos. Meas. Tech., 7, 2169–2183, 2014
www.atmos-meas-tech.net/7/2169/2014/
doi:10.5194/amt-7-2169-2014

Atmospheric Measurement Techniques
Open Access

Mobile air monitoring data-processing strategies and effects on spatial air pollution trends

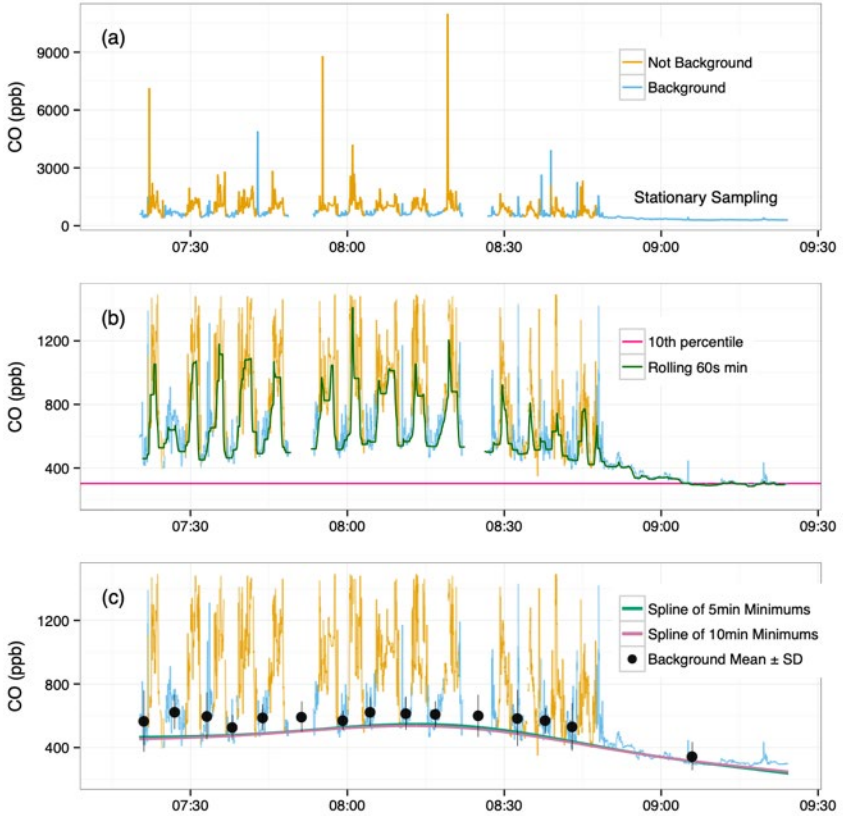
H. L. Brantley[1,2], G. S. W. Hagler[1], E. S. Kimbrough[1], R. W. Williams[3], S. Mukerjee[3], and L. M. Neas[4]



What are you interested in?

Temporal aspect

- High-resolution timeseries data
- Are you interested in the peaks (i.e., local exhaust / emissions?)
  → we subtract the background concentration.
- Or do you want to remove the peaks to assess “background”?
  → we filter the peaks.

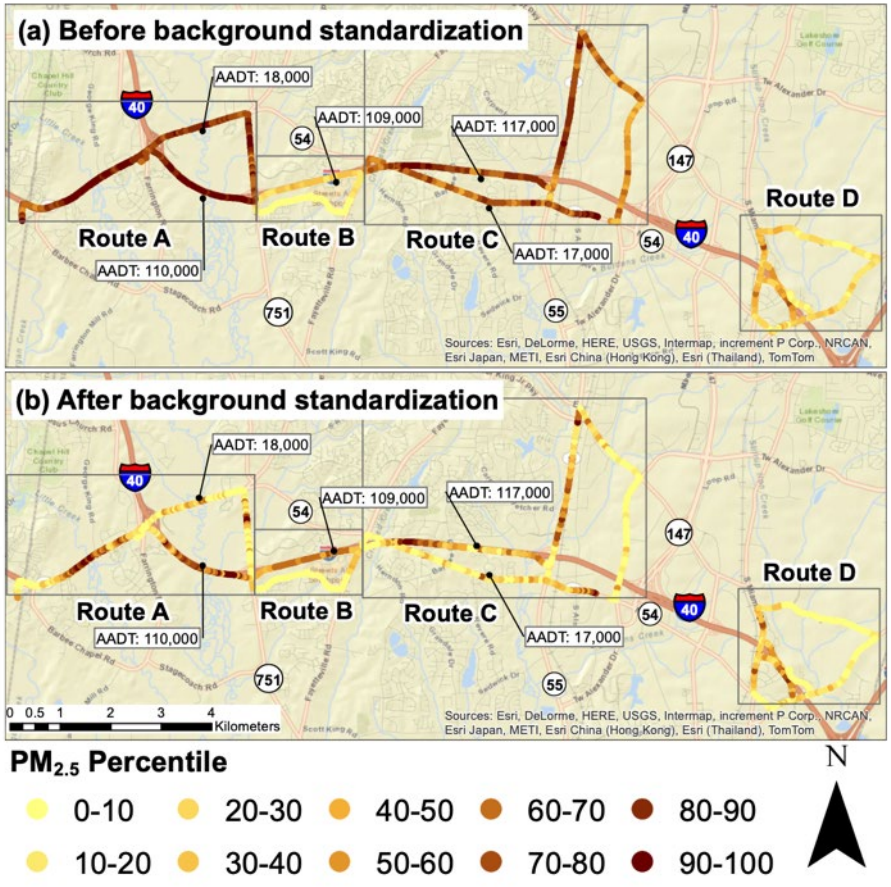


What are you interested in?

Spatial aspect

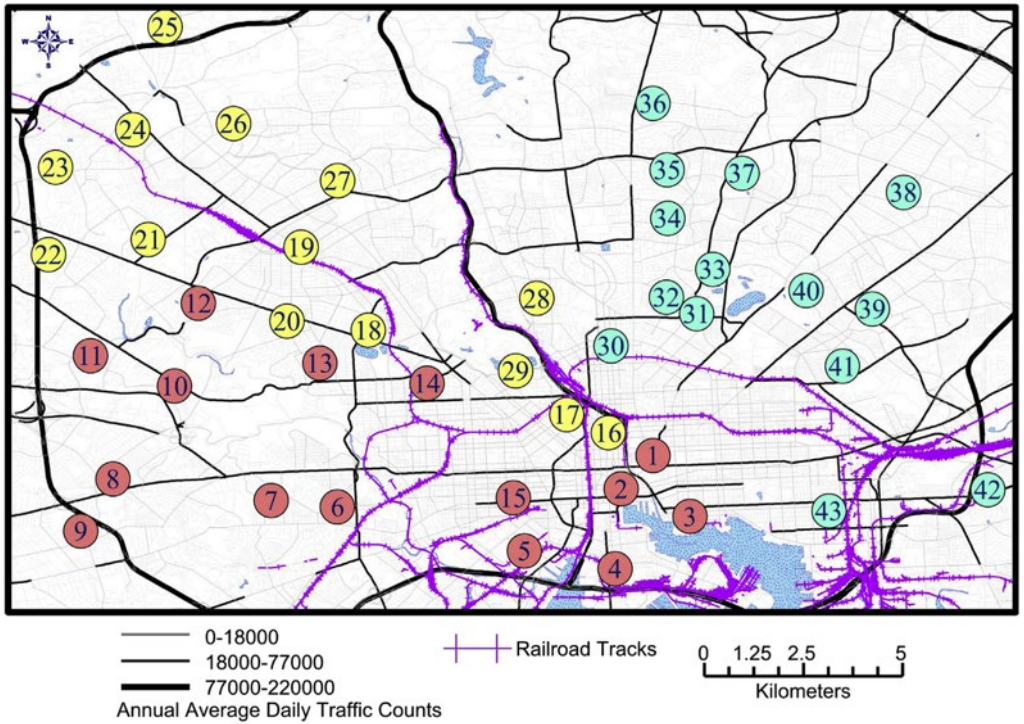
(Look at the highway I-40)

- Space-time confounding (*most of the time*, we can't be in two places at once!)
- What if we sampled local roads on different days than the highway?
- We need to standardize for different background concentrations on those different days in order to better observe the higher concentrations on the highway.



Data integration from Different Monitoring Modalities

Baltimore, MD



Instrumentation Issues

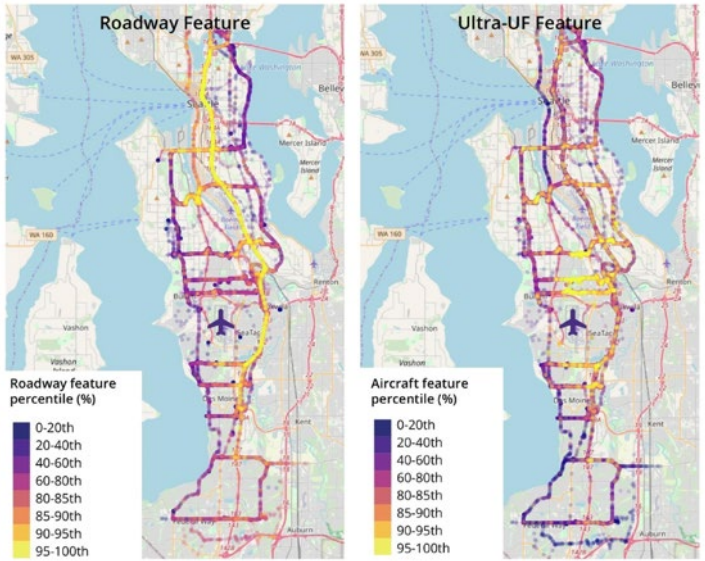
Continuous fast-response

- Self-pollution challenge
- Sampling vehicle in front
- Instrument vibration
- QA/QC systems
- Data integration

- Tailoring of instruments to research questions

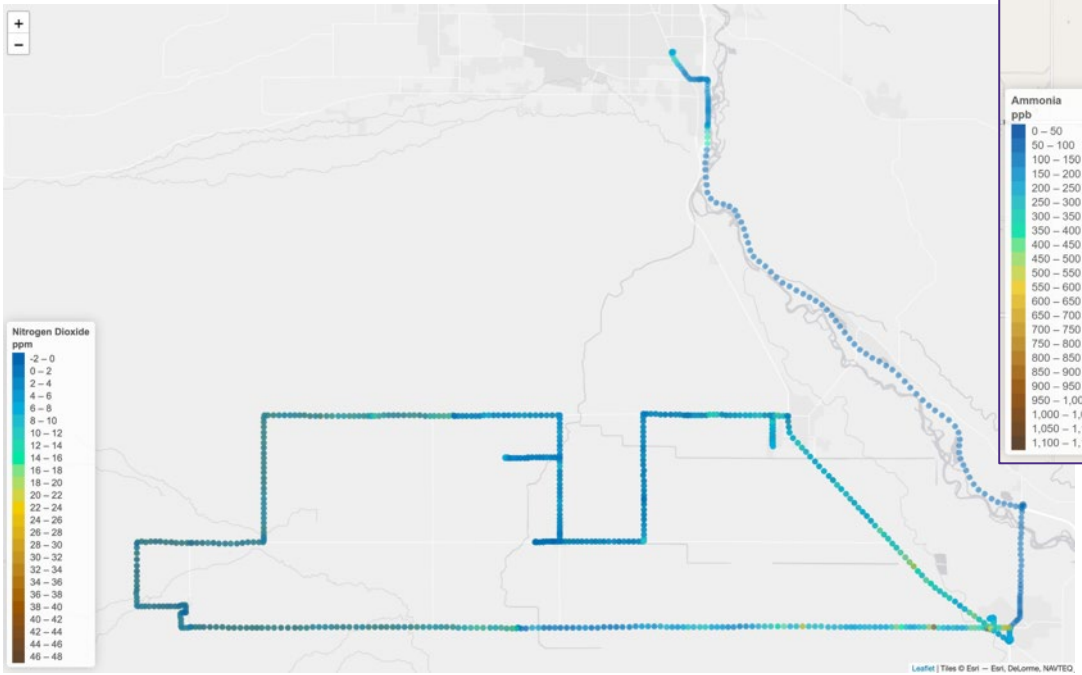
Dr. Elena Austin

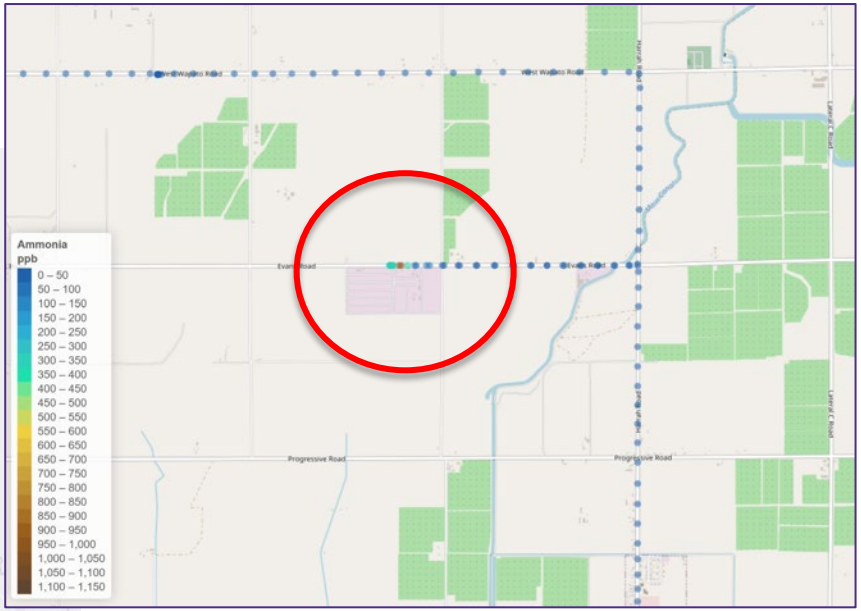
Focus on identifying aviation-related air pollution via ultrafine particle size



Austin, et al., 2021, ES&T

Focus on sources of ammonia in rural areas

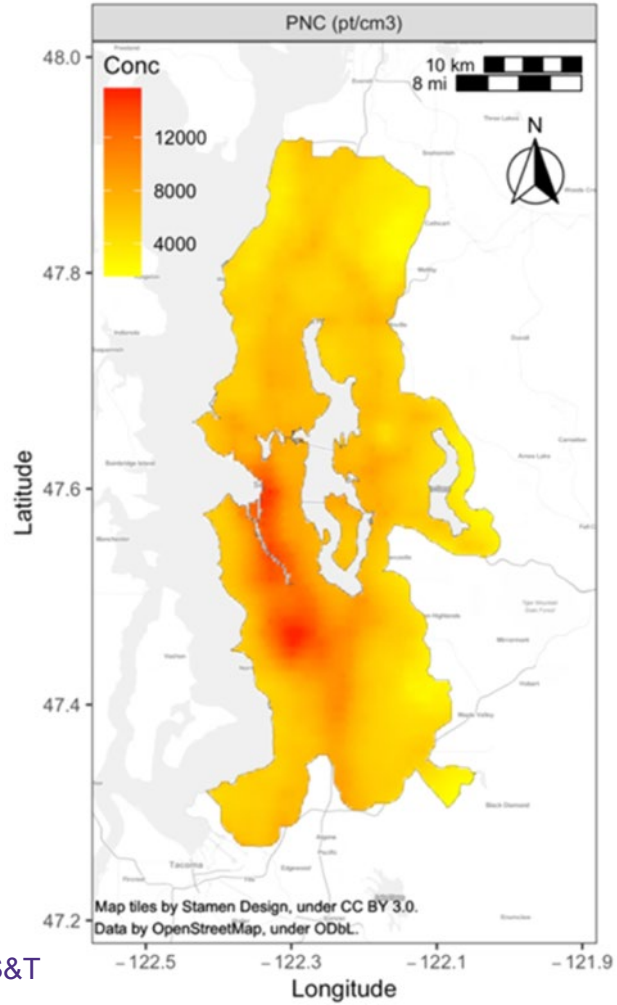




Dr. Magali Blanco

Mobile monitoring long-term average concentrations for epidemiologic studies

- Focus on traffic related air pollution (TRAP)
- Integrating relatively short-term mobile monitoring campaign with longer-term stationary monitoring data
- Utilization of spatiotemporal modeling framework

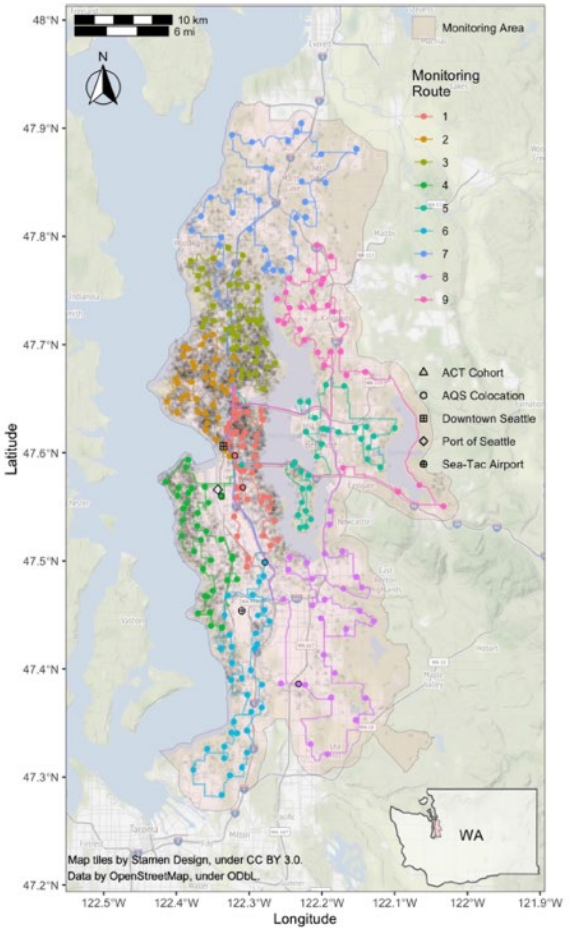


Blanco, et al., 2022, ES&T

Dr. Ningrui Liu

Mobile monitoring campaign in the Greater Seattle Area

- **Pollutants:** Size-resolved UFPs, $PM_{2.5}$, BC, total carbon (TC), NO_2, CO_2
- **Time:** Mar 2019 – Mar 2020
- **Location:** 309 sites in Seattle, WA
- Apply **positive matrix factorization (PMF)** to characterize emission sources and assess source-specific air pollution exposure with multiple **factor interpretation approaches**:
  - Particle size distribution
  - Relationship between factor contribution and external variables (e.g. seasons, rush hours, wind directions, temperatures)
  - Land use regression model
  - Ratios: BC/$\triangle CO_2$, BrC/$\triangle CO_2$, NO_2/$\triangle CO_2$, PNC/$\triangle CO_2$, $PM_{2.5}$/BC
- Estimate **traffic-related emission factors** using pollutant-to-background-subtracted CO_2 ratios derived from PMF factor profiles

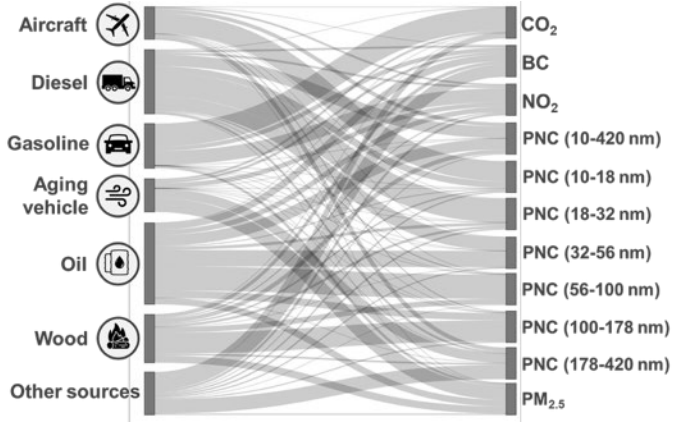


Mobile monitoring routes of ACT study

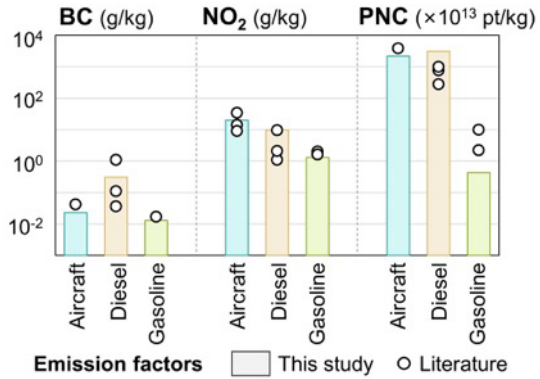
Liu et al., ***Environ. Sci. Technol.***, 2025, 59, 3443−3458.

Mobile monitoring campaign in the Greater Seattle Area

Source contributions

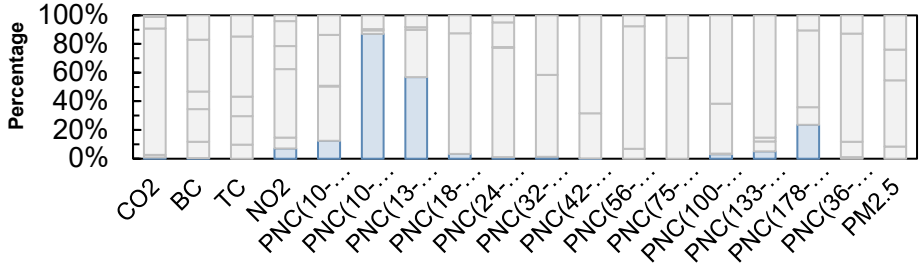


Emission factors

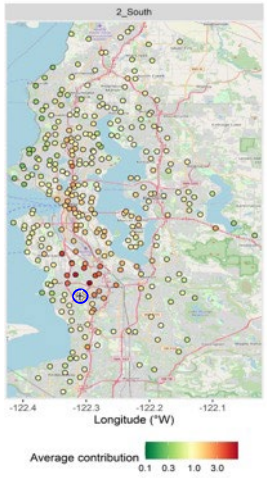


Example of aircraft emission source

Particle size distribution: Dominating PNC (10-18 nm)



Wind direction



Land use regression

Identify important covariates:

- Distance to the large airport
- Distance to the landing/takeoff air routes

Ratios

Compared to road traffic factors:

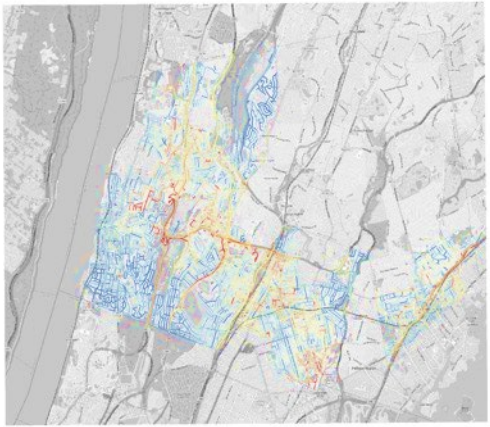
- Higher PNC/△CO_2 than gasoline
- Lower BC/△CO_2 than diesel

Mobile monitoring campaign in Westchester, NY

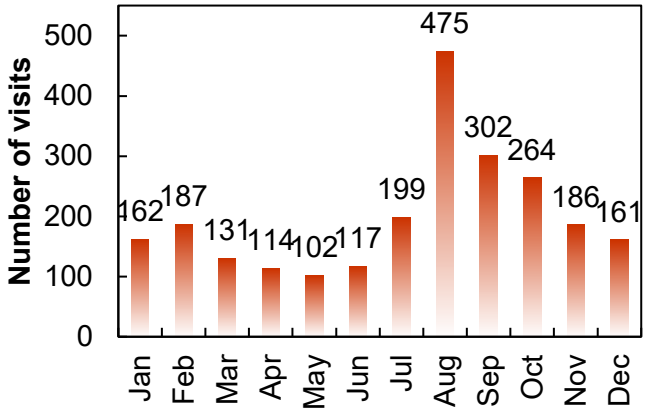
Dr. Magali Blanco

Dr. Ningrui Liu

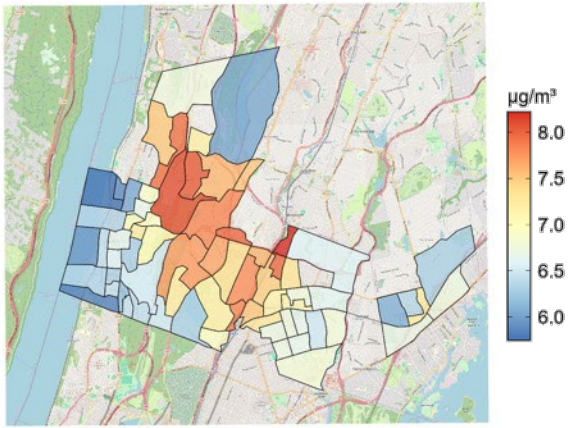
- **Pollutants:** $PM_{2.5}$, BC, ozone, NO_2, NO, CO_2, CO, CH_4, and C_2H_6
- **Time:** Sep 2022 – Aug 2023; **Location:** 70 census tracts in Westchester
- Characterize **source contributions** based on multipollutant data
- Evaluate the tract-level **health risks** attributable to $PM_{2.5}$ and NO_2 exposure
- Quantify the health benefits of **mitigation strategies** (e.g., vehicle electrification)



Mobile monitoring data of $PM_{2.5}$



Temporal balance checking



Tract-level weighted annual average $PM_{2.5}$

Fleet-wide Mobile Monitoring with Low-cost Sensors

- Study in Switzerland
- All major cities sampled
- Sensors on postal vehicles (PM1, PM2.5, PM10, CO, CO2, NO2, T, RH, hPa)
- Swiss-specific air quality questions

Thank you

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Dr. Elena Austin

Dr. Magali Blanco

Dr. Ningrui Liu

Others at UW involved in mobile monitoring:

- Lianne Sheppard
- Julian Marshall
- Adam Szpiro
- Chris Simpson
- Mike Yost
- Tim Larson
- Tim Gould
- Dave Hardie
- Amanda Gassett

Students working on mobile monitoring projects:

- Yeon Cheong
- Sue Yu (Pomona)
- Olivia Wang (UC Berkeley)
- Grace Gao