PM2.5 is not the same across seasons: Characterization of $PM_{2.5}$ composition at a fixed urban site for the DOE BSEC project

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Wednesday, September 4, 2024

PM2.5 is not the same across seasons: Characterization of $PM_{2.5}$ composition at a fixed urban site for the DOE BSEC project

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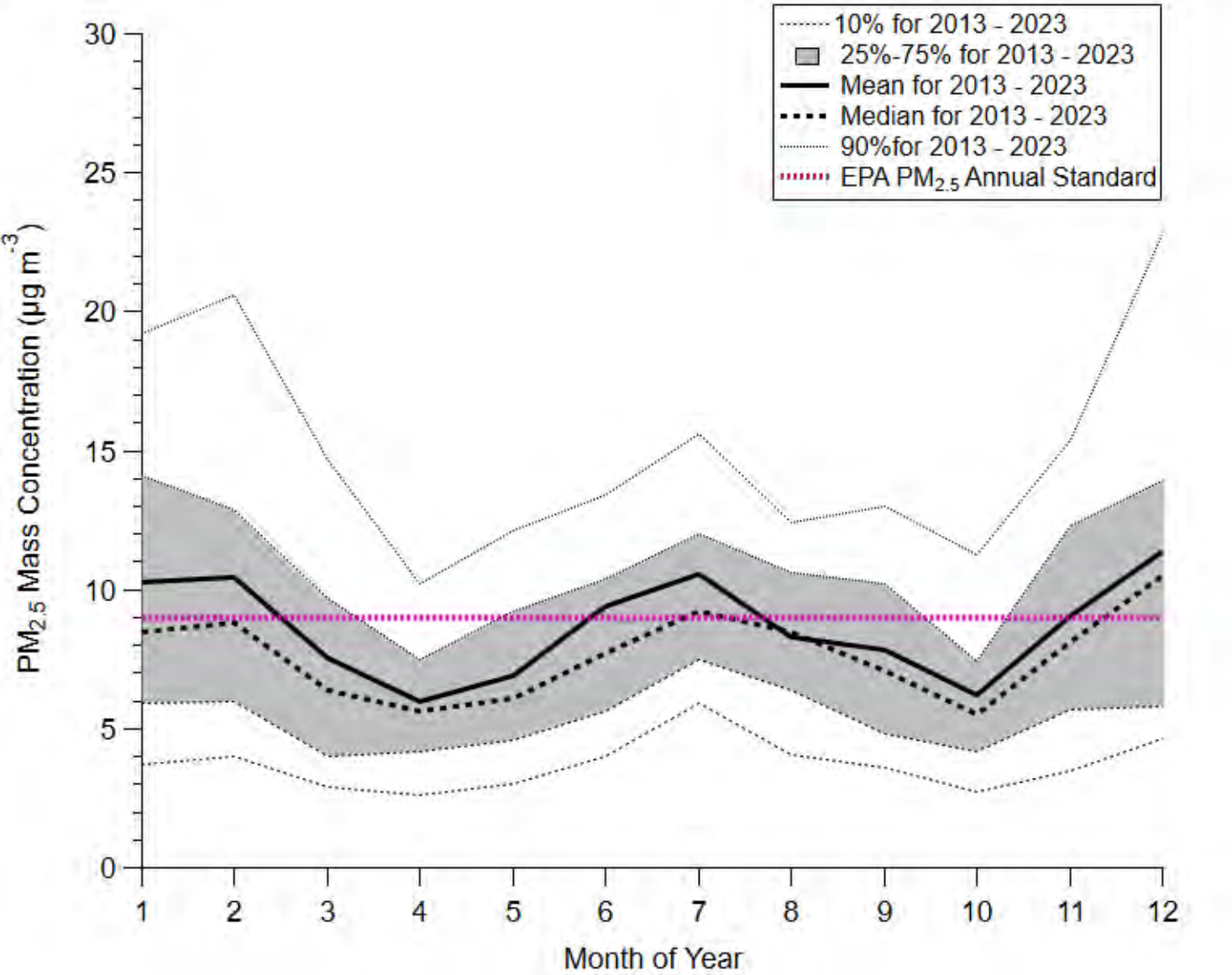
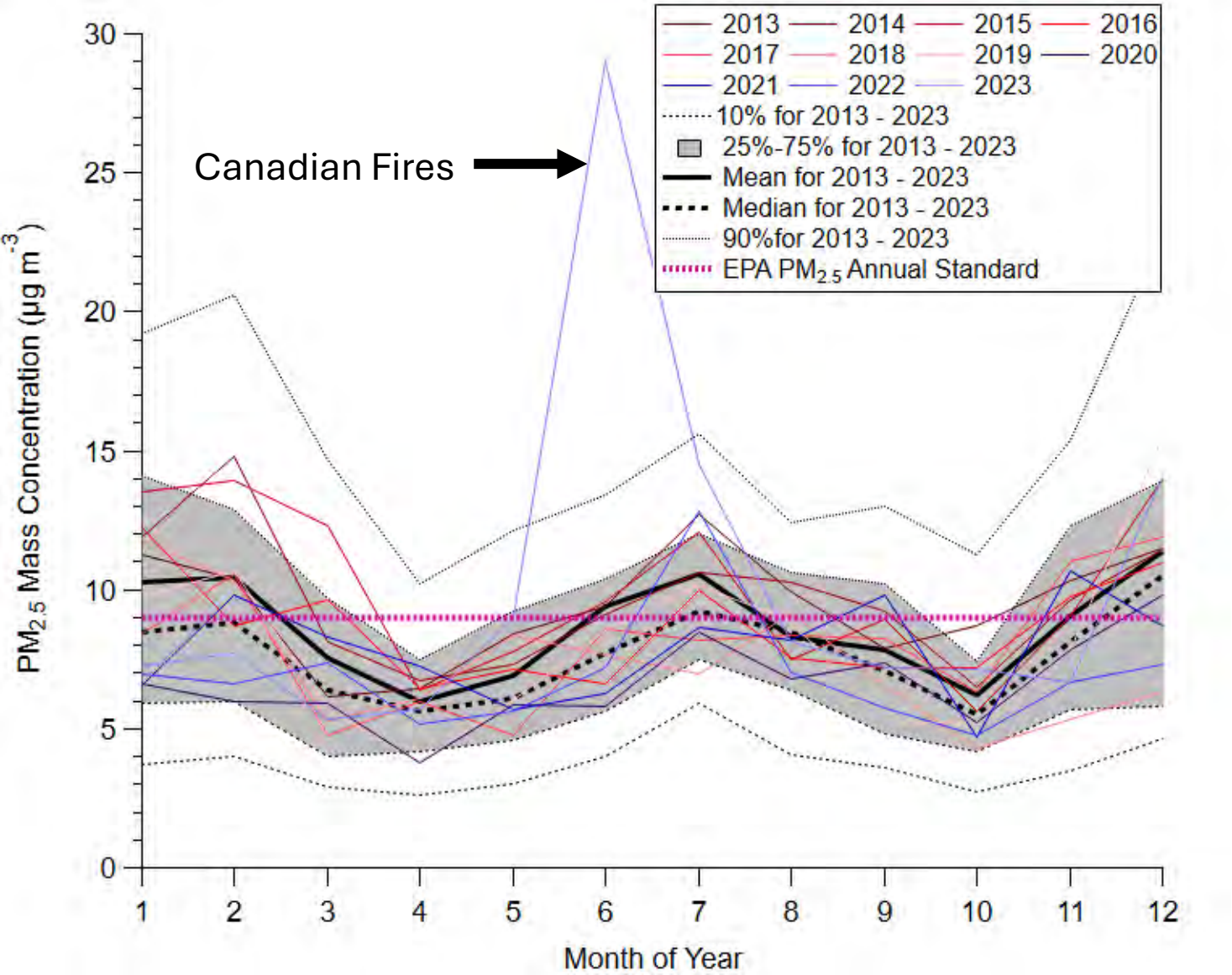
Though the Baltimore Region is known for its ozone non-attainment, PM is still a concern



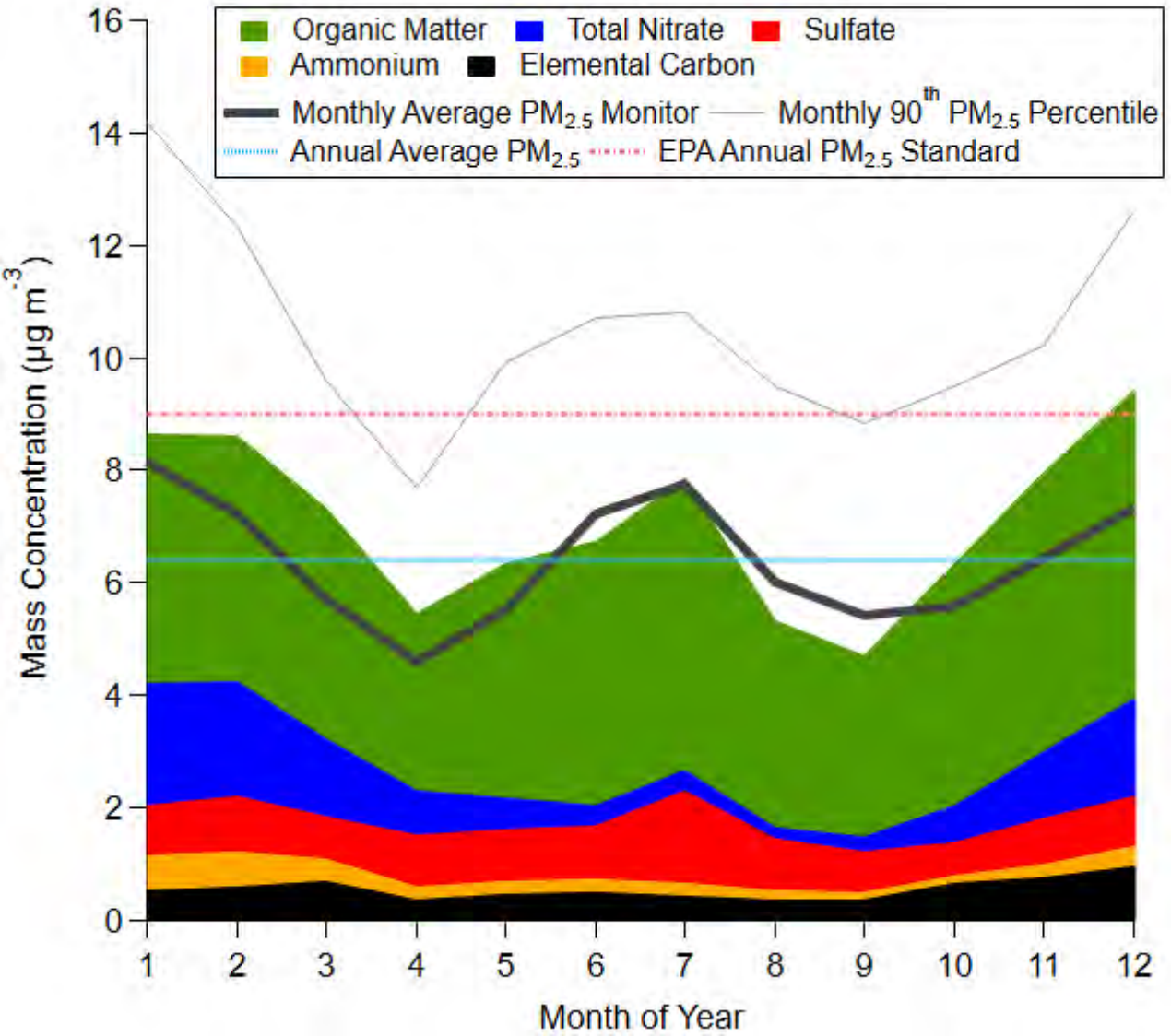
- One-decade average value for Essex
- Average ~8.5 µg m^{-3}, close to new EPA annual standard
- Surprisingly consistent across seasons
- Aerosol nitrogen important nitrogen source for Chesapeake Bay

Though the Baltimore Region is known for its ozone non-attainment, PM is still a concern



- One-decade average value for Essex
- No trend across the last 10 years
- All years show minimal seasonal dependency

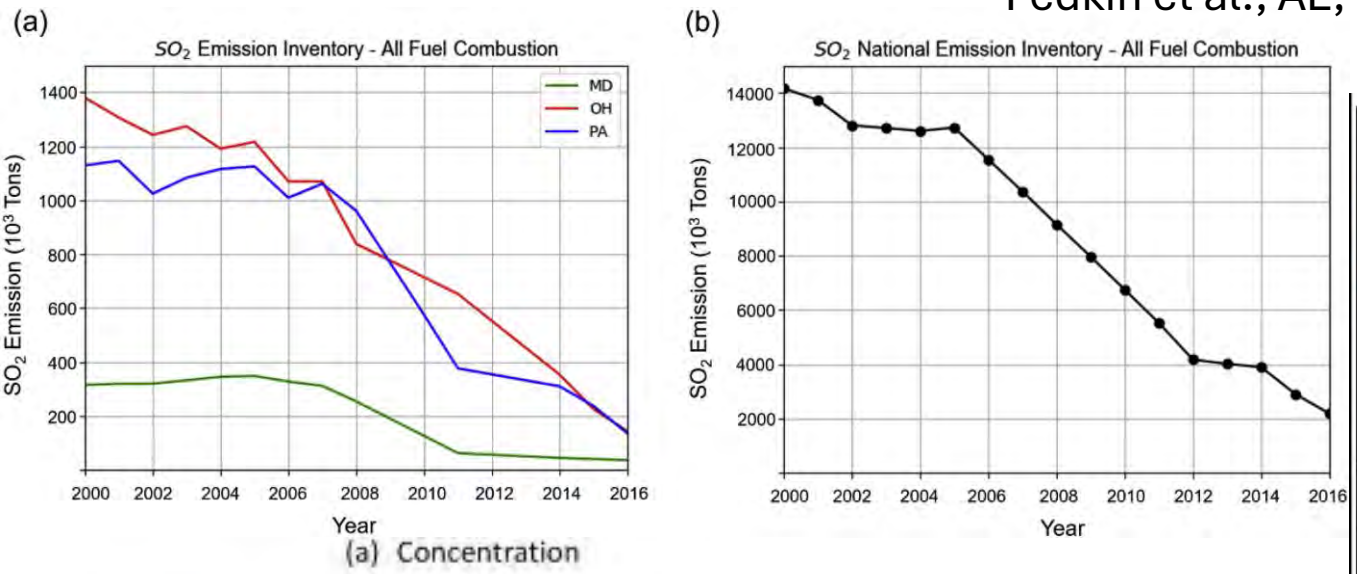
Compositional changes in $PM_{2.5}$ appears to be driving consistency, but measurements challenge to attribute sources



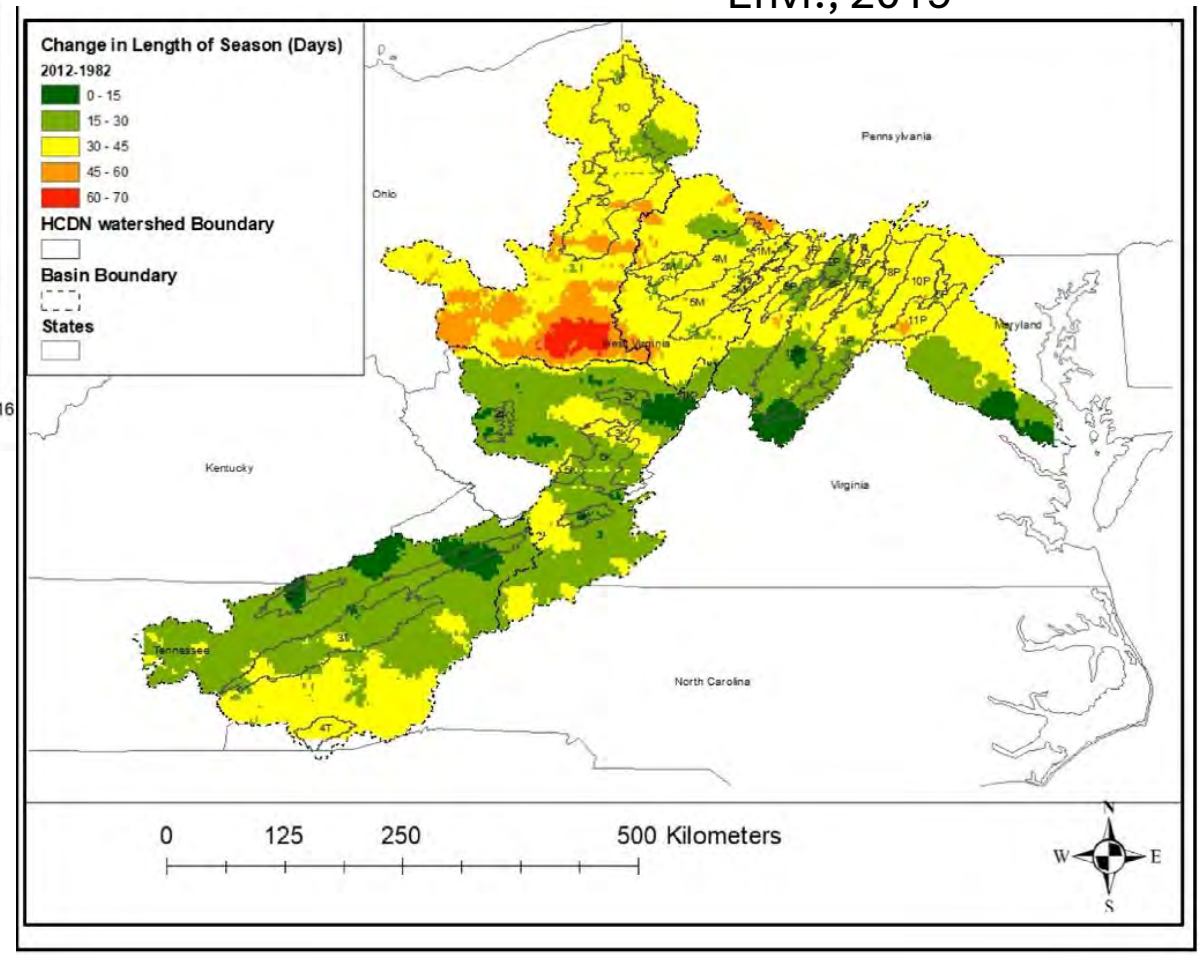
- Year 2022 for Essex
- $PM_{2.5}$ Chemical Speciation Network used to show “OA”, nitrate, sulfate, ammonium, and elemental carbon
- Changes in nitrate vs OA (and sulfate) appears to be driving constant $PM_{2.5}$

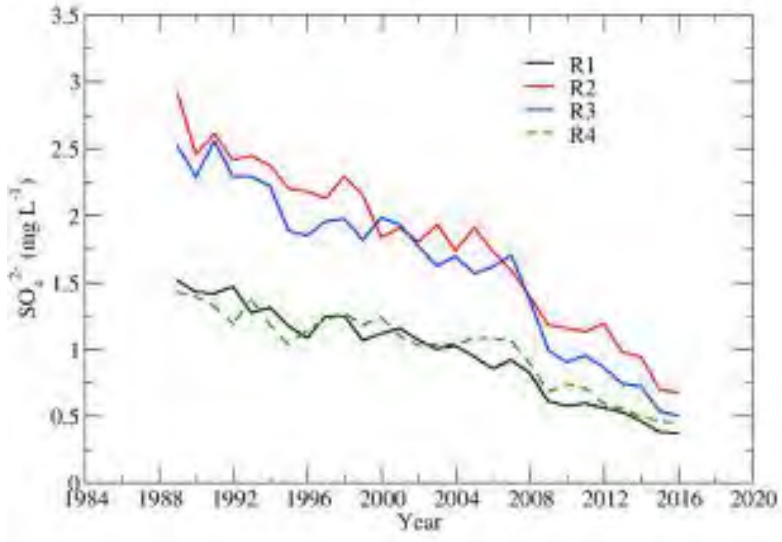
Large changes in sources due to regulation and climate change

Fedkin et al., AE, 2019



Gaertner et al., Sci. Tot. Envr., 2019





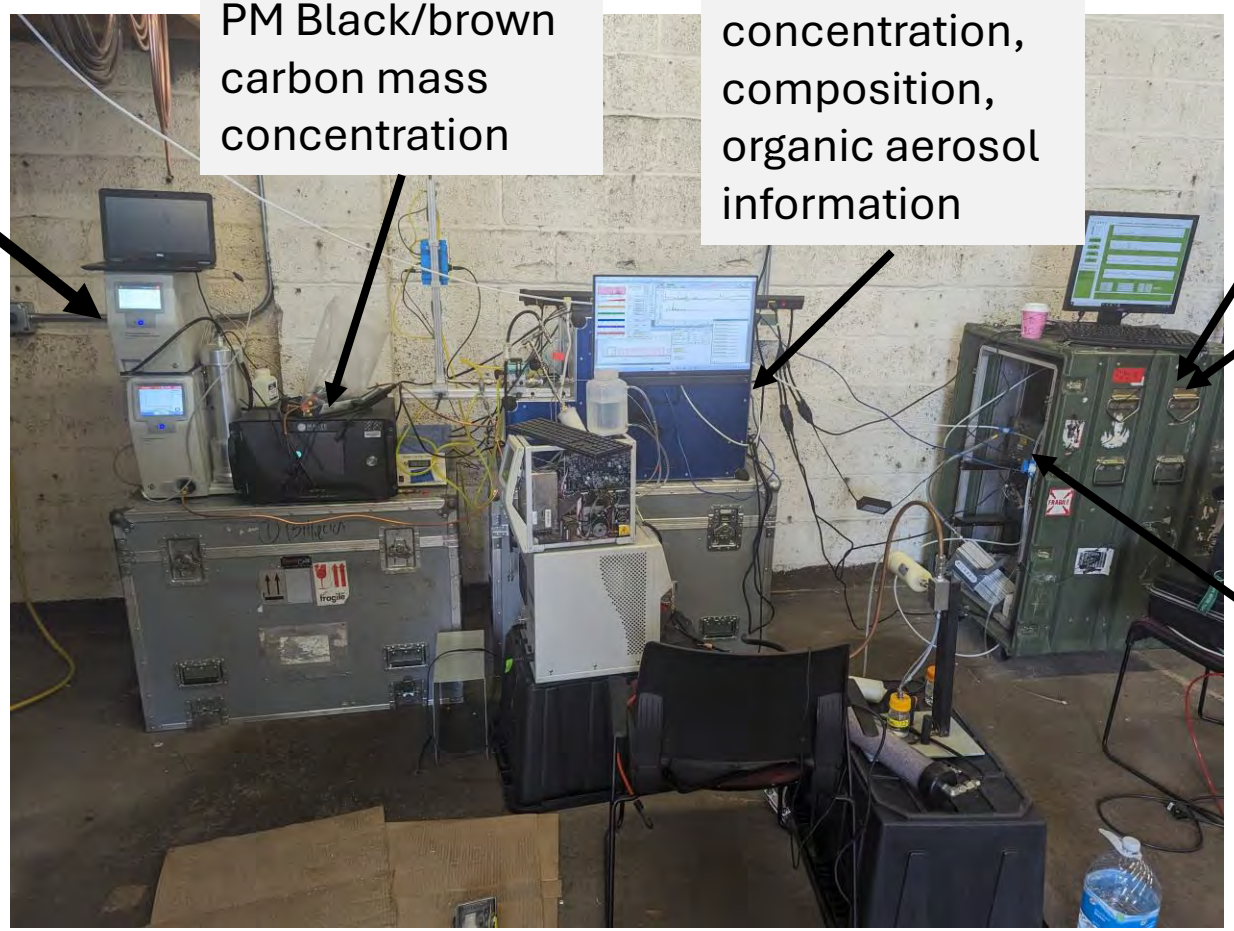
Feng et al., AE, 2021

Current set-up for the BSEC/CoURAGE urban site

Scanning mobility particle sizer (size / volume distributions)

PM Black/brown carbon mass concentration

Aerosol mass concentration, composition, organic aerosol information



Ozone

Nitric oxide
Nitrogen dioxide

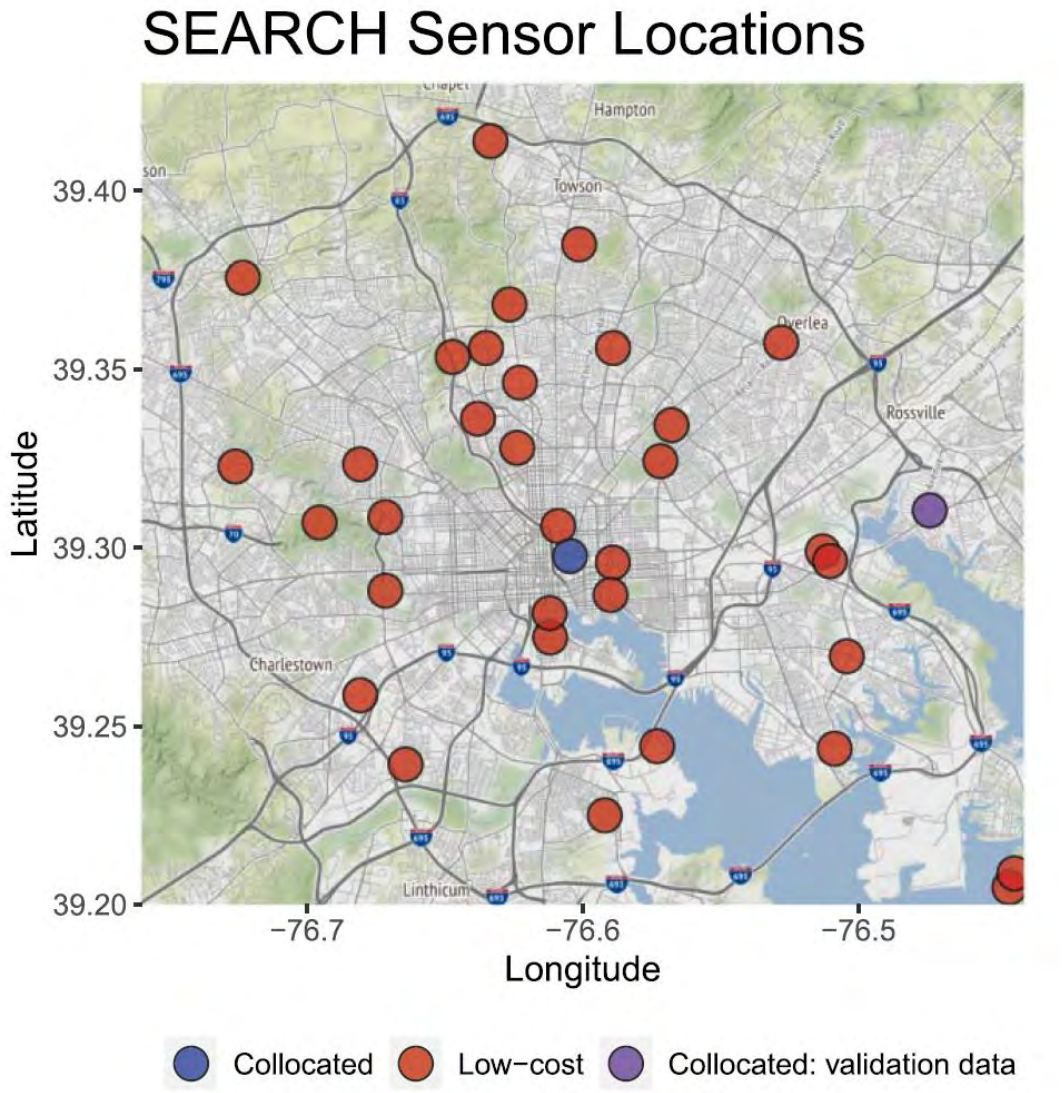
Methane, carbon monoxide, carbon dioxide

Instrument to add:
New Aethalometer (Black carbon, brown carbon)
New trace gas analyzer (O_3, NO, NO_2, etc)
Temporary for “intensive”: Formaldehyde, Speciated VOCs (GC and PTR)

The Johns Hopkins Mobile Laboratory

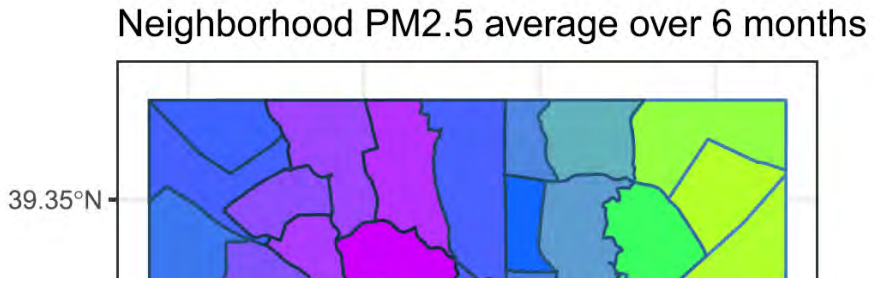
- Particle-phase measurements
  - Mini-AMS (OA, NO3, SO4, NH4, nr-Chl)
  - Mini-Aethalometer (BC)
  - mSEMS (size distributions)
  - Magic CPC (particle #)
  - Dustrak (PM1, PM2.5, PM10 mass)
- Gas-phase measurements
  - EC-TOF (PTR + GC, range of species)
  - CAPS NOx
  - Picarro EtO, HCHO, NH3, CO/CO2/CH4
  - 2BTech O3
- Associated lat, long, RH, & T

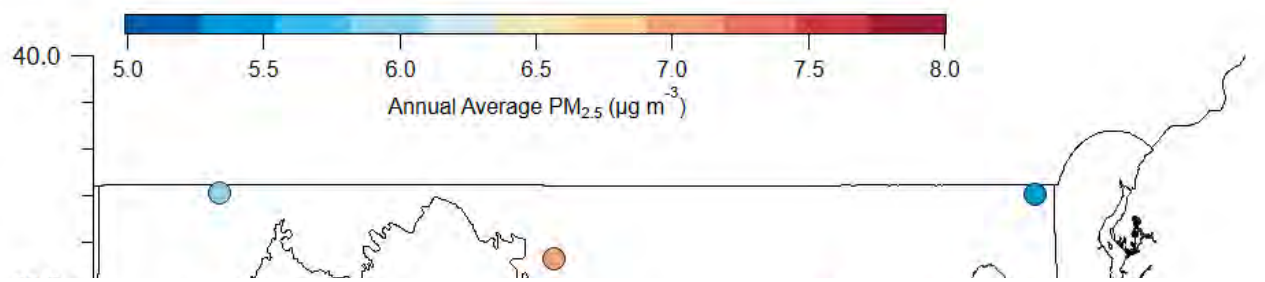
Low-cost sensor network of Baltimore



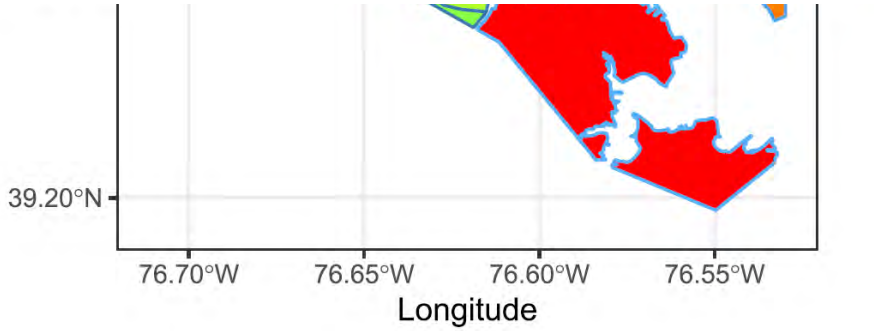
- $PM_{2.5}$
- Gas-phase includes:
  - CO
  - NO2
  - NO
  - CO2
  - O3
  - CH4

Minimal mass concentration variability in $PM_{2.5}$ across Baltimore, but small differences due to urban area

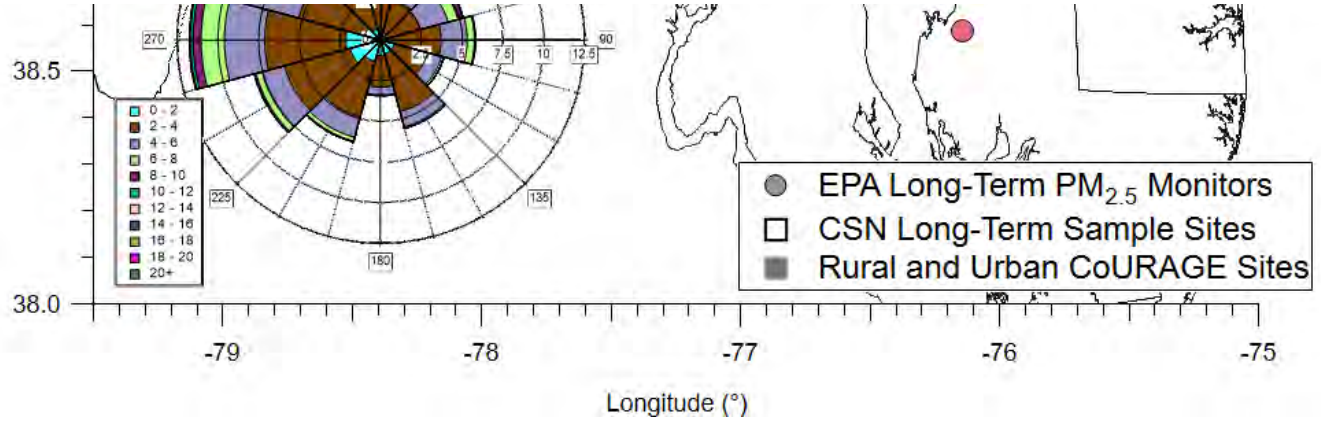




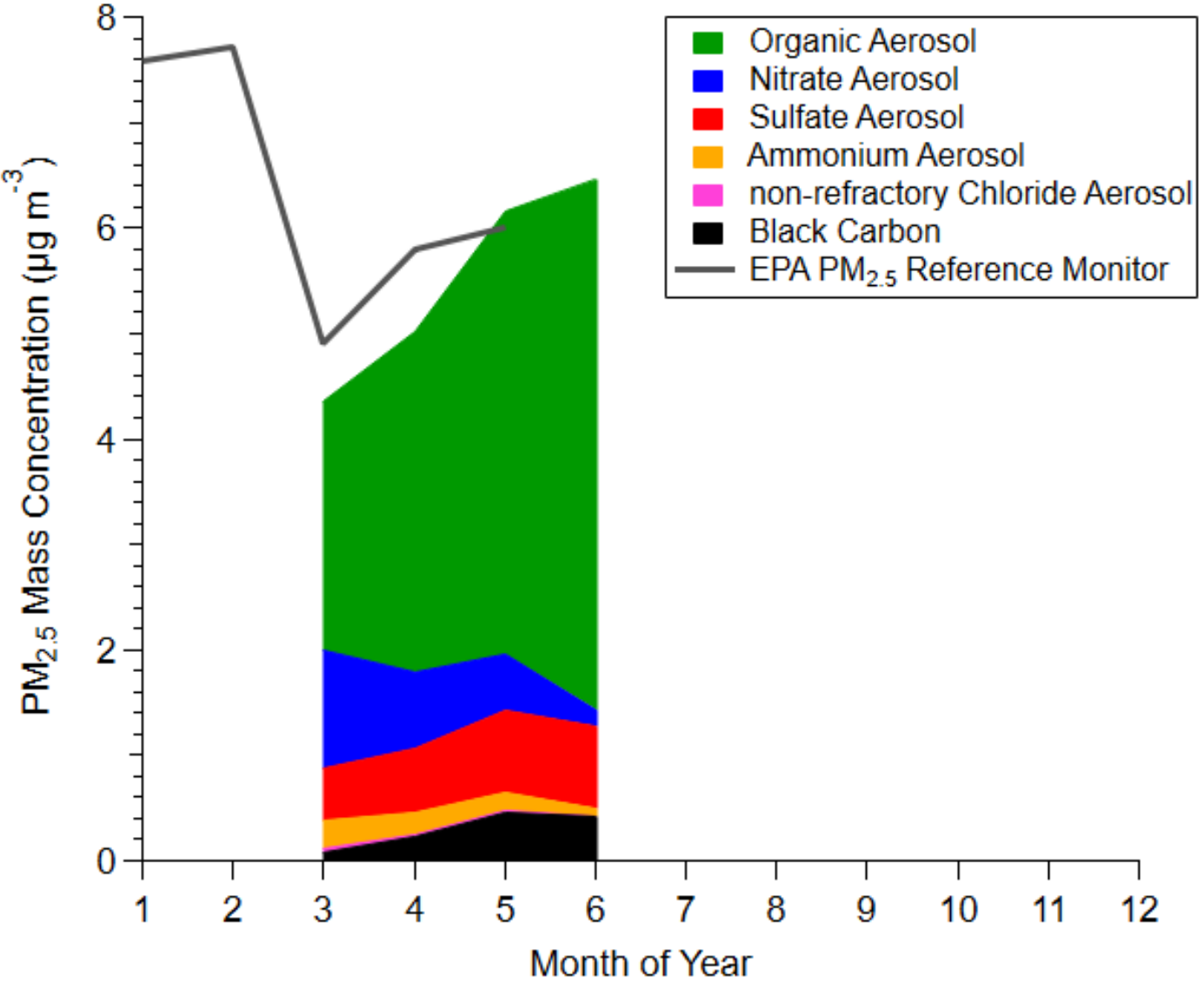
Is there a compositional difference and/or differences in the ultrafine (< 100 nm) or supermicron (> 2.5 μm) and how does Baltimore enhance $PM_{2.5}$?



(a) Average $PM_{2.5}$

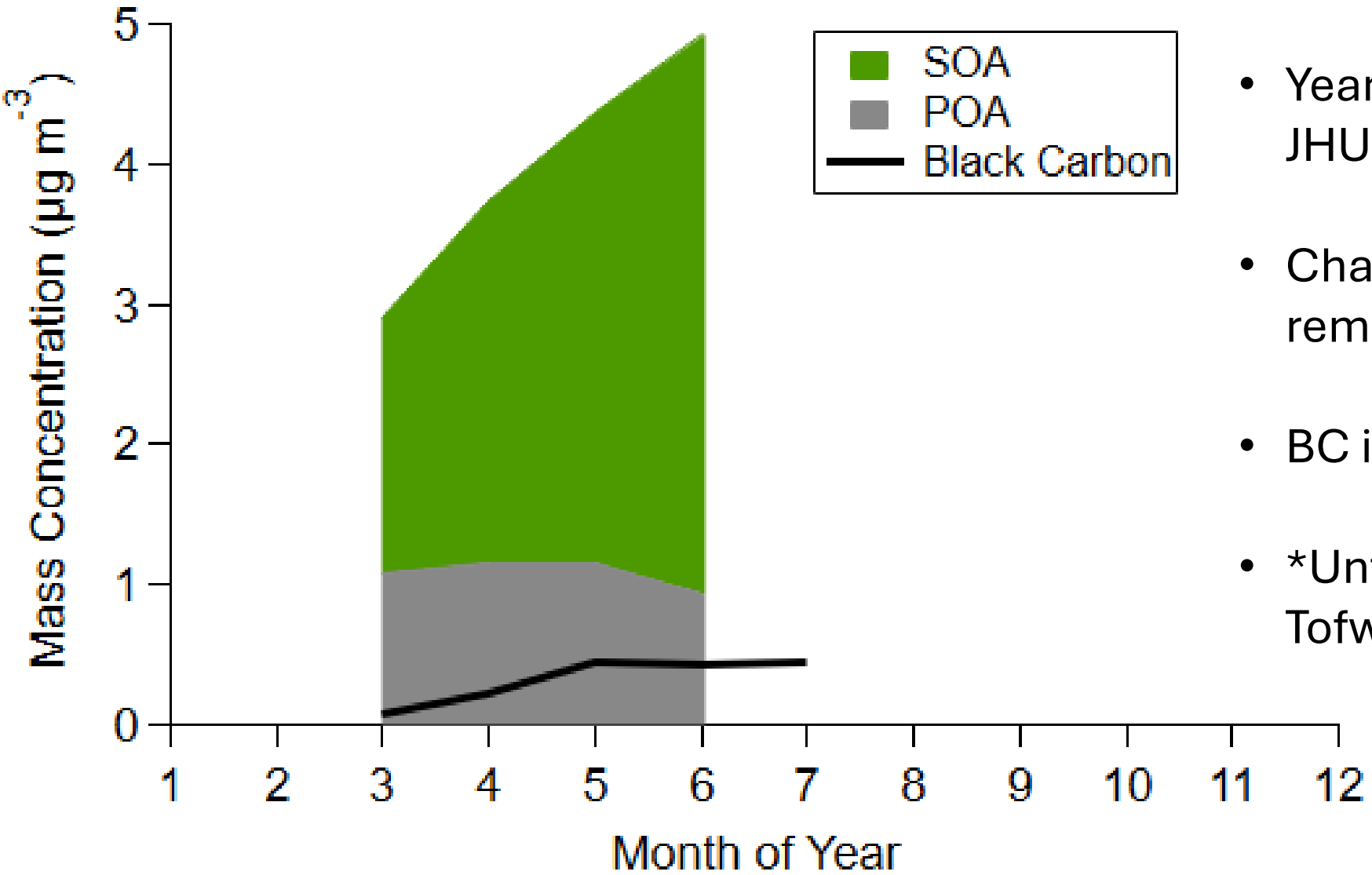


Evaluation of BSEC vs EPA long-term $PM_{2.5}$ shows importance of chemical speciation



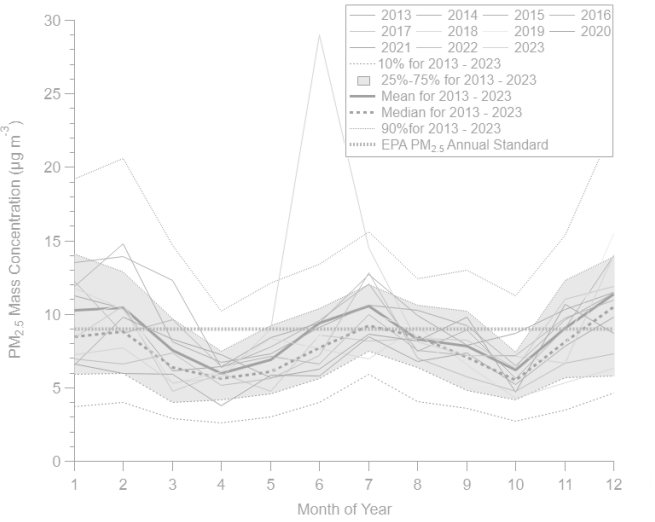
- Year 2024 for BSEC site (near JHU) and Essex $PM_{2.5}$
- Changes in nitrate vs OA appears to be driving constant $PM_{2.5}$, similar to prior years
- *Unfortunately, ACSM-X back to Tofwerk for repairs

Though BC is increasing, there is not a similar increase in POA but instead SOA

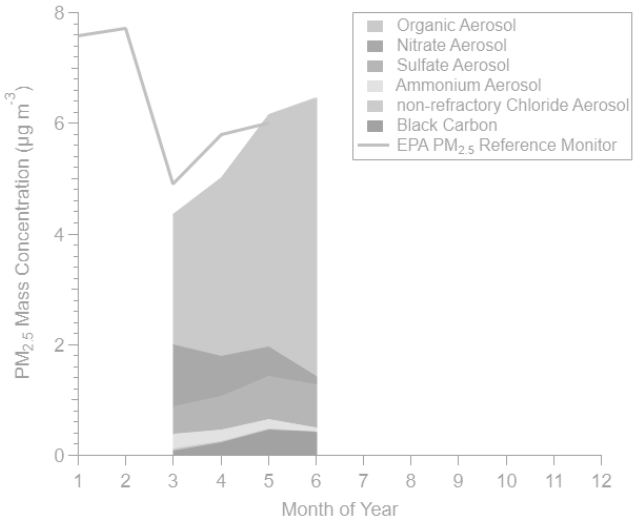


- Year 2024 for BSEC site (near JHU)
- Changes in SOA while POA remains constant
- BC increasing
- *Unfortunately, ACSM-X back to Tofwerk for repairs

Understanding what is driving $PM_{2.5}$ (and potentially larger/smaller) is important for Baltimore



Minimal variability in $PM_{2.5}$ across years/seasons



Changing composition driving that
How does that look at finer temporal and spatial scales?
Other size particles?

Have fixed, mobile, and low-cost sensor network
Working on funding for mobile
Other collaborations/support?