Establishing an Ambient Mercury Baseline in New York State: Results from an EPA Community Assessment Grant

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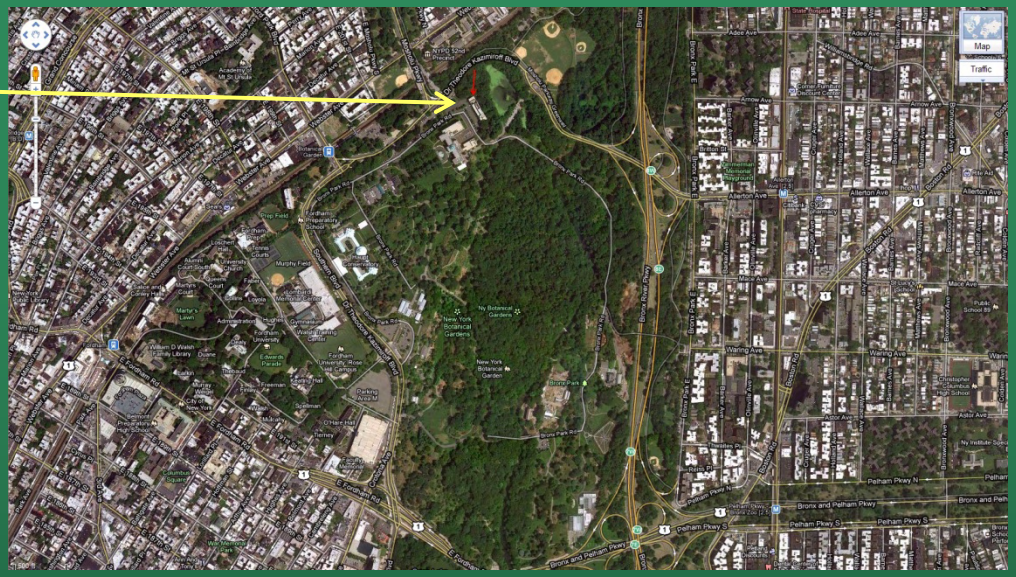
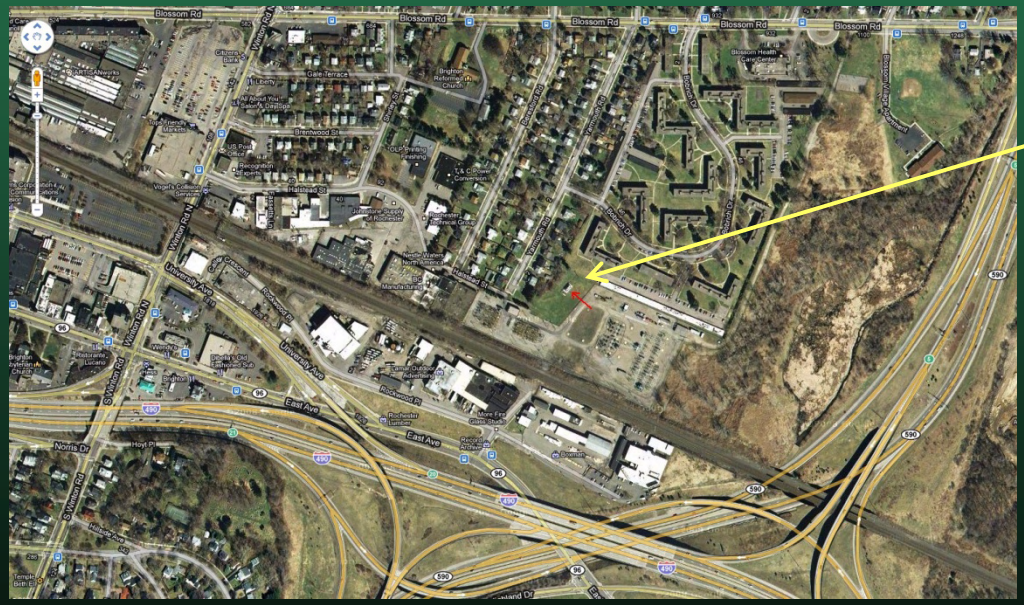
Objectives

- Establish a mercury baseline in NY – speciated air concentrations and wet deposition
- Track progress of recent emission reduction strategies, and ensure that monitoring is in place to assess future planning efforts
- Characterize diurnal, seasonal, and year-to-year patterns in Hg at two urban locations
- Compare data with rural sites across NY
- Participate in & provide feedback to MDN/AMNet

Bronx, NY

- NY Botanical Gardens – Pfizer Plant Research Laboratory in north Bronx
- ~20 million people in metro area
- Numerous pollution sources and long chemical/industrial legacy in the region





Rochester, NY

- NYSDEC continuous air monitoring station, east of downtown Rochester
- ~1 million people in metro area
- Site downwind of numerous coal-fired utilities

Atmospheric Mercury

- Elemental gaseous mercury, Hg(0)
  - Weakly water soluble
  - Global background concentrations ~1 to 2 ng/m^3
  - Atmospheric lifetime ~0.5 to 2 years
  - Typically >95% of atmospheric Hg
- Reactive gaseous mercury, RGM
  - Divalent, oxidized...
  - Highly reactive & water soluble, readily wet/dry deposited
  - Short lifetime (hours to days), pg/m^3 concentrations
- Particle-bound mercury, PBM
  - Condensed Hg, semi-volatile Hg bound to aerosols
  - Readily wet/dry deposited
  - Short lifetime (hours to days), pg/m^3 concentrations

MDN wet deposition system

N-CON 00-125-2 automatic precipitation sampler

ETI NOAH IV total precipitation gauge

Weekly total Hg wet deposition and precipitation

Tekran ambient air system

Continuous speciated Hg air concentrations

Model 1135 PBM module

Model 1130 RGM denuder module

Heated line for desorbed RGM/PBM

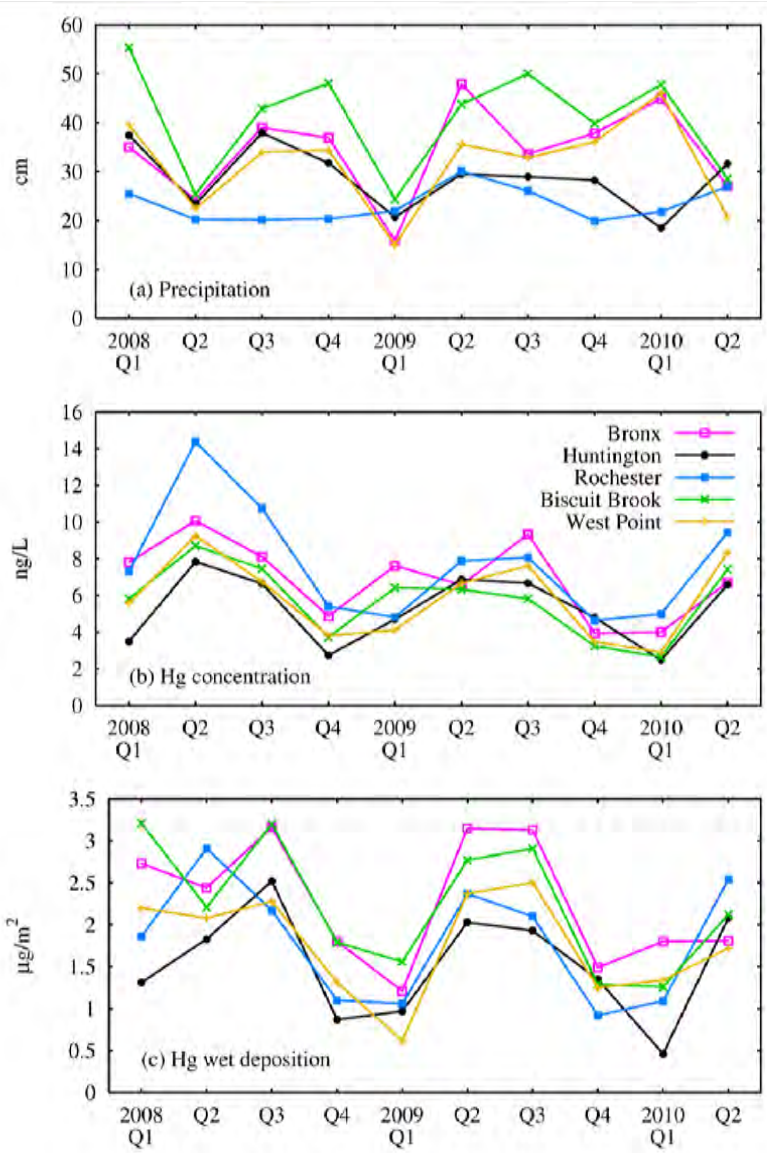
Model 2537B – collects Hg(0) on gold traps; every 5 minutes Hg(0) thermally desorbed and detected using CVAFS

Model 1130 pump module to provide extra flow for RGM/PBM detection

First two hours: PBM collects on quartz filter, RGM collects on KCl denuder, analyze Hg(0)

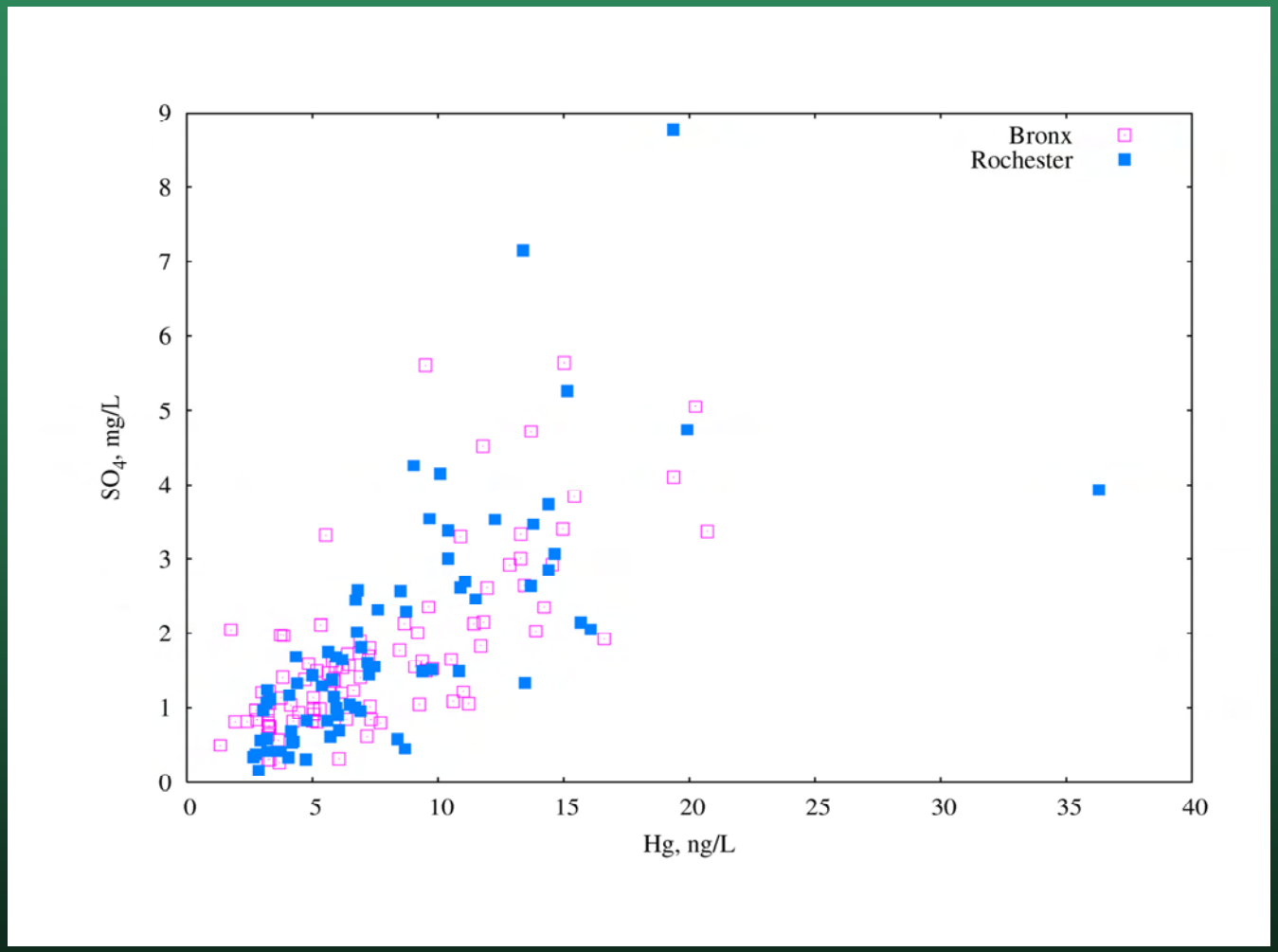
Third hour: PBM & RGM sequentially desorbed and sent to 2537B for analysis

Quarterly MDN data



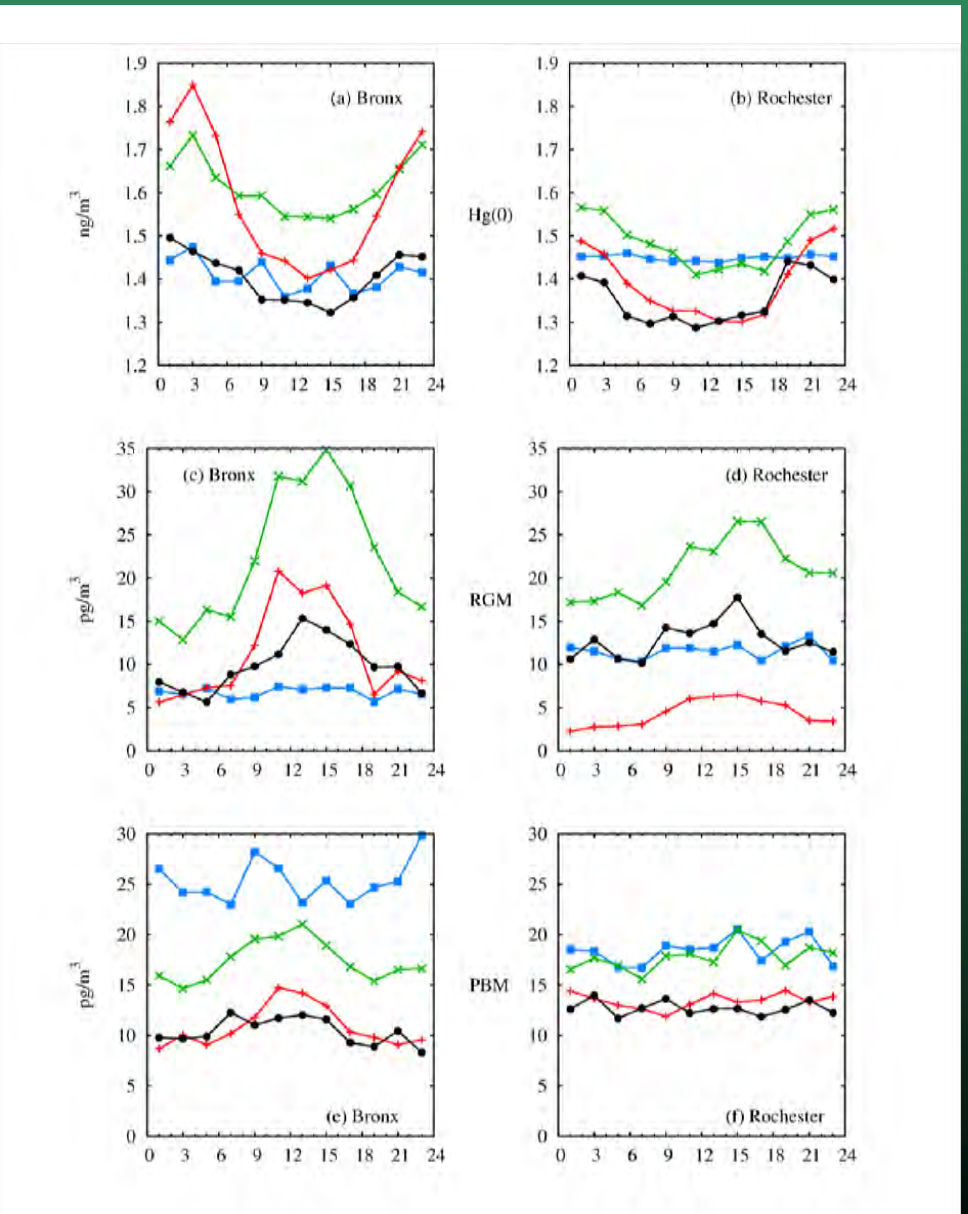
- Precipitation (top), Hg concentration (middle), and Hg wet deposition (bottom) at Bronx and Rochester, in comparison with three more rural MDN sites – Huntington Wildlife (Adirondacks), Biscuit Brook (Catskills), and West Point (Hudson Valley)
- Biscuit Brook and Bronx generally receive the most precipitation in NY, Rochester the lowest
- Hg concentrations were considerably higher at Rochester than other sites in 2008, but the discrepancy is much smaller now
- Considerable seasonal variation in wet Hg deposition over the past 2.5 years

SO_4 vs. Hg in wet deposition



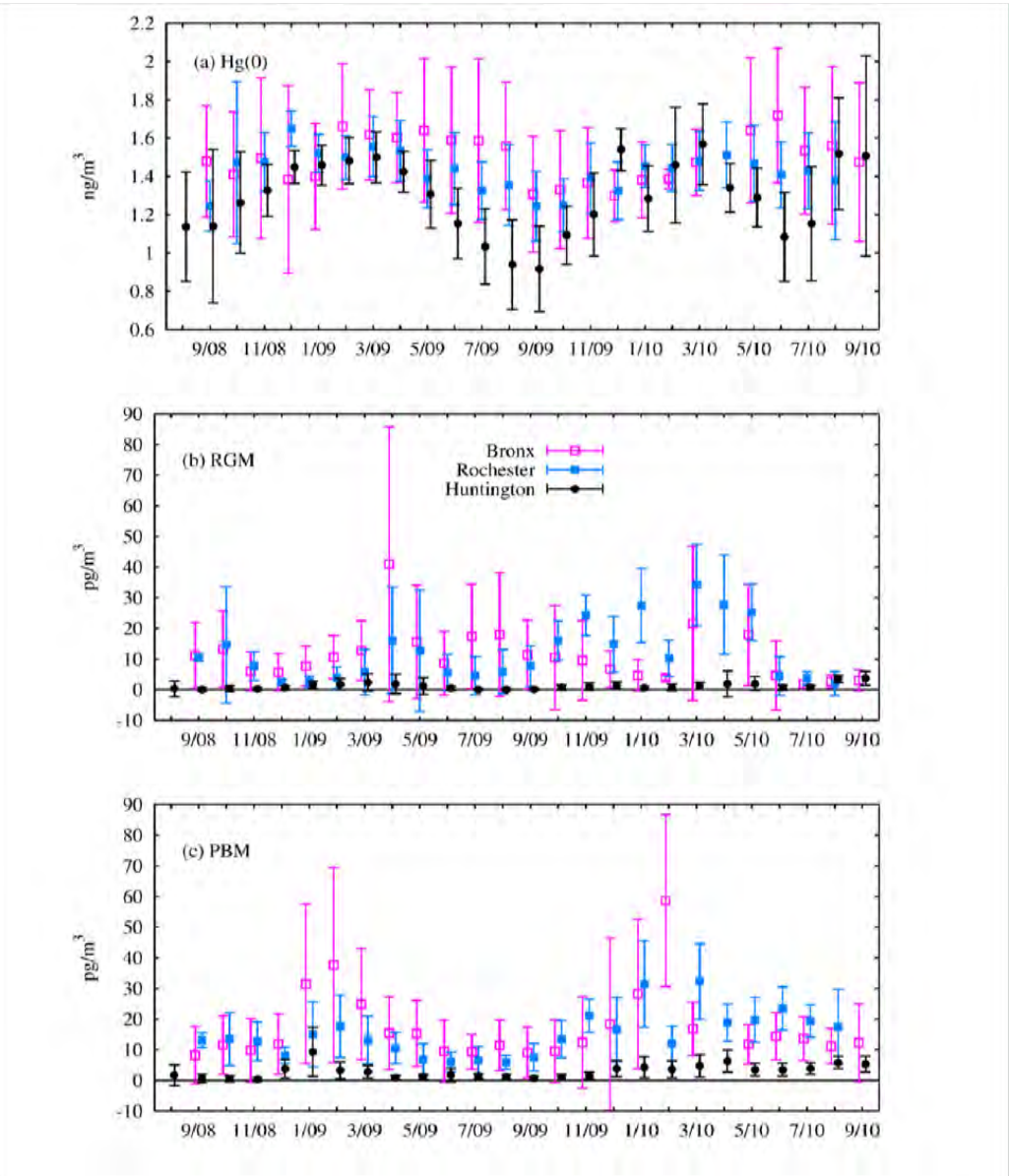
- Weekly concentrations at Bronx and Rochester
- Pollutants share common combustion sources

Diurnal variations, ambient Hg



- Diurnal variations at Bronx and Rochester – winter (blue), spring (green), summer, (Red) and fall (black)
- Hg(0) (top), RGM (middle), PBM (bottom)
- Distinct nighttime peak in Hg(0) at the Bronx, especially during summer; amplitude is less at Rochester
- Distinct daytime peak in RGM at both sites, especially during spring (looks photochemical)
- Slight daytime peak in PBM during the warmer months at Bronx, not as noticeable at Rochester
- Bronx data are more variable

Monthly variations, ambient Hg

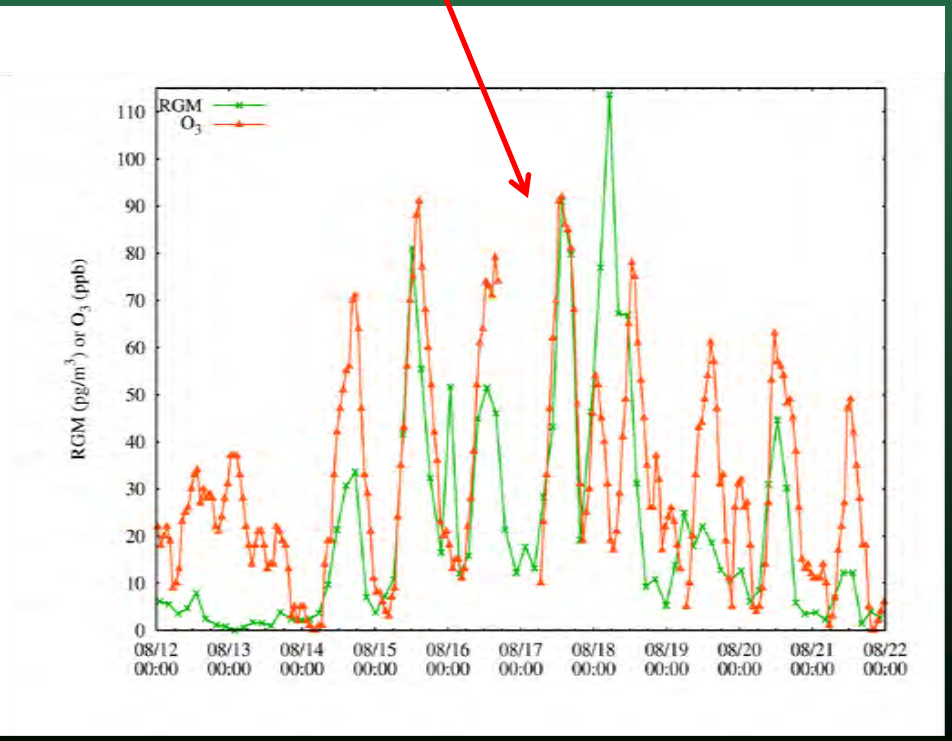


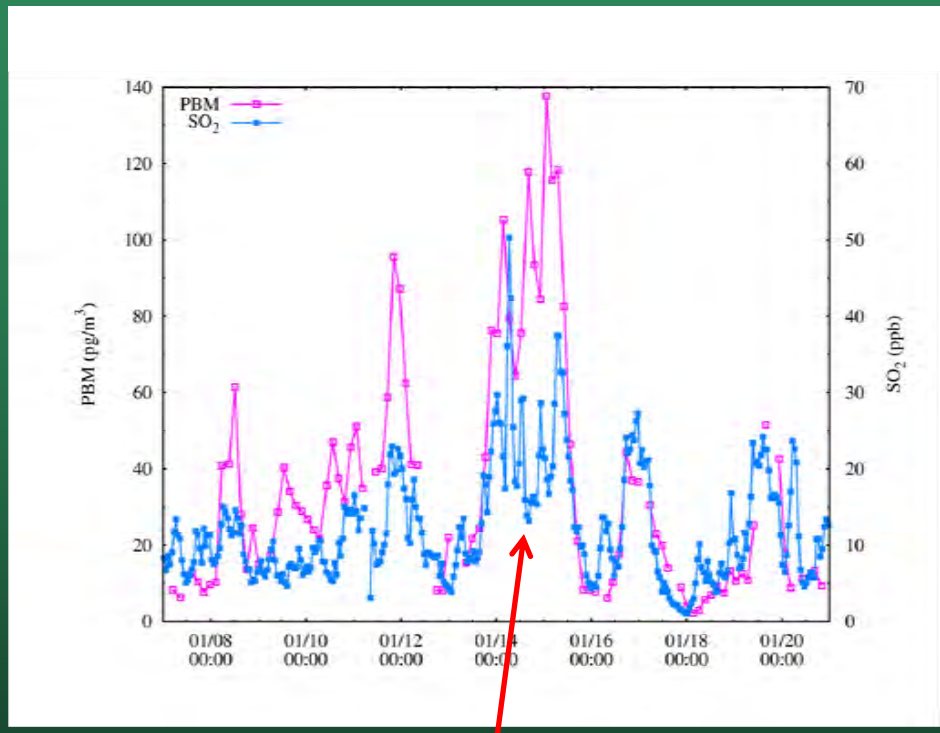
- Monthly speciated Hg at Bronx, Rochester, and the rural Huntington Wildlife site
- Hg(0) (top), RGM (middle), PBM (bottom)
- Huntington Hg(0) exhibits a summer minimum, winter maximum; seasonal amplitude not as pronounced at Bronx or Rochester
- RGM has pronounced spring peak at Bronx and Rochester
- PBM has pronounced winter peak at Bronx and Rochester

Variations with co-pollutants, Bronx

August 12-21, 2009

Photochemical nature of RGM – correlation with O_3 during a summertime episode

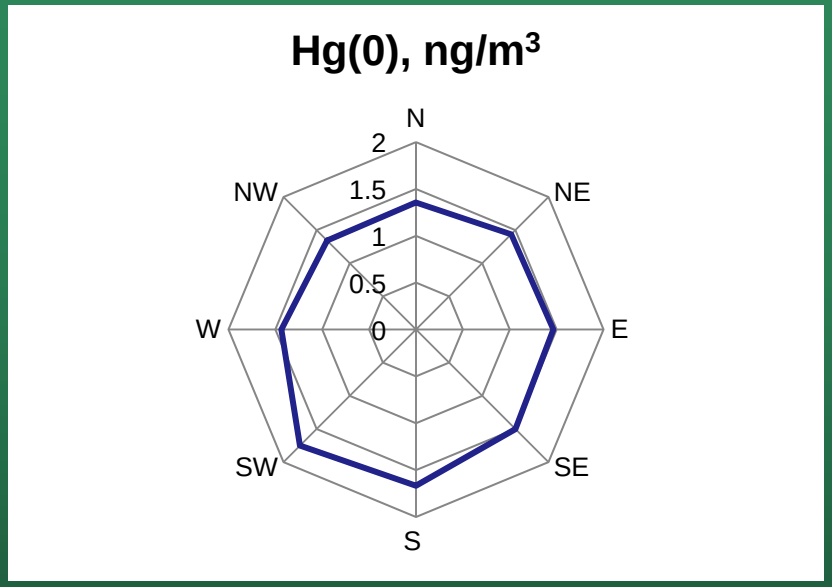


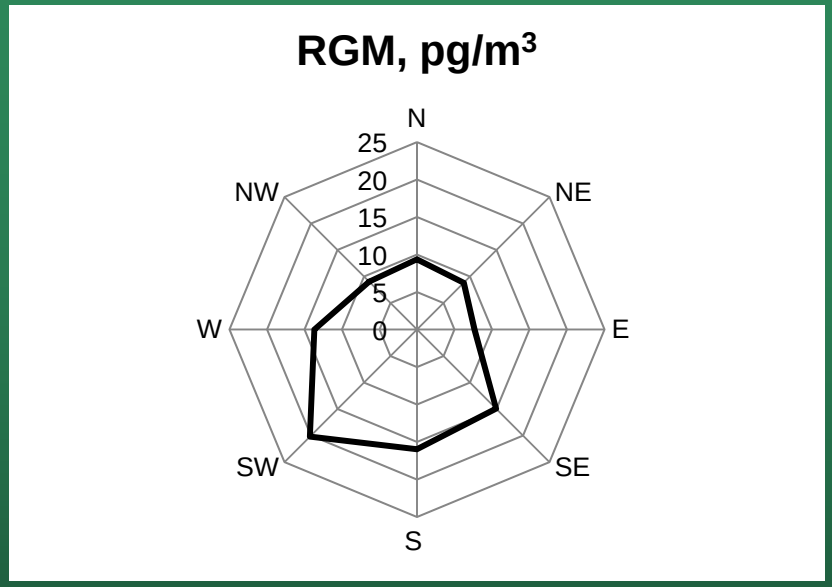


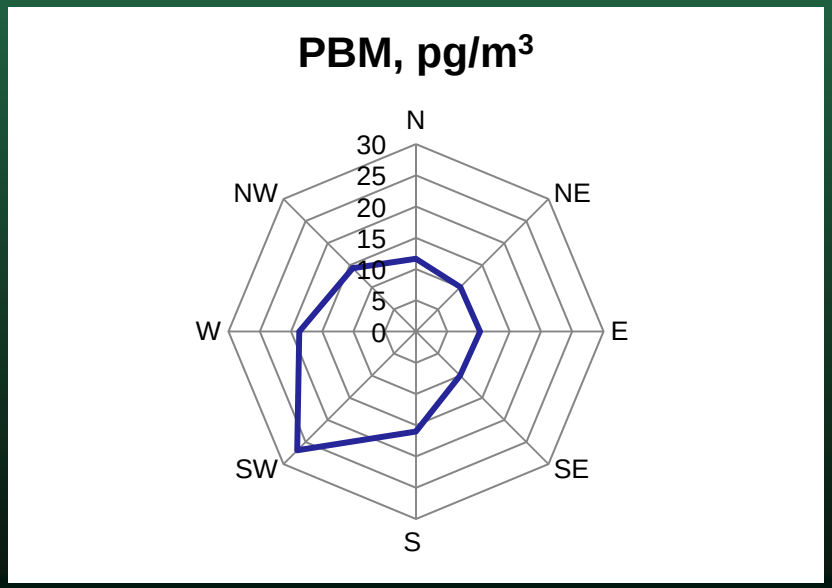
January 7-20, 2010

PBM correlated with SO_2 during a wintertime event

Pollution rose analysis, Bronx

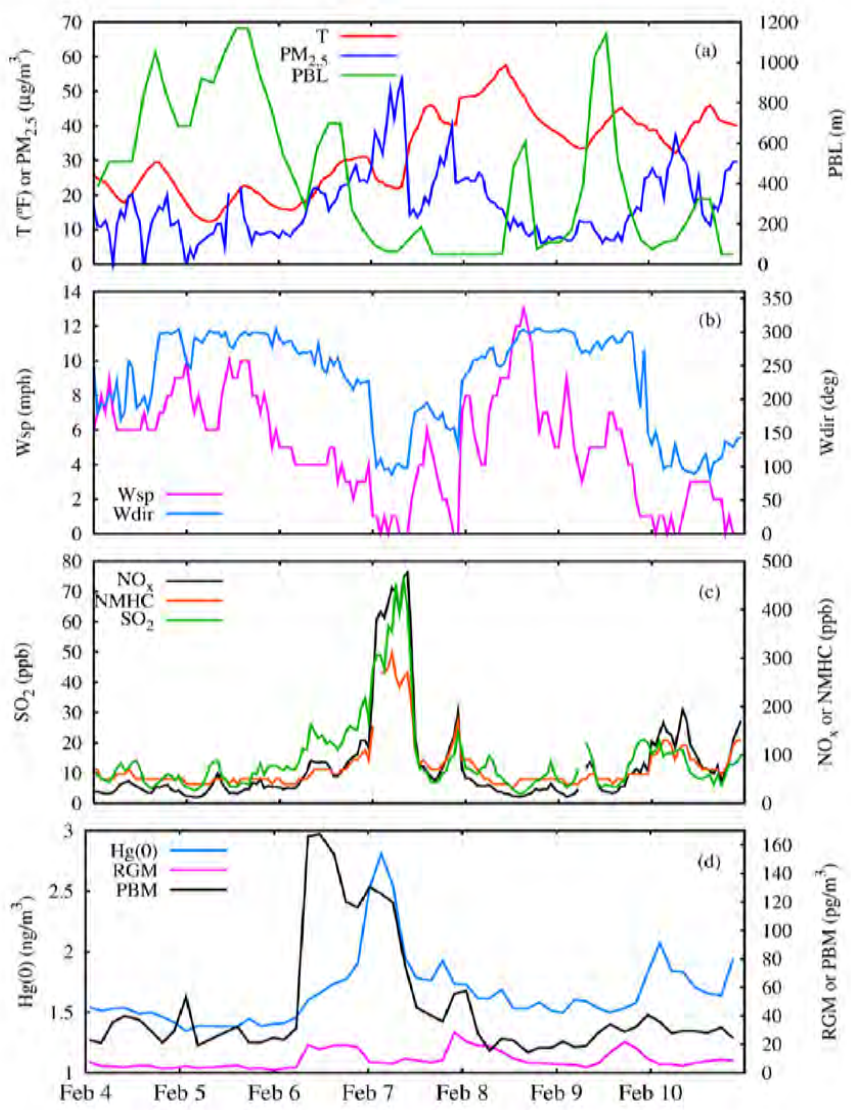






- Clear enhancement of Hg from the S/SW, especially for PBM
- Current and/or legacy sources of Hg?
- Future plans may include comparison with Tekran and wind data from NJ

Winter stagnation event, Bronx



- Early February 2009
- Strong low-level inversion – low PBL heights and wind speeds, rising temperatures – February 7-8
- Hg(0) and PBM correlated with $PM_{2.5}$, NO_x, NMHC, and SO_2
- peak Hg(0) levels nearly doubled, peak PBM values exceeded 120 pg/m^3

Summary

- NYSDEC has collected nearly 2.5 years of Tekran and more than 3 years of MDN data at two urban sites to establish a Hg baseline
- The method development work helped to make the measurements more reliable and more consistent across the country
- The study data show that the wet and speciated ambient Hg concentrations from rural sites cannot be used to characterize concentrations in urban areas
- Additional data analysis will include urban co-pollutant interaction and collaboration with NJ to assist in potential source identification

Acknowledgments

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