



ovrattig@gw.dec.state.ny.us

Real-time PM2.5 Black Carbon Measurements at Rochester and the South Bronx, NY

Oliver V. Rattigan, H. (Dirk) Felton, and Kevin L. Civerolo

New York State Department of Environmental Conservation, Division of Air Resources, 625 Broadway, Albany, NY.



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IMPORTANCE of PM2.5 Carbon

- Constitutes ~30 to 60% of PM2.5 in New York.
- Present in the sub micron size range and is associated with deleterious health effects.
- Real-time measurements can be used to track rapid changes as emissions vary throughout the day.
- Carbon has 2 major components
 - (a) a non-volatile fraction; "elemental carbon" (EC) or "black carbon" (BC) which is ~10-20% of PM2.5 carbon balance. It is emitted directly from combustion processes.
 - (b) a semi-volatile component; organic carbon (OC) which is the major carbon fraction. It is emitted directly or produced by photochemical processes.
- EC/OC ratio can be used to indicate photochemistry.

INSTRUMENTS

- (1) A Magee Scientific Aethalometer provides 5 minute BC concentrations. It measures the change in optical absorption at 880 nm as particles are collected on a quartz filter tape. A calibration factor of 16.6 is used to convert to mass.
- (2) A Sunset Labs OC/EC carbon aerosol analyzer provides hourly measurements of EC and OC using thermal optical transmission (TOT).
- (3) The R&P Speciation Sampler provides 24 hr integrated filter measurements of EC and OC every 3rd day using EPA standard protocol.

SITES

- South Bronx, NY. The site is located at Intermediate School 52, 681 Kelly St., South Bronx. It is impacted by several major highways, I87 Major Deegan Expressway, I278 Bruckner Expressway, the Cross Bronx Expressway, Sheridan Expressway and the Bronx River Parkway. LaGuardia airport lies within a few km to the south east.
- Rochester, NY. The site is located at Blossom St. in Brighton on the east side of the city close to I590 and I490.

RESULTS

Aethalometer Black carbon in the South Bronx peaks in the early morning from 6-10 am and tracks NO_x and Nitrate concentrations. This pattern is observed throughout the year but is most pronounced from May to August.

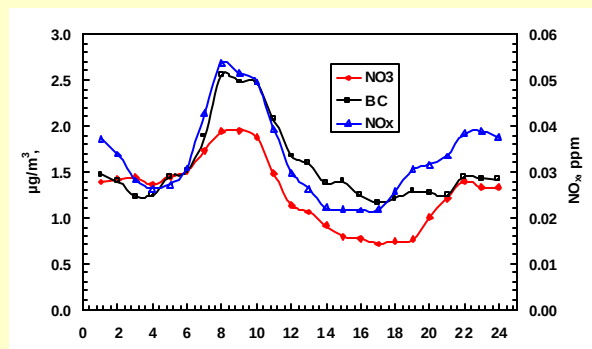


Figure 1. Average Diurnal BC, NO_x and NO₃ August 2003, South Bronx.

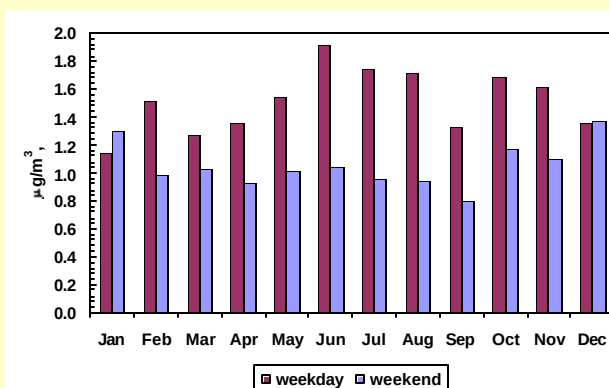


Figure 2. Average weekday vs weekend BC at the South Bronx.

BC concentrations at the South Bronx are generally higher during weekdays compared to weekends except for December and January when the trend is reversed. June, July, August show the largest difference (~factor of 2). Data from May 2003 to July 2005 are included. In contrast there is no particular weekday/weekend trend observed at the Rochester site although measurements have only been performed at this site since July 2004.

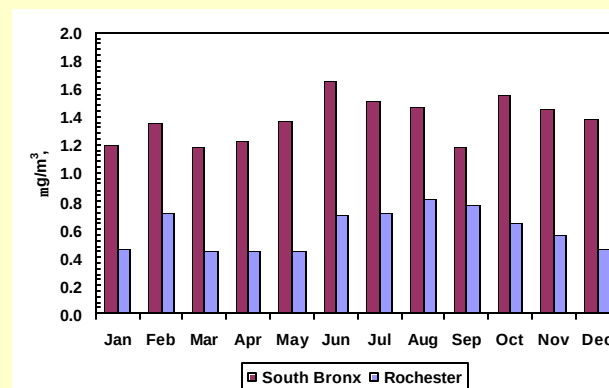


Figure 3. Comparison of BC at the South Bronx and Rochester.

Monthly averaged BC concentrations at the South Bronx are a factor of 2 to 3 times higher than at Rochester reflecting the influence of the larger urban center. At both sites concentrations tend to be higher from June to December.

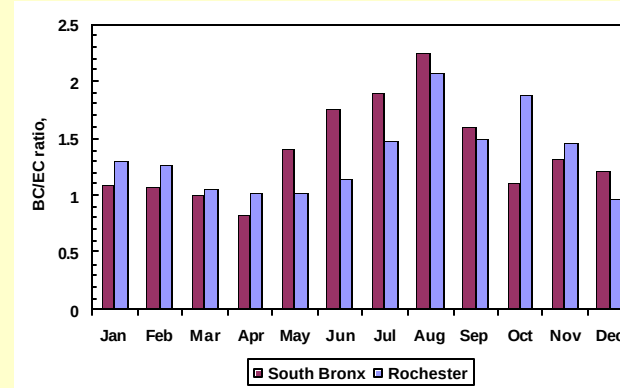


Figure 4. Ratio of Aethalometer Black Carbon to 24 hr integrated Filter Elemental Carbon.

Aethalometer BC data generally tracks the 24 hr integrated filter EC data but there is a distinct seasonal bias with BC a factor of 1.5-2 higher than EC during July and August and between 1-1.5 from December to April. There are also some differences in the BC/EC ratio between the two sites especially from May to July. The Aethalometer measures the optical density on a filter and an absorption coefficient of 16.6 is used to convert to mass. However, the coefficient may depend on the aerosol composition which varies seasonally and with location. The 24 hr filter data is a direct mass measurement. Differences in sampling techniques (cyclone vs impactor) and sample flow rates for these instruments may also affect the collection efficiencies.

Note BC at the South Bronx also tracks hourly EC from the SUNSET carbon instrument averaging 10 to 30% higher for July to September.

SUMMARY

The Aethalometer can provide useful temporal information on black carbon which appears to track NO_x and aerosol Nitrate and therefore most likely mobile emissions. However, the relationship between BC and EC appears to vary seasonally, and most likely with location, indicating that the Aethalometer calibration factor used to calculate BC mass concentrations may vary depending on the aerosol matrix composition.

Work in progress includes a longer term comparison of the Aethalometer with hourly measurements of EC from a Sunset labs instrument at the South Bronx site.

Acknowledgments

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