Source apportionment of airborne particulate matter in Rochester, NY

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Objective

Black carbon (BC) is an important component of the atmospheric aerosol. Fossil fuel combustion and biomass burning are generally the two most important anthropogenic BC sources. In this study, we investigated the sources of BC and if changes in the impacts of diesel traffic emissions on airborne particle characteristics in Rochester, New York from January 2007 to December 2010 could be observed using two-wavelength aethalometer measurement.

Experimental Methods

Rochester, located on the southern shore of Lake Ontario, is the third largest city in New York State. In 2009, it had a population of 207,294. The New York State Department of Environmental Conservation (NYS DEC) maintains a monitoring site in Rochester, NY (43°08'46" N, 77°32'54" W, Elevation = 137 m, U.S. EPA site code 36-055-1007).

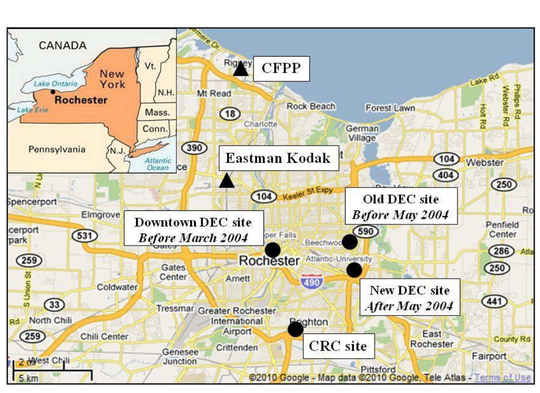

Figure 1. Location and view of the sampling site.

Every third day 24-hour average $PM_{2.5}$ elements, sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonia (NH_4^+), elemental carbon (EC) and organic carbon (OC) concentrations during 2007-2010 were obtained from the U.S. EPA speciation network. BC concentrations were measured from January 2007 to December 2010 using a two-wavelength aethalometer (370 nm and 880 nm, Model AE-21, Magee Scientific, USA). the loading effects on the aethalometer data were corrected. Organic components of wood smoke particles absorb light at 370 nm more effectively than 880 nm in two-wavelength aethalometer measurements. This enhanced absorption (Delta-C = $BC_{370nm} - BC_{880nm}$) was found to strongly correlate with wood smoke molecular markers (levoglucosan and potassium) during the heating season. Therefore, Delta-C serves as a tracer of wood combustion particles. The Delta-C

24-hr data that were combined
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sults

n 4 to 8 in the PMF analysis
quality of fit as indicated by the
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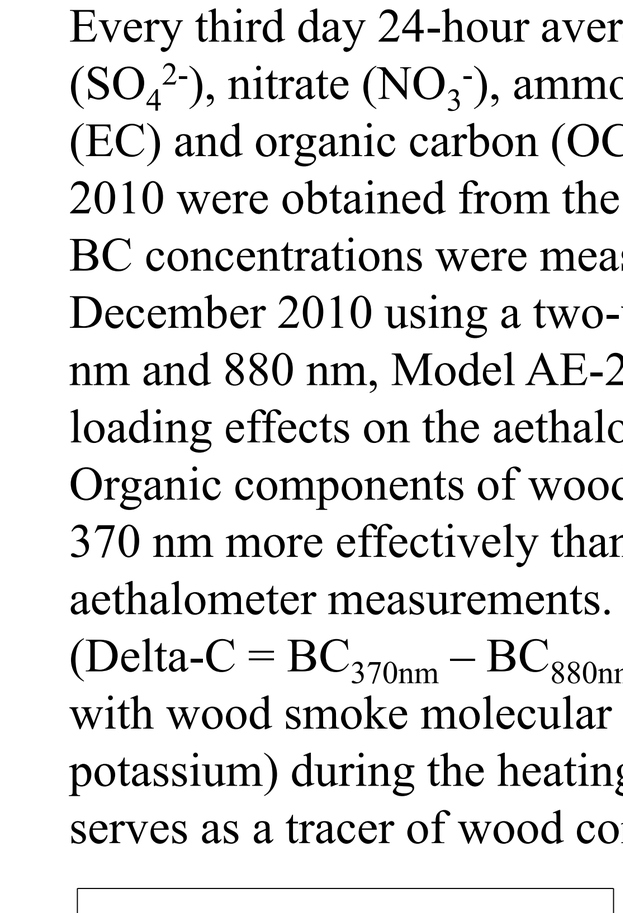

Results and Discussion

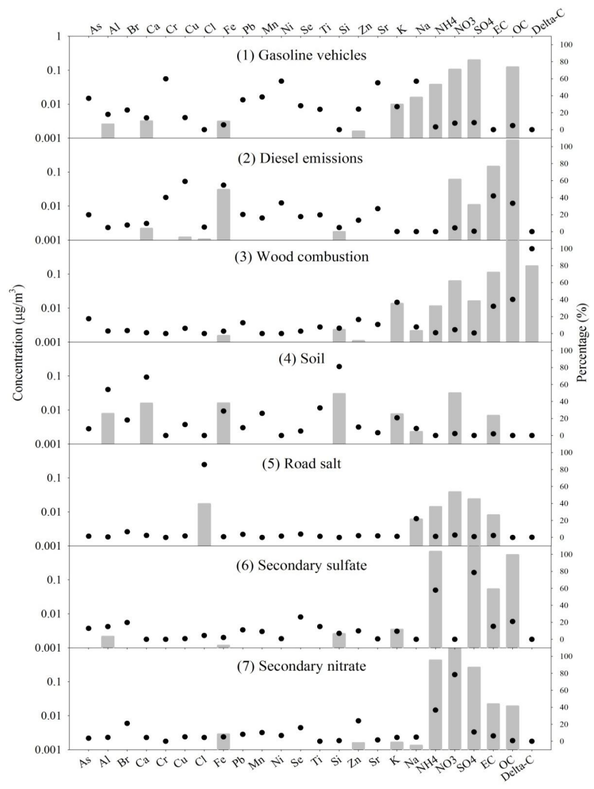

Figure 2. Source profiles and % of explained variation of the measured species

Figure 3. Monthly variation of source contributions of the secondary species.

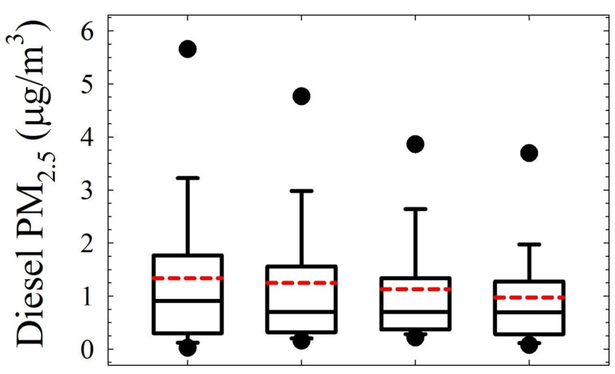

Figure 5. Annual variation of $PM_{2.5}$ of diesel emissions between 2007 and 2010 showing the decline over this period

Figure 4. Monthly variation of source contributions of wood smoke and diesel emissions.

Table 1. Summary statistics for source contributions to $PM_{2.5}$ in Rochester.

Source Type	Mean (μg/m³)	Fractional Contribution	Std Dev (μg/m³)	Median (μg/m³)
Gasoline	1.44	1.26	15.5%	1.26
Diesel	1.09	0.85	11.8%	0.89
Wood	0.85	0.85	9.2%	0.60
Soil	0.60	0.71	6.5%	0.42
Salt	0.12	0.38	1.3%	0.02
Sulfate	3.55	4.54	38.2%	2.04
Nitrate	1.63	2.87	17.5%	0.65

Conclusion

- Annual average $PM_{2.5}$ concentrations apportioned to diesel emissions decreased by 10% between 2007 and 2010.
- Delta-C was used as an input variable in source apportionment models, and
- Wood smoke was represented about 9% of the annual average PM2.5 mass in good agreement with prior studies.

Related Publications

Y. Wang, P.K. Hopke, O.V. Rattigan, Y. Zhu, *J. Environ. Monitoring* 13:1919-1936. (2011).

Y. Wang, P.K. Hopke, M.J. Utell, *Aerosol & Air Quality Research* 11: 473–481 (2011).

Y. Wang, P.K. Hopke, O.V. Rattigan, X. Xia, D.C. Chalupa, M.J. Utell, *Environmental Sci. Technol.* 45: 7387–7393 (2011).

Acknowledgements

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