

Field validation of a semi-continuous method for aerosol black carbon (Aethalometer) and temporal patterns of summertime hourly black carbon measurements in southwestern PA.

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Abstract

Two methods for measuring aerosol elemental carbon (EC) are compared. Three-hour integrated carbon samples were collected on quartz filters during the summer of 1990 in Uniontown, PA, primarily during episodes of elevated particulate pollution levels. These samples were analyzed for EC and organic carbon (OC) using a Thermo/Optical Reflectance (TOR) method. Aerosol black carbon (BC) was measured using an Aethalometer, a semi-continuous optical absorption method. The optical attenuation factor for ambient BC was supplied by the instrument manufacturer. Three-hour average concentrations were calculated from the semi-continuous BC measurements to temporally match the EC/OC integrated quartz filter samples. BC and EC concentrations are highly correlated over the study period ($R^2=0.925$). The regression equation is $BC (\mu\text{g}\cdot\text{m}^{-3}) = 0.95 (\pm 0.04) EC - 0.2 (\pm 0.4)$. The means of three-hour average measurements for EC and BC are 2.3 and 2.0 $\mu\text{g}\cdot\text{m}^{-3}$ respectively; average concentrations of EC and BC ranged from 0.6-9.4 and 0.5-9.0 $\mu\text{g}\cdot\text{m}^{-3}$ respectively. TOR OC and EC concentrations were not highly correlated ($R^2=0.22$). The mean OC/EC ratio was 1.85.

The 10-week Aethalometer hourly dataset was analyzed for daily and weekly temporal patterns. A strong diurnal BC pattern was observed, with peaks occurring between 7 am and 9 am local time. This is consistent with the increase in emissions from ground level combustion sources in the morning, coupled with poor dispersion before daytime vertical mixing is established. There was also some indication of a day-of-week effect on BC concentrations, attributed to activity of local ground level anthropogenic sources. Comparison of BC concentrations with co-located measurements of Coefficient of Haze in a separate field study in Philadelphia, PA, during the summer of 1992 showed good correlation between the two measurements ($R^2=0.82$).