Intercomparison of measurement techniques for black or elemental carbon under urban background conditions in wintertime

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Keywords: Black Carbon (BC), Elemental Carbon (EC), wood combustion.

Black carbon (BC) and elemental carbon (EC) are important fractions of the atmospheric aerosol because of their light absorbing properties (IPCC, 2001) and possible health effects. Despite all the efforts during the past 20 years, however, no globally accepted standard measurement methods exist. At this time, measured values of BC and EC concentrations are still method specific and can differ widely (e.g., Schmid et al., 2001; ten Brink et al., 2004).

In an earlier study at the same site under summer conditions, the agreement between optical and thermal measurement methods was quite good (Hitzenberger et al., 2006). Campaign average values determined with different methods agreed within their standard deviations.

In order to investigate the effect of the different measurement methods on BC (or EC) concentrations also under winter aerosol conditions, the present study was performed in February and March 2006 on the roof (35 m above ground) of the building of the Institute for Experimental Physics, which is located in downtown Vienna. Ambient urban aerosol was sampled on filters (pre-heated quartz fibre filters and MSI polycarbonate filters with 0.2 µm pore size). Sampling times were approximately 24 hours. The sampling substrates were analyzed for EC using a thermal-optical method (Schmid et al., 2001), the Cachier method (Cachier et al., 1989) and a thermal-optical transmission method using two different temperature protocols, one commonly used in Sunset instruments (Birch & Cary, 1996) and one with a lower temperature in the first phase (Schauer et al., 2003). The filters were analyzed for BC using a filter transmission method similar to the aethalometer (Hansen et al., 1984), the multi-angle absorption photometer MAAP (Petzold & Schönlinner, 2004) and the integrating sphere method (Hitzenberger & Tohno, 2001). Total carbon (TC) was determined with the method developed by Puxbaum and Rendl (1983) and also with the thermal-optical transmission method.

In this study, agreement between the methods was found to be much worse, with largest differences between the thermal methods. The optical methods agreed reasonably well during the whole campaign. On days with low temperatures, the differences in the methods (especially in the thermal methods) were found to be more than a factor of 2. Lowest concentrations were always measured with the thermal-optical transmission methods. During warmer periods, the agreement was better and comparable to the agreement in the summer study. If the BC data obtained with the integrating sphere (IS) method are corrected for the influence of biomass combustion aerosol (“brown” carbon), the agreement between corrected IS data and data measured with the thermal-optical transmission methods becomes acceptable.


This work was supported by the Belgian Federal Science Policy Office and by internal projects of the Vienna University of Technology.