On the use of the field Sunset semi-continuous analyzer to measure equivalent black carbon concentrations

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The study describes a method how to calculate equivalent black carbon (EBC, Petzold et. al 2013) concentrations, obtained from raw laser intensity data measured by a semi-continuous thermo-optical EC/OC analyzer (Sunset Laboratory Inc., USA), compares the calculated EBC concentrations to several EBC-dedicated instruments, and also examines various correction methods and their influence on the calculated EBC concentrations.

Comparative measurements to EBC-dedicated filter-based instrumentation (MAAP (5012, Thermo Scientific 5012), aethalometer (AE31, Magee Scientific), and microaethalometer (AethLab AE51)) were conducted during two intensive campaigns at a north-west suburb of Prague, Czech Republic. The summer campaign lasted 27.6.-8.7.2012, and the winter campaign 6.-15.2.2013. All instruments were equipped with PM10 inlets. An example of uncorrected EBC data from the winter campaign is shown in Fig. 1. The EBC concentrations from the individual instruments were compared to the EBC from MAAP concentrations and fitted with linear functions forced through zero. A good agreement was found not only between EBC obtained with the semi-continuous Sunset analyzer, the aethalometer and the microaethalometer, but also an agreement with EBC obtained with the MAAP was observed in both the summer and winter campaigns.

Not only original EBC concentrations from the instruments were compared to each other, but several corrections were applied as well, to show the applicability, advantages, and also disadvantages of deriving EBC concentrations from the semi-continuous Sunset analyzer which was originally intended to measure elemental carbon and organic carbon in a thermo-optical analysis. The calculated EBC data were corrected for:

- simple loading (Virkkula et al. 2007)
- loading by using also the scattering data from a nephelometer (Collaud Coen et al. 2010)
- multiple scattering (Collaud Coen et al. 2010)
- wall reflection correction for a quartz tube in the semi-continuous analyzer (Zíková et al. 2016).

Based on the analyses, we conclude it is necessary to correct the laser signals given by the Sunset semi-online analyzer for light reflection on the quartz tube, and the new correction was introduced. With the new correction, it is possible to use the semi-continuous Sunset analyzer to measure EBC concentrations with a reasonable agreement to aethalometer data with no additional costs or alterations of the instrument. Such derived data cannot compete with data obtained from instruments dedicated to measure EBC concentrations, as the Sunset analyzer is designed primarily for thermo-optical analysis. In the absence of a dedicated instrument, however, EBC from the semi-continuous Sunset analyzer can be used to obtain an indication of EBC concentrations, as the results are comparable to EBC concentrations obtained from an aethalometer and a microaethalometer. Nevertheless, the study also showed a need for a correction of the raw attenuation data given by the semi-continuous Sunset EC/OC analyser, similarly to corrections developed for aethalometers.

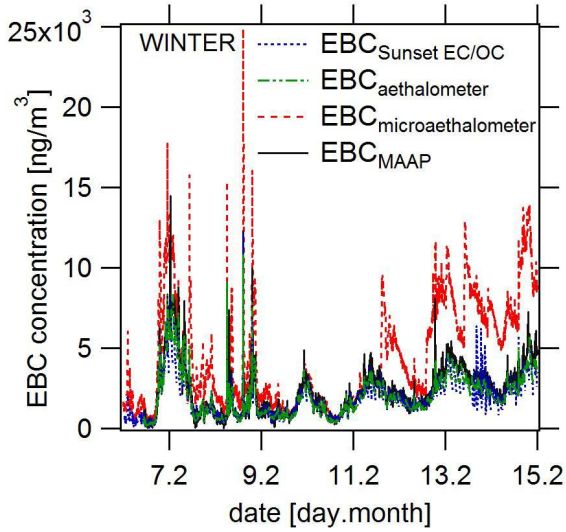

Figure 1. Time series of the original EBC concentrations during the winter campaign without any corrections.

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