On the wavelength dependence of the AE33 aethalometer multiple scattering correction factor C

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The Aethalometer (AE; Magee Scientific) is a widely used filter-based instrument that provides in-situ real-time optical measurements of light absorbing aerosols in 7 different wavelengths ranging from 370nm to 950nm. As for any other filter-based technique, Aethalometer measurements are affected by two artefacts: the multiple-scattering effects caused by the scattering of sampling light by both the filter fibres and the aerosol particles on the filter (C(λ) in Eq. 1) and the loading effect due to the saturation of the measurement as a function of deposited particles (R_{ATN}(λ) in Eq. 1). Thus, the light absorption coefficient (b_{ABS} (λ)) of deposited particles can be obtained from the measured light attenuation coefficients (b_{ATN} (λ)) following the equation:

$$b_{ABS}(\lambda) = \frac{b_{ATN}(\lambda)}{C(\lambda)\cdot R_{ATN}(\lambda)} \qquad \text{(Eq. 1)},$$

where C(λ) and R_{ATN}(λ) depend on the amount, size distribution and optical properties of deposited particles. An accurate determination of C(λ) and R_{ATN}(λ) is fundamental for a reliable estimation of b_{ABS} (λ) from AE measurements. The new Aethalometer model AE33 corrects on line for R_{ATN}(λ) using two parallel measurements with different loading (Drinovec et al., 2015). The C(λ) can be determined by dividing the b_{ATN} (λ) measurements from AE33 by independent b_{ABS} (λ) measurements. However, due to the paucity of independent multi-wavelength b_{ABS} (λ) measurements, the wavelength dependence of C(λ) has been poorly explored. Here we report on the wavelength dependence of C(λ) by comparing the AE33 b_{ATN}(λ) with the multi-wavelength b_{ABS} measurements obtained at four wavelengths (405, 532, 635, and 780nm) using an off-line polar photometer (PP_UniMI; Bernardoni et al., 2017). Spots from multi angle absorption photometers (MAAP; Petzold and Schönlinner, 2004) deployed at three different measuring sites in NE Spain (urban, regional and remote) were analysed (number of analysed spots: from 87 and 127 according to the site) with the PP_UniMI to estimate the four-wavelength b_{ABS}(λ). AE33 measurements collected at the three sites were then averaged over the MAAP spot sampling periods and the C(λ) was determined. Results show that the absolute value of C(λ), its seasonal variation and wavelength dependence changed depending on the measuring site. Larger C(λ) values and larger dependence of C(λ) on the wavelength was observed at the remote site (MSA) compared to the urban site (BCN) (Figure 1) likely because of the predominance of aged particles at this remote site compared to the urban and regional sites. The seasonal and site variations of C(λ) reflected well the changes in aerosol composition and may be due to the cross-sensitivity of the filter-based measurement to scattering (e.g. coarse Saharan dust or fine aged regional aerosols). Finally, we calculated the C at the MAAP wavelength (637 nm) by comparing the b_{ATN} and b_{ABS} measurements from AE33 and MAAP, respectively, and compared it with the C derived at the same wavelength by the PP_UniMI polar photometer.

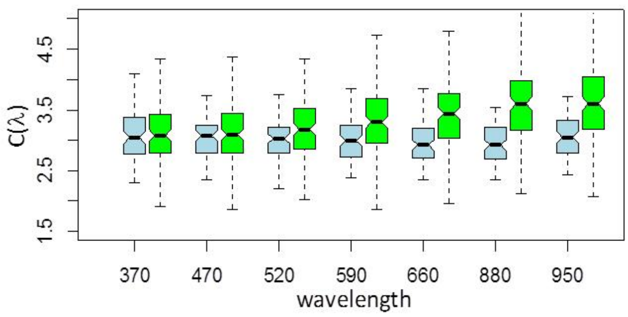

Figure 1. Wavelength dependence of C(λ) at the urban (BCN; blue box plots) and remote (MSA; green box plots) sites comparing AE33 attenuation values with PP_UniMI absorption values.

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