

The effect of Brown Carbon on thermal-optical analysis: a correction based on optical multi-wavelength analysis

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Carbonaceous aerosol (CA) has an important impact on air quality, human health and climate change. Total Carbon (TC) is generally divided in organic carbon (OC) and elemental carbon (EC) (although a minor fraction of carbonate carbon (CC) may be present). This classification is based on their thermo-optical properties: while EC is strongly light absorbing, OC is generally transparent in the visible range except for some particular compounds. In fact, another fraction of light-absorbing organic carbon exists which is not black and is generally called brown carbon (BrC) (Andreae and Gelencsér, 2006).

We recently introduced a new method to apportion the absorption coefficient (babs) of carbonaceous atmospheric aerosols starting from multi-wavelength optical analysis (Massabò et al., 2015). This analysis is performed by the MWAA, an instrument developed at the Physics Department of University of Genoa (Massabò et al., 2013) able to measure the aerosol absorption coefficient at 5 different wavelengths ranging from UV to IR. The method is based on the information gathered at these five different wavelengths, in a renewed and upgraded version of the approach usually referred to as Aethalometer model (Sandradevi et al., 2008). The resulting optical apportionment provides the quantification of EC and, with some assumptions, also of OC coming from fossil fuels and wood burning.

Thermal-optical methods are presently the most widespread approach to OC/EC speciation. Despite their popularity, there is still a disagreement among the results, especially for what concerns EC as different thermal protocols can be used. In fact, the pyrolysis occurring during the analysis can heavily affect OC/EC separation, depending on PM composition in addition to the used protocol. Furthermore, the presence in the sample of BrC can shift the split point since it is light absorbing also @ 635nm, the typical laser wavelength used in this technique (Chen et al., 2015).

We present here the results of an apportionment study of carbonaceous aerosol sources performed in a rural area and in a coastal city, both located in the North-West of Italy. The optical apportionment also provides a direct measurement of the absorption Ångström exponent of BrC (α_{BrC}) which resulted to be $\alpha_{BrC} = 3.95 \pm 0.20$. Results obtained by the proposed approach are validated against independent measurements of levoglucosan and ^{14}C concentration.

We also present the last outcomes of a new approach, based on the apportionment of the absorption coefficient of particle-loaded filters, for correcting the thermo-optical analysis of PM samples (Massabò et al., 2016).

References:

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