Source Apportionment of Carbonaceous Aerosols with High Time Resolution

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Introduction

Chemical composition of aerosols is characterised by a large spatio-temporal heterogeneity, being carbonaceous aerosols the major components of the submicron fraction of atmospheric particulate matter (PM) (Mohr, 2011). It is emitted by different sources that exerts a negative impact on human health, and also affects the climate and the environment. (UNEP-CCAC, 2014).

The components of carbonaceous PM (total carbon, TC) are organic carbon (OC), elemental carbon (EC) and inorganic carbon (IC). When EC is measured using optical methods relying on its strongly light absorbing character it is called black carbon (BC), which is emitted during the incomplete combustion of fossil fuels, biofuels, and biomass burning and absorbs at all wavelengths of solar radiation (Becerril-Valle, 2017). It is thus of paramount importance to determine the chemical composition of submicron PM at high time resolution, providing the necessary information for accurate source apportionment.

Methods

With the purpose of characterising ambient aerosols and their time evolution and to assess the contribution of the main emission sources and processes leading to aerosol formation in the atmosphere a campaign was conducted in the urban centre of Moscavide (North of Lisbon, Portugal). Different fractions of air particulate matter were collected and on-line black carbon measurements (BC, Aethalometer AE33) and total carbon (TC, measured by Total Carbon Analyzer TCA08) were performed, simultaneously. The sampled filters were analysed by gravimetry, thermo-optical analysis for the measurement of OC/EC (using two different thermal protocols), and Transmissometer OT21 to measure the absorption of light.

The Aethalometer Model (Sandradewi, 2008) was applied for the BC source apportionment due to fossil fuel (BC_{ff}) and biomass burning (BC_{bb}) contributions (Figure 1). The recently developed TC-BC online method, which combines an optical method for measuring BC by the AE33 (Drinovec, 2015) and a thermal method for TC determination by the TCA08, was used for source apportionment of carbonaceous aerosols with high time resolution. This method determines equivalent OC fraction (eOC) of carbonaceous aerosols that is the difference between TC and EC (inferred from BC), at high time resolution as $eOC = TC - b \cdot BC$. The determined proportionality parameter b is region/site specific and depends to a large extent on a thermal protocol used to determine the EC fraction with the conventional OC/EC method.

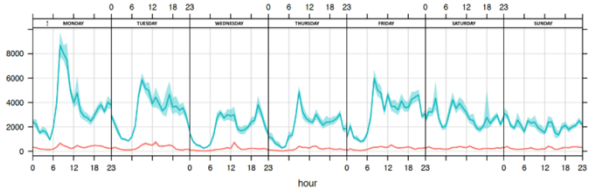

Figure 1. Source apportionment of BC using $\alpha_{ff} = 1.0$ and $\alpha_{bb} = 2.0$ (green: BC_{ff}, orange: BC_{bb}).

Conclusions

The combination of the data generated by the on-line equipments with data from the analysis of the filters allowed us to obtain the parameters for the thermal protocol applied in CESAM and perform an inter-comparison between this protocol and EUSAAR2.

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