Two-wavelength thermo-optical determination of Organic, Elemental and Brown Carbon.

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Introduction

Thermo-optical analysis (TOA) is widely adopted for the quantitative determination of Carbonaceous Aerosol in aerosol samples collected on quartz fibre filters. Nevertheless, the quantification of Elemental and Organic Carbon (EC and OC) presents several issues, as the well-known artefacts induced by the formation of pyrolytic carbon (Pyr-C) during the analysis. Furthermore, it is usually neglected the uncertainty due to the possible presence of Brown Carbon (BrC) i.e. the optically active fraction of OC produced by biomass burning and with thermic characteristics intermediate between OC and EC.

Methods

In (Massabò *et al.*, 2019), a modified Sunset EC/OC Analyzer was introduced. Briefly, the unit was upgraded making possible the alternative use of a laser diode at $\lambda = 635$ nm and at $\lambda = 405$ nm. In this way, the optical transmittance through the sample can be monitored at both the wavelengths. Both BrC and Pyr-C absorbance increases at shorter wavelength, so the new set-up has a better sensitivity to these species. First results (Massabò et al., 2019) suggested that the 2-lambda TOA could reduce the discrepancy usually observed between EC/OC quantification by the NIOSH and EUSAAR protocols (Cavalli *et al.*, 2010).

Adopting the methodology described in (Massabò *et al.*, 2016), i.e. the coupled use of the Multi-Wavelength Absorbance Analyzer (MWAA) and of the Sunset EC/OC Analyzer, we therefore performed a new experiment based on a set of samples collected in a rural site. Half of the samples were analysed with the EUSAAR_2 and NIOSH protocols at both the wavelengths looking for OC, EC and BrC concentration values.

The other sub-set was instead used to compare the TOA results on untreated and water-washed samples, again using both the laser diodes at $\lambda = 635$ nm and $\lambda = 405$ nm. The water-wash step removes the water-soluble compounds, which are expected to be the main responsible of the Pyr-C formation in TOA (Piazzalunga P. *et al.*, 2011).

Finally, all the samples were also analysed to quantify the Levoglucosan (1,6-Anhydro-beta-glucopyranose) content. This step, performed by High Performance Anion Exchange Chromatography coupled with Pulsed Amperometric Detection (HPLC-PAD, more details in Piazzalunga A. *et al.*, 2010), provided the quantification of this biomass burning tracer regardless of BrC thermo-optical properties.

The BrC Mass Absorption Cross-section (MAC) at $\lambda = 405$ nm and $\lambda = 635$ nm was finally determined.

Conclusions

The data reduction of the described experiment is still in progress: the results will be presented and discussed at the Conference.

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Cavalli, F., Putaud, J. P., Viana, M., Yttri, K. E., & Gemberg, J. (2010). *Toward a standardized thermal-optical protocol for measuring atmospheric Organic and Elemental Carbon: the EUSAAR protocol.* Atmos. Meas. Tech., 3, 79-89.

Massabò, D., Altomari, A., Vernocchi, V., & Prati, P. (2019). *Two-wavelength thermo-optical determination of Light Absorbing Carbon in atmospheric aerosols*. Atmos. Meas. Tech. Discuss.

Massabò, D., Caponi, L., Bove, M. C., & Prati, P. (2016). *Brown carbon and thermal-optical analysis: a correction based on optical multi-wavelength apportionment of atmospheric aerosols*. Atmos. Environ., 125, 119-125.

Piazzalunga, A., Fermo, P., Bernardoni, V., Vecchi, R., Valli, G., & De Gregorio M. A. (2010). *A simplified method for levoglucosan quantification in wintertime atmospheric particulate matter by high performance anion-exchange chromatography coupled with pulsed amperometric detection.* Int. J. Environ. An. Ch., 90, 934-947.

Piazzalunga, P., Bernardoni, V., Fermo, P., Valli, G., & Vecchi, R. (2011). *On the effect of water-soluble compounds removal on EC quantification by TOT analysis in urban aerosol samples.* Atmos. Chem. Phys., 11, 10193-10203.