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Lensing effect on Black Carbon particles by secondary organic aerosols and sulfates in Barcelona

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ABSTRACT

Black carbon (BC) or elemental carbon (EC) is considered the second most important climate warming agent after CO2. BC is one of the components of ambient particulate matter (PM). The high absorption efficiency of BC is due to its electronic structure and composition that allows BC particles to absorb electromagnetic radiation over a wide range of wavelengths. The mass absorption cross-section (MAC) represents the efficiency that a BC particle has for absorbing light at a given wavelength and it is related to EC via eq. 1. Photochemical ageing of BC due to mixing with non-absorbing (or less absorbing) particles, such as sulfate or organic aerosols, can increase the apparent MAC of BC above that of an uncoated BC particle. This absorption enhancement ($E_{Abs}(\lambda)$), can be obtained by the following equations:

$$b_{abs} = EC \cdot MAC(\lambda) \qquad \text{(Eq.1)}; \qquad E_{Abs}(\lambda) = \frac{MAC(\lambda)}{MAC_{uncoated}(\lambda)} \qquad \text{(Eq.2)}$$

Variability in $E_{Abs}(\lambda)$ has a strong regional/local character thus leading to large uncertainties within calculations of the near-term BC global warming effect. Here at IDAEA, we have a set of instruments that allows us to determine the $E_{Abs}(\lambda)$of BC particles by comparing the absorption coefficient (b_{abs}) measured online by a set of photometers (MAAP and AE33), with the EC concentrations measured by the semi-continuous OCEC analyzer (Sunset Laboratories) using thermal-optical analysis with EUSAAR2 protocol. The concurrent measurement of the concentrations of non-refractory aerosol components from an Aerosol Chemical Speciation Monitor (ACSM) allow us to study the dependence of the $E_{Abs}(\lambda)$ with the PM chemical composition. Fig. 1 illustrates the correlation of the $E_{Abs}(\lambda)$ with sulfate and more-oxidized oxygenated organic aerosol (MO-OOA) concentrations, showing that both species may enhance the absorption efficiency of BC.

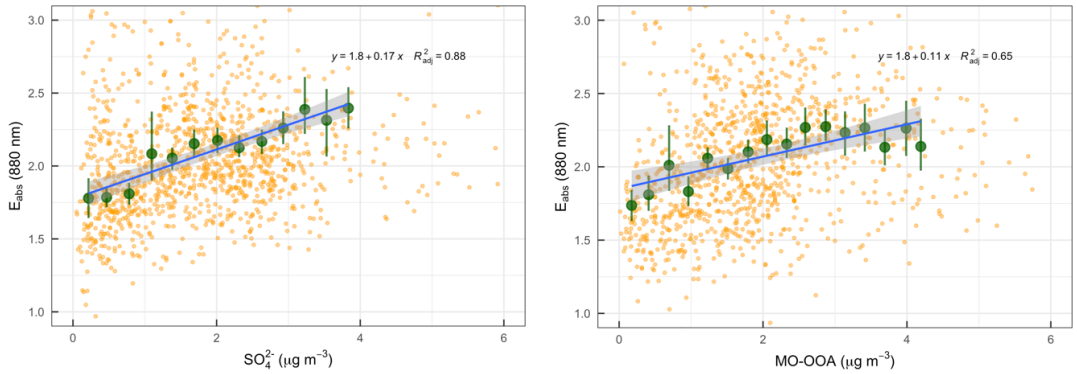

Fig. 1 $E_{Abs}(\lambda = 880\ nm)$ dependence on sulfate (SO_4^{2-}) and MO-OOA concentrations (green points represent the result of doing a bin over the whole dataset, i.e. the yellow points).

Keywords: aerosols, light absorption, lensing effect, global warming.

Key Contribution: We show that internal mixing of BC particles with non-absorbing sulfates and oxidized organic compounds may enhance the absorption efficiency of BC

Reference(s):

Zhang, Y., Favez, O., Canonaco, F. *et al.* Evidence of major secondary organic aerosol contribution to lensing effect black carbon absorption enhancement. *npj Clim Atmos Sci* **1,** 47 (2018). https://doi.org/10.1038/s41612-018-0056-2