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Constraining the absorbing fraction of organic aerosol in an atmospheric chemistry model

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Atmospheric aerosols have a significant influence on the climate system. On average, aerosols cool the atmosphere directly by scattering solar radiation and indirectly through aerosol–cloud interactions. However, some aerosol components are capable of absorbing visible solar radiation and warming the lower atmosphere. The most prevalent types of absorbing aerosols are black carbon (BC) and mineral dust. Most organic aerosols (OA) can be characterized as "white" because they efficiently scatter visible radiation. Recently, analyses from laboratory and field experiments have provided strong evidence for the existence of some OA with light absorbing properties. In recent scientific literature, the term "brown carbon" (BrC) has emerged to describe this type of OA, characterized by an absorption spectrum that smoothly increases from visible to UV wavelengths. Main sources of primary BrC are biomass burning and residential coal combustion, but recent studies have postulated the existence of various secondary sources of BrC resulting from multi-phase reactions of volatile organic compunds exposed to nitrogen oxides and ammonia.

In this work, we combine different evaluation strategies to constrain the absoprtion of organic aerosols simulated by the Multiscale Online Nonhydrostatic Atmosphere Chemistry (MONARCH) model. The validation of the model focuses mostly on the concentrations and optical properties of BC, OA and BrC. In-situ surface measurements of PM chemical composition (both off-line and on-line) and optical properties (multi-wavelengths scattering and absorption) provided by IDAEA-CSIC and columnar integrated optical properties (optical depth, single scattering albedo and asymmetry factor) derived from the Aerosol Robotic Network (AERONET) are used. We discuss different sensitivity runs at the regional and global scale perturbing (i) the OA/BrC fraction of biomass burning and biofuel emissions, (ii) the refractive index of OA and BrC aerosol components, and (iii) the aging rates of photobleaching and browning processes.