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Global modelling of radiation absorbing aerosols: budget assessment and sensitivity of direct radiative effect to mixing state assumptions

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Aerosol particles affect directly the climate by scattering and absorbing of solar and planetary radiation. In particular, some aerosol species such as mineral dust, black carbon (BC), and brown carbon (BrC) heat the atmosphere with significant absorption of solar radiation. Mineral dust, in addition, also absorbs the longwave terrestrial radiation. The local warming may increase the atmospheric stability, leading to a decrease in cloud cover through the so called semi-direct effect. An estimate of the aerosol direct radiative effect (DRE) depends critically on many assumptions about the aerosol size, shape, and optical properties. One of the most uncertain factor in the calculation of aerosol optical depth (AOD) and single scattering albedo (SSA) is the assumption on the aerosol mixing state. In this study, we have used the global chemical and transport model GEOS-Chem to perform a multi-year simulation of the radiation absorbing aerosol (RAA) mass concentration. Starting from the GEOS-Chem output, we have calculated the aerosol optical properties with the FlexAOD post-processing tool (Curci et al., ACP, 2015). RAA mass and optical properties have been calculated by using the most recent updates in terms of aging, size distribution and absorption properties, inferred from observational constrains. The aim is to study the sensitivity of the absorption properties of black carbon to the mixing state hypothesis and BrC presence. We explore also the sensitivity of dust particle absorption to the refractive index and shape. The results obtained in these sensitivity tests are compared with observations from the Aerosol Robotic Network (AERONET)). Finally, using the optical properties obtained in the sensitivity tests, we explore the implications for the DRE.