Light absorption enhancement of black carbon aerosols due to complex particle morphology

Yu Wu[a,*], Tianhai Cheng[a], Dantong Liu[b], Shuaiyi Shi[a], Xin Zuo[a], Wannan Wang[a], Xiaochuan Zhang[a], Can Meng[a], and Qi Ruo[a]

[a]*State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences. No.20 Datun Road, Chaoyang, Beijing, 100101, China*
[b]*Department of Atmospheric Sciences, School of Earth Sciences, Zhejiang University, Hangzhou, Zhejiang, China*

[*]*Presenting author (wuyu@radi.ac.cn)*

Black carbon (BC) is formed by incomplete combustion of fossil fuels, biofuels, and biomass, and is the second most important anthropogenic contributor to global warming after CO_2. Climate impact of BC aerosols is poorly qualified due to the systematic discrepancy between model and observation estimates of BC light absorption enhancements (E_{abs}) after aging which transfer directly into large uncertainties in model estimates of BC radiative forcing. Until now, a proper description of E_{abs} varying with BC aging has not been validated, leading to a curial question of BC climate impact. In this study, BC absorption enhancements are qualified using a theoretical model considering their realistic particle morphologies and mixing states dependent on aging scales. The fractal aggregated morphologies with bare, partly coated, partially encapsulated, and heavily coated states of BC-containing particles are simulated dependent on the mass ratio of non-BC and BC components in the individual BC-containing particles, and their optical properties are validated by the comprehensive laboratory and field ambient data. Our results indicate that previous conflicting results of E_{abs} were possibly observed in different BC aging states, which lie in the range of modelling descriptions. The observed E_{abs} can be simulated by the model considering particle morphology if BC aging states are exactly obtained. The small observed values of E_{abs} correspond to a partly aging stage with the BC particles that have inclusions and are thinly coated. The large results of E_{abs} are mainly produced by heavily coated BC particles in their fully aged stage. It is suggested that the predictions of E_{abs} varying with BC aging can be largely improved by considering their realistic particle morphologies and mixing states dependent on aging scales.

Preferred mode of presentation: Poster