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Estimate of the radiative effect of brown carbon using AERONET products

Mikko RA Pitkänen (1,2), Gregory L Schuster (3), Oleg Dubovik (4), Anders V Lindfors (1), Kari EJ Lehtinen (2,1), and Antti Arola (1)

(1) Finnish Meteorological Institute, Kuopio, Finland, (2) Department of Applied Physics, University of Eastern Finland, Kuopio, Finland, (3) NASA Langley Research Center, NASA, Hampton, VA, United States, (4) Laboratoire d'Optique Atmosphérique, Universite Lille-1, Villeneuve dAscq, France

The AErosol RObotic NETwork (AERONET) provides aerosol size distributions and complex refractive index at four wavelengths (440, 675, 870, and 1020 nm). This information is used in the method of Schuster et al. 2013 to retrieve the relative proportions of brown carbon BrC, black carbon BC, dust mineral and scattering host, separately for fine and coarse modes. The absorbing part of fine mode is initially assumed to consist of BC and BrC, but dust is added if necessary. Likewise, the absorbing coarse mode is initially assumed to consist of mineral dust, but BC and BrC are added if necessary.

We estimated the direct radiative effect ADRE of BrC by using the volume fractions of BrC retrieved by Schuster et al. 2013 for all available AERONET sites. The effect of BrC at TOA was estimated as the difference between net fluxes for all aerosols and non-BrC aerosols using the radiative transfer package libRadtran. Non-sphericity of mineral dust was taken into account using the spheroid aerosol model by Dubovik et al. (2006).

The aerosol components retrieval from AERONET suggests that the highest amounts of brown carbon appear in locations close to intense aerosols sources eg. in China and India, but notably the fraction of BrC compared to other absorbing species (here BC and dust) can be comparably high at locations with lesser aerosol loading. According to our initial results the higher BrC content does not automatically translate into a significant BrC ADRE (all aerosols - non-BrC), but the presence of other absorbing species and the albedo also play a significant role. Annual BrC ADRE seems to vary from -0.8 W/m2 to 0.8 W/m2 and monthly averages can vary in a much larger range for locations with high BrC volume fraction and loading.