Attribution of aerosol light absorption to black carbon and brown carbon

S.-W. Kim[1], C. Cho[1], D. Jo[1], R.J. Park[1], M. Lee[2] and J.A. Ogren[3]

[1]School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea
[2]Department of Earth and Environmental Sciences, Korea University, Seoul, Korea
[3]NOAA/ESRL Global Monitoring Division, Boulder, Colorado, USA
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Presenting author email: sangwookim@snu.ac.kr

Black carbon (BC) is functionally defined as the absorbing component of atmospheric total carbonaceous aerosols and is typically dominated by soot-like elemental carbon (EC). Organic carbon (OC) has also been shown to absorb strongly at visible to UV wavelengths and the absorbing organics are referred to as brown carbon (BrC; Alexander *et al.*, 2008). These two aerosols contribute to solar radiative forcing through absorption of solar radiation and heating of the absorbing aerosol layer, but most optical instruments that quantify light absorption are unable to distinguish one type of absorbing aerosol from another (Moosmüller *et al.* 2009). In this study, we separate total aerosol absorption from these two different light absorbers from co-located simultaneous in-situ measurements, such as Continuous Soot Monitoring System (COSMOS), Continuous Light Absorption Photometer (CLAP) and Sunset EC/OC analyzer, at Gosan climate observatory, Korea. We determine the mass absorption cross-section (MAC) of BC. and then estimate the contribution of BC and BrC on aerosol light absorption, together with a global 3-D chemical transport model (GEOS-Chem) simulation.

Figure 1(a) shows the frequency distribution of MAC of BC determined from Sunset EC/OC analyzer and COSMOS measurements during January-June 2012. At 565 nm wavelength, BC MAC is found to be about 5.0±2.2 m^2 g^{-1} from COSMOS and Sunset EC/OC analyzer measurements during January-May 2012. This value is similar to those from Alexander et al. (2008; 4.3 ~ 4.8 m^2 g^{-1} at 550 nm) and Chung et al. (2012; 5.1 m^2 g^{-1} at 520 nm), but slightly lower than Bond and Bergstrom (2006; 7.5±1.2 m^2 g^{-1} at 550 nm). The COMOS BC mass concentration calculated with 5.0 m^2 g^{-1} of BC MAC shows a good agreement with thermal EC concentration, with a good slope (1.08; Figure 1(b)).

Aerosol absorption coefficient and BC mass concentration from COSMOS, meanwhile, are approximately 35 ~ 40 % lower than those of CLAP. This difference can be attributable to the contribution of volatile light-absorbing aerosols (i.e., BrC). As shown in Figure 2, the absorption coefficient of BrC, which is determined by the difference of absorption coefficients from CLAP and COSMOS measurements, increases with increasing thermal OC mass concentration

Figure 3 shows monthly variation of BC and BrC absorption coefficients estimated from in-situ measurements and GEOS-Chem model simulation are generally well agreed, even though GEOS-Chem simulation overestimates BC absorption coefficient while underestimates BrC absorption coefficient. Here, we note that MAC of 5.0 m^2 g^{-1} and 3.8 m^2 g^{-1} (taken from Alexander *et al.*, 2008) are used to calculate aerosol absorption coefficient of BC and BrC, respectively. The contribution of BC to aerosol light absorption is estimated to be about 63~66%, while BrC accounts for about 34~37% of total aerosol light absorption, having a significant climatic implication in East Asia.

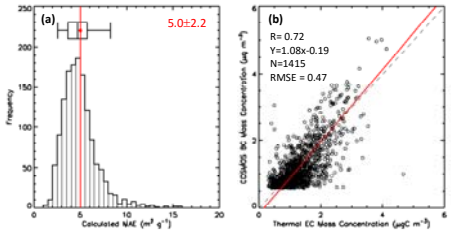

Figure 1. (a) Frequency distribution of BC MAC and (b) comparison of Sunset thermal EC and COSMOS BC mass concentrations.

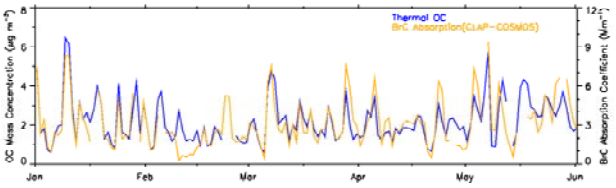

Figure 2. Temporal variation of Sunset thermal OC mass concentration and BrC absorption coefficient.

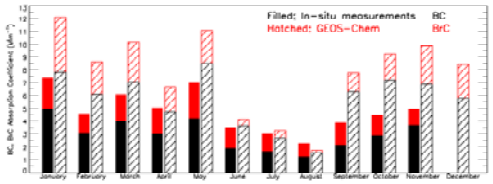

Figure 2. Monthly variation of BC and BrC absorption coefficients.

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