Absorption properties of atmospheric aerosols from a high-altitude site in northern India

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Black carbon (BC), one of the major absorbing aerosol species in after GHGs, is being considered as driver of the global warming due to increase in anthropogenic emissions on a regional to global scale. BC is produced during incomplete combustion processes from fossil-fuel and biomass burning and forms a primary constituent of “soot” particles in the atmosphere. Light absorbing carbon (LAC) mass in atmospheric aerosols is either assessed by optical method (as BC mass) or by thermal methods (referred as elemental carbon; EC). The LAC mass determined by the two analytical methods can differ by a factor of two to four (or even more). Thus, search for an absolute method for LAC mass determination is still a debatable issue in atmospheric scientific community. The measurement via optical methods is convenient and rapid but requires knowledge of mass absorption efficiency (σ_{abs}, in unit of m^2g^{-1}) in order to convert the measured absorption coefficient (b_{abs}, Mm^{-1}) into BC mass concentration. Using thermo-optical EC-OC analyzer, we propose a novel and unique approach for the determination of b_{abs} and σ_{abs} in aerosol samples, collected from a high-altitude site Manora Peak (29.4°N, 79.5°E, ~1950 m amsl) in northern India.

The optical properties (b_{abs} and σ_{abs}) were simultaneously assessed using the measured optical-attenuation (ATN) at 678 nm laser source employed in the thermo-optical EC-OC analyzer. The measurement of ATN is primarily used to define the split-point between organic and elemental carbon (OC and EC) (Ram et al, 2008). The measured b_{abs} (equivalent to measured ATN values) shows a strong linear dependence on thermal EC concentration (R^2=0.75, n=65) indicating the validity of Beer-Lambert’s law. The b_{abs} exhibit a large temporal variability with higher values typical of winter (Dec-Feb) and post-monsoon (Sept-Nov) and lower were associated with the summer (Apr-May) and monsoon (June-Aug). Further, the slope of the linear plot (Fig. 1) provides a value of 10.4 m^2g^{-1} for σ_{abs} at Manora Peak; however, a large temporal variability for σ_{abs} has been observed during sampling period (range: 6.1-18.8 m^2g^{-1}). The σ_{abs} value obtained in this study is similar to that used in the PSAP (10.0 m^2g^{-1}) for the determination of BC mass concentration. As σ_{abs} shows a large temporal and spatial variability and depends on the source, aerosol composition and mixing state of BC in aerosols, the use of ‘site-specific’ σ_{abs} values has been suggested (Liousse et al, 1993; Sharma et al, 2002). However, use of ‘site-specific’ σ_{abs} values for BC determination is not a very common practise because it requires two independent measurements of absorption (from optical methods) and EC concentration (from thermal methods). The analytical approach used in this study involves the use of only one instrument (thermo-optical EC-OC analyzer) to infer b_{abs} and ‘site-specific’ σ_{abs} values which can be used in optical methods for BC mass determination.

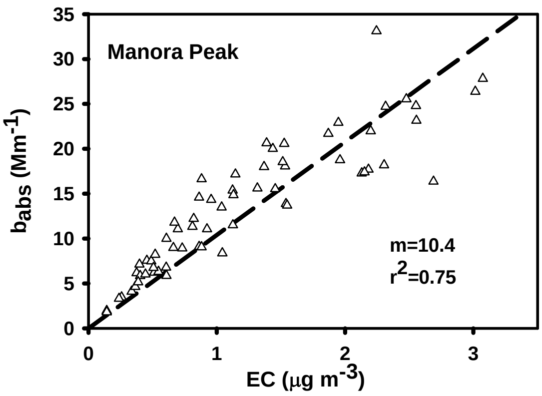

Figure 1. The linear regression plot of absorption coefficient (b_{abs}, Mm^{-1}; 1 $Mm^{-1}=10^{-6}$ m^{-1}) vs. EC concentration.

Ram K., et al (2008). *Atmospheric Environment*, 42, 6785-6796.
Liousse et al. (1993). *Atmospheric Environment*, 27A, 1203-1211.
Sharma S., et al (2002). *J. Geophysical Research-Atmosphere*, doi: 10.1029/2002JD002496.

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