Light absorption by atmospheric aerosol brown carbon in the high Himalayas

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The Himalayan glaciers that determine the albedo of the mountains and provide the water supply that feeds large south Asian rivers are very sensitive to anthropogenic climate warming. Carbonaceous aerosols are among the key forcing agents for anthropogenic warming. The dominant light-absorbing component of the aerosols is combustion-derived black carbon, however, other carbonaceous aerosols may also absorb light, but typically with more pronounced wavelength dependence – 'brown carbon' (BrC) (e.g., Ramanathan and Carmichael, 2008).

The main purpose of this research is the quantification of BrC in atmospheric aerosols in the high Himalayas.

Aerosol sampling was conducted at the GAW-WMO Global station "Nepal Climate Observatory-Pyramid" (NCO-P) located in the high Khumbu valley at 5079 m a.s.l. in the foothills of Mt. Everest.

PM_{10} aerosols were collected on pre-combusted 150 mm quartz-fiber filters (Pallflex, Pall) using a custom-built high volume sampler behind a DIGITEL PM_{10} pre-separator DPM10/30/00. The sample collection period was from December 2013 to April 2014. The sampling strategy was set up in order to discriminate the daytime valley breeze allowing polluted air masses to the Observatory and free tropospheric air during nighttime (Bonasoni et al., 2010).

Brown carbon was extracted from the 1.13 cm^2 filter subsamples by ultrasonication during 30 minutes in 5 ml of methanol or by shaking for 1.5 hour in 5 ml of Milli-Q water. For the measurements of light absorption by BrC in the water and methanol extracts TIDAS E UV/VIS spectrophotometer (J&M Analitik AG, Germany) was combined with a Liquid waveguide capillary cell (WPI, USA) and for the water extract analysis with a LWCC Continuous Flow Injection System (WPI, USA). The measurements were performed within 190-720 nm. The liquid waveguide length is 50 cm, which allows ultra-sensitive absorbance measurements for low sample concentrations.

The results show that the light absorption by the BrC extracts in methanol is higher than in the water extracts (Fig.1).

Mass absorption cross section at 365 nm (MAC_{365}) for the water extracts of the daytime samples impacted by the pollution from the valley is slightly higher (0.71±0.14 m^2g^{-1}) compared to the night samples (0.56±0.18 m^2g^{-1}). Overall, the MAC_{365} values at NCO-P are comparable with these values previously measured in the Indo-Gangetic Plain (0.78±0.24 m^2g^{-1} Srinivas and Sarin, 2014) and in the outflow from South Asia (0.46±0.18 m^2g^{-1} Bosch et al., 2014).

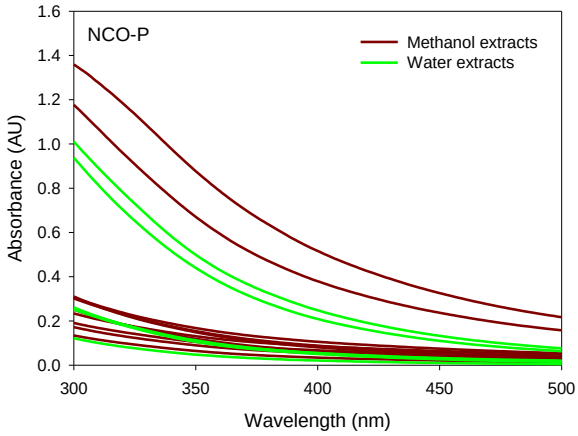

Figure 1. Comparison of the light absorbance by the brown carbon extracts in methanol and water for the daytime samples impacted by upslope breeze.

Hence, BrC in the high Himalayas has significant absorptive properties especially in the polluted air masses and can be an important agent of anthropogenic climate forcing in this region.

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