Absorbing aerosol long-term trend at Mukteshwar, a pristine location in Central Himalayas foothills

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Keywords: long-term trend, absorbing aerosols, Himalayas foothills
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Only recently have we become aware that anthropogenic absorbing aerosols, particularly BC (black carbon), can potentially play a major role in the global scale changes in hydrological cycle (Ramanathan et al., 2001; Liepert et al., 2004). Thus, the Finnish Meteorological Institute together with The Energy and Resources Institute have conducted continuous measurements of aerosol physical and optical properties in Mukteshwar, about 350 km northeast of New Delhi in India since 2006. The site is located at 2180 m above the sea level at the Himalayan Mountains. This is a background location in the foothills of Central Himalayas, and absorbing aerosol measurements with such a time span are unique from the area. Long-term trends in absorbing aerosol concentrations can be observed to emerge from the data set.

The black carbon concentrations were measured with a Magee AE 31 Aethalometer. The PM_{10} and $PM_{2.5}$ measurements were carried out using real-time beta attenuation particulate monitors (FH 62 I-R) manufactured by Thermo Scientific. In addition, other measurements included the particle number size distribution from 10nm to 800nm, aerosol scattering coefficient, and meteorological parameters including temperature, pressure, relative humidity and wind speed/direction (Hyvärinen et al., 2009). The black carbon concentrations were sampled from a $PM_{2.5}$ inlet.

The black carbon and $PM_{2.5}$ concentrations for the 7-year measurement period show high seasonal variability (Fig. 1). The maximum concentrations are observed in April, before the annual monsoon season. The average value of $PM_{2.5}$ fraction of PM_{10} was about 66%, indicating dominance of fine particles. The annual $PM_{2.5}$ concentrations during last 7-year measurements have not shown a clear increasing trend. In contrast, long-term trend of BC in $PM_{2.5}$ has shown a clear increase (Fig. 2). This reveals that anthropogenic activities which emit black carbon have increased during the time.

The highest concentrations of black carbon observed during the warm summer could be due to air lofted from the Indo-Gangetic plains below, when the boundary layer height is at its yearly maximum. It was noted that the $PM_{2.5}/PM_{10}$ ratios between 0.50 and 0.75 and the monthly mean ratio of BC to $PM_{2.5}$ mass lies between 3.0 and 7.5 % (Panwar et al., 2012). Furthermore, it is also observed that the winter months have a higher ratio of BC to $PM_{2.5}$ since the biomass burning is increased due to heating requirements. Therefore, it is not well evident which is the most vital factor for BC variations at this remote location: far emitting sources or changes in meteorological conditions.

In near future, our expanded study in the region would enhance knowledge of absorbing aerosols (brown and black carbon) horizontal variation, ageing processes and influence on climate. India has recently launched an ambitious program NCAP (National Carbonaceous Aerosol Program). The main focus of NCAP is on elemental carbon (EC) while our main aim is to chemically as well as optically characterize both brown and black carbon.

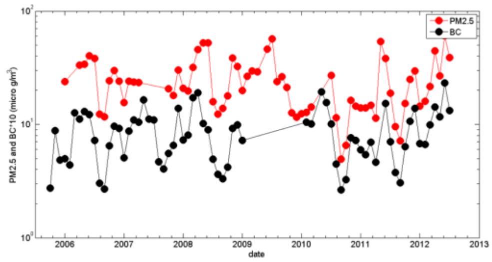

Figure 1. Trend in properties of aerosols

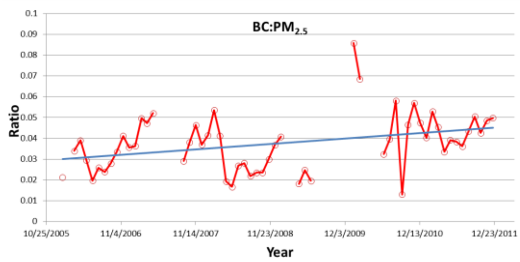

Figure 2. Mass fraction of BC (absorbing aerosol)

This work was supported by the Ministry of Foreign Affairs of Finland.

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