

## **Yearlong first measurements of black carbon in the western Indian Himalaya: Influences of meteorology and fire emissions**

Black carbon (BC) particles are carbonaceous aerosols typically produced during incomplete combustion of fossil fuels and biomass burning along with a variety of other co-emitted species. Measurements of equivalent black carbon ([EBC]) aerosols are presented for the first time for the period January-December 2016 from a high-altitude station Ranichauri (30°18' N, 78°24' E; 2200 m amsl) located in the Lesser Himalaya. The influences of meteorology, fire emissions and transport, on [EBC] variations have been investigated in detail. On a seasonal basis, the average [EBC] levels are found to be higher during winter ( $2.72 \pm 1.86 \mu\text{g m}^{-3}$ ) and pre-monsoon ( $2.56 \pm 1.80 \mu\text{g m}^{-3}$ ), and lowest during the summer monsoon

Our measurements in conjunction with the analysis of model meteorology (Era Interim reanalysis) show profound effects of boundary layer dynamics on [EBC] concentrations. Wintertime maximum concentration of equivalent BC is suggested to be due to confinement of regional anthropogenic emissions in shallow boundary layer. In addition, transport from the North-West, and Western regions, characterized by wood-burning and fossil fuel combustion, also found to affect the variations here, except during the summer monsoon.

BC can be transported both vertically and horizontally to long distances due to residence times of up to a week or so, finer size and chemical inertness. As the observing station is away from any major industrial area, therefore, fossil fuel contribution to equivalent BC is due to the transport from nearby cities such as Dehradun, Rishikesh and Haridwar where traffic activities are very high. Also, the household burning for warmth (in winters) and cooking by the nearby township may be other sources.

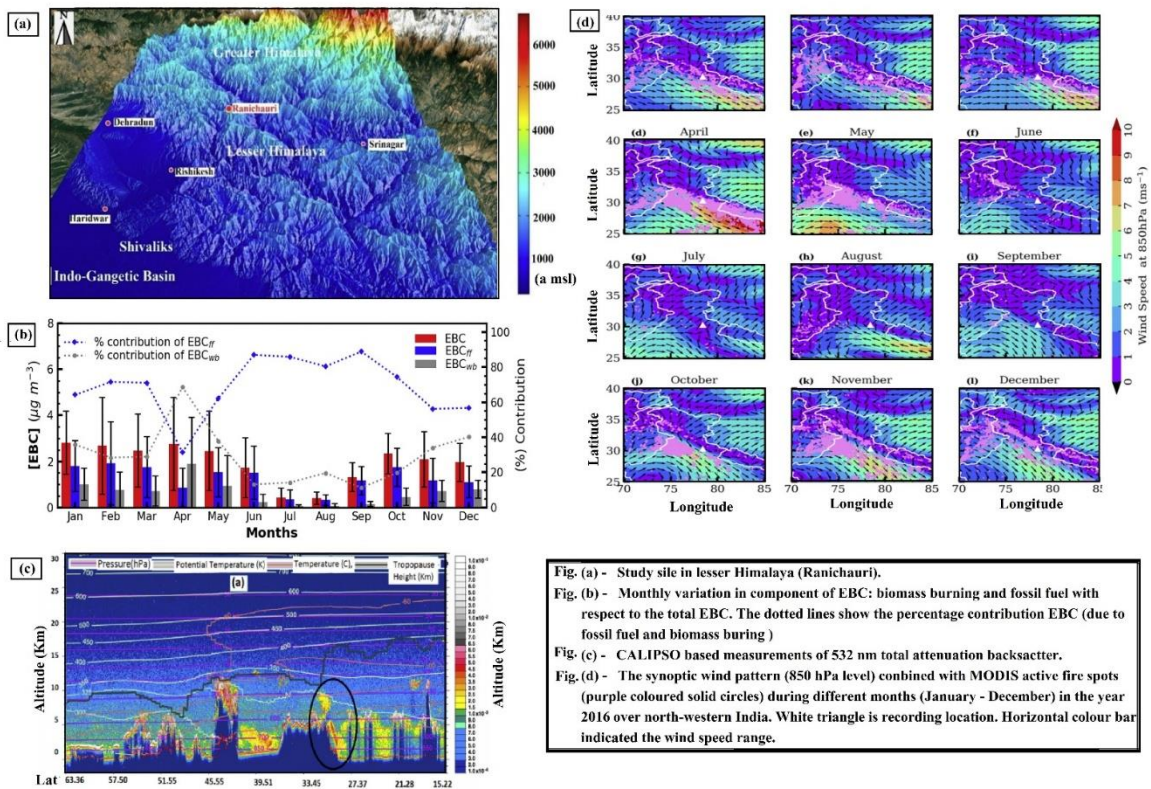


Fig. (a) - Study site in lesser Himalaya (Ranichauri).  
 Fig. (b) - Monthly variation in component of EBC: biomass burning and fossil fuel with respect to the total EBC. The dotted lines show the percentage contribution EBC (due to fossil fuel and biomass burning).  
 Fig. (c) - CALIPSO based measurements of 532 nm total attenuation backscatter.  
 Fig. (d) - The synoptic wind pattern (850 hPa level) combined with MODIS active fire spots (purple coloured solid circles) during different months (January - December) in the year 2016 over north-western India. White triangle is recording location. Horizontal colour bar indicated the wind speed range.

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