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# 1 Scavenging Ratio of Black Carbon in the Arctic and the Antarctic

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## 7 Abstract

8 Long-term monitoring of atmospheric aerosols and their interaction with radiation, cloud, and  
9 cryosphere over the Arctic and the Antarctic are very important for the global climate change  
10 related issues. In this regard, for conducting aerosol measurements, India has extended the  
11 concerted efforts to the Indian stations at the Svalbard region of the Norwegian Arctic (Himadri,  
12 78°55'N 11°56'E, 8 m a.s.l.) in the northern hemisphere and the Larsemann Hills of coastal  
13 Antarctic (Bharati, 69°24.4'S 76°11.7'E, 40 m a.s.l.) in the southern hemisphere. In the present  
14 study, we have examined darkening of snow due to black carbon (BC) deposition in different  
15 sunlit seasons and estimated the scavenging ratio of BC over both the poles from simultaneous  
16 measurements of atmospheric BC and BC deposited in snow. The study reveals distinct spatio-  
17 temporal variability of BC in polar snow, even though the magnitude of BC concentrations is, in  
18 general, low ( $< 12$  ppbw, parts per billion by weight). During local summer seasons, the  
19 concentration of BC in Arctic snow (median  $\sim 7.98$  ppbw) was higher compared to the values at  
20 Antarctica (median  $\sim 1.70$  ppbw). Concurrent with this, the scavenging ratio (SR) also showed  
21 large variability over both the poles. Relatively higher values of SR over the Antarctica (mean  $\sim$   
22  $119.54 \pm 23.04$ ; during southern hemispheric summer) in comparison to that over the Arctic  
23 (mean  $\sim 69.48 \pm 4.79$ ; during northern hemispheric spring) clearly indicates the difference in  
24 removal mechanisms (aerosol mixing, aging and size distribution) of BC from the atmosphere  
25 over distinct polar environments. Measurement of spectral incoming and reflected radiances over  
26 the Arctic snow during the early spring season of 2017 indicated the values of surface broadband  
27 albedo varying between 0.64 and 0.79. The Snow, Ice and Aerosol Radiative (SNICAR) model  
28 simulated values of spectral albedo correlated well with the measured ones and indicated the role  
29 of dust absorption, in addition to that of BC, in changing the snow albedo. This information  
30 needs to be accurately incorporated in the radiative transfer models for the accurate estimation of  
31 snow albedo forcing over the Polar Regions.

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