Black Carbon and Inorganic Aerosols in Snowpack over the Arctic

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Black carbon (BC) deposited on snow lowers snow albedo, potentially contributing to the warming in the Arctic. The distributions of inorganic aerosols (ions), which contribute to direct and indirect aerosol effects, are also greatly influenced by deposition. It is critically important to measure the spatial distributions of BC and ions in snowpack in different regions of the Arctic to quantify these effects. Because accurate measurements of BC and ions in snowpack are very limited, we measured the mass concentrations of size-resolved BC (C_{MBC}) and ions in snowpack over Finland, Alaska, Siberia, Greenland, and Spitzbergen in early spring during the period of 2012 –2016 by using a single-particle soot photometer and ion chromatography, respectively. BC deposition amounts (DEP_{MBC}) during snow accumulation periods were derived from C_{MBC} and snow water equivalent (SWE). Detailed analyses have shown that the spatial distributions of the anthropogenic BC flux and topography strongly influenced the latitudinal variations of C_{MBC} and BC size distributions. The average size distributions of BC in snowpack shifted to smaller sizes with the decrease in C_{MBC}, likely due to an increase in the removal efficiency of BC with the increase in BC diameter during transport from major BC sources. The present C_{MBC} were much lower than previous C_{MBC} measured by using an Integrating Sphere/Integrating Sandwich spectrophotometer by a factor of about 13. The present accurate data of C_{MBC}, SWE, and DEP_{MBC} are very useful in constraining climate model to estimate the effect of BC on the climate of the Arctic.

Keywords: Black carbon, Wet deposition, Arctic

