

Long-term variations of snow impurity concentrations and albedo in Sapporo

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The atmospheric absorptive aerosols such as black carbon (BC) and mineral dust deposited onto snow surface have a radiative effect to reduce the snow albedo. Particularly, the light absorption of BC is so strong that it is a possible cause to accelerate the warming of polar region through the effect to enhance the snow/ice melting. According to the recent measurements of BC concentrations in the Arctic region, it was reported to be several ppbw in Greenland ice core (McConnell, 2007), and several to several tenth ppbw in the Arctic snow (Warren, 2009). We have observed the concentrations of snow impurities for elemental carbon (EC), organic carbon (OC), and dust in Sapporo during 5 winters. Long-term variations of these snow impurity concentrations and albedo are reported. In this study, EC is treated to be optically the same as BC.

Snow sampling and albedo measurements were carried out during 5 winters from 2003 to 2008 at the meteorological observation field of the Institute of Low Temperature Science, Hokkaido University in Sapporo. Snow samplings for the analyses of snow impurity concentrations were conducted twice a week together with snow pit work. The snow impurities were filtered using Nuclepore filters and silver membrane filters, and the total concentrations of snow impurities were estimated by measuring the weights of Nuclepore filters with the use of a balance. The EC and OC concentrations were measured with OC/EC analyzer for silver membrane filters. The dust concentration was determined from the difference between the total and EC + OC concentrations.

The variation ranges of snow impurity concentration were 0.01 to 2 ppmw for EC, 0.05 to 20 ppmw for OC, and 0.2 to 800 ppmw for dust. The background level of EC concentration in Sapporo lay at high concentration level in the Arctic region. Among the three components, the dust concentration was always highest and EC was the lowest in each snow sample. Those concentrations were, in general, low in accumulation season (January - February) and high in melting season (March - April). The measured albedos decreased well synchronized with snow impurity concentrations in melting season, while the correlations between albedo and impurity concentrations were not so different for three impurity components. In the winter of 2003/2004, the very high dust concentrations around several hundreds ppmw were kept after dust fall event in March 11-12. However, high concentrations beyond 100 ppmw were also observed in melting season for the other winters. Although the trends of all snow impurities apparently negative, the OC trend is not uncertain due to the pollution of OC from sampling bag used in the first four winters.