

## Snow impurity concentration and snow grain size measured in Ny-Alesund, Svalbard

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Mass concentration of light absorbing impurities in snow and snow grain size are important parameters controlling snow albedo. An increase in light absorbing impurities such as black carbon (BC) reduces the visible albedo and that in snow grain size reduces the near-infrared albedo. To monitor these snow physical parameters and evaluate those effects on snow albedo in the Arctic, we have measured the snow parameters using a ground-based spectral radiometer system for albedo and flux (GSAF) in Ny-Alesund, Svalbard (78°55'N, 11°55'E). The BC concentration in snow and snow grain sizes in the topmost and subsurface layers were retrieved from spectral albedos measured using the GSAF from March to June, 2013. Furthermore, the retrieved snow parameters were validated by comparing with in-situ measurements based on snow pit work and snow sampling in April, 2013. The collected snow samples were filtrated, and then elemental carbon (EC), organic carbon (OC) and dust concentrations in snow were measured by filter weighing and thermal optical analysis.

The snow depth gradually increased up to 40 cm during the polar night from late October to late February. It maintained around 40 cm until the middle of May, and then rapidly decreased to 0 cm in early June. The BC concentrations retrieved from the GSAF varied little during March to June with about 110 and 40 ppbw for external and internal mixture models employed in the retrieval algorithm, respectively. The in-situ measured EC, OC and dust concentrations were 8-35, 32-190 and 570-3180, respectively. The BC-equivalent concentrations estimated from the light absorbing effects of both EC and dust were 18-43 ppbw, which agreed with the GSAF-derived BC concentrations using the internal mixture model. The topmost layer snow grain radius retrieved from the GSAF were varied within the range 30-300  $\mu\text{m}$  until the middle of May, then increased more than 1000  $\mu\text{m}$  with the snow melting. The snow grain sizes in the subsurface layer were generally larger than those in the topmost layer, which was consistent with the in-situ measurement. We estimated the possible albedo reduction by snow impurities using a physically based snow albedo model with the GSAF-derived snow parameters. The albedo reduction was enhanced to -0.038 during snow melting period after the mid-May, compared with -0.027 before the mid-May, mainly due to the increase in snow grain size.

Keywords: light absorbing snow impurity, black carbon, dust, snow grain size, Ny-Alesund