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History of snow grain modification evaluated by specific surface area (SSA) and density using two ice cores from Greenland.

Takuto Ando (1), Yoshinori Iizuka (2), Mai Shibata (2), Sumito Matoba (2), Shin Sugiyama (2), Satoru Adachi (3), Satoru Yamaguchi (3), Koji Fujita (4), Akira Hori (5), Masashi Niwano (6), Teruo Aoki (7), and Shuji Fujita (8)

(1) Arctic Research Center, Hokkaido University, Sapporo, Japan (tact@arc.hokudai.ac.jp), (2) Institite of Low Temperature Science, Hokkaido University, (3) The National Research Institute for Earth Science and Disaster Prevention, (4) Graduate School of Environmental Studies, Nagoya University, (5) Department of Civil and Environmental Engineering, Kitami Institute of Technology, Hokkaido, Japan, (6) Meteorological Research Institute, Japan Meteorological Agency,, (7) Graduate School of Natural Science and Technology, Okayama University, (8) National Institute of Polar Research

Snow grain size is indispensable property for evaluating surface albedo of ice sheets. Especially, information of ice sheet albedo in the past is necessary for improving climatic models and future prediction. Ice core samples have potential to provide these data. However, the most parts of ice core samples, are composed of firn and ice, which have already lost initial information of snow grain size after densification. From this reason, it is important to develop a new method to evaluate history of snow grain from ice core samples. There is a correlation between specific surface area (SSA) and near-infrared reflectance. Continuous SSA values of ice core samples can be obtained by near-infrared reflectance analysis. Here, we investigate SSA and density of ice core samples and suggest new proxy to reconstruct history of snow grain modification.
We collected two ice cores from the southeastern (SE-Dome) and northwestern (SIGMA-A) Greenland. The ice core from SE-Dome clearly records about 60 years of seasonal variations and include few ice layers, which indicate it barely experienced melting/refreezing. In contrast, SIGMA-A ice sample includes a lot of ice layers, indicating influence of melting/refreezing process. Density and SSA data from these two ice cores are negatively correlated. These negative correlations show SSA values basically decrease with snow densification. On the other hand, SSA decreased as the grain size increased under a constant density. SSA values measured for some SE Dome summer samples are smaller than those estimated from density using approximation formula. This result indicates grain size growth or sintering were enhanced under higher air temperature during summer. Our study demonstrated a possibility to reconstruct grain size growth due to climate change based on a relationship between SSA and density of ice core samples.