

## Snow grain growth and NIR albedo reduction due to temperature rise on accumulation area in Greenland ice sheet

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Drastic surface melting of Greenland ice sheet (GrIS) is occurring after the middle of 1990s. Surface albedo is one the most important parameter for heat budget of ice sheet surface. In accumulation area of GrIS the surface albedo is controlled by change of snow grain size because a contribution of light absorbing snow impurity to albedo reduction is low. In particular, the near-infrared (NIR) albedo is an important indicator for the change of snow surface condition, as NIR albedo strongly depends on snow grain size. As snow grain size increases with an evolution of snow metamorphism (snow grain growth) that depends on snow temperature, NIR albedo is expected to correlate with air temperature and snow surface temperature. We investigated this relationship using the data observed with an automatic weather station (AWS) at SIGMA-A site (78°N, 67°W, 1,490 m a.s.l.) since June 2012. NIR albedo correlated strongly with both air temperature and snow surface temperature at around 0°C and substantially decreases at the temperatures > -2°C.

We also examined the relationship between snow surface temperature and snow grain size both retrieved from Terra and Aqua/MODIS data from 2012. Snow grain size also correlated clearly with snow surface temperature > -2°C. Thus, it is confirmed the mechanism that an increase of temperature accelerates snow metamorphism, by which snow grain growth occurs and thus NIR-albedo decreases. Summer of GrIS including SIGMA-A was very warm in 2012 and 2015 and cold in 2013 and 2017. We examined correlation of monthly-mean MODIS-derived snow grain size in July with the monthly-mean NAO-index and AO-index. The snow grain size correlated with NAO-index further than AO-index.

Keywords: Greenland ice sheet, snow grain size, NIR albedo, MODIS