

Growth conditions of snow algae inferred from snowpack observations in Greenland

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Snow algae are photosynthetic microbes growing on snow and ice and are commonly found on glaciers and snowfields in many parts of the world. Bloom of snow algae can change color of snow to red or green, and reduce its albedo, then accelerate melting of snow. Therefore, it is important to determine factors of their growth in order to project melting of snowpack. However, it is still not known what the most major factor for the growth is.

In this study, we aim to determine the factors of initiation and growth of snow algae on snowpack based on field study on Qaanaaq ice cap in the northwest Greenland (N 77, W 69). The field study was carried out from June to August of 2013 and 2014. We measured physical and chemical properties of surface snow and collected the snow samples at two locations (Site-A 550m, Site-B 950m a.s.l) on the glacier every week. In a laboratory, we counted cells of algae using a microscope and analyzed chlorophyll-a concentration (*Chl-a*) using a fluorescence meter in snow samples to observe temporal change of algal growth on the snow surfaces. These data were compared with other physical properties of snow surface and meteorological conditions in order to determine the factors driving the snow algal growth.

Red snow visibly appeared on the snow surface on August 3 at Sites-A, but didn't appear at Site-B during the study period in 2013, while it appeared on July 20 at Site-A and August 3 at Site-B in 2014. *Chl-a* concentration on the snow surface started to increase when the red snow appeared. The algal cell concentration also showed a similar temporal trend to the *Chl-a*. Daily mean temperature exceeded 0 °C on June 8 at Site-A in 2013, and on June 2 at Sites-A and B in 2014. These timing were 49-63 days prior to the appearance of red snow. The positive degree-day sum at the appearance of red snow were 106-140 °C day at Site-A in 2013, 116-141 °C day at Site-A and 93-107 °C day at Site-B in 2014. When the red snow appeared, no significant change was observed in physical or chemical conditions on the snow surface including solar radiation, snow density, water content, EC, and pH. These results suggest that initiation of snow algae does not require a certain physical or chemical condition of snow surface, but may require a certain period of surface melting or positive degree-day sum.

Keywords: snow algae, red snow, chlorophyll-a, positive degree-day, Greenland