

## Recent changes of satellite-derived snow grain size and glacial microbial activities in Greenland ice sheet

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Snow surface albedo strongly depends on snow grain size and mass concentration of light absorbing impurities. These snow parameters are uncertain factors for the recent drastic snow and ice meltings in the Arctic. Particularly, Greenland ice sheet (GrIS) is presently undergoing drastic changes. In 2012 a record melting event of surface snow/ice occurred over the GrIS. When air temperature increases, snow grain size is also increased by accelerating the snow metamorphism and thus the albedo is reduced (positive albedo feedback). This process is mainly dominant in the accumulation areas. On the other hand, the bare ice area is extended by snow melting on ice associate with air temperature raise in ablation areas. It is recently reported that wide bare-ice areas in GrIS are covered with glacial microbes whose albedos are lower than that of blue ice surface. This albedo reduction effect is also another positive albedo feedback effect by glacial microbes. To examin these feedback effects by snow grain growth and glacial microbial activities in conjunction with air temperature increase, we retrieved snow grain size and glacial microbe concentration from Moderate Resolution Imaging Spectroradiometer (MODIS) data. The employed algorithm is based on a look-up table method for bidirectional reflectance distribution function at the top of the atmosphere as functions of snow grain size, snow impurity (soot) concentration, solar and satellite geometry. The employed satellite channels are 0.46, 0.86, 1.24, and 1.64  $\mu\text{m}$ . Since the snow impurity concentrations in accumulation area are the same or lower level of the detection limit of soot concentration in GrIS, we use this retrieval result as an indicator of microbial activities in bear ice areas. The monthly averages of snow grain size and snow impurity concentration from 2000 to 2013 in GrIS derived from Terra/MODIS revealed the following facts. (1) The areas of large grain size changed year by year. (2) There is no constant increasing trend, but the larger values were observed in recent years (2009-2012) and especially for 2012 the remarkable increase in whole Greenland. (3) Larger snow grain size and high impurity concentration, which indicate the areas of high glacial microbial activities, are distributed in coastal regions of GrIS in June (mainly in southern part), July and August. These parameters in colder summer of 2013 than the recent several years, were almost the same as those in 2000.

Keywords: Greenland, snow grain size, glacial microbe, albedo, satellite remote sensing, MODIS