Monitoring of snow albedo and ice surface temperature in the North-West Greenland using MODIS data

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Much works in the Greenland ice sheet (GrIS) have reported recent Arctic warming. The GrIS has been experiencing extensive melt. The surface melt extent can be seen especially in northwestern Greenland. Such an event results in increasing the ice surface temperature as well as decreasing the snow surface albedo. It makes a large contribution to the ice-albedo feedback in the total melt energy. Thus, the monitoring of snow surface albedo and the ice surface temperature in the northwestern GrIS by using NASA's optical sensor MODIS data are important. We developed algorithms to retrieve the snow surface albedo and the ice surface temperature based on the radiative transfer model of atmosphere-snow system. We employed the MODIS (Collection 6) images to show temporal and spatial variation in more detail. We built monthly composite MODIS images by collecting clear day (cloud-free) pixels, and then estimated the snow surface albedo and the ice surface temperature from 2002 to 2014. Results show that the edge of the ice sheet was confirmed to be both low visible and near-infrared albedo through May to September in common. This implies that there are a dark region and a surrounding blue ice area. These low-albedo areas were gradually expanded toward the inland during recent 13 years. For the ice surface temperature, the edge of the ice sheet was measured to be almost melting point, and these areas were also gradually expanding toward the inland. This means that there is a potential of melting the ice sheet and increasing snow grain size over a wide area, resulting in the accelerate near-infrared albedo reduction more rather now. At SIGMA-A site (N78º03'06"/W67º37'42"; 1490 m a.s.l.) where an automate weather station was installed in 2012, a significant negative trend in both visible and near-infrared albedo reduction can be seen in the melting season. Both albedo reduction was largest in August. As corresponding to albedo changes, the positive trend of the ice surface temperature can be seen in the melting season. Comparison between SIGMA-A site and NEEM (N77º30'08"/ W58º04'22"; 2454 m a.s.l.) site shows that the positive (negative) trends for the near-infrared albedo (ice surface temperature) were common each other while that for the visible albedo were different. In NEEM site, small positive trends can be seen in the visible albedo. If major surface melt events such as 2012 summer and increasing the ice surface temperature trend will be measured in the near future, it may cause the expansion of the melting snow area toward the inland, and thereby decreasing the snow surface albedo can be observed in the NEEM site as well after increasing the snow grain size. So, we will continue to focus on these areas to monitor snow physical parameters. In addition we will attempt to use a Japanese satellite mission named "Global Change Observation Mission-Climate (GCOM-C)" to be launched in 2017 which may help to be aimed at a more temporal/spatial detailed monitoring of these parameters.

Keywords: Snow albedo, Ice surface temperature, Greenland, Remote sensing

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