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Greenland ice sheet surface albedo: trends in surface properties (2000-2011)

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The Greenland ice sheet has shown significant mass loss in recent years due to increased melting and ice discharge. Since solar radiation is the most important source for melt energy, the ice sheet surface albedo, determined by the surface characteristics, plays a crucial role in the surface energy budget, as it controls the amount of radiation that is reflected. Assessing the spatio-temporal patterns of surface albedo is therefore essential to quantify albedo-melt forcing and to characterize the surface characteristics that drive this forcing.

In this work, broadband and spectral albedo data from the MODIS data are used to assess Greenland ice sheet albedo changes over the 2000-2011 period. Trend analysis of the broadband albedo shows that significant albedo reductions are evident along ice sheet margins, especially on the West side, consistent with trends detected by microwave melt detection methodologies. This negative albedo trend increases solar energy absorption of the ice sheet by 0.3 W/m2/yr (0.4 W/m2/yr along the edges), which equals $\sim$10% per decade and promotes enhanced melt water production.

Analysis of the trends in spectral albedo due to surface characteristics shows larger reductions in albedo in the NIR spectrum on the interior of the ice sheet, whereas near the edges the albedo reductions are stronger in the visible spectrum. The former can be attributed to changes in snow grain size due to snow metamorphism. The changes near the edges, on the other hand, can be attributed to areas of bare ice, ice with melt water and dust accumulation, water content and refreezing.