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Changes in surface properties of the Greenland ice sheet (2000-2012)

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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 properties, 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 properties is therefore essential to quantify the albedo-melt forcing and to model the changes that drive this forcing.

In this work, spectral albedo data from the MODIS satellite are used to assess the Greenland ice sheet surface properties every 16 days over the 2000-2012 period based on radiative transfer model experiments. Classification of the Greenland ice sheet surface into snow/ice with varying i) grain size, ii) melt water content and iii) impurity concentrations (soot, dust, cryoconite) shows the spatio-temporal patterns of surface properties that affect the albedo feedback.

Analysis of the recent changes in surface properties indicate longer periods of ice exposure along the ice sheet margins, especially on the West, consistent with significant increases in melt water and impurities. This results in strong broadband albedo reductions that increase solar energy absorption (0.4 W/m2/yr) and again promote enhanced melt water production. Moreover, recent changes show ice exposure at higher elevations and increases in snow grain size on the interior of the ice sheet. These results are related to enhanced snow metamorphism and consistent with trends detected by microwave melt detection methodologies.