Particulate geochemistry and algal growth as factors driving melting of the Greenland Ice Sheet

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Ablation rates of the Greenland Ice Sheet (GrIS) are closely linked to the albedo of the ice sheet surface. Light absorbing impurities (LAI), including black carbon (BC), mineral dust, and microbes, lower the ice sheet albedo and increase rates of ablation. BC is the amorphous carbonaceous product of hydrocarbon-based fuel combustion. Although BC is present in low concentrations in the atmosphere over the GrIS, it can still reduce the albedo of the ice sheet surface due to its tendency to be highly absorbent of solar radiation.

The ability of BC to lower albedo is compounded by its coexistence with allochthonous mineral dust, which can increase the darkening effect of the BC through optical lensing.[1] The mineral dust also provides a substrate for growth of snow and ice algae[2]. Detailed mineralogical, microspectroscopic, elemental, and isotopic techniques were used to characterize aerosol and surface LAI samples collected during the 2016 melt season. Nutrient availability was evaluated and linked to algal growth, a relationship that will become more important as a warming climate will increase the duration of the summer algal growth season. Here we present a preliminary assessment of the complementary and combined roles that BC, mineral dust, and pigmented algae have in changing the 'bioalbedo' parameter[3] used for modelling the darkening of the GrIS surface. These results will aid in disentangling the biogeochemical controls on the albedo of the GrIS.

[1]Liu *et al*. Black-carbon absorption enhancement in the atmosphere determined by particle mixing state. *Nat Geosci* 10:184 (2017).
[2]Lutz *et al*. Variations of algal communities cause darkening of a Greenland glacier. *FEMS Micro Ecol* 89:402 (2014).
[3]Cook *et al*. A predictive model for the spectral "bioalbedo" of snow. *J Geophys Res*. 122:434 (2017).