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Impact of fine debris on ice melt rates at Russell Glacier, central-west Greenland

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Losses from the Greenland Ice Sheet (GrIS) have increased sharply in recent years, due to accelerated glacier discharge and increased surface melting. In 2012, 99% of the Greenland ice sheet experienced melt, which was exceptional on centennial timescales, but is expected to occur frequently in the future, as climate warms. Ice albedo is a primary control on melt rates and remotely sensed data shows that the GrIS has darkened substantial in recent decades, due to both inorganic and biological material. This has been particularly marked in south- and central-west Greenland and can lead to the development of positive feedbacks. Consequently, it is important to understand the relationship between melt and surface albedo on the GrIS. Here we use a combination of satellite remote sensing and field data to assess the impact of fine debris on melt rates at Russell Glacier, central-west Greenland. Our field data demonstrate that areas with a greater percentage coverage of fine, largely inorganic debris experienced higher melt rates than in areas with a sparse coverage. However, the relationship between melt and debris cover was highly spatially variable. Furthermore, the debris cover evolved substantially over time and we saw marked changes over a period of a few days. Using ASTER imagery, we show that the spatial extent of debris has expanded markedly in this section of the GrIS during the last decade, which could substantially accelerate melting. However, the complex and variable relationship between debris cover and melt rates highlights the need for further research, in order to accurately forecast its impact on GrIS melt rates.