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Interactive comment on “Dust from the dark region in the western ablation zone of the Greenland ice sheet” by I. G. M. Wientjes et al.

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We thank Douglas MacAyeal for his interest and his useful suggestions, which will help to improve the paper. Below we will discuss his comments.

Comment: This is an interesting paper that meticulously documents the material, chemical and biological composition of material forming a dusty surface on the ice sheet (I am still unsure if all the dust is located in "holes", i.e., cryoconite holes, or whether it forms a surface lag, or is located "englacially" within the ice that is outcropping at the surface (I presume it is, since there is stratigraphy shown in one of the figures).

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Answer: We assume that (part of) the dust is located “englacially” and is outcropping at the surface, were it accumulates on the surface to form patches and streams of dust as well as cryoconite holes, when aggregated amounts of dust melted in the ice.

Comment: What is missing still is this: This is the first time I've ever heard of the "dark region"... I didn't know that Greenland Ice Sheet ablation zone had "dark regions" where what I would presume to be natural variation in dustiness suddenly builds a regional, large scale signal. (I haven't read into the citations, so perhaps this is known from other studies). Thus, after reading the abstract and perusing the conclusions and figures (I'm not a mineralogist, geochemist or biologist, so the very detailed descriptions in the middle of the paper were read only in a skim fashion), I was left asking: What causes this dark region? And what aspect of the study sheds light on this cause? Can some scenario of glaciologically meaningful mechanisms be constructed to explain what is seen?

Answer: We assume that the dark region is caused by higher amounts of dust relative to the surrounding brighter ice. This dust is likely outcropping from the ice, based on the position of the dark region at some distance from the margin, fixed for the whole summer season when the ice is exposed and based on the stratigraphy visible on the Aster images. As a horizontal profile perpendicular to the margin in the ablation zone of an ice sheet represents a time line, we assume that ice from a period when more dust settled on the ice sheet, causes the dark region. To find out more about the origin of the dust in the dark region, we investigated its composition and compared it to dust from the reference ice as well as to literature values. We found not only mineral dust in the dark region, but also microorganism, which also seems to contribute to the darkening process.

Comment: Again, not all papers need to make a "big picture", and this paper certainly provides extraordinary data to investigate an interesting phenomena on the ice sheet. It would be nice, however, to see more speculation or a cartoon figure or something like that to suggest why the dark region exists at all.

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Answer: This is a great idea. We made the below figure and caption.

Figure 1: Schematic overview of possible mechanisms for dust to reach the dark region. Both red lines indicate recent wind-blown material from the tundra area and dry or wet deposition, whereas blue lines indicate the outcropping of the dust after settling higher on the ice sheet in the accumulation zone and travelling through the ice sheet. Dust following the blue trajectories has a certain age depending on the flow characteristics of the ice. ELA indicates the position of the Equilibrium Line Altitude, and the black line indicates the position of the dark region.

Interactive comment on The Cryosphere Discuss., 4, 2557, 2010.

TCD

4, C1728–C1731, 2011

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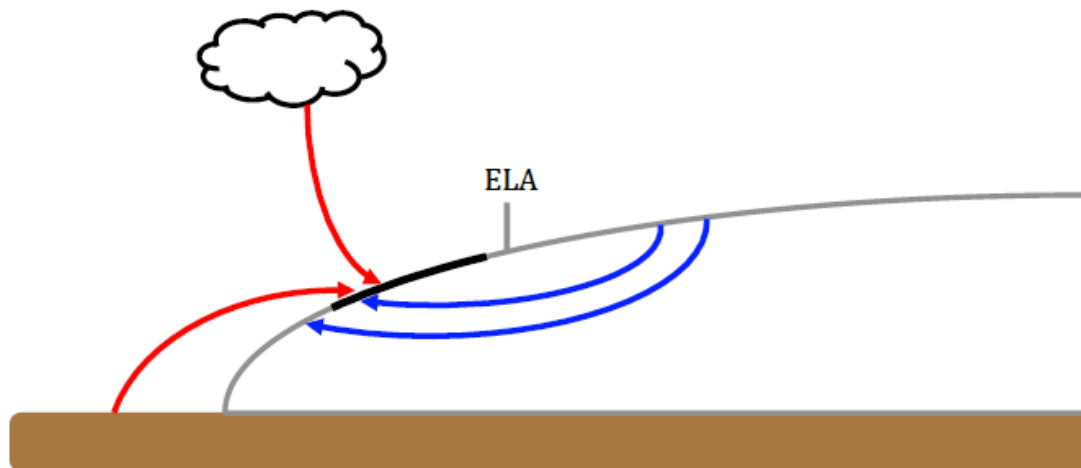


Fig. 1. Schematic overview of possible mechanisms for dust to reach the dark region.

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