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The Cryosphere Discussions

Interactive comment on "An explanation for the dark region in the western melt zone of the Greenland ice sheet" *by* I. G. M. Wientjes and J. Oerlemans

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General comments

This manuscript described spatial and temporal variations in surface reflectance in the ablation area of the Greenland icesheet based on sattelite images. The variations described in this paper could affect total melting of the ice sheet, thus their findings are very important to estimate mass balance of the ice sheet. However, discussion on origin of the debris in the dark region is too speculative, probably because no in situ observational data is shown in this paper. Authors could discuss that more carefully based on obaservational facts shown by previous litertures. I would recommend the following revisions before the final publication.

The major points are:

1. The possible causes for the debris of the dark region have to be discussed more carefully. The authors considered only two possibilities: windblown dust and Holocene origin dust contained in the ice. However, there are some litertures that biogenic surface dust, i.e. cryoconite, covers the ablation ice, and significantly affect the surface reflectance of the Greenland ice sheet (e.g. Gajda 1958). That would also be another possibility.

2. Spatial variation of cryoconite coverage on an Alaskan Glacier has been shown in Takeuchi (2009). According to the paper, cryoconite is abundant on the surfaces near the margin and snowline. The abundance cryoconite near the snow line is due to high biological (snow algal) production. This pattern seems similar to the case of this paper. Authors may mention this possibility.

3. Gajda (1958) also describe stripes (wavy pattern) on the ice surface based on in situ observation. He concluded the stripes were due to deposition of cryoconite by wind action, which is different interpretation from that of this paper. Authors should mention this difference of the interpretation.

4. Cryconite hole development may also affect surface reflectance. If the holes significantly developed on the ice surface, reflectance would become higher even if abundant dust exists on the glacial surface. Development of the holes is physically determined as shown by e.g. Gribbon (1979). Spatial variation in such physical factor may cause the reflectance variation.

Miner comments:

P.169 L.10 The dark region seems to remain in the same location in Fig. 4, however, it is not clear in 2001, 2004, and 2006. Authors should explain why.

P.169 L.19 Takeuchi et al. (2001) is probably wrong citation. The spectral reflectances of ice with cryoconite and clean bare ice is not shown in the paper, but in another paper

shown below (Takeuchi et al., 2001).

P.169 L.23 If authors want to conclude that the melt water does not caused the darkening in the area based on the spectral reflectance, authors should show spectra of glacial surface with meltwater and show that it differed from the spectra obtained from the image.

P.171 L.4 Authors should present an ASTER example of the brighter ice as well as dark region in Fig.8 to show the wavy pattern is less clear on the brighter ice. Also, it is not clear that why the wavy pattern can be evidence of dust from colder periods. Authors should explain this logic more carefully.

References

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Takeuchi, N. (2009) Temporal and spatial variations in spectral reflectance and characterisitics of surface dust on Gulkana Glacier, Alaska Range. Journal of Glaciology, 55(192), 701-709.

Gribbon P.W.F. (1979) Cryoconite holes on Sermikavsak, west Greenland. Journal of Glaciology, 22(86), 177-181.

Interactive comment on The Cryosphere Discuss., 4, 163, 2010.