

Interactive comment on “Dark ice dynamics of the south-west Greenland Ice Sheet” by Andrew J. Tedstone et al.

Anonymous Referee #2

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See attached supplement.

Please also note the supplement to this comment:

<https://www.the-cryosphere-discuss.net/tc-2017-79/tc-2017-79-RC2-supplement.pdf>

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2017-79>, 2017.

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Discussion paper



Dark ice dynamics of the south-west Greenland ice sheet

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Summary

MODIS satellite imagery is used to examine fluctuations in the extent of impurity-rich bare ice (dark ice) along the western margin of the Greenland Ice Sheet. A threshold on MODIS blue and red reflectance is used to identify bare ice and dark ice. Potential drivers of bare ice variability are examined using outputs of the MAR regional climate model, including shortwave radiation, longwave radiation, and sensible heat flux, in an attempt to understand causes of variability. The authors argue that while outcropping particulates are a major factor in bare ice albedo variability, the presence of biological organisms may also play an important role.

General Comments

The topic covered by the paper is important to our understanding of factors contributing to fluctuations in the albedo of impurity-covered ice in the ablation area of the Greenland ice sheet. It overlaps somewhat with the recent study of Shimada et al. (2016), but extends the analysis to a full summer season and attempts to understand drivers of dark ice variability.

I feel the authors need better support for their arguments that biology is a major driver of bare ice albedo variability. There is no definitive proof for this and I don't think the authors have successfully ruled out melt-out of impurities, sub-grid scale variability in snow cover and/or superimposed ice, or even the presence of liquid water, as potential causes of the variability. The authors have suggested that microorganisms appear to require the presence of outcropping material at the surface. If this is the case on a large scale, outcropping dust should control local and inter-annual variations in albedo as well. The authors' arguments that local-scale variability in dark ice extent can be explained not by dust melt-out, but by microorganisms, is inconsistent with the apparent need for dust as a microbial nutrient source on a larger scale.

I think that much of the variability the authors attribute to microorganisms could be attributed to dynamics of melt-out at small scales instead. Inter-annual variations in dark ice extent can be explained by the presence of superimposed ice, perhaps not fully accounted for in MAR. Increases in "Dark Ice Intensity" over time could be related to changes in surface cover within a relatively large MODIS grid box as snow patches and areas of superimposed ice melt away, exposing dark material beneath. The fact that sensible heat flux is a relatively important factor, as is the number of days where temperature is greater than zero suggests that melting of snow and ice could be an important factor independent of biological organisms.

Therefore, there appears to be insufficient information to state definitively the cause of the variations in dark ice extent and intensity, although I think the authors have shown that local deposition from year to year can probably be ruled out as a contributing factor.

Fig. 1.