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The Cryosphere Discussions

Interactive comment on "Algal growth and weathering crust structure drive variability in Greenland Ice Sheet ice albedo" *by* Andrew J. Tedstone et al.

Anonymous Referee #2

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This paper aims at investigating Greenland Ice Sheet surface albedo variation from algal growth and weathering crust using UAS, Sentinel-2, and MODIS albedo datasets. The paper is well-written but there are two major issues that need to be addressed before it can be considered publication in The Cryosphere. 1. There is some confusion about the use of reflectance and albedo, which may cause potentially large errors in the "albedo" comparison. For example, both the UAS camera and the Sentinel-2 observations are multispectral bi-directional reflectance, not same as the albedo, even after the normalization with the Spectralon, atmospheric correction, and narrow-to-broadband conversion. To calculate albedo from reflectance, Bi-directional Reflectance Function (BRDF) needs to be taken into account. The MODIS snow albedo product (MOD10A1)

is derived using surface reflectance and pre-assumed BRDF shapes. Recent studies have shown that snow/ice BRDF effects cannot be ignored especially under high solar zenith conditions (Gatebe and King, 2016; Jiao, et al., 2019). UAS reflectances from the backward and forward viewing directions can have a large difference (resulting from the BRDF effects), leading to the bi-modal instead of the unimodal albedo distribution.

Gatebe, C. and King, M. (2016). Airborne spectral BRDF of various surface types (ocean, vegetation, snow, desert, wetlands, cloud decks, smoke layers) for remote sensing. Remote Sensing of Environment, 179, 131-148

Jiao, Z. et al. (2019). Development of a snow kernel to better model the anisotropic reflectance of pure snow in a kernel-driven BRDF model framework. Remote Sensing of Environment, 221, 198-209

2. One of the key findings is that albedo datasets at different spatial resolutions can have different results; this could also be a result of artifacts from data selection/preprocessing. For example, surface albedo increases as solar zenith becomes larger, so for the same object surface albedo will be the lowest at local noon. The UAS data obtained at Jul 20th had the lowest solar zenith and thus the lowest surface albedo, so the albedo obtained at Jul 21st and 22nd would be larger than albedo at Jul 20th. Since the solar zenith angles for the images obtained at Jul 21st and 22nd would be similar, so would be their albedo values. In comparison, the Sentinel-2 and MODIS would have much smaller difference in albedo values on Jul 20th and 21st. Solar zenith corrections are needed here before any further analysis on albedo changes can be carried out.

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