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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 #3

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Tedstone et al. presented a study using field data and remote sensing data to analyze how algae and weathering crust change Greenland Ice Sheet albedo over two ablation sites in west Greenland (namely S6 and UPE). It is concluded in the abstract that ice albedo is affected by both light-absorbing impurities (not only algae??? please clarify) and physical ice processes (specifically weathering crust??? please clarify), and there is a spatial scale dependency in albedo measurements which should be considered. I found this manuscript very similar to a very recent TC discussion paper by Cook et al. (2019) 'Glacier Algae accelerate melt rates on the south-western Greenland Ice Sheet'. I think the authors need to clarify the difference of this manuscript from that paper, given the same datasets, methods, and surface classification results at S6 site.

The title needs to be improved. It is not quite right to say that algal growth and weathering crust drive the albedo variability of the Greenland Ice Sheet given the importance of snow metamorphism on the albedo of the accumulation zone. Since the authors only discussed two sites at the ablation zone in west Greenland. Please specify west Greenland and bare ice albedo.

Sections 3.1, 3.2, 3.3, and 3.4 are almost as same as the Cook et al paper. Although the Cook et al paper is cited, it is inappropriate to repeat the same content from another independent paper unless the authors clarified the relationship and difference between these two papers.

The surface type classification section is a critical part for analyzing the changes of algae and weather crust (I guess the authors are trying to focus on these two factors). However, why don't the authors include weathering crust as a surface type when using the random forest method to classify the UAS image and Sentinel-2 image. Again, the authors directly used the surface type classification results from Cook et al. (2019) which didn't consider weathering crust. Besides, it is not appropriate to make statements based on the results from another under-review paper (Cook et al. 2019). What's the criteria to separate the high algae surface from low algae surface? Using thresholds? How to define the threshold? The high vs low algae sound very arbitrary.

As the authors mentioned that the remote sensing data they were using don't contain spectral signature of algae, in this case, how could the algae surfaces be classified? In other words, how to separate them from other impurities?

Page 11 line 4-15, this part is very unclear, rephrasing is necessary.

Although the authors emphasized the importance of weathering crust on surface albedo, but I didn't find detailed quantitative analysis about this subject? Section 4.3 reads quite speculative. Any references to use 840nm to identify the weathering crust?

The authors aimed to analyze the impact of algae and weathering crust on Greenland ice sheet albedo, but the datasets are limited to two specific sites. Discussion about the generalization of those two specific sites to larger spatial scale is necessary.

Regarding the scale problem, particularly the impact of scale on melt flux estimation (page 15 line 11-18), did the authors use the actual MODIS albedo to estimate the melt flux? Please clarify. It seems that all the melt flux estimates are based on Sentinel-2 albedo, one scenario is to use Sentinel-2 albedo for each individual Sentinel-2 pixel, another scenario is to calculate an average Sentinel-2 albedo over a MODIS pixel scale. I don't think this comparison is fair, what the difference between the Sentinel-2 averaged albedo and the real MODIS albedo? Without considering this, "the $\sim$2% underestimate in melting derived from surface energy budget calculations which use only MOD10A1 albedo" (in abstract and conclusion) is wrong. Besides, using only two MODIS pixel to make this statement is not sound. The authors should consider conducting the calculation over a large scale, since Sentinel-2 image and MODIS image can cover a large area instead of two MODIS pixels.

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