Comment on tc-2021-116

Anonymous Referee #1

Referee comment on "An empirical algorithm to map perennial firn aquifers and ice slabs within the Greenland Ice Sheet using satellite L-band microwave radiometry" by Julie Z. Miller et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-116-RC1, 2021

The paper comprehensively describes the method for analysis and the modeling exercise. The authors present the results and fairly point out the sources of uncertainty. I find this paper a valuable contribution to our knowledge of using L-band radiometry for mapping of subsurface features of the GrIS. Nevertheless, I believe the paper could be much more concise. Thus, in addition to addressing the scientific comments and questions, I strongly suggest that authors try to shorten the text which I hope leads to fewer redundancies and better readability.

General Comments and Technical Questions

* L 509: The closer we are to the Brewster angle, the less sensitive the TBV measurements are to the snowpack dielectric properties. In other words, TBV observations are more sensitive to the subnivean layer properties. With this in mind and that the SMAP observations are at 40°, could you describe the uncertainties introduced to your analysis when considering an ice surface temperature of -1°C and linking them to the TBV measurements?

* Can you explain more what do you expect to be the effect of using multi-angle TBV measurements on your analysis results?

* The authors have used enhanced-resolution L-Band imagery which includes using multiple satellite overpasses over an area for improving spatial resolution. Given the fact that surface melt could be significantly between two local overpasses at the similar local times but different days, would you expect to see a difference if you'd repeat your work with the original lower resolution SMAP data?

* In the last section, when talking about future work and potential ideas to follow, it is perhaps good to shed light on the usefulness of other satellites' data or future missions. As an example, ESA's ROSE-L mission could provide us with valuable lower frequency active measurements of the ice sheets.

More detailed comments

L 40—44: The sentence is too long. Please break it down to two or three sentences for improved readability. "An empirical algorithm previously developed to map the extent of Greenland's perennial firn aquifers via fitting exponentially decreasing temporal L-band signatures to a set of sigmoidal curves is recalibrated to also map the extent of ice slab and perched firn aquifer areas using airborne ice-penetrating radar surveys collected by NASA's Operation Ice Bridge (OIB) campaigns (2010-2017)." □ ""An empirical algorithm was previously developed to map the extent of Greenland's perennial firn aquifers via fitting exponentially decreasing temporal L-band signatures to a set of sigmoidal curves. This algorithm is recalibrated to also map the extent of ice slab and perched firn aquifer areas using airborne ice-penetrating radar surveys collected by NASA's Operation Ice Bridge (OIB) campaigns (2010-2017)."

L 59: "~tens" □ "approximately tens"

L 218: "since the beginning of the satellite era" unnecessary. Can be omitted.

L 233—234: "Deep enough to directly detect the upper surface of stored meltwater over the entire depth range mapped by airborne ice-penetrating radar surveys over the GrIS." This sentence is grammatically incorrect. Please revise it.

L 110—144: It is just a suggestion. Can the authors include a table that help summarize and explain the formation features and relative TBs of each of the three types of firn structures they discuss in the introduction? For example the rows could be "percolation facies areas", "ice slabs", "perennial firn aquifer areas". The introductory material is written well; nevertheless, it is a bit ling for an introduction section in a paper.

L 175—197: This part can be shortened as it goes into details which bet fit in the "Methods" section.

L 209—214: I see this as a redundancy to the same information provided in the "Introduction" section.

L 236: The beginning of Section 2.1 contains introductory information about SMAP. It is best to include such information in Section 2.1. where you first talk about SMAP and using its passive observations.

L 272—277: The statement given in these lines is basically the same as in lines 175 to 183. Please remove these redundancies.

L 323: "Enhanced-resolution (3.125 km)". This expression potentially created a misunderstanding in reader's mind. The grid is 3.125 km while the actual spatial resolution is at best ~16 m. Please revise the wording to avoid this misunderstanding. The same comment is true for the cation of Fig. 1.

L 326: "*(Brodzik et al., 2019)* " This reference does not seem to be needed here.

L 327: There is no panel (c) in Fig.2. It seems that the statement for panel (c) is copied and pasted in the caption for Fig 2.

General comment about figures and their captions: The figure captions are too long and they seem to go beyond a general description necessary to read the maps over to detailed discussion of the content.

Figure 3: Please explicitly write the unit of the values in the colorbars next to the radargram profiles (panels (a) and (b)).

L 450: Much of the text before Table 1 can be summarized. Thanks to Table 2, there is not a strong need of writing down the same numbers within the text.

L 459 – 469: At this point we are far away from the "Introduction" and you include unnecessary background information including about the methods for mapping Greenland's ice facies. Please remove these statements and simply explain the method you have developed for this purpose based on L-band measurements.

L 1130—1133: Please keep the Summary and Future Work section free from material which are supposed to be in the "Introduction".