The Cryosphere Discussions

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Comment on tc-2021-266

Anonymous Referee #1

Referee comment on "High-resolution subglacial topography around Dome Fuji, Antarctica, based on ground-based radar surveys over 30 years" by Shun Tsutaki et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-266-RC1, 2021

Review of "High-resolution subglacial topography around Dome Fuji, Antarctica, based on ground-based radar surveys conducted over 30 years" by Shun Tsutaki and coauthors.

Summary:

This a report on a subset of ice thickness data that has been collected over Dome Fuji, which has seen increased activity over the last few years as part of the Oldest Ice Challenge. This is a unique dataset, and I think the authors miss some opportunities to make it more relevant to the community and to the search for old ice. There is a significant focus on uncertainty analysis, but little quantitative justification for the significance of the uncertainties in the context of the old ice search. I recommend revisions that more fully utilize the available data.

Major issues:

Data: I think at a minimum, given the main point of the paper is the quality of the new grid derived from point data, to validate those claims the point data really should be released as part of the paper (if not here, where?). This will make this paper a lot more valuable for both future data intercomparion papers, but also research into interpolation methods, and comparison studies between old ice sites.

Data integration: This does seem to be a missed opportunity to integrated both the Kansas-Alabama radar data from JARE59 and the AWI data, would make the conclusions stronger. The Rodriguez-Morales et al., 2020 paper cited for the Kansas-Alabama radar is a radar engineering paper, and does not deal with interpretation or presentation of the ice thickness data in the context of old ice at all.

Beam patterns: Given the focus on the Yagi improvements over the years, having a figure plotting the beam patterns for the different systems would be beneficial, including any side lobes. Given the anisotropy in the beam patterns, caution should be used using crossovers to account for intersystem bias - over rough terrain, bias for an anisotropic sensor may be a function of the intersection angle (see the Appendix on the Young et al., 2017 Dome C paper). It seems expanding Figure 2 to include JARE 33 and JARE 37 would be instructive.

Comparison with other ice thickness products (section 4.2): It is unclear what the goal of section 4.2 is, in particular Figure 6. Comparing an interpolated DEM which includes recent radar along the line of comparison, with other that don't, does not seem to be a fair comparison. It would be better to the different interpolations along lines that are not aligned with included radar profiles, or better yet, along a radar profile that was not included in any of the DEMs, including the JARE DEM. For each of the DEM's compared with, maps of the datasets that were used in their generation should be included in the supplementary material, with the line of comparison plotted.

Importance of the uncertainty analysis: A lot of effort is spent on ways to quantify the uncertainty in ice thickness both of the profile data and of the interpolated grid; however, it is not made clear quantitatively what science reduced uncertainty allows. How does improved confidence in ice thickness allow for a better assessment of locations of old ice? What are the horizontal and vertical resolution requirements for constraining these targets?

Analysis beyond ice thickness: The authors don't really go beyond ice thickness in any quantitative fashion. Bed reflectivity for water distribution with such heterogenous data could be a stretch, but some additional parameters, like bed interface roughness, bed rock slope, and ice driving stress could easily be calculated from these data and be informative of regions for follow up.

Minor issues:

"Conventional" and "modern" radar should explicitly defined in the introduction - I think you mean by "conventional' is "real aperture" or "incoherent" radar.

Line 238: Bedmachine Antarctica does not use mass conservation in slow moving regions, but instead a streamline diffusion method (Morlighem et al., 2019).

Figure 2: what is the cause of the change of gain in the NDF end of the JARE59 radargram? The authors should highlight the key 2500 m depth on these radargrams. It is notable that in general the bed roughness and the brightness of the scattered bed return appear much brighter above that line, consistent with a frozen, immobile bed with very

little englacial attenuation.

Figure 7: Using the final 2500 m ice thickness contour on these difference maps would help orient the reader as to where major differences are.

Figure 8: Hill shading the zoomed in region may help in visualizing the roughness better.