

The Cryosphere Discuss., referee comment RC1
<https://doi.org/10.5194/tc-2021-15-RC1>, 2021
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Comment on tc-2021-15

Anonymous Referee #1

Referee comment on "Impact of dynamic snow density on GlobSnow snow water equivalent retrieval accuracy" by Pinja Venäläinen et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-15-RC1>, 2021

General Comments:

This manuscript is fairly straightforward and logical. It is mostly well written, but some sections could use clearer language or additional explanation. The study seems worthwhile, because there is a large amount of uncertainty in global snow estimates and assuming a constant snow density over time and space (as in GlobSnow) is not realistic, so any method that could introduce empirical density estimates would be beneficial. However, the improvements in SWE estimation did not seem all that significant/impressive, so I wonder if post-processing is not the best approach. I have some additional specific comments below about the methodology, interpretations, and presentation.

Specific Comments:

- The title is a bit misleading, because it makes it sound like the dynamic snow density is incorporated directly into the retrieval, when in fact it is applied in post-processing.
- Line 64: Do the authors have a citation that they can provide to show that the Sturm et

- al. approach did not improve retrieval skill?
- Lines 141-142: Why was there so much more validation data than implementation data in the Eurasian portion of the analysis, but the opposite in North America?
 - Line 163: The method does not produce SWE estimates for mountainous areas, but most of the SNOTEL data come from mountainous regions. How do the authors justify using mountain snow to determine the density for snow that is not in the mountains?
 - Line 224: How was the multi-decadal snow density field produced for only 2000-2009? Is it a running average, or were the data actually produced using data from the full 1979-2018 time period? If the data were limited to only 2000-2009, wouldn't that make it the same as the decadal field?
 - Figure 5: When the authors compare the in situ densities used to reprocess GlobSnow to their nearest neighbors (used for ground truth), is a similar pattern seen, or does it better fit the 1:1 line? Is the interpolation smearing out the range/variability of the density values? If so, the authors might search for a different interpolation method. Additionally, by interpolating across large distances (which may have different land cover, elevation, etc.), the authors are effectively taking local density estimates assuming that they are representative of large areas. Do the authors think this is a fair thing to do? Might it be better to use an interpolation method akin to PRISM (Daly et al.) to take land surface properties into account?
 - Line 244: "...SWE values up to 500 mm and SWE values up to 150 mm...". This is a confusing sentence, and I was only able to understand what the authors meant by looking at Table 2.
 - Line 269: Is GlobSnow calibrated to SWE in any way? If so, then post-processing might not be a good idea? The authors note in lines 338-349 that implementing densities directly into the retrieval may be more beneficial, as a wrong density may lead to reduced retrieval skill. So, then why bother with post-processing?
 - Line 272: Calculating decadal density maps and applying them to the entire decade seems a bit arbitrary. For instance, the density applied to data from 1981 would be from (approximately) the next 10 years into the future, while for 1989 the density would be from (approximately) the past 10 years. Why not calculate a running decadal average, centered on the year of interest?
 - Line 277-278: I don't know what the authors mean in this sentence.
 - Table 3: The improvements in post-processed SWE seem marginal, so I wonder if post-processing is worth doing at all. Do the authors have any way to evaluate the statistical significance of the improvements in SWE?
 - Figure 8: What does the colorbar in this figure show? It is not labeled.
 - Figures 8-10: Why are these 3 separate figures? Why not one figure with 6 different panels?
 - Lines 339-347: Do the authors have a citation(s) for this?
 - Lines 350-351: To what methods are the authors referring? This paragraph needs to be further explained.

Technical Corrections

- Line 17: "was found to produce the best results"?
- Lines 58-59: Snow also undergoes metamorphism that can cause density to increase.
- Line 130: "The North American dataset"?
- Line 133: "The SNOTEL dataset"?
- Caption of Figure 4: "for snow transects"?
- Line 231: "differs from the other two versions more" – could improve grammar
- Figure 8, y-axis label: "Estimated SWE"?
- Figures 8 & 9: The font sizes of the titles of these two figures are different.