

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2022-227

Jennifer Jacobs (Referee)

Referee comment on "Implementing spatially and temporally varying snow densities into the GlobSnow snow water equivalent retrieval" by Pinja Venäläinen et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-227-RC2>, 2023

The inclusion of density in the GlobSnow SWE estimates for both snow grain size and final estimate of SWE are a welcome improvement for global estimates of SWE. The key findings, that dynamic density improves SWE estimates, is not surprising. It is interesting that there is little difference among the three methods that are compared. Additional recommendations for the presentation of the comparisons are suggested below. It is also notable that the performance did not improve as much as one might expect over using a constant density value.

The collection of in situ density values was a massive undertaking. The point made late in the manuscript regarding near real time estimates of SWE not being possible with these same in situ value suggests that a decadal field rather than annual will serve the community better and eliminate the annual collection and QA/QC of density measurements. Since IDWR is recommended and decadal seems to be the most viable and flexible solution, Table 3 should include the performance of decadal IDWR. It is recommended that performance for individual years be assessed using the decadal minus one data set (leave one out) to assess the range of possible performance in any given year. Also, consider making the in-situ density dataset openly available. This resource would extend the value beyond GlobSnow users to the snow community members. For example, there is a rapidly expanding capacity to make snow depth measurements using lidar and structure from motion on airborne and drone platforms that would greatly benefit from insights and data in this current effort.

L24 Provide a measure of the average or percent improvement

L112 "Around 19 GHz..." is an awkward phrasing. The point being that SSM/I and SSMIS have slightly different frequencies might be stated in a clearer manner.

L118 to 119 "removing measurements from stations where the mean March SWE exceeds 150 cm in at least 50% of the years that the station has had at least 20 measurements"
This criteria is difficult to follow.

L120 to 121 How was snow wetness determined?

L180 and others "significant differences" implies a statistical test was performed. Please rephrase.

L260 and others Results indicate differences in western versus eastern NA, but are not presented. Perhaps present in supplementary material. Similar for data in Russia later in the manuscript

Table 2 and others Add columns for average values of in situ and modeled

L284 Paragraph break needed starting at "Figure 4"

L294 How was the decision made to use a single semivariogram for such large regions, yet a different semivariogram was determined for each day?

L347 "grain"

Figure 6 Excellent figure, shows that performance varies by month. Additional monthly results would be valuable.

Section 5.2.2 While it is fine to present a single year, please provide information about why that year was selected and whether it is representative for most of the study regions.

L373 concentration

Figure 7. Reduce the number of significant digits to 3.

Figure 8 A density scatter plots would be more useful. Scatter plots should use the same scale

in the x and y -axes (x is much longer). This figure would be valuable to be presented on a monthly basis?

Figure 10 caption should describe the middle row as well.

The discussion needs to be expanded. This first paragraph is unnecessary because it largely repeats the introduction and the methods rather than putting the work in context. There are a number of topics that would be valuable to consider in the discussion. For example,

- It appears that performance is not the same globally. One suggestion is to discuss why North America performance is so poor compared to Eurasia. Another is to address the challenges in Russia in greater detail. Also, does performance differ by year – most applications are interested in changes over time or specific years rather than average conditions.
- There are a number of researchers who have used earlier versions of GlobSnow for applications. The impact and value of these modest improvements in previous research and to the applications in the first paragraph in the introduction could be discussed.
- The differences between the global snow density product produced here versus other products (global or otherwise) and how the approaches researched for this paper might provide value.

Please consider these to be potential topics that this paper is uniquely qualified to comment on and a request to consider at least one broader topic in the discussion as opposed to a request to discuss all of the examples listed above.

L535 Is there a final recommendation on which approach will be used? Will there be a revised GlobSnow dataset in the future or will the algorithm change moving forward?

Overall, this manuscript presents a clear next generation approach to providing improved estimates of SWE globally. Well done.