

## Response to Alain Royer

This article presents a new version of Globe Snow v.3.0 (new product) including a retrieval with variable density. The principle of the approach has already been presented and discussed by P. Venäläinen in TC 2021. In this paper, the improvement is described and analyzed over a larger dataset.

Even if the retrieval of SWE including a variable density in the inversion process improves the SWE a bit (reduction of the bias by 5% on average), the lack of sensitivity of the retrieval for large amounts of snow (SWE>150 mm) remains a major problem with this approach (Fig. 8). This should be recalled in conclusion, even if it is known.

But this long database has the merit to exist and has to be kept up to date.

We thank you for your time and constructive comments on the manuscript. We take all the comments into account and our replies can be seen in red.

We would like to mention that the approach for implementing dynamic snow densities from in-situ data was presented in Venäläinen et al. 2021. but that this paper's focus is on implementing these densities into the SWE retrieval algorithm, not using snow densities in post-processing as before. Implementing varying snow densities into the retrieval improves snow mass estimates when compared to a post-processed product.

The issue of retrieving large SWE values is mentioned in the Discussion and we will mention of this into the Conclusion.

Abstract: reduced RMSE and MAE by about 4 mm and 5 mm: in %tage?

Implementing IDWR densities into the SEW retrieval reduced RMSE and MAE from 54.2 mm to 49.8 mm and from 34.3 mm to 28.7 mm (around 4 mm and 5 mm) when compared to the baseline GlobSnow product. We will clear this by modifying the abstract.

L.94 For GMON too, the snow density was calculated for SWE and snow depth? But snow depth is not systematically measured at the GMON sites?

Yes, snow density was calculated from SWE and snow depth at GMON sites. We have only used GMON data from locations where the snow depth is also measured. Many of the automatic stations are also equipped with automatic measurements of snow depth using ultrasonic ranging instruments (Vionnet et al. 2021).

We will add mention of this to the text,

L. 170 Figure 2. Not clear: The “Dynamic snow density information’ is derived from Tb (a red arrow is missing?) and from Step 2: the upper arrow should go the other way?

The dynamic snow density information is derived from in-situ snow density measurements, not from Tb measurements so the arrow is pointing in the correct direction. We will update figure 2 to make this clearer.

L. 380 The figures show the SWE retrievals. Wording of the caption not clear: may be confused with “snow” density scatter plots! To reword more clearly?

We will update the caption as follows:

Figure 7: Scatter plots showing the normalized density of scattered points and validation parameters for SWE retrievals without final assimilation with static density (left) and annual IDWR interpolated dynamic density (right) for 2005.