

Dear editor and reviewers,

Here is our response to your very helpful and constructive comment in blue. We responded point by point for every major and specific comments.

We also provide a track change version of our manuscript with significant changes to improve the presentation of the manuscript.

Thanks the authors

## **Reviewer 1**

In the revised manuscript, the authors effectively addressed technical issues highlighted in the initial review. While the study is well-designed and presents relevant and interesting results, the presentation quality remains a concern. I found substantial effort was needed to understand the study due to the writing style, sentence/paragraph structure, irregular flow of concepts, grammatical errors, and terminology. This writing impacts the overall quality of the manuscript, however the technical components are now adequately addressed. At a minimum careful proofreading and correction of numerous grammatical errors is strongly recommended before this manuscript could be published.

Other minor comments:

- The track changes version of the manuscript did not identify all the changes to the text body from the original manuscript, which made the review more difficult. The following line numbers refer to the tracked changes version.
- Line 124: Mt Albert is Fig 1a, not Fig 1b.

Fixed

- Line 128/141: Do you mean “soil roughness” or “ground roughness”?

**We changed soil roughness for ground roughness**

- Line 131: This sentence is unclear, please try to simplify the explanation of why these surveys were included.

**We changed the sentence for : “However, these two surveys were not used for the variogram analysis and spatial modeling because their spatial extent and density are insufficient compared to the other surveys. They were added to the study only to obtain more data points for Figure 3.”**

- Line 168: I only see one profile site for the 24 Jan survey (red) in Fig 1e.

**We cannot see the second profile site on this particular aerial imagery.**

- Line 269: The proper citation to the R gstat function can be found with the command citation(‘gstat’) (i.e., Pebesma, 2004).

**The citation was corrected for Pebesma, 2004.**

- Table 1: The table and text should present the covariates in the same order; the different orders are confusing.

The order has been modified to fit the text and the table.

- Table 2: PST results are typically presented in centimetres, not metres. Why were columns cut to 1.5 m long when the standard length is 1 m for weak layers less than 100 cm deep?

We choose to present the PST results in m for consistency in units with the other metrics.

The columns were cut 1.5 m long to counteract the edge effect with smaller PST. This decision were suggested by some SLF scientist in a private discussion so I cannot refer to a scientific paper for this matter.

- Results should be in past tense, not present tense.

We change it to past tense.

- Sect 3.1: Briefly describe the other 2 surveys listed in Table 2 and Fig 3. Even if not in the same level of detail they should at least be acknowledged and explained why they were included for one part of the analysis.

We added these sentences to describe these two surveys: “The last two surveys presented in Table 2 were added to the study to obtain more data points in Figure 3. The snow spatial survey EP20-DF had a mean slab thickness of 0.32 m and slab density of 241 kg m<sup>-3</sup>, similar to AR22-PP. The snow spatial survey EP19-FC recorded the highest mean slab thickness of 0.85 m and the highest mean slab density of 333 kg m<sup>-3</sup>. The number of SMP measurements and spatial extent were not sufficient for spatial analysis. However, they provided good data points characterized with a higher slab thickness  $D$ , that better assess the quality of the two empirical power law fits (Bazant et al., 2003; McClung et al., 2009).”

## **Reviewer 2**

We thank the authors for their response to the first review and adaptations made to the paper that make the paper easier to follow and clarified most of the points. I would just have some remaining points.

The main concern is that the 1st main comment of reviewer 2 was not addressed. One sentence to clearly state what is needed to reapply the method at an other site would be welcome (do we need 50 SMP measurements or with the 1217 we already have are sufficient). Maybe a sentence in the perspectives would be sufficient to clarify what you imagine with this method in the future.

We are sorry that the main concern of reviewer was not clearly addressed. It is a good comment and we added a paragraph at the end of our discussion to discuss this result and possible perspective:

“The transferability of our results to different sites is not feasible. The selection of covariates by the model was specific to each site, snow properties and stability metrics. As demonstrated by Reuter et al. (2016), the interaction between meteorological processes and terrain leads to distinct spatial variation in snow properties across different surveys. These micrometeorological processes vary between sites, and differences emerge not only between slab deposition patterns, but crucially, between different types of weak layer. More spatial snow surveys are needed to gather a robust dataset to highlight trends in spatial pattern between different types of weak layer, slab deposition, microtopographic, and microclimatic contexts. To obtain a more robust dataset, future research should aim for an equivalent or higher sampling density and extent presented in this study (60 and more SMP covering 60-80 m extent). Lowering the sampling density and extent could compromise the estimation of the experimental variogram and the spatial modeling. An alternative approach to sampling with fewer SMP measurements could be to incorporate distributed 3D snow cover modeling tools like ALPINE3D. This avenue was explored by Reuter et al. (2016), but acknowledged the need to improve performance in distributed snow cover modeling. Implementing 3D snow cover modeling has the potential to capture a portion of these site-specific micrometeorological processes without requiring an extensive spatial survey of SMP measurements.”

Line 270 : We may not need all use cases of fractal dimension but rather the one that is used here (surface).

The sentence is now : “The fractal dimension expresses the roughness or complexity of a surface (2-3D) in a noninteger dimension “

Figure 3 : Please use the same notation in the axis labels and in the caption (rho\_slab or rho ?). Same for the legends (SMP\_fit or SMP).

The notation were corrected and are now consistent both in the legend and the plot.

The identification of weak spots (line 438-440) seem still not fully clear for me. However, I can imagine you talk about the areas on the right (center) and at the top (center).

We modified the sentence for :” The spatial patterns of the stability metrics indicate two major weak spots represented by two cluster of low SPI values near 0, on the north side (right) and northwest (upper-middle).”

Figure 9 : Only the use of TPI and VRM are discussed in the result section, however, xy and convexity have seem to play an important role for some variables. It would be great to at least comment that in the results and/or discussion section.

There was already a sentence in the results section about the use of the coordinates xy :” The easting and northing coordinates were widely used in the models showing the presence of autocorrelated residuals.”

We added this sentence in the results section for convexity :”Convexity was selected numerous times, especially for the slab density by almost never for the slab thickness.”