

Response to review by Rune Engeset

Dear Rune,

Thank you for reviewing our manuscript, and providing detailed, constructive feedback. Please find below our response to the points raised and the suggestions made. As most of the comments are technical corrections, we will provide a point-by-point response to these points when submitting the revised manuscript. We intend to address all these recommendations when revising the manuscript.

The manuscript contributes to scientific progress in the field of avalanche hazards, with respect to the process of avalanche forecasting and how contributing factors may be used to improve the resolution the danger level in forecasts. The applied methods are valid, and the results are presented and discussed in a clear and balanced manner. The manuscript is well written, presenting the study in a structured and complete way. The scope of the study, its results, and the quality of the manuscript make it well suited for publication in NHESS.

I recommend it for publication in NHESS, after technical corrections / minor revision.

In the following, I draw attention to the following minor issues (referred to by line, figure, or table numbers) that could be addressed before publication:

Line 1 I suggest adding “and manual” before “decision-making” to point out that the process is currently not done by a machine.

Line 14 Improve the “and in which part of” part of the sentence

Line 22 Please describe briefly what is meant by “increased predictive value”

With «increased predictive value», we mean: the sub-levels increase the resolution of the last step of the avalanche danger assessment. As shown in the manuscript, the forecast sub-levels correlate with all the parameters studied, and thus increase the predictive value of the forecast, compared to «full» danger levels.

Line 34 Explain the acronym CMAH when first used

Figure 1 The boxes in (b) have different dimensions. I suggest adding “and boxes” between “curve” and “(b)” in the legend

Will be done.

Line 79 Improve the part of the sentence which reads “and to data”

Line 85 Replace “research” with “research questions (RQs)”

Line 107 / Figure 2: The white polygons referred to in line #107 are white or grey outlines rather than white polygons and are difficult to see in Figure 2b. The colours used in 2b are very difficult to separate. I recommend improving the map and text.

We will revise the map in Figure 2b to become more reader-friendly (by changing the size of lines, and/or colours).

Line 120 It would be of value if you explain how this was (internally) analysed, and why there is a difference between wet and dry avalanche situations.

After the first season of using the sub-levels, the forecasters discussed issues and challenges relating to their use. In general, forecasters were comfortably assigning a sub-level to a danger level for dry-snow conditions. This was different for wet-snow conditions: forecasters had essentially always assigned sub-level + for wet-snow conditions. We interpreted this as forecasters being unable to make the relative comparison within the danger level for wet-snow conditions. At the time, we (the forecasters) did not analyze in detail as to the why this was the case but we suspect that forecasters at SLF have more difficulty assigning a danger level in a wet-snow situation compared to dry-snow conditions. As the absolute judgement precedes the sub-level assignment, this means that reliably assigning a sub-level is essentially impossible.

Table 1 Add “and” before “(x)” in the third line of the caption

Line 145-147 Could you improve readability of this sentence, and add a short explanation of why this was done?

We will rephrase this sentence.

Figure 3 Why not reduce the number of rows for full ECTP to one? Why have an “*” after “only” in the caption?

*We would like to keep the three rows for ECTP to highlight the overlapping definition of these three classes. The asterisk refers to the asterisk in the figure. The * should indicate that the class part of the block actually includes two classes: part of the block and edge only. We will revise figure and caption to make this clear.*

Line 196 Please explain what you mean by avalanche terrain in this context. Release areas only or release areas and runout zones?

The terrain classification by Schmudlach and Köhler (2016) evaluates the danger resulting from human-triggered avalanches at a point. This means that not only points within release areas but also points, which are in slopes below release areas, are considered avalanche terrain. – We will explain this briefly when revising the manuscript.

Line 226-228 I recommend improving this very long sentence

Line 258 I recommend improving this sentence.

Line 355 You would like to write “human-triggered”

Figure 7 In the first line in the caption, consider if “surface area” should probably be replaced by e.g. “area of PRA”. Consider using x103 (by thousand) rather than x104 on the vertical axis of the top row diagrams

We will adjust to area of “area of PRA” instead “surface area”.

Figure 8 The shaded areas in the diagrams c and d are difficult to see, consider improving legibility of the shading

We will improve the shading to improve legibility of these figures by changing shading and/or colour.

Table 4 This is probably a matter of preference, but I suggest using “,” instead of “/” in the table as these are pairs of sublevels

Line 443 I suggest replacing “main” with “second”

Line 453 I suggest using another word than “tendency”, as tendency is often used to describe a temporal trend

We will consider changing when revising the manuscript.

Line 472 I presume you would like to say that there is a need for enough (not only relevant) data. I suggest improving the sentence. If possible, could you describe what criteria should be met (in terms of amount and relevance)?

We agree: enough relevant data has to be available with sufficient spatial density and temporal frequency. – We will add a comment to highlight this. - Unfortunately, we are unable to give an indication regarding the amount of relevant data. All we can say is that the spatial density and temporal frequency of this data seem to be sufficient to reach the “quality” of the sub-level assignments as presented in this study.

Line 528 I suggest adding “enough” before “relevant” and removing “if” after “(2)

Frank Techel, on behalf of all the co-authors

References

Schmudlach, G. and Köhler, J. 2016. Automated avalanche risk rating of backcountry ski routes. In: Proceedings ISSW 2016. International Snow Science Workshop, 2–7 October 2016, Breckenridge, Co., 2016, p. 450-456