Review for NHESS

Fu et al.: *Forecasting different types of avalanches based on snowpack and snowfall/snowmelt conditions on the Southeastern Tibetan Plateau*

General comments

The manuscript describes a study where the avalanche probability is forecast based on three variables. The study area is the Galongla Valley, which has a snow climate that was characterised as maritime. In maritime snow climates, avalanche activity is predominantly controlled by precipitation and snowmelt. The data used for the study are daily weather and snow data (from 10 monitoring stations) and avalanche records (13 dry-snow avalanche events, 24 wet-snow avalanche events) covering two winter seasons. The predictor variables were snowfall intensity, snowfall duration, and snow depth prior to the snowfall period. For dry-snow and wet-snow avalanche events, corresponding non-events were selected, three times as many as events. With these data, a logistic regression model was developed. The model performed well. The authors compare model performance with and without using the snow depth as input, and report an improvement in model performance when using snow depth.

Overall, the study is mostly well described; results are easy to follow and are adequately discussed. The scientific significance, however, is rather modest. It is hard to identify a substantial contribution to the understanding of avalanche forecasting (new concepts, ideas, methods, or data). Still, the study may be helpful for local authorities responsible for road safety, but such application is not shown.

Specific comments

Background snow depth

The term “background” snow depth is not particularly clear. I suggest omitting the qualifier “background” and explaining that you use the snow depth prior to the snowfall period, and then rather use a qualifier in that sense, e.g., “prior” snow depth (or “pre-event” snow depth). It is partly misleading to refer to snow depth as pre-event snowpack conditions. I suggest replacing such terms with simply snow depth, since no information on the quality of the snowpack (stratigraphy) is provided.

The importance of snow depth prior to snowfall has been explained in previous studies (Schweizer et al., 2009) that a certain amount of snow on the ground is needed for large avalanches to reach infrastructure. If there is not enough snow prior to the snowfall, the terrain is very high and often prevents far-reaching avalanches. This seems the most relevant reason, in particular in a region with a maritime climate, where the presence of persistent weak layers in the snowpack is typically not a major concern.

By the way, the snow depth prior to the snowfall event has traditionally been considered (e.g.,Schweizer and Föhn, 1996; Schweizer et al., 2009; Stoffel et al., 1998). However, in these studies, the snow depth 3 days before the actual day was used, since also the 3-day-sum of new snow height was considered (in addition to new snow height of 24 hours).

In this context, it would be interesting to see statistics of the variable snowfall duration. This might indicate that it is advantageous to use the effective snowfall duration rather than the often used 3-day period.

Technical corrections

Lines 59-60: As far as I understand, you refer to spatial variability of the snowpack. If so, the reference to Monti et al. (2016) does not make sense to me. I suggest referring to, for instance, a review paper on spatial variability.

Lines 64-65: The value of snowpack information (stratigraphy, stability) for avalanche forecasting has been known for a long time, conceptually (LaChapelle, 1980), but also for forecasting models (Schweizer and Föhn, 1996).

Line 80: I suggest changing the mean slope angle to 34°.

Line 81: … and *the* adjacent transportation corridor.

Line 99: avalanche *release* areas

Line 102: Are several transportation corridors threatened? If so, use plural also above in line 81.

Figure 2b I suggest also labeling the instrumentation in the lower right corner of the monitoring station.

Line 114-115: What is the temporal resolution of the predictor variables? Days? Hours?

Line 116: For clarification, I suggest replacing truncated with terminated or cut off, and adding snowfall to event.

Line 117: I suggest using lower fonts (not capitalized), even though the abbreviation is capitalized. This is the common practice in NHESS. Here, and elsewhere in the manuscript. https://www.natural-hazards-and-earth-system-sciences.net/submission.html#english

Figure 3: *deposit* instead of deposition, as well as in Figure 4. Figures 3 and 4 are nice but also very basic.

Lines 143-154: This paragraph is rather hard to follow, but it is important to understand how the negative samples were selected. Maybe an illustration showing the snow depth and the avalanche event, and then indicate the time block of the positive event, and any negative event blocks.

Finally, it is not clear to me whether the predictor variables were selected from the monitoring station closest to the avalanche event, or whether another approach was selected.

Line 155: Here or in the Discussion, I suggest referring to previous forecasting models employing logistic regression, e.g., Gauthier et al. (2017).

Line 158: I find it somewhat misleading to refer to "meteorological and snowpack predictors" but only two meteorological variables and one snowpack variable were used. I suggest explicitly stating that you use three predictor variables.

Line 175: In avalanche forecasting where the history of the winter is important, one usually does not use leave-one-out cross-validation but rather tests one season against the other. I agree that this is difficult with only two winters of data, but doing so would still indicate a realistic alternative level of performance. This could also be discussed in the Discussion chapter.

Lines 185ff: If models are trained on unbalanced datasets, some metrics are biased by the abundance of non-events, including the F1 score. One metric which is known to be insensitive to this bias is the true skill statistic (TSS), also known as Peirce skill score (PSS), or Hanssen–Kuipers discriminant (HKD), see, e.g., Ebert and Milne (2022).

Line 205: I suggest replacing increased with were.

Figure 5: Please use the international day format (1 January 2024, or 1 Jan) as specified in https://www.natural-hazards-and-earth-system-sciences.net/submission.html#english; it is also specified there that in axis labels only the first word is capitalized.

Line 246: I suggest omitting *basal*.

Figure 7: The use of the rainbow color bar is strongly discouraged for data visualization in science.

Line 279: It would be interesting, as mentioned before, to have graphs with summary statistics for the variables, maybe separated for events and non-events.

Lines 304-305: I suggest replacing information on snowpack conditions with (pre-event, or prior) snow depth.

Lines 326-328: I doubt that the explanation given here is very relevant. A deeper snowpack can only increase stress if weak layers exist within the snowpack prior to the snowfall event. However, this is not typical in mountain ranges with a maritime climate. In maritime snow climates, the failure most often occurs at the interface between the new snow and the old snowpack.

Line 336: I suggest deleting "newly accumulated snow" since it is redundant, and not sure whether McClung (2021) is the most appropriate reference for this rather basic statement.

Line 340: I would expect SFD and SFI to be correlated. I suggest providing the details.

Line 360: … when the pre-event snow depth is sufficiently deep.

Line 361: I don't know how you demonstrated the complex coupling between meteorological forcing and snowpack conditions given that you used three predictor variables.

Figure 10: I suggest changing the color bar.

Line 424: What do you mean with "integrated"?

Line 426: What does " state-constrained framework " mean?

Line 432-433: I suggest rewording: These gains were primarily associated with the incorporation of pre-event snow depth into the forecasting model. Compared with baseline models that excluded snow depth…

Assets / datasets

I have finally looked at the assets; thank you for providing those. I am surprised to see values of snow depth with 6 significant digits such as: 1.045633.

Davos, 24 August 2026
Jürg Schweizer

References

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