Response to Reviewers
Elizabeth Fischer
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Reviewer 1

Wolken et al 2026 DOI is currently in review at Alaska Division of Geological & Geophysical Surveys (DGGS). We will notify the Journal as soon as it is published.

> I think the Discussion (included in Results) could be bolstered by comparisons with other avalanche-climate studies throughout North American and the rest of the world. This would provide some context to the projected results.
We will add comparisons with these papers (below). The present study is in line with past avalanche-climate studies that use RAMMS to generate hazard indication maps: overall decreased avalanche activity is expected with climate change.

- Mayer et al 2024: Quantile Matching used to downscale RCP climate predictions to 7 automatic weather stations in Switzerland and evaluate resulting snowpack. Found changes in avalanche type; and overall decline for RCP 8.5
- Ortner et al 2025: RAMMS in Switzerland to make hazard indication maps, similar to this paper. Like this study, found overall decline in avalanche risk in the future.
- Ballesteros et al 2018: Enhanced avalanche risk found in Himalayas, through more wet snow avalanches.
- Ding et al 2021: Review paper for cryospheric hazards in general.

Mayer, S., Hendrick, M., Michel, A., Richter, B., Schweizer, J., Wernli, H., and van Herwijnen, A.: Impact of climate change on snow avalanche activity in the Swiss Alps, The Cryosphere, 18, 5495–5517, 10.5194/tc-18-5495-2024, 2024.

Ballesteros-Cánovas, J. A., Trappmann, D., Madrigal-González, J., Eckert, N., and Stoffel, M.: Climate warming enhances snow avalanche risk in the Western Himalayas, Proceedings of the National Academy of Sciences, 115, 3410–3415, 10.1073/pnas.1716913115, 2018.

White, K. S., Hood, E., Wolken, G. J., Peitzsch, E. H., Buhler, Y., Wikstrom Jones, K., and Darimont, C. T.: Snow avalanches are a primary climate-linked driver of mountain ungulate populations, Commun Biol, 7, 423, 10.1038/s42003-024-06073-0, 2024.

Ortner, G., Michel, A., Kropf, C. M., Bründl, M., and Bresch, D. N.: Assessing the impacts of climate change on snow avalanche-induced risk in alpine regions, Natural Hazards, 121, 10877–10904, 10.1007/s11069-025-07229-9, 2025.

Ding, Y., Mu, C., Wu, T., Hu, G., Zou, D., Wang, D., Li, W., and Wu, X.: Increasing cryospheric hazards in a warming climate, Earth-Science Reviews, 213, 103500, https://doi.org/10.1016/j.earscirev.2020.103500, 2021.

> I think a more quantitative approach to comparing this study's output to the previous studies (i.e. runout distance or extent differences) would be beneficial. This would provide some context to the influence of uncertainty in this study especially given these previous studies are the main source of validation data.

We have re-published figures and maps from previous studies. We have no way to reliably and accurately georeference them to compare extent differences quantitatively. Moreover, the TetraTech study only included high elevation avalanches, whereas ours was more systematic in finding PRAs.

> Additionally, the authors mention local avalanche knowledge (Lines 49 and 254 and Figure 12 caption) as methods of validation. What does this entail? Are actual observations used? More information regarding this type of validation and the period of record knowledge of these observations would be useful for the reader.

The local knowledge referred to are contained in three studies mentioned on line 254:
- Valdez: Fesler & Fredson (2000)
- Juneau: WSL 2011, Tetratech 2022

Section 3.1.1 describes the Juneau studies. Both are modeling based. Dickson (2021) is mentioned as an observational study of avalanche hazards on Behrends Ave. With the exception of Behrends ave, local knowledge in Juneau is encoded into the landscapes:

across downtown, our study showed avalanches coming close to but not overrunning existing development.

Figure 13 provides a direct comparison between our results and TetraTech. Figure 14 provides a direct comparison between WSL and our study for Behrends Ave. Figure 15 shows correlation between our avalanches and avalanche tracks visible in satellite imagery in Snowslide Creek. Figure 16 provides direct comparison between our study and Felser & Fredson 2000. All studies we validate against are referenced and dated. Formal records are sparse, if at all; studies like the ones referenced are the best expert knowledge we have.

> but I would strongly suggest that the authors provide a statement, at least in the Conclusions, about using these hazard indication maps with caution for operational or planning purposes given the uncertainty and lack of in-situ validation data.
In prior art (referenced), Bühler defined the concept of a *hazard indication map* vs a *hazard map*. We can state in the conclusions and elsewhere that these are hazard *indication* maps and should be used appropriately.

> Line 59/Section 2: There are a lot of data and processing steps in this study. I think this manuscript would benefit greatly from a figure explaining the workflow

We have developed such a figure and can integrate into the text.

> Line 82: How do you account for the scenario when only part of the PRA releases in a medium or large PRA? I assume that the major change in simulation is the release depth, but how do you account for partial propagation across the PRA? Or are you simply treating full PRA release in every simulation? This probably deserves some explanation.

In the large scale approach we simulate every avalanche individually as a full PRA release. This is a simplification but makes sense for large scale simulations, especially given that we are evaluating *maximum* possible effects of avalanches. More detailed PRA release analysis could be done in single slope assessments

> Line 85 and onward: First abbreviated as NLCD, but then NCLD is often used.

It is NLCD, fixed!

> Lines 167-168: This is a bit confusing as written. I assume the 30-year and 300-year return periods for frequent and rare are based on 3-day maximum snowfall occurrence and that the runout is simply a function of that rather than a more sophisticated 30-year and 300-year avalanche probability, correct? Consider clarifying.
We use different parameters for the segmentation for different avalanche return periods. A detailed description of the PRA algorithm is out of scope for this paper, see papers by Bühler et al that further explain the algorithm that we used.

> Line 187: snow depths are given in m2. Should be m.

Fixed

> Line 210: Why did you choose 1000 m as a buffer?

Under the hopes that "most" avalanches will fit into this buffer. The buffer size does not affect the output, only the efficiency of the overall computation: avalanches that overrun this domain are re-run in a larger domain.

> Line 228 (Sec. 2.10): Given the coastal avalanche climate, wet snow avalanches (both winter and spring) are common in southeast Alaska. How did you account for a difference between wet and dry snow avalanches or mixed flow regimes (i.e. those that start dry but entrain wet avalanche debris as they run downslope) and how this would impact runout distance?

As in prior art, we only simulate the dense core of dry avalanches without powder clouds. These avalanches are in most cases decisive for the hazard mapping approach in Switzerland. We do not account for different flow regimes such as wet snow avalanches.

> Line 361: Suggest including a sentence about what Sykes et al. (2022) did that would improve forest cover related runout and PRA identification in your study.

We can do this. Sykes et al applied SPOT6 and Rapid Eye satellite imagery to classify the forest, identifying gaps and sparsely forested areas.

> Line 385: “…inherent limitations of climate modeling…” and also forest cover inaccuracies?

No not forest cover inaccuracies. We have no informaton on how forest cover might change in the future, hence it remains the same in this study for different climate scenarios. If there are detailed studies of expected future changes in forest ecology, it would be interesting to incorporate that in our understanding of avalanche changes.

> Figure 10: This figure is not referenced in the text.

Reference added.

> Additionally, please include a legend that identifies what the dark green and light green represent.

Dark and light green are in NLCD legend end Figure 3; added description / reference to it.

> Figure 11: Please add location dots for the town centers and N arrows or grid tick marks on the exterior as in other figures.
We can do this.

> Figure 13 right: It is difficult to see the blue outlines in the dark green areas.

Agreed, white would be a better color. Colors need to be legible under various color blind scenarios.

> Figure 15: ‘light greet’ to green.

Fixed

> > Figure 19: caption “…show that expected precipitation [phase] changes are the...”

No change to the text (don’t include the word “phase”). Lader et al has not quantified how much of change in 3-day max snowfall is due to phase change vs total precip changes. Both effects are expected to happen.

> Figure 20: The resolution is quite poor in this figure.

But it's good enough.