

Exploring the relationship between avalanche hazard and large-scale terrain choices at a helicopter skiing operation – Insight from run list ratings

Response to Anonymous Referee #2

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July 6, 2019

We would like to thank the reviewer for taking the time to read our manuscript in detail and provide constructive feedback. The following sections describe our response to the comments raised by the referee and outline the changes we made to the manuscript to address these concerns.

1 Methods: Description of avalanche problems with examples

Review

[...] Page 4, lines 20 to 31: this content does not really belong to the description of the data. In my opinion it also could be skipped. [...]

Response to the review and changes made to the manuscript

The avalanche problem types are a crucial part of the Conceptual Model of Avalanche Hazard (CMAH) and the data set used for our study. However, we agree that a brief description of the importance of identifying avalanche problems and their connection to terrain choices might be enough information so that readers can understand what we did in our study and the essence of the results but can refer them to Statham et al (2018) for the details. We shortened and changed the text of lines 20-31 as following.

[...] “While some avalanche problems are of relatively short duration and can be managed easily by avoiding specific terrain features within runs (e.g., wind-loaded slopes when a wind slab avalanche problem is present), others can persist for weeks, even months and require a more conservative risk management approach that includes a broader range of terrain (Haegeli et al., 2010; Statham et al., 2018).” [...]

2 Methods: Encoding the nature of the ski terrain

Review

[...] Page 5, lines 12 to 30: This part rather belongs to the introduction and could be adapted in a way to emphasise the motivation for this study.

Response to the review and changes made to the manuscript

A similar comment was made by reviewer #3. We shortened and changed the text of lines 11-30 as following.

Page 5, line 11ff

[...] To identify meaningful patterns between avalanche hazard and terrain choices numerically, it is critical to encode the nature of the available ski runs in a concise, but insightful way. To comprehensively capture of complex nature of entire ski runs into our model in a way that reflects how professional guides perceive them, we used the approach introduced by Sterchi and Haegeli (2019), which groups the ski

runs into operation-specific terrain classes based on multi-seasonal patterns in run list ratings (i.e., revealed terrain preferences). In comparison to existing terrain classification systems with small numbers of universal terrain classes (e.g., ATEs; Statham et al., 2006; Campbell and Gould, 2013), Sterchi and Haegeli's approach identifies high-resolution, operation-specific ski run hierarchies based on multi-seasonal patterns in run list ratings (i.e., revealed terrain preferences). Sterchi and Haegeli first identified groups of ski runs by clustering similarly coded ski runs over the course of several winter seasons. Subsequently, they arranged the identified groups into a hierarchy that ranges from runs that are almost always open to runs that are only open when conditions are favourable. To better understand the nature of the revealed ski run classes, the authors had a senior lead guide at each participating operation provide a comprehensive but structured description of their ski runs with respect to access, type of terrain, skiing experience, operational role, hazard potential, and guide-ability. Since this ski run classification is based on past operational risk management decisions, it reflects the local terrain expertise and avalanche risk management practices in the context of the available terrain and local snow and avalanche climate conditions (Sterchi and Haegeli, 2019). Thus, this approach represents a more meaningful characterization of ski run classes to analyze professional terrain choices in mechanized skiing operations. [...]

3 Methods: Avalanche sizes

Review

[...] Page 5, line 18: Better talk about avalanche sizes on figures 1-3 e.g. because the wording has changed in the European classification.

Response to the review

Thanks for highlighting this inconsistency in avalanche size description.

Changes made to the manuscript

To address the reviewer's concern, we made the following changes (highlighted in green):

[...] and the potential of being seriously injured or deeply buried by avalanches of smaller or equal to size 3. [...]

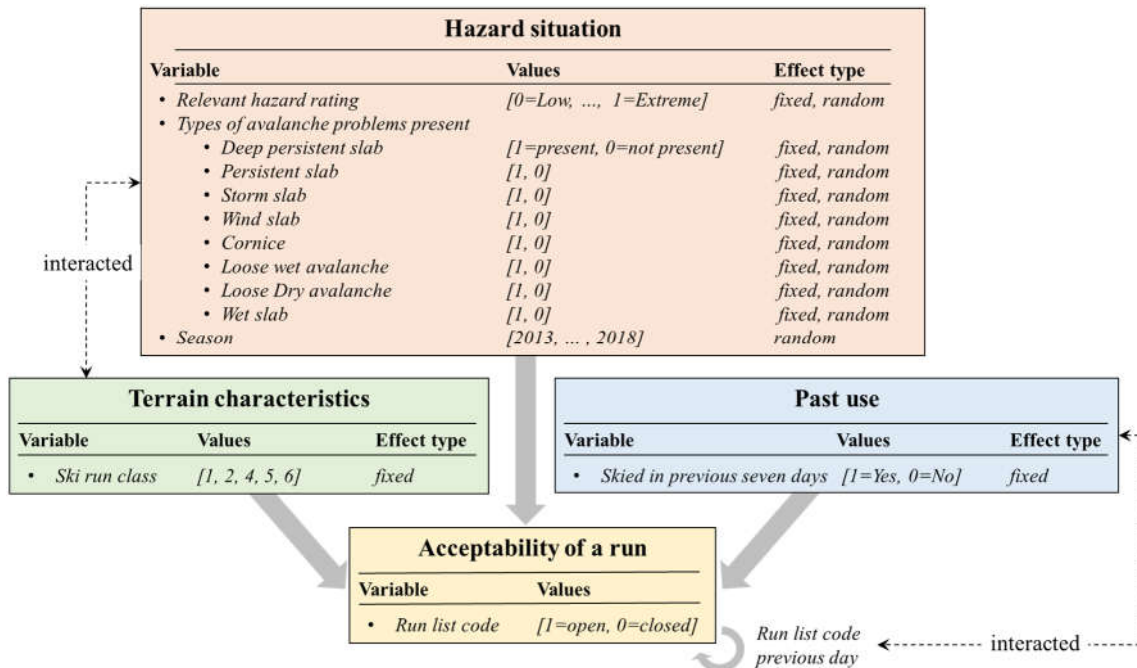
4 Methods: Model description

Review

[...] Page 8/9: The explanatory variables and interactions are well explained but could be summarized in a table for a better overview. Further the illustration and explanation of the model is not clear. Better describe model with a formula than with figure 3. Or change Fig.3 for better understanding.

Response to the review and changes made to the manuscript

Thank you for pointing that out. After considerable reflection, we believe that a formula would not provide much clarification of the model due to the many variables and interactions involved. However, we believe that structuring the figure in a more table-like layout with additional variable information on could help to overcome the highlighted shortcomings. To address the reviewer's concern, we made the following changes to the figure.



5 Methods: Description of result presentation

Review

[...] Page 10, lines 17 to 24: This section rather fits to the results chapter and explains Fig. 4. [...]

Response to the review and changes made to the manuscript

We agree that this description of the graph can also be moved into the results section and moved it into section 3.1 where we present figure 4.

6 Results: Description of parameter estimate

Review

[...] Page 11, line 8: Mention value in the text (e.g. in brackets) for better understanding. [...]

Response to the review and changes made to the manuscript

Thanks for pointing out this inconsistency. To address the reviewer's concern, we added the parameter estimates on several instances throughout the results section.

7 Results: Falsely referenced table

Review

[...] Page 15, line 28: Table 2 not 1 [...]

Response to the review

Thanks for highlighting this typo. We made the following changes (highlighted in green):

Page 15, line 28

[...] This means that runs in severe alpine terrain are much less likely to be open during times when Deep persistent slab avalanche problems are a concern (OR=0.10 and OR=0.07, respectively, Table 2) [...]

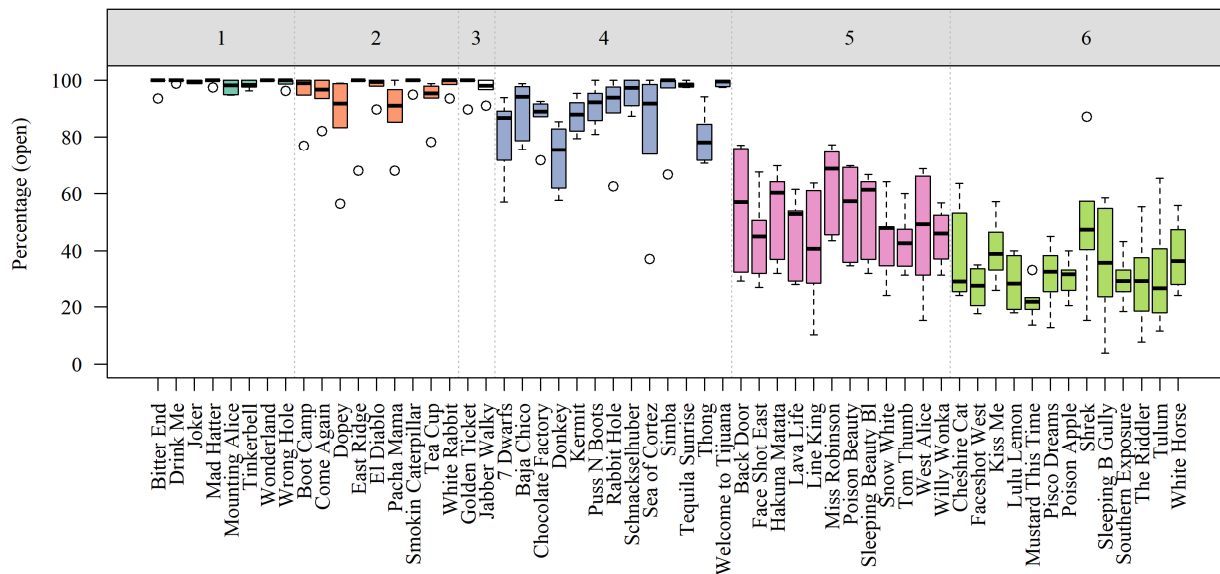
8 Figures: Size of figure 2

Review

[...] Fig. 2: Is rather small. Could be expanded to entire page width. [...]

Response to the review and changes made to the manuscript

A similar comment was made by reviewer #3. We agree with the reviewers and propose to increase the size of the figure and will use the entire width of the page for the figure.



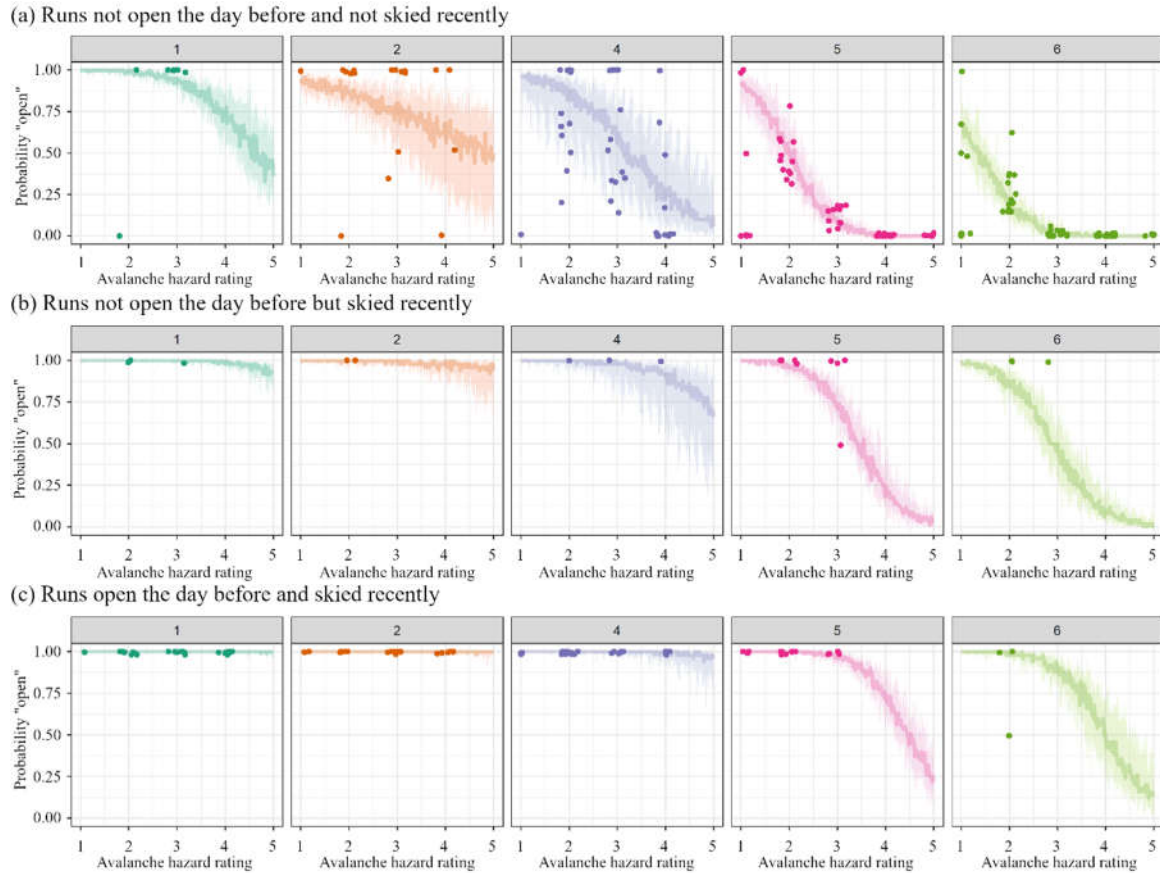
9 Figures: Figure 4

Review

[...] Shading in graphs is not clear. What is 50%, 80% and 95%. Better reduce to 2 percentages. Label of x-axis is missing. Mention avalanche hazard as x-axis in caption text. [...]

Response to the review and changes made to the manuscript

Thank you for pointing out this shortcoming of Figure 4. We agree that the including three different percentages is too much and makes the different shadings difficult to distinguish. To address the reviewer's concern, we will only use two percentages (50% and 95%). We also addressed the missing label of the x-axis and mentioned the axis in the caption text (highlighted in green).



[...] Figure 4: Probabilities of ski runs being open for Storm slab avalanche problems *shown for increasing hazard levels* with (a) a scenario where ski runs were neither open previously nor skied recently, (b) a scenario where runs were not open the day before but recently skied, and (c) a scenario where runs were open the day before and recently skied. The visualizations include probability intervals of *50% and 95%* for each ski run class as a whole based on 50 draws from the posterior distribution. Average daily percentages of open runs per ski run class are plotted as points where observations for this scenario exist in the dataset. [...]

10 Figures: Figure 5

Review

[...] Fig. 5: Figure is too small and not readable. Label of x-axis is missing. [...]

Response to the review and changes made to the manuscript

Thank you for pointing this out. We replaced this figure in response to a comment of reviewer #3.

11 Technical corrections

Review

[...] Page 16, line 5: Typo: "..., the influence *of* different ..." [...]

Response to the review and changes made to the manuscript

Thank you for point this out. We changed the sentence accordingly.

Review

[...] Page 16, line 12: Typo: "..., **they** can gain size and speed." [...]

Response to the review and changes made to the manuscript

Thank you for point this out. We changed the sentence accordingly.

Review

[...] Page 19, line 4: Typo: "s" is missing either for "results" or "shows" [...]

Response to the review and changes made to the manuscript

Thank you for point this out. We changed the sentence accordingly ("results**s**").

Review

[...] Page 19, line 12: Typo: "... method that is able **to** account for ..." [...]

Response to the review and changes made to the manuscript

Thank you for point this out. We changed the sentence accordingly.

Review

[...] Page 21, line 5: Typo: "... envision these decision aid**s** to ..." [...]

Response to the review and changes made to the manuscript

Thank you for point this out. We changed the sentence accordingly.