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Interactive comment on "Characterizing the nature and variability of avalanche hazard in western Canada" *by* Bret Shandro and Pascal Haegeli

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This is a very interesting paper with a unique database of avalanche hazards for different geographic location of western Canada. I really appreciate the innovative methodology (self-organizing maps) and the robustness of the results and related figures and tables. In that regards, most of them present useful information although some might be considered as supplemental material.

We would like to thank this anonymous reviewer for the positive assessment of our manuscript and their suggestions towards future research questions. Your comment regarding moving material into the supplementary section aligns with previous comments by Dr. Mock and Dr. Sokratov. We decided to move the SOM error figure (Fig.

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4) and the prevalence anomaly figures (Fig. 7, 8 &10) into the supplemental material. To enable readers to extract information on the seasonal and regional variabilities of the hazard situation prevalence values directly out of the bar charts (Fig. 6 & 9), we added an additional bar representing mean prevalence values on the very left as a reference.

Considering the high quality of the submitted paper, I only have a few general comments. As mentioned, the inter-annual variability is not surprising and clearly shows the importance to have a deeper look at the synoptic situations leading to an increased avalanche hazard. It also demonstrates the limitations of the snow avalanche climate classification and related avalanche hazard for risk management. In this regard, and considering the importance of storms for avalanche problems, it could be interesting in the next future to look at the ratio from different storm tracks and 500-mbar composite anomaly maps such as reported by Martin and Germain (2017).

We support the reviewer's assertion that investigating storm track variability is a useful approach for exploring the effects of seasonal climate variability on avalanche hazard. We believe that this would be an interesting next step for investigation.

I also completely agree with the authors concerning the need of good quality and specific data to improve our knowledge. However, I suggest adding one or two sentences in the discussion section about the availability of the weather data and the extrapolation based on a few weather stations. Do you think a more robust network of weather stations could significantly improve the delimitation of avalanche climate?

While additional weather stations allow for more local summaries following the Mock & Birkeland (2000) classification scheme, we believe this would not significantly improve the characterization of avalanche hazard because this requires a meaningful link between average weather observations and the nature of avalanche hazard. In the

introduction and discussion, we cover the limitations of using weather station observations for characterizing avalanche hazard.

On page 3 line 23:

> *This result highlighted that the existing snow climate classifications have considerable limitations for informing avalanche risk management practices. This is not surprising as seasonally summarized weather observations only have limited connections to the factors driving daily avalanche hazard. Instead, avalanche hazard is determined by short-term weather fluctuations and particular sequences of weather events that dominate over general climate effects (Gruber et al., 2004; Mock and Birkeland, 2000).*

On page 25 line 8:

> These results highlight that examining the interseasonal prevalence of typical hazard situations can offer a more insightful perspective on the avalanche hazard conditions of a winter than the snow climate classification algorithm of Mock and Birkeland (2000). While the classification schema considers early season faceting, a common situation in continental snow climates that affects the nature of avalanche hazard for the entire rest of a season, it is limited because avalanches and their particular character are the result of specific sequences of weather events and not the average weather conditions of a winter.

Also, in the Conclusion section, the authors stated the need for looking at smaller scale variabilities but also to include the U.S. hazard assessments. However, because snow avalanches are mainly driven by climate at various spatiotemporal scales, it should also be stated the need for better climate variability

analysis such as teleconnexion (PDO, El Nino and so on) but also in order to detect trends, if any, in climate variability and what might explain this intra- and inter-annual variability.

We completely agree with the anonymous reviewer that the logical next step is to explore the effects of climate variabilities on avalanche hazard by correlating the inter-annual hazard variability mentioned in this study with climate oscillation indices (ENSO, PDO, PDA, AO). Our study actually includes the analysis of some of these relationships and identified some interesting correlations but including all our results in a single manuscript would have been too overwhelming. Hence, the present manuscript focuses on the method for identifying hazard patterns, while a second manuscript (currently in preparation and soon to be submitted to NHESS) will focus on the relationship with climate oscillations.

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