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Interactive comment on "Geo-climatic hazards in the eastern subtropical Andes: Distribution, Climate Drivers and Trends" *by* Iván Vergara et al.

Iván Vergara et al.

ivergara@comahue-conicet.gob.ar

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General Comments

The authors try to correlate the spatio-temporal occurrence patterns of geo-climatic hazards (G-CHs) in the Andes near Mendoza, western Argentina, to precipitation and temperature patterns. Thereby, they focus on snow avalanches and landslides. The study presents a highly relevant topic, and the manuscript is generally concisely and well written, structured, and illustrated. Not all statistical analyses yield significant results, but this is clearly communicated, so that it is possible to capture the essence of the outcomes. I have some recommendations to the authors which should be considered before publication. Consequently, I suggest minor revisions.

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Discussion paper

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[Reply] We thank and appreciate your general and specific comments. Your inputs helped us to improve the manuscript. We addressed all the observations made as you can see below.

Even though the paper is well understandable, there are some issues of grammar and style. Improvements should be included in the revised version, even though final polishing can be done through copy-editing anyway

[Reply] Done. We polished the revised version of our manuscript.

The 15 km buffer on both sides of the Río Mendoza appears a bit arbitrary to me. Is there a specific reason why exactly this distance was used? And might it be an alternative way to consider those catchments draining to the Mendoza Valley, instead of a fixed distance? This would probably not change the results at all – but the maps (which are in principle very nice) look a bit awkward with the buffer of the elevation map and the catchments with G-CHs reaching beyond that buffer.

[Reply] The buffer was chosen to show the minimum, average and maximum elevations of the area (Fig. 1b) and to give an average elevation value of the two zones that we used in our study. Therefore, its utility is secondary. The alternative of using a larger rectangle covering the whole region for Fig. 1a results in a very similar map.

In Line 121, it is mentioned that the G-CHs are concentrated in ravines, talus cones, and rock walls. I suppose that the individual zones were derived by computing the catchment areas (particularly for the ravines). This is absolutely fine, but you should mention it explicitly.

[Reply] Done... We now mention how we draw the terrain units in lines 128-129.

It would be interesting to know a little bit more about how reliably you could determine the occurrence of daily precipitation. You mention the use of the CMORPH data. Did this work well? And how did you do it before 2002? Particularly convective events can have a very patchy occurrence, and are not necessarily recorded at stations. How did

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you deal with this issue, and do you expect that it significantly influences your results?

[Reply] Assessing the occurrence (set aside the amount) of precipitation over the Andes is indeed a major challenge. The task is more simple in wintertime, when there is a good agreement between CMORPH and station data given the widespread nature of frontal precipitation (yet, how much snow fall in each storm is largely unknown). But as you guessed, the situation is more complex in summertime, when rainfall is delivered by convective systems. To assign the rain trigger to the G-CHs that occurred during the convective season and for which the source did not inform the trigger, first it was seen if potentially influential earthquakes had occurred (Moreiras et al., 2006) or if conditions for rapid melting were met (Vergara et al., 2020). Only then it was observed if some of the nearby stations or the CMORPH had measured some precipitation. We acknowledge that identification of summertime rainfall-induced hazards have higher uncertainty that winter G-CHs and discuss further on this in lines 148-151.

Table 1: some of the meteo stations do not cover the entire investigation period –could this induce some bias in the derived trends? You might wish to briefly discuss this issue.

[Reply] Effectively, not taking cautions in the combination of stations with unequal record periods would lead to errors in the calculation of trends. In this work precautions were taken. This procedure is better explained now (lines 205-211).

Fig. 1: maybe you could put the names of the major settlements, or label the meteorological stations. Some labelling would be nice in this introductory map.

[Reply] The names of the stations could not be added since they are 16 and there is little free space. But the locations of some towns were added.

A minor issue in the legend of Fig. 5: the probability of annual occurrence is a continuous number. This should also be reflected in the legend – as it is now, e.g. a probability of 2.5% would not be covered at all. Better write: 0; >0-2; >2-5;

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[Reply] Thank you for warning us of this error, now it was corrected.

New References

Moreiras, S. M.: Frequency of debris flows and rockfall along the Mendoza river valley (Central Andes), Argentina: Associated risk and future scenario, Quat. Int., 158(1), 110-121, 2006.

Vergara Dal Pont, I., Moreiras, S.M., Santibañez, F., Araneo, D., and Ferrando, F.: Debris flows triggered from melt of seasonal snow and ice within the active layer in the Semi-Arid Andes, Permafrost. Periglac., 10.1002/ppp.2020, 31(1), 57-68, 2020.

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