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The Cryosphere Discussions

Interactive comment on "Rock glaciers in the Daxue Shan, southeastern Tibetan Plateau: an inventory, their distribution, and their environmental controls" *by* Zeze Ran and Gengnian Liu

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General Comments This paper provides the first inventory of rock glaciers in the Daxue Shan, including an analysis of the topographic controls on them, so fits the general scope of the The Cryosphere. However, there are a few major issues that will need to be addressed before the paper can be published: 1. The outlines provided in the supplementary material often appear to provide outlines of basins which may contain rock glaciers, but they don't do a good job of outlining the actual rock glaciers themselves. Many of the outlines also appear to define talus deposits or debris-covered

glaciers, rather than rock glaciers. For example, from a quick review of a few outlines: - ZDSRG-363 seems to contain a rock glacier in its upper and central parts, but the outline extends into forested areas where no rock glaciers are present - ZDSRG-373 seems to mainly consist of the lower part of a debris-covered glacier on the left and talus deposits on the right, with no clear evidence of any rock glacier - ZDSRF-350: there appears to be at least a couple of different rock glaciers in this basin, and the current outline includes surrounding rock cliffs in addition to the rock glaciers themselves The outlines therefore need to be much better defined, and the text also needs to be improved to more clearly describe exactly what is and isn't a rock glacier and how they can be defined in satellite imagery.

2. It's stated in the abstract that accurate ground truthing was completed in the field, but this isn't described anywhere in the text. A comprehensive description of field validation would help to strengthen the paper and address some of the issues brought up in the previous point.

3. The statistical analysis of the topographic influences on rock glacier distribution does not properly take into account the collinearity between explanatory variables. As detailed below, Principal Components Analysis provides one way to do this, and without doing this I don't have high confidence that the stated topographic relationships are real.

I also have a number of specific comments as detailed below.

Specific Comments P1, L14/15: can delete the text in brackets: '(i.e., slopes facing north, northeast...)' P1, L16: it would be useful to mention what the key topographic controls are in the abstract P2, L8: millions is a gross over-estimate. The most recent near-global estimate for the number of rock glaciers is ∼73,000: https://www.nature.com/articles/s41598-018-21244-w P2, L11: please provide more refs to back up the statements here, e.g., in relation to the hydrological cycle P2, L22: should also include the new Jones et al. (2018) inventory mentioned above:

https://www.nature.com/articles/s41598-018-21244-w P3, L12: I don't think what 'matric' is a word. Do you mean 'matrix'? P4, L4: please provide some actual elevation values for the study area description P4, L18: I don't think that it's accurate to say that Google Earth contains the best available imagery, as there are other data sources with higher resolution (e.g., WorldView imagery). However, it's probably the best freely available source. P4, L21 – P5, L3: a clearer explanation of the unique features that you used to identify rock glaciers is needed; the current description is ambiguous. You also mention in the abstract that your inventory is based upon 'scientific validation in the field', but not mention of this is made in the methods. P5, L4: the ASTER GDEM is not a program, it's a dataset P5, L5: please clarify the date: is November 2015 the date when you undertook the analysis, or the date on which the satellite imagery was acquired? In figure 2 you show some images from October 2014, so why isn't that date mentioned here? P5, L11: please provide more details for these values; e.g., does length refer to centerline length? What does width refer to – average, maximum? What does altitude refer to – highest, lowest, average? P7, L3: similar to above comment, please clarify what these elevations refer to – e.g., mean elevation? Highest elevation at which rock glaciers are found? Lowest elevation at which rock glaciers are found? P7, L8: please clarify whether the upper elevational for rock glaciers occurs due to lack of topography above this altitude, or because of some other factor (e.g., presence of ice glaciers) P7, L3-L22: this is a very long paragraphs. I would suggest splitting it into two or more shorter paras. P9, L10: it would be useful to make some comparisons between the location and characteristics of rock glaciers found in your study vs. the location and characteristics of ice glaciers found by others in the Daxue Shan region. For example, this 2017 paper provides a good recent review of Daxue Shan ice glaciers: https://www.cambridge.org/core/journals/journal-of-glaciology/article/changes-of-glaciers-and-glacial-lakes-implying-corridorbarrier-effects-and-climate-change-in-the-hengduan-shan-southeastern-tibetan-plateau/F0C89671AA75211650FA02FD66AE4DE0/core-reader P9, L15: a significant problem with interpretation of the topographic influences is that there is significant

collinearity between many of the parameters (as shown in Table 2). This means that it's almost impossible to understand what the true topographic factors are. To address this issue in other similar studies, several authors use Principal Components Analysis to collapse the original explanatory variables into new components that are uncorrelated with each other. See, for example, the Discussion section in: White, A. and Copland, L. 2015. Decadal-scale variations in glacier area changes across the Southern Patagonian Icefield since the 1970s. Arctic, Alpine and Antarctic Research, 47(1), 147-167. P10, L15-25: the discussion here would be helped by a better comparison with the present and historical location of ice glaciers in this region, so that the connection to glacial landforms such as moraines can be better understood. E.g., are current rock glaciers found in close association with current ice glaciers? Do you observe any direct evidence of a present ice glacier transforming to a rock glacier? P11, L23: change 'highly' to 'high' P12, L8: this seems to be the only location in the paper where you refer to ground truthing, and the uncertainty here contrasts with the 'scientific validation in the field' stated in the abstract. In the paper you need to much better describe what kind of field validation you did, any inherent errors or uncertainties with it, and adjust the wording in the abstract and elsewhere as appropriate. P13, L3: similar to the comment for p7, define whether the upper altitudinal limit is due to lack of topography above this altitude or some other factor. P13, L12: have there been any field measurements in your study area that can help to define the distribution of permafrost? E.g., have there been any direct ground temperature measurements? Or ground probing or digging of pits?

Fig. 1a: it seems that this data is plotted in lat/long (i.e., unprojected), which makes it look strange at this scale as it seems to be squashed in a north-south direction. This would be better plotted in a projected coordinate system Fig. 1c: it would be more useful to show a satellite image of the study area (perhaps with a contour map superimposed over it), rather than the topographic map that basically repeats what is already shown in Fig. 1b. No regional satellite imagery is currently provided in the paper, which makes it difficult to understand the general characteristics of the region

and location of other features such as ice glaciers. Fig. 2: the scale on these figures need to be clearer Fig. 3: a zoom-in of some of the areas with the largest rock glacier concentration (e.g., Mt. Zheduo) would be useful to add, preferably with the rock glacier outlines superimposed on a satellite image Fig. 4: add labels to different figure parts: (a), (b), (c), (d) Fig. 5: add labels to different figure parts: (a), (b), (c), (d). Also define acronyms used in bottom two figures: MTRG, MLRG, TTRG, TTLG Fig. 6: this is a pretty low quality figure that's difficult to follow. Please make clearer and prevent number labels from overlapping. Fig. 7: several of the colours in this figure are similar (lots of pinks/purples), which makes it difficult to distinguish between the various rock types. It's also unclear what the letters/numbers on the map refer to: e.g., T2-3zg-z? T3xd? These need to be described in the legend or deleted.

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