

***Interactive comment on “Impact of natural parameters on rock glacier development and conservation in subtropical mountain ranges. Northern sector of the Argentine Central Andes” by Ana P. Forte et al.***

**Anonymous Referee #1**

Received and published: 20 March 2017

Dear Editor,

I have reviewed the manuscript “Impact of natural parameters on rock glacier development and conservation in subtropical mountain ranges. Northern sector of the Argentine Central Andes” by Forte et al. with interest. The authors provide a new inventory of rock glaciers and protalus rampart for subtropical mountain ranges in the northern sector of the Argentine Central Andes. The authors mainly describe the characteristics of the inventory and finally apply a statistical approach (frequency ratio) to investigate controlling factors. The topic is of interest for The Cryosphere and the statistical anal-

C1

ysis demonstrate that elevation, lithology and aspect are also dominant controls for subtropical mountain ranges. Nevertheless, my review pointed out a number of serious scientific issues, which are listed in the following general comments and in the following detailed comments section. In my point of view, these points must be carefully addressed before the manuscript can be considered for publishing in a high-level journal as The Cryosphere. Thus, I suggest reconsideration of the manuscript after major revisions.

**GENERAL COMMENTS**

- 1) The authors provide a new inventory of rock glaciers and protalus rampart and use it for further analysis. The inventory bases on a singular survey and therefore can be used to describe the occurrence of rock glaciers and protalus rampart, but not to describe the development and conservation which is the intention of the authors (see title, abstract and elsewhere).
- 2) The authors formulated the overall aim of the study, but a clear research question in the introduction is missing. An overall clear structure would facilitate reading the manuscript.
- 3) The rock glaciers and protalus rampart inventory for this region is novel. The resulting inventory database includes basic descriptive information, localization, physical parameters and a classification (dividing rock glaciers into active, inactive and fossil). The generation of the inventory and inventory database need to be explained in more detail. A validation and uncertainty assessment are missing and would be very important, because the statistical approach bases on it. Especially the detection and classification leaves a lot of room for interpretation. Further it is not clear how the observed features are assigned to protalus rampart or rock glaciers (what are the criteria for distinction?).
- 4) The description of the statistical analysis should be extended and formulated more clearly. Please ensure that the mathematical variables are unique and correctly de-

C2

fined.

5) The discussion section is much too short and should be extended adequately. There are many open questions: How do rock glaciers in subtropical mountain ranges differ from other regions? How reliable/robust are the results of the statistical analysis? And many more...

6) There is a lot of potential to improve the figures with regards to content, graphics and readability. Try to make the content of the figures and the relation between the subfigures clear. Try to avoid repetition of figures (e.g. Fig. 2 and Fig. 3: the relevant pictures are shown twice). I suggest to reduce the content in figures. Putting the maps providing physical parameters and geology in a figure with several subplots facilitates comparison. Try to use appropriate chart types and to avoid duplicated information visualization (e.g. bar chart and table) unless there is real advantage. A consistent style of the figures with less color, better color selection (e.g. [colorbrewer2.org](http://colorbrewer2.org)) and clear color definition would improve the quality. Be aware of the quality of the figures and the readability of text. Parts in Fig. 1, 3, 4, 6 and 7 are non-readable and need to be guessed.

7) Language and consistency: I'm not a native speaker myself, but spell check and language check would be very helpful. Further be aware of inconsistencies in word/term choice, citing (e.g., p.2, l.4: who is Schrott H.?) and definitions (e.g., mostly rock glacier and protalus rampart are distinguished, but sometimes combined or mixed up).

#### DETAILED COMMENTS

p. 1, l. 1: The title does not clearly reflect the contents of the study (see General Comment 1).

p. 1, l. 11: Rock glaciers can be a part of periglacial environment, but the occurrence is not necessary and there are many other features.

p. 1, l. 25: Using an inventory based on a singular survey, how do you know that the

C3

rock glacier conservation is mainly controlled by lithology?

p. 2, l. 39: If you mentioned the study area, you would already emphasize that there is no existing inventory/study for your study site.

p. 2, l. 46: How do you know the state of the periglacial environment? A time series of observation/inventories would allow to investigate the evolution.

p. 2, l. 46: Glaciers have a reaction time to climate change of up to several decades.

p. 2, l. 48: I would rather use degradation instead of deterioration.

p. 2, l. 54ff: Is this relevant for this study?

p. 3, l. 67: SW = south west?

p. 3, l. 68f: Change order, first inventory, then statistical analysis...

p. 3, l. 77: This needs to go to the discussion.

p. 3, l. 80: Study site?

p. 3, l. 84: Is there a reference?

p. 3, l. 89: Rephrase this sentence.

p. 4, l. 98: Why is the accumulation of glacier mass relevant? Or do you mean rock glacier?

p. 4, l. 104: I would use rather "shaped" than "modeled".

p. 4, l. 115: As you are only considering lithology and not geology, shorten this paragraph

p. 5, l. 122: confirmed?

p. 5, l.137ff: This paragraph is hard to read and it is not clear what the date of physical inventory is.

C4

p. 6, l. 149: It is not described how the protalus ramparts are distinguished from the rock glaciers.

p. 6, l. 174: What is a “medium” elevation? Do you mean “median” or “mean”?

p. 6, l. 177: What is a “attitudinal distribution”? Do you mean “altitudinal distribution”?

p. 6, l. 178: Why do you have 5 classification?

p. 7, l. 180: For me it is not clear how you calculate a mean aspect. Please explain in more detail.

p. 7, l. 187: Could you please explain in more detail how you calculate the potential incoming radiation?

p. 7, l. 188: How do you know the “vapour pressure”?

p. 7, l. 190: Please explain more precisely.

p. 7, l. 196: For your analysis, you should consider the different classes (e.g. i) of all parameters (e.g. j). Try to use appropriate naming (e.g. classes, parameters, ...) here and elsewhere in the manuscript.

p. 7., l. 202: Language.

p. 8, l. 207ff: Why 4 belts? The characterization (seasonal frost belt, unstable periglacial environment, ...) is not only caused by the altitude. And how do you get the boundary values of the belts?

p. 8, l. 222: What is a “slope gradient”? Why do you combine rock glaciers and protalus ramparts here and distinguish them elsewhere?

p. 9, l. 244: Could you show the rock glaciers which are in the altitudinal range 3868-4225 m a.s.l., aspect between 113° and 247°, slope between 11 and 19° as well as “Oligocene to Lower Miocene – Intrusive Rocks” lithology? Are these parameters in combination most appropriate?

## C5

p. 9, l. 245: Do you now include protalus ramparts or not?

p. 9, l. 255: This study shows the affect of the different parameters only for rock glaciers and protalus rampart and not for periglacial landforms in general.

p. 9, l. 261: Again, how are you able to provide information on development and conversation of active rock glaciers using an inventory of a singular survey?

p. 9, l. 262: What is with the first belt of before?

p. 10, l. 264: Are inactive rock glaciers really an indication that no permafrost occurs?

p. 10, l. 276: Variable, parameter or factor? Try to be precise and consistent with terms.

p. 10, l. 291: This is a new result and should not be presented the first time in the conclusion. Further, I doubt that the accuracy is such high that you can distinguish 10 m of difference.

p. 11, l. 295: Where/how do you determine the aspect?

p. 11, l. 297: Again new result. . .

p. 11, l. 304: What does “(n:15)” mean?

p. 11, l. 313: Do you consider geology in your analysis?

p. 12, l. 321: Again try to be consistent, even in the References. Once “Arenson, L.” and once Arenson, L. U.”.

p. 17, Fig 1: Different coordinate systems are used in the different subfigures. There is an error in the coordinates (subfigure left). What is the meaning of the colors? How do the subfigure left and the subfigure top right fit together? Legend of subfigure top right is non-readable.

p. 18, Fig. 2: Where were the pictures taken? What is the relevance of the picture top right?

## C6

p. 19, Fig. 3: Try to use better colors to indicate the periglacial landforms. The pictures in the middle right are the same as in Fig. 2. Try to use appropriate chart types and to avoid duplicated information visualization (e.g. bar chart or table, but not both). Legend in subfigure bottom right is non-readable.

p. 19., Fig. 4: Protalus ramparts and rock glaciers are almost not visible and the different landforms are almost not distinguishable from each other. Subfigure bottom right is non-readable.

p. 20, Fig. 5: It is very difficult to take advantage of the colors in the legend ob subfigure top left.

p. 21, Fig. 6: What are the high and low values of the slope map (subfigure top left)? Subfigure top right is non-readable.

p. 21, Fig. 7: I suggest to emphasize the spider chart.

p. 23, Tab. 2: I would suggest to use histogram to visualize the data of this table. How are the classes defined? Sometimes, the classes are not the same as in the Figures/text.

p. 24, l. 470: I guess this should show an example how the values in the column are calculated. Please try to use appropriate variable names (same as in Eq. 7) and give an explanation.

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