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# *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 #2**

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General comments

The authors present an inventory and spatial anaysis of rock glaciers in a small watershed in the semi-arid Argentinean Andes. The analysis is based on the frequency ratio method. Due to the limited spatial extent of the study area, the methods used and the depth of the discussion, the implications of this study are very limited and could be of interest to researchers with a focus on the semi-arid Andes. The study furthermore suffers from various conceptual and terminological limitations.

In its present form and with this geographical scope, from my view this study seems to



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be too limited for publication in The Cryosphere.

Specific comments

L11 "affect", Title and P2L39 "impact", and in other instances the wording indicates a causal interpretation of empirical patterns that is not supported by an in-depth discussion of underlying processes and possible confounders. Descriptive wording (e.g., association, correlation, relationship) should be used where appropriate

L34-36 Proper reference should be made to recent studies focusing on relationships between cryosphere (and mountain permafrost in particular) and hydrology as well as "human activities" (mining) in semi-arid mountain regions.

L46 "unlike glaciers" - Glaciers also show delayed responses (and complex feedback mechanisms) e.g. due to their size or an increasing debris cover thickness.

L48 "faithfully reflect..." - This statement is in clear contradiction to the previous comment concerning the delayed response of rock glaciers to climate change.

L49-50 Wahrhaftig and Cox (1959) reference - references to more recent publications would seem appropriate here

L50-51 "closely related to their equilibrium state" - provide reference

L56 That depends on the type of inactivity; see e.g. Barsch (1996)

L58 protalus rampart - If they can be considered small rock glaciers, why use the concept of protalus rampart? Can protalus ramparts be active, inactive and relict?

L89 To my knowledge, this area is located south of the Arid Diagonal. Please refer to the climatological literature.

L90 Aridity in this region is not primarily due to the "rain shadow" of the Andes. Please refer to the climatological literature.

L93 Is the Zonda reelevant for this study, which focuses on high-altitude regions in the

central part of the Andes, not the valleys and foreland toward the East?

L95 "close" relationship with ENSO is overstated

L97-100 This summary of the relationship between ENSO and glacier mass balance is weak and of little relevance for the present study

L101-103 MAAT for which years? are these years representative?

L104-106 This section overstates the degree to which Pleistocene glaciations have modified the landscape.

L110 "As regards glaciers" - none of the features mentioned in this sentence is considered a glacier

L116-121 Unnecessary structural geological detail

L154ff - Provide references supporting the relationship between form and activity status. Roer and Nyenhuis (2007) provide a comprehensive summary of criteria, which should be considered more carefully. Azócar et al. (2017) in The Cryosphere apply similar criteria to an area in the semi-arid Andes.

L154 "thermodynamic equilibrium" - is it appriopriate to apply this concept here, in particular to inactive rock glaciers that may be degrading?

L192 provide reference(s); is this a state-of-the-art technique? The frequency-ratio method requires splitting of predictors into discrete classes. These classes are poorly justified in this study. Methods such as logistic regression or generalized additive models allow for continuous relationships and are capable of accounting for the influence of each predictor while accounting for the other predictors.

L199 The goodness-of-fit of the model should be assessed using criteria that are to be indicated in this section.

L204-206 This paragraph does not report results

L209-210 How do the authors know that seasonal frost is of particular importance in this elevation range? Rock glaciers and their possible preservation or degradation are not primarily driven by seasonal temperature fluctuations.

L222ff The authors need to distinguish between the distribution of the environmental variables conditional on rock glacier presence (or activity status), and the occurrence of rock glaciers (or their activity status) conditional on these variables. The former way of conditioning does not account for the different frequencies (in the landscape) of, e.g., west-facing and south-facing slopes. Again, a multiple-variable logistic regression model would account for possible confounders.

L247-248 The mentioned Oligocene class represents only 0.57% of the study area; its frequency ratio has insufficient empirical support.

L255-256 The empirical relationship between lithology (and effectively only one of its classes) and rock glacier occurrence can be confounded with other possible factors such as slope angle or solar radiation since the frequency ratio method is unable to separate these empirical relationships. Furthermore, a possible causal link related to specific characteristics of these rocks should be established before claiming that periglacial landforms (or specifically, rock glaciers) are "affected" by lithology.

L276 Much of the material covered in the Conclusions section should be part of the Discussion section where it should be discussed in the context of the available literature; part of this section also simply repeats some of the results and interpretations made before. The current Discussion (considering both sections 5 and 6) of results, their interpretation, uncertainties and limitations of methodology, is currently too weak.

Technical corrections

Terminology and language: - natural parameters -> environmental variables - conservation -> preservation

Additional language editing is required.

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