The Cryosphere Discussions

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Comment on tc-2021-342

Jan Henrik Blöthe (Referee)

Referee comment on "Incorporating InSAR kinematics into rock glacier inventories: insights from 11 regions worldwide" by Aldo Bertone et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-342-RC2, 2022

Review of Bertone et al.: "Incorporating kinematic attributes into rock glacier inventories exploiting InSAR data: preliminary results in eleven regions worldwide".

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In their manuscript, Bertone et al. present a standardized workflow to integrate kinematic information into rock glacier inventories. Largely building their work on the guidelines proposed by the IPA action group on rock glacier inventories and kinematics, the authors test the integration of rock glacier kinematics as derived from InSAR data in eleven regions across the globe, for some of which they produce new inventories, but also using published data. In total, the study identifies more than 5000 moving areas that were then integrated in the respective inventories. The authors find considerable differences in the rock glacier kinematics for the eleven regions investigated, though these are only briefly attributed. Instead, the study focuses on the proposed workflow, also comparing two different delineation strategies for moving areas. The authors conclude that their study demonstrates the feasibility of integrating kinematic attributes into rock glacier inventories using a standardized procedure that reduces operator bias.

Overall, the manuscript is well written and presents an interesting contribution to global rock glacier research, though placing a strong focus on the technical details of the proposed workflow. In my view, shifting the focus on the results obtained from InSAR analysis in eleven regions worldwide would increase the impact of the manuscript. In any case, before acceptable for publication in TC, the authors need to address a number of general concerns, specific comments and technical corrections that I will outline in detail below.

Kind regards

Jan Blöthe

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General comments:

- The authors focus their work on InSAR approaches for the derivation of kinematic attributes for rock glaciers, which is also clear from the title of their work. Still, the paper would benefit from a few additional details on other techniques that have been applied for obtaining kinematic data. This is only very briefly included in the manuscript, yet there is a huge potential to also include kinematic information from different techniques that can very well be integrated following the approach presented here (Line 440). Adding a few sentences on the potential to do so would broaden the scope of the work presented here.
- Is there a technical reason why only velocity classes are included in the inventory, instead of using mean, median, or quantile values for the "moving areas"? Pressing data into pre-defined classes certainly has some advantages, but represents a loss of information at the same time. By using very broad groups, monitoring of dynamic changes could be both, disguised on the one hand and overstated on the other, if average velocities change across class boundaries. The authors should elaborate on the reasons for using defined class boundaries in order to make the process more transparent. Furthermore, it is also not clear to me, why only one kinematic category (moving area) can be included for each rock glacier unit (L272-274)? Is this also a technical limitation of the inventory?
- Surprisingly, Figure 5 that presents the results from the semi-automated delineation of moving areas for Nordenskiöld Land shows numerous moving areas that containing one or few pixels. This seems contradictory to section 3.3, where in lines 206-207 moving area is defined as a part of the rock glacier surface that shows a uniform (spatially consistent) flow field. Lines 215-216 further explain that the signal of movement needs to cover at least 20-30 pixels. Furthermore, Figure 5 shows moving areas of few pixels that were integrated as kinematic information into the rock glacier inventory. Yet it seems some of these rock glaciers are not attaining the minimum size of 0.01 km^2 (Line 145). Here it would be helpful to show the outlines of mapped rock glacier units, as done in Figure 3.
- The authors have obtained kinematic information from eleven regions across the globe. While devoting a lot of discussion to the technical details, there is only a few sentences that discuss the significant differences within this data set. This is surprising, as there is huge potential to gain valuable insight into rock glacier behaviour on a global scale that remains unexploited. In connection to my general comment 2, it would be very interesting to see the full distribution of displacement velocities obtained from all regions. Figure 9 indicates sharp contrasts between the regions, but velocity classes mask very interesting details.
- A final point to consider is the error assessment of the InSAR derived velocities. The manuscript does not present much details on the errors associated with the method itself, nor with assigning moving areas to pre-defined velocity classes. In Lines 223-224 it is described that the velocity classes reflect the "spatio-temporal mean movement rate". In my view, this deserves a bit more detail. Naturally, and also visible in the Fig.

3 c-e, there is significant variability in surface velocities within moving areas. How precisely is the distribution of values used to obtain the "mean movement rate"? Do you differentiate between moving areas with very narrow distributions from those with large scatter in velocities? This would be especially relevant, when the mean movement is close to class boundaries.

Specific comments:

- L1-3: In what regard are the results presented here preliminary? In L520, 531, L553 preliminary refers to the completeness of inventories, while in the Abstract (L34) preliminary seems to be referring to the InSAR data itself? In the manuscript, this should be clarified to avoid confusion. As for the title, I am unsure if the word preliminary sends the right message here?
- L24: As rock glaciers not only depend on, but contain permafrost, maybe the authors could rephrase their statement here?
- L36: Does this statement refer to the IPA action group, or to the study presented here?
- L40-42: I think this should be stated with a bit more precision. Many landforms could be "detected" based on "front, lateral margins, […]". Here, it seems the authors want to say that the landform outlines can be mapped along these features? If this is intended as a list of diagnostic criteria for the identification of rock glaciers, this should be elaborated.
- L44: might want to cite: Corte A. 1976. The hydrological significance of rock glaciers. Journal of Glaciology 17: 157 – 158.
- L52: as this is a long list already, Krainer, K. and Ribis, M. 2012. A rock glacier inventory of the Tyrolean Alps (Austria). Austrian Journal of Earth Sciences, 105, 32-47.
- L76-80: Is there a way to elaborate here, why the ESA project solely focused on the inclusion of InSAR approaches into rock glacier inventories?
- L81-83: At this point, but also throughout the manuscript (e.g. L66), it is difficult to discern what the authors did in this study and what the contribution of the IPA action group was. I think the clarity could be greatly enhanced by incorporating a sentence here that illustrates the relation between IPA action group and the author collective.
- L87-89: Not clear what the "irregularities and differences" refer to here
- L109: I am sure the authors took great care of this, but still it would be good to explain here shortly how snow-free conditions were assured.
- L162-163: Here it is not clear how moving areas are included within inventories. I suggest to shortly elaborate this here.
- L176: "[…] we present the standards of moving areas […]" is unclear. I think the authors want to express that below they will describe details on the standard procedure to identify and include moving areas?
- Figure 2: The authors might want to use boxes of similar size here. Standing in very small boxes, the reader might get the impression that e.g. InSAR and Moving area inventory are subordinate to much larger boxes. Also, the outlines are very thin and differences might be better visible, if these were thicker?
- L266-267: Please specify "on a significant part of its surface" here.
- L273-275: This seems to be arbitrary. Why should an area closer to the front of the rock glacier be more representative by definition? Is there a technical reason that

forecloses the inclusions of multiple moving areas? (see general comments)

- L300-301: If there is a specific reason to use a qualitative estimation of the percentage of moving area(s) instead of calculating this precisely, this should be explained here.
- Figure 4: for consistency, outline the mapped rock glaciers here as well, as has been done in Figure 3?
- L337: Interesting observation that would deserve to be discussed
- L338-340: While the observation that the number of moving areas exceeds the number of rock glaciers is little surprising, an analysis of the correlation between number of moving areas and rock glacier size would be interesting here.
- Figure 9, Tables 3 and 4: Essentially, Figure 9 a and b are showing the data provided by the Tables 3 and 4, respectively. I would suggest to move the tables to the supplementary information. If necessary, the in information from the final two columns could be added to Figure 9.
- L394-395: State the resolution that would be necessary for the documentation here.
- L424-426: Okay, but using velocity classes instead of precise values is a loss of information on the other hand. I think the authors should discuss the downsides of using velocity classes here as well.
- L440: I think the manuscript would benefit from a more detailed appreciation of alternative techniques that would be suited to derive kinematic information that could be included in a rock glacier inventory.

Technical corrections:

- L25: hydrology and climate changes reasons? Maybe "hydrological and climate change assessment"?
- L33: These "slope movements" are termed "moving areas" in most of the remaining manuscript. To avoid confusion, I'd like to suggest to stick to either one of these terms.
- L34: This should be analysis (or analyses), also throughout the manuscript (e.g. Lines 59, 88, …)
- L34-36: Complicated sentence, rephrase.
- L43: This should be: "can be important for…"
- L57: Maybe: "were produced after the year 2000"
- L73: Not clear: "were developed in literature"
- L81-83: Rephrase, maybe: "[…] and test the inclusion of kinematic information in rock glacier inventories (RoGI) in an international cooperation effort […].?
- L161 and 166: This should be: "consists of"
- L162: This should be: "moving areas are"
- L181-182: Maybe: "that includes kinematic information"?
- L178: This should be: "to a rock glacier unit", right?
- L221: This should be "In accordance with recent studies […]" or "Following recent studies […]
- L300-301: The use of the terms rock glacier unit and rock glacier is confusing here. Is the percentage estimated with respect to the area of the rock glacier unit or rock glacier system here?
- Tables 3 and 4: Total extent instead of extension?
- L359: This should be: "investigated in the study regions"
- L364: This should be: "were not mapped" The authors refer to published inventories

here, right?

- L408-409: I guess kinematics should be plural in this sentence
- L551: This should be: "numerical modelling of permafrost and mountain landscape dynamics"
- L552: delete "if at all"
- L553: "even if still preliminary for some of them"?