

## ***Interactive comment on “Glacier detachments and rock-ice avalanches in the Petra Pervogo range, Tajikistan (1973–2019)” by Silvan Leinss et al.***

### **Anonymous Referee #1**

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#### General Comments:

The authors present new data and observations on the locations and characteristics of glacier detachments in Tajikistan. Given the lack of worldwide data on these types of events this is a valuable dataset. The authors used an impressively large amount of imagery and DEM data to conduct their search. However, this paper lacks key information on the methodology used to identify and classify detachment and other mass flow events. The authors provide valuable comparisons of event conditions and geometry (glacier slope, bedrock geology, surging, etc.) and provide some comparisons to other detachments worldwide. However, the conclusions drawn about climate change and temperature are largely unsubstantiated given that the inventory of detachment events was collected from data with varying resolution and quality, and may therefore

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be biased towards more detections with higher quality (recent) imagery.

Specific Comments:

1. The terminology used for glacier detachments and other mass flow events should be addressed near the beginning of the manuscript and clarified throughout. Several terms including “glacier detachments,” “mass flows,” and “avalanches” are used interchangeably throughout the paper and at points it is difficult to understand whether you are referring broadly to all types of studied events or to specific types of events. In Table 1 you further classify events as detachments, ice avalanches, or rock/ice avalanches, yet this classification scheme is not consistent with the ways that these events are addressed throughout the paper. I would recommend adding a section to the introduction that describes the dichotomy of event types which are addressed throughout the paper. For example, overall you are studying mass flow events, which can be further classified as either glacier detachments, ice avalanches, or rock/ice avalanches, etc.

2. An improved description of the methods used to identify and classify detachments and other events is needed. Please provide more details on how you identified events. Was this done with a manual search, an automated search, etc.? Did you attempt to distinguish between detachment events and rock/ice avalanches or were both event types combined in your search. If they were separated, what was your criteria with which you were able to differentiate events? At what scale did you conduct your search? What is the minimum event size that you were able to detect using your technique?

3. It seems likely that your inventory is biased by the quality of available imagery since you used 15 m resolution imagery for recent years, but much larger resolution for older events. This is a reasonable approach for the purposes of detecting as many events as possible given the available data, but you cannot justify the conclusions you draw about temperature trends with an inventory that is likely biased by data availability/quality.

4. I would recommend improving the structure of the paper in several areas. The



methods section is very disjointed by all of the subsections discussing measurements of event characteristics. You could potentially combine many of these subsections into a more coherent description of data attribute collection, which would also leave room for an expanded discussion of your detection and identification techniques. I would also recommend removing or shortening the portions of the Results section that highlight the smaller events that are not discussed further. Highlighting them with reference to Table 1 may be sufficient. Instead I would focus more on the major events which you have more data for and include in the discussion.

5. Consider focusing more on the strengths of your observational data and emphasizing your analysis of detachments in relation to surging glaciers, bedrock geology, glacier slope etc. I think these aspects of your results and discussion are very interesting and important to emphasize given the overall lack of data on these types of events throughout the world. It would also be interesting to expand your discussion/comparison with other documented events.

6. Technical language, in particular the use of vague or ambiguous terms, should be improved. I have attempted to make suggestions for several of these instances in the following section. Grammatical errors and typos, as detailed in the following sections, should also be addressed.

Technical Corrections:

L2: Suggest removing “the” so the phrase reads “Common to all known cases are large. . .” L7: What type of temperature data are you referring to with the phrase “the past 46-years trend”? Are you referring to mean air temperatures, maximum temperatures, minimum temps? Average annual temperatures, etc.? The statement is vague as is. L7: Suggest rewording to “No active glacier surges were observed immediately before detachments. . .” L8: Insert “digital” preceding “elevation model” L9: Unclear what is meant by “pronounced” in this context. Would “preceded” be a better description here? L18: Unclear why there is a section labeled 1.1 here since there are no other

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sub-sections in the introduction. The use of "Glacier detachments" as a heading does not fit with your discussion of multiple different types of events (surges, rock avalanches etc.) in this section. L21: Remove "a" preceding "relatively low" and would recommend changing "low slopes" to "low-angle slopes" L22: Recommend changing to "velocity increases by one or two orders of magnitude, but detachment does not occur." L23: What is meant by "favored by a climatic envelope"? L24: Should rock avalanches also be included if you are discussing events that initiate from headwalls? L25: Change to "For both types of mass flows.." L26: Remove "in additionally" L27: Suggest changing to "increase in liquid water content, making the resulting mass flows, which sometimes transform into debris or..." L29: Replace "potentially reaching inhabited areas" with "which increases the potential for such events to reach inhabited areas." L35-36: Please check grammar. L37: Replace "for all of the probably best-studied" with "for many well-studied events, including..." L46: Remove "of a series of" L48: Recommend changing to "and the surging history of individual glaciers." L49: You switch from present ("analyze") to past ("investigated") tense. Choose one and be consistent. L58-59: Based on journal standards, is this the correct citation format for in-line citations? L60-61: Elsewhere you use "runout" as one word. L61: Insert "the" preceding "two largest detachments" L72: Word missing near the end of the line? L79: Year for Ibrohim et al. reference? L89: Recommend changing to "with an increase of almost 1 degree C in fall and winter" L90-91: Check use of "run out" versus "run-out". Elsewhere you use "runout." L102: Suggest changing to "at resolutions of" L108: Suggest changing to "No imagery from" L111: "green bands" L116: Should rock avalanches also be included in this? At some points throughout the text you distinguish between rock and ice avalanches, while at others you seem to use the terms "ice avalanche" and "rock avalanche" interchangeably. Please clarify your terminology and make it clear to readers whether your use of "ice avalanche" encompasses both rock and ice (and rock-ice) avalanches or is distinct. L118: check use of "run out" as two words. L118-119: How did you distinguish the runout zone from the source (detachment) zone? L128: Please write out the full name prior to introducing an acronym. L129: "to esti-

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mate” L132: How did the DEM differencing reveal a previously unknown event? What criteria was used to classify this as an event? L134: “estimated following” L134-135: Please check reference formatting for in-line references. L135-136: Are clouds the only cause for large differences in your images? Please discuss other potential sources of error. What about snow cover? What is the intrinsic error of individual DEM layers based on processing etc.? L142: Was this only done for the events that you know are detachments or also for rock/ice avalanche events? If so, how were detachments distinguished from the other event types? I would work to clarify your terminology surrounding detached glaciers versus rock/ice avalanches and make it clear whether you are using the overall term for both types of events. L147: Please check grammar. L152: Earthquakes is one word. Please check here and elsewhere. L152: What was your screening criteria for determining whether an event was triggered by an earthquake or not? L170: Are you using “mass flows” as an encompassing term for both detachments and rock/ice avalanches? If so, please define your use of terminology earlier in the text so it is clear to readers what event types you are talking about here. L191: Remove one instance of “until” L197: Remove “leading” L203: See notes on clarification of terminology. L211: What was your criteria for “unusual crevassing”? L212: How do you quantify “heavy crevassing”? L232: Spelling of “loosing” L287: Specify what you mean by “long-term trend” L290: Here and elsewhere please correct the use of “earth quakes” as two words. L314: Please check grammar. L329-330: What do you consider “large” in the context of your study area. Please specify. L335: In reference to your point about vegetation being missing in strongly eroded valleys, what about areas/ecosystems/elevations that would not be expected to sustain vegetation in the first place? L336-337: Please explain what you mean by “separation of snow and clouds.” Based on the Landsat channels, how do you distinguish between snow and clouds? Do they appear texturally different? Different colors? L342: Correct “single-pass” and change “mean” to “means” L345: Correct “images a few weeks prior” L355: A word seems to be missing from the end of the line. L362-363: Here you briefly describe the criteria used to distinguish glacier detachments from other types of mass flow events.

I would recommend moving this discussion to the methods section and expanding on it in more detail. This is a critical piece of how you collected your results, but has yet to be mentioned in the text. L363: Correct “out” L381: Typo “out” Line 398: Change to “investigated events” L415: “earthquakes” is one word

Figure 1: Include North arrow on map. Can you specify what you mean by “modified” in the Figure 1 caption?

Table 1: - What do you mean by “other events”? Please clarify in the Table caption. - This table distinguishes between detachments, ice avalanches, rock avalanches, and questionable detachments, however you do not indicate in the methods section how you distinguished between each event type. Additional discussion of this process is needed in the methods section. - Furthermore, I would recommend clarifying the terminology you use interchangeably for the different event types that you discuss throughout the paper. It seems like in the broadest sense, you are discussing mass flows, which can be classified as either detachments, ice avalanches, or rock/ice avalanches. To make this clearer, I would clarify your terminology throughout the text and for example, use “Mass Flow Type” instead of “Avalanche Type” in the Table header. - How did you distinguish between release and runout areas? This should be explained more thoroughly in the methods section. What does “yes” in parentheses mean under the “surge observed” category? - What does your Slope measurement correspond to? - Check use of “run out” as two words.

Figure 3: The presence of increased crevassing in a) and b) is not visible at this scale. Can you show a more detailed image or indicate what area of the image you observe the crevassing in? Is increased crevassing not expected normally throughout the season? How do you distinguish between snow melt which exposes more crevasses and an otherwise significant increase in crevassing?

Figure 4: Is this the same area that is shown in Figure 3 (with the exception of Figure 3d)? If so, it would be helpful to indicate such with a common point or lat/long ticks.

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Can you point out what you mean by “strong crevassing” in part d?

Figure 5: Suggest changing first line of caption to “locations of”

Figure 6: This figure shows the glacier detachment sufficiently, but there is also overall snow/ice melt between the pre- and post-event images. Could you compare the final “detachment” image with an image from the previous year around the same time period (July) to show what the area looked like prior to the detachment, but with similar snow conditions?

Figure 9: - In the caption “cyan” for temperature at the Lyairun station should be corrected. - Replace “earth quakes” with earthquakes. - Please clarify the use of black “bullets” versus black “dots.” Instead you could use “large” and “small” black dots.

Figure 10: Figure appears blurry, resolution should be improved.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2020-285>, 2020.

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