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# *Interactive comment on* "Current glacier recession causes significant rockfall increase: The immediate paraglacial response of deglaciating cirque walls" *by* Ingo Hartmeyer et al.

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Dear Robert Kenner,

thank you for your constructive and insightful comments which we feel helped to improve the manuscript.

We (i) uploaded a revised version of the manuscript (one version with markups showing revisions and responses to minor comments, the other with a clean layout), (ii) posted a new author's comment to inform on general amendments in the manuscript, and (iii) below provide a point-by-point response to your comments. Our response is structured as follows: (1) referee comment, (2) author's response including direct references to manuscript changes.

(1) You did a good job in estimating the accuracy of your measurements. However, I miss something similar for the statistics. Some of the statistical analysis are based on very small sample sizes or are strongly influenced by single events. I wonder if all this is significant and would appreciate something like a sensitivity analysis.

(2) Following your suggestion we added a sensitivity analysis to the manuscript (see last two paragraphs of Sect. 4.5 and new Fig. 13). The sensitivity analysis is described in full detail in the companion paper.

(1) The second part of 5.1 when you describe subglacial rock fracturing is not convincing. First you say, that there is no active layer here (I agree with Jan that there is one at least in the upper meters but likely clearly thinner than above the glacier line) and that the melt water refreezes at the surface but then you write, that large amounts of melt water enables frost cracking. How should that be possible from the surface? Important for subglacial rock weathering within a Bergschrund is probably ice-segregation but this is not even mentioned.

(2) We added a multi-year temperature dataset from the Randkluft to describe its thermal regime in more detail. Data acquisition and measurement sites are described in Sect. 3.2, results are described in Sect. 4.7, and discussed in Sect. 5.1 and 5.2. Our measurements/observations suggest sustained freezing and ample water supply inside the Randkluft at the same time (during summer) – two key requirements for ice segregation (and thus for frost cracking) (see also analyses of Sanders et al. 2012, Alley et al. 2019, Evans et al. 2020 who all assume enhanced frost cracking inside the Randkluft). We feel that some confusion was arising from our use of the term "subcritical fracture propagation" (which results from ice segregation). We adapted the terminology to emphasise the role of ice segregation more clearly (see amendments in Sect. 5.1).

(1) Section 5.1 gives the subliminal impression that rock wall erosion or at least rock wall weakening is higher in the Randkluft than on a not glacially affected rock. This is however the major question which is not satisfyingly discussed: If I imagine a constant slope and put a glacier at its foot and than I wait for 50'000 years, the rock wall is commonly steeper in the area around the Bergschrund after this time. These steep belts are called Schrundlines and you made a similar observation at your site. Now where does this steepening come from? Is it because the glacier erodes the foot of the rock wall below the Randkluft or does the glacier in contrast protect the rock wall from temperature forcing and decelerates rock erosion while higher erosion rates above the randkluft cause a flattening of the rock wall? Obviously, erosion rates increase after glaciation right? But what is higher? Subglacial erosion or erosion in summit regions not affected by glaciation? Perhaps you can discuss this very basic but unsolved question.

(2) Following your suggestions we added a brief discussion on the implications for (subglacial) headwall retreat. See last paragraph of Sect. 5.1.

(1) I am fundamtally not convinced by these error specification and consider them as much to low and highly theoretical. 1.5 m3 is already the talus which is deposited within failiure scar of a rock fall.

(2) Gaussian error propagation brought the error down to unrealistically low values and was therefore replaced. We updated the error calculation accordingly (which now yields an average relative error of 5.5 %), which is described in Sect. 3.1.2.

References

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Discussion paper

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