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Interactive comment on "Subglacial permafrost dynamics and erosion inside subglacial channels driven by surface events in Svalbard" *by* Andreas Alexander et al.

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Open discussion comments on Alexander et al. (2020)

This very interesting study provides timeseries of subglacial channel temperatures and erosion under two cold based valley glaciers on Svalbard. It indicates a link between meteorological events at the surface and the yet poorly understood soft bed subglacial processes affecting glacier hydrology and potentially basal slip under cold based ice. The highlighted importance of extreme events is especially relevant in the context of understanding the effects of climatic change on Svalbard.

1. The study uses sudden changes in sediment temperature to identify certain erosion events, such as the August 30^{th} event for the Tellbreen "subglacial 1" sensor (**p.18 l.35**) and the late July unearthing of the 1.05 m sensor under Larsbreen (**p.18 l.33**). However, other variations in measured sediment temperature are not addressed much in the paper, while it seems they could contribute to the compelling case for the occurrence of episodes of strong erosion linked to surface events. For example, on **Figure 6** the 0.45 sediment temperature follows the channel temperature very closely from the the late June / early July peak rainfall event onward. Could it be possible that this event eroded the channel bed down quite close to the buried sensor, in addition to coupling the subglacial conduits to the atmosphere? Similarly, both 'subglacial 2' sensors in **Figure 7** register a step-wise temperature increase when surface melt starts to occur around June 24^{th} and the 0.45 sensor shows more variation after the late June rainfall. Both the 0.45 and 0.9 sensors vary with channel air temperature after the second major rainfall event of August 30^{th}, and are exposed upon recovery. Maybe it can be argued that these observations point towards distinct episodes of stream erosion occurring over the summer season?

2. page 19, last paragraph
In the way I understand the proposed thermo-mechanical erosion mechanism (**Figure 10**), it relies on high stream power to produce high rates of permafrost melting and erosion. The mechanism is especially effective after extreme rainfall and melt events, and applies to the channels of an efficient drainage system, which is where the measurements occurred.
On **lines 23 to 25**, the paper mentions that a more inefficient drainage system would allow more widespread influence of extreme events on basal slip. It would be nice to clarify what is meant exactly, as it seems that in a fully inefficient distributed drainage system, water flow velocities would be too low to allow for turbulent heating and the thermo-mechanical erosion mechanism to occur. It could be interesting to consider Rippin et al. (2005), as they suggest that after mass build-up, pressurized and fast

water flow through the cold based margin sediments could increase local ice velocities. This seems like it could be a situation where the mechanism presented in this study would be quite relevant.

3. A final short remark is that in a recent paper, Haga et al. (2020) mention the potential importance of an efficient drainage system in the partial freezing of the Negribreen glacier terminus to its bed surface. The rapid erosion in response to surface events in this study could indicate the capacity of a drainage system to adjust rapidly to changes, even in permafrost. Maybe such an adjustable system is necessary for the cold based conditions of many Svalbard glaciers termini to form, or at least facilitates formation?

References

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