## ESurf reviewer #2 — Velio Coviello

| Line | Reviewer comment | Our response |
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| N/A | Structure: the background and methods sections are quite long and have many sub-sections. I would try to shorten the paper and simplify its structure. For instance, I would skip section 2.3 and move part of the text describing ice-rock avalanche to the Introduction. In addition, I suggest moving the text contained in the section 2.5 to the beginning of Data. Finally, I would skip the whole section 4.2.3 and move it all to a supplement file. | We have moved the text in §2.5 to the beginning of the Data section. We would like to retain §2.3 to provide some general context to the following description of Iliamna's ice–rock avalanches. We have moved the former §4.2.3 into a supplemental file. |
| N/A | Dataset: did you consider extending your analysis to similar events that occurred at Iliamna Volcano before 2016? In Caplan-Auerbach and Huggel (2007) quite a lot of ice-rock avalanches are reported that produced seismic signals at Iliamna Volcano. | It is true that there are many candidate Red Glacier avalanches which we could analyze. However, here we focused only on the two most recent events because:<br>1. These two events occurred during/after the deployment of the TA network, which provides us with acoustic as well as seismic data. We don't have acoustic recordings for earlier events.<br>2. There were very few broadband seismometers available in 2004 and earlier. An IRIS station query for stations within 200 km of Iliamna that were operational/available on 1 January 2006 reveals only 4 broadband stations available — 3 Güralp 6TD's (30 s corner) and 1 Güralp 40T (60 s corner). The 2016 inversion also benefited from the presence of the temporary SALMON seismic array.<br>3. Availability of auxiliary data such as satellite and ground-based imagery is not as good for the events from 2004 and earlier. |
| N/A | Methods: the inversion of low-frequency seismic data used to reconstruct the force history of the two ice–rock avalanches is a consolidated method. Given the large number of events (see point 1) and broadband seismic stations available, it would be possible to show and discuss the impact of the network geometry on the force history? | Though there are a relatively large number of Red Glacier avalanches, only these two events have sufficient data for inversion (see response immediately above). Therefore, the best way to explore the sensitivity of inversion results to changing network geometry is via synthetic examples. We do not perform a formal investigation of this effect here, but we plan to address the network geometry consideration in an upcoming force inversion "best practices" paper. The jackknifed trajectories shown in this paper serve to convey some idea of the expected spread of the solutions under changing input data. But we lack a high-quality balance of three component data (most data used here is vertical) to understand this issue from real data alone — hence the need for synthetic testing. |
| N/A | Event volumes: how did you estimate the value of 1.5 m deposit thickness? I would add the range of error to the event volumes. Ice-rock partition: is | The deposits for these two events were not measured directly, so we must make an educated guess. Previous studies have been forced to do the |

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| | fifty-fifty consistent with field-based estimates of previous events? In any case, I do not expect that such an information on the volume uncertainty would explain the discrepancies between the masses inferred from the force inversion trajectories versus the ones calculated with satellite imagery. I suggest indicating where and when fragmentation and erosion- deposition processes occur, maybe adding some graphical features to figure 10 or some text to the description of stages A-E in section 6.2. | same — Huggel et al. (2007) estimated deposit thicknesses of 1–3 m for a 2004 avalanche on Iliamna's Lateral Glacier. Waythomas et al. (2000) estimated 1.5 m thickness and a composition of "at least 50 percent" ice/snow for 1996 and 1997 Red Glacier avalanches. We've added a citation for the 50–50 composition, and attached upper and lower bounds to the 1.5 m thickness estimate which we propagate into the volume and mass calculations.<br>We can't make too many statements about erosion/deposition processes based upon our limited groundtruth. We now mention fragmentation in both stages B and C. |
| N/A | Results: quantitative results descend from the analysis of the seismic information. I appreciated the explicit acknowledgement of the limitations precluding the authors from assessing a complete infrasound source estimate. Actually, infrasound data are mainly used in the discussion to highlight the limitations of the force-history in describing the mass movements. However, I have the impression that section 6.4 can be extended mentioning that the transition from a block-type failure to a granular flow likely results in a higher frequency seismicity. Near-field seismoacoustic observations of debris flows can support this discussion, see Hürlimann et al. (2019) and references therein.<br><br>Hürlimann, M., Coviello, V., Bel, C., Guo, X., Berti, M., Graf, C., Hübl, J., Miyata, S., Smith, J.B., and Yin, H.Y., 2019, Debris-flow monitoring and warn-ing: Review and examples: Earth-Science Reviews, v. 199, p. 102981, doi:10.1016/j.earscirev.2019.102981. | Thank you for alerting us to this very relevant review paper. We've added some discussion in §6.4 regarding the similarity of high-frequency seismic and infrasound waveforms for the 2016 and 2019 events and the resemblance of this observation to some of the debris flow studies referenced in Hürlimann et al. (2019). This provides additional evidence that Iliamna ice–rock avalanches transition into a granular flow that (at least seismoacoustically) exhibits flow dynamics similar to those of debris flows. |
| N/A | Stick-slip activity: although this is not the objective of the paper, this is an intriguing point. I am wondering if precursory tremors like those mentioned in the paper can be produced by small ice-rockfall events preceding the main collapse. Progressive rockfall activity is a common process during the first phase of motion of a large landslide. What do you think? | Caplan-Auerbach and Huggel (2007) make a compelling case for the origin of the Iliamna avalanche precursory signals being on the ice-rock interface or within ice. The precursory, transient signals are found to be highly similar and their inter-event timing shrinks as the time to failure approaches. See e.g. Fig. 10 in Caplan-Auerbach and Huggel (2007). While precursory ice-rockfall activity may certainly be intermittently present, the high similarity of the precursory transient signals and their reliable increase in event frequency is more consistent with a sub- or intra-glacial source. |