Interactive comment on “Contribution of calving to frontal ablation quantified from seismic and hydroacoustic observations calibrated with lidar volume measurements” by Andreas Köhler et al.

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The manuscript by Dr. Andreas Kohler et al. presents a new empirical model for estimating calving flux. The model is using seismic and hydro-acoustic records as a proxy for calving, which was calibrated on precise, frequently repeated lidar scans and time-lapse imagery. The uncertainty of the calibrated model is thoroughly assessed before employing it to long-term seismic records of a permanent seismic station (for studying multi-year variations of frontal ablation at the Kronebreen glacier, Svalbard).

The model is based on a short, but very comprehensive field campaign using multiple sensors (seismic, hydro-acoustic, lidar, time-lapse) and diverse methods for signal/image processing, supported with various statistical models and tests. The manuscript is well written, easy to follow and should be of general and practical interest to the cryospheric community.

As I answer the questions guiding TC referees in their evaluations (https://www.the-cryosphere.net/peer_review/review_criteria.html), there are only two major aspects I would like to comment on:

1) “Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?”

There are multiple places there descriptions could be improved/completed/corrected as I have specifically listed in MINOR details (e.g., 3 hydrophones deployed, yet locations of only 2 shown; how time-stamping was done underwater to be synced with seismics? hydro-acoustic units are in nm s⁻¹? how signal duration is obtained without “unflag” threshold indicated? and etc.).

Moreover, it would be informative to provide a new figure showing the observed calving statistics in a way similar to recent studies trying to find which law (exp, power, etc.) represents best such distributions as inter-event time and event size? For examples, see Chapuis & Tezlaf, JG, 2014; Petticki & Kinnard, JG, 2016; Minowa et al., JG, 2018, Minowa et al., EPSL, 2019. I guess, such plots will also better expose completeness issues of the dataset.

2) “Do the authors give proper credit to related work and clearly indicate their own new/original contribution?”

To my knowledge, the contribution is indeed novel. However, as it comes to Introduction and Discussion, I would like to point out the following. There are more recent studies than those “qualitatively estimating the relation between . . . calving . . . and . . . volume” [p.14, Line 3]. For example, continuous high-res. calving records were recently obtained by using another calibrated model, which is linking water-surface waves
with time-lapse- or UAV-derived calved ice volumes (Minowa et al., J. Glaciol., 2018 & EPSL, 2019). The latter studies are of a high relevance to presented here analysis, because they report very comparable findings (for example, the calved volume is up to 10⁵ m³ and contribution of calving to frontal ablation is 20% at another arctic tide-water glacier, while subaqueous calving is negligible).

Also, calibrated seismic models for a particular glacier/site are not “The only successful approach so far” [p. 2, line 11]. Because recently there was a progress in developing seismo-mechanical approaches, for example, for glacial earthquakes by Sergeant et al. (Ann. Glaciol. 2019). Moreover, it is not correct to associate glacial earthquakes with tabular icebergs in Greenland; those are usually nontabular.

MINOR

p.1 affiliation #3: missing city, country

p.2, line 1: please, provide literature examples to “radar and liar surveys”

p.2, line 5: “Calving events are also successfully detected from . . .”/ . . . and water surface (or tsunami) waves (Minowa et al., 2018 & 2019)

p.2, line 6: “Seismic and hydroacoustic methods have the advantage to produce continuous calving records . . .”/ -> please consider “Seismic, hydroacoustic and water-wave methods”

p.2, line 10: for glacial earthquake signals from tabular iceberg calving such as observed in Greenland (Murray et al., 2015)

-> it is misleading to use “tabular iceberg” here, because usually tabular icebergs do not capsize and do not generate significant glacial earthquakes (Sergeant et al., 2019). Consider re-writing as:

“for glacial earthquake signals from buoyancy-driven nontabular iceberg calving such as observed in Greenland (Murray et al., 2015; Sergeant et al., 2019).”

C3

p.2, line 11: iceberg impact on the sea surface -> please consider re-writing serac impact on the sea/lake surface

p.2, line 11: “The only successful approach so far” -> see my comment above (about Sergeant et al. 2019)

p.2, line 27: Ny Alesund or Ny-Alesund? -> please, use consistent dash/no dash through out the manuscript.

p.2, line 29: with more than 1 km -> {for} more than 1 km?

p.2, line 31: (Nuth et al., in preparation) ->Please, note that according to TC guide for authors [Works "submitted to", "in preparation", "in review"; or only available as preprint should also be included in the reference list.]

p.3, lines 8-16:

->3 hydrophones deployed, yet locations of only 2 shown. I could not follow the destiny of the third recorder.

->please, explain how time-stamping of the hydroacoustic data and possible time drift was dealt with for comparing with seismic data?

The recording unit was recovered -> The recording units were recovered

p.5, line 9: scans of acquired from ->{of} could be omitted?

p.5, line 10: to the west of the main camp. ->Does the reader know where is the main camp in the first place?

p.5, line 14: mismatches . . . was removed ->were removed

p.20, lines 21-22: Calving event scars have low reflectance in near infrared part of spectrum -> is it your finding? Perhaps, a reference should be helpful here?

p.20, lines 26: point cloud differences . . . is added ->are added
Figure 2: hydroacoustic pressure has nm s^{-1} units?

lambda/4 criterion: -> please, elaborate or reference this criterion

p.7 line 8: when for example ocean -> when, for example, ocean

p.7 line 22: signal duration -> please explain how you define the duration - otherwise it remains unclear because earlier mentioned STA/LTA was applied to array and did not show any flag-off threshold.

Figure 3: I suggest to explain abbreviation GLM because the reader sees it before reading the text.

here, and in Fig. 5, it would not hurt to explain in the captions the dashed 1:1 lines.

p.9 line 13: using the deviance, the common -> using the deviance, d, the common

p.9 line 15: Perhaps, you could add that null deviance is the same for all models of each station?

p.9, line 26: . i.e.,, -> For example,

p.10, lines 16-17: Additionally to total ice volume, I suggest to show how much volume per day does it correspond to - for easier comparison with other studies.

p.10, line 18: The volumes . . . lays -> lay

Table 1: KRBN -> KRBN2 ?

KRBS -> KRBS3 ?

Figure 6, caption: Right panels shows -> panel (there is only one)

consider re-writing as: Right panel_ shows {the corresponding} box plot{s} for . . .

p.14, beginning of Discussion: see my previous comment that there are more recent calving flux estimation studies based on “tsunami” wave monitoring. As you would see from the following 5 remarks below, I believe, it is highly relevant work to your study.

C5

p. 15 - as in other places, line numbering has collapsed here, so I just cite the place: “dynamic ice loss to frontal ablation at Kronebreen of 5-30%” ->Similarly, Minowa et al. (2019) finds 20% at another tide-water glacier.

p.15, lines 8-9: It is well-known that also submarine calving generates underwater acoustic and weak seismic signals. -> as well as water surface waves (Minowa et al., 2018).

p.15, lines 18-19: 97% of all events occurred subaerially ->Similarly, Minowa et al. (2018) finds 98%.

p.15, lines 18-19: Another possible solution is to . . . ->use UAV-derived DEM (Minowa et al., 2019)

p.16, line 1: please, consider giving an example to previous efforts like this suggestion of yours: to measure calving areas from time-lapse images (e.g., Minowa et al., 2018).

p. 16, line 9: a different or more generalized approach. -> (Sergeant et al., 2019)

p.16, line 15: carried out over longer recording periods than 1–2 weeks -> carried out over recording periods longer than 1–2 weeks

p.16, line 26: to asses model -> to asses[s]
p. 17, line 6: contributed with 5-30% -> do you need [with] here?

p. 18, line ? - line numbering collapsed here:

As the ice breaks off and hit -> hits

variations in pixel brightness that occurs -> variations ... that occur

location and coordinates of calving from gifs - I am not sure how do you get location from non-geo-referenced (?) images. Manually? Elaborate, please.

Figure B1:

Grey line is results -> Grey line shows results

I also note that you keep using [grey] and [gray], why not to stick to just one spelling?