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The Cryosphere Discussions
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Interactive comment on "Quantifying iceberg calving fluxes with underwater noise" *by* Oskar Glowacki and Grant B. Deane

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General comments:

Glacier calving can be observed indirectly through records of underwater-acoustic, infra-sound, seismic, and ocean waves. The key advantage of monitoring these signals compared to (optical) sensing methods is the high temporal resolution and independence from visibility. However, only a few studies so far have attempted to quantify iceberg mass or volume using the observed calving signals. This can be done for example by utilizing empirical models which relate signal properties and calving event sizes. Therefore, this study is a welcome and timely contribution to the development of new methods suitable for monitoring the calving flux of tidewater glaciers. I appreciate

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in particular the incorporation of physical models to correct for the effect of wave propagation on the recorded signals, and the detailed discussion of uncertainties. There are a few issues which need clarification and maybe some additional work, but I do not have any major objections that would prevent publication of this well-written article.

Specific comments:

(1) I miss the comparison of the relation between measured acoustic energy and impact energy with and without correcting for the propagation effect. If bathymetry information and sound speed profiles would not be available for Hansbreen, how much worse would the correlation coefficient of log energies be for the same data set? Does the correction also increase correlation for location A2 which you did not consider further? Also, what would be the correlation coefficient if the signal duration instead of total energy of the signal is compared? Showing how taking into account propagation effects on amplitudes actually reduces the scatter in the log energy relation would better emphasize the importance of incorporating local bathymetrical and sound speed profile data. However, since such information might not always be available, it would be interesting to see how much more uncertain or biased the calving flux estimate would be.

(2) In section 4.5 the authors describe how the cumulative ice loss and its uncertainty can be estimated. I miss the actual application of this approach to all hydro-acoustic calving signals in the entire record. This could then potentially be compared to independent measurements of the calving flux at Hansbreen. As far as I understand, the signals of the 169 matched events are only used for model calibration. How many calving signals in total occurred in the entire record, including those without camera observations and unsuccessful matching? If this information is not available, is there any particular reason why the entire data set has not been screened for all calving signals?

(3) How well suitable is the method for long-term continuous monitoring? I encourage

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to discuss briefly aspects such as (real-time) data retrieval, power supply, instrument clock drift and regularly updating sound speed profiles. Could detecting calving signals, including picking start and end time of events, be automated? Are there signals of other origins which could be mistaken for calving? Do you see any benefit from using in addition data from the permanent seismometer at the Hornsund station?

Technical corrections:

I personally prefer writing “Hansbreen” over “Hans Glacier” since this is an official place name in Svalbard.

Page 1 line 15: “temporal fluctuations” or better “time dependency of the thermohaline structure”

Page 1 Line 17: Writing “the corresponding measured acoustic energy corrected for these three factors” or something similar would be more precise.

Page 1 Line 19: remove “as we demonstrate”

Page 1 Line 21: “50% uncertainty is . . .”

Page 2, Introduction: It is worth mentioning here that several studies found submarine melting to be the dominant contributor to frontal ablation.

Page 6 line 30: Please explain “calibration of camera geometry” Do you refer to geo-referencing the images? How precise is the pixel-area conversion (Equation 1)? Do you take into account the orientation of the calving front with respect to the camera?

Page 7 line 3: “The newly exposed area” or “Newly exposed areas” (same in following sentence)

Page 8 line 6: This sentence describes that PSDs are calculated, but later you do not refer to Pxx again in the text. From this paragraph it is also not clear what PSDs are used for, because in the next sentence you already describe a different processing step, i.e., how the energy is computed in the time domain. I suggest to refer to Figure

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6 and/or to write that PSDs are computed to investigate the spectra of events. If Pxx is just used as label in the figure, you do not need to introduce it as a variable in the text.

Page 8 line 26: Please clarify what is meant by “32, 46, 61 and 30 detachments” Is it the day in the measurement period which you group into 4 time segments? What did motivate this division? According to Figure 2, the CTDs are not centered in the middle of each time segment. How fast do you expect the sound profile to vary over time?

Equation 5: For clarity, you could write TL in terms of the modelled factors described in the previous section (terminus reflections, wave propagation).

Page 12 line 3-6: I was not able to follow these sentences. Could you provide more details about the “error-in-variable model”? I do not understand what you mean with “Eq (7) can also be applied”?

Page 12 line 17: Do you actually present an estimate for the solid ice discharge for Hansbreen (see comment 2)? You present the method, but as far as I understand you did not apply it to data. What do you mean with “specific number”? Here you should make clear if you refer to the cumulative total number of calving signals in the considered time period or the different number of calibration events that you use for estimating the calving flux uncertainty (in percent).

Page 13 line 6: Krone Glacier -> Kronebreen

Page 14 line 13: Remove “which are now considered”

Page 14 line 21: Rephrase sentence. Instead of “The actual f_low” write “The lowest frequency was . . . “

Page 14 line 31: Explain “net result”. Could you show this decrease in correlation in a figure? Isn’t your model supposed to correct for the longer propagation path? See also comment 1.

Page 15 line 14: What do you mean with “changeable camera orientation”?

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Page 18 Equation 11 & 12: Can you explain in a bit more detail where these equations come from and why there are valid?

Page 20 line 27: “Calving flux has been quantified”: As written earlier, this can be misleading. Impact energies are quantified for individual events and a methodology for quantifying the calving flux is suggested. However, no actual calving flux estimates are computed for Hansbreen because this would require a complete hydro-acoustic calving record (see comment 2). Please clarify.

Page 20 line 28: I am not sure if “inversion” is the correct word here.

Page 20 line 29: Do you mean above 100 Hz? As I understood it, this is the lower frequency limit.

Page 26 line 19: This paper has just been published in The Cryosphere.

Figure 5: How representative is the calving size distribution in (e) with respect to the actual size distribution at Hansbreen? Since this is based on the 156 events unambiguously matching with acoustic signals, could some size range be under- or over-represented due to size-dependent matching ability?

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