

# Manuscript Review for **High frequency broadband acoustic systems as a tool for high latitude glacial fjord research**

## **Summary**

The authors describe the applications and utility of broadband active acoustics systems in glacier fjord environments to quantify important ice-ocean processes in Horsund Fjord, Svalbard. In particular, the authors observe variability of thermohaline structures and mixing, characterize a subaqueous glacier calving face, and estimate geophysical parameters. Throughout the manuscript, the authors strongly promote that broadband acoustic systems should be more widely adopted among the polar oceanography community.

## **Review**

This manuscript presents a thorough description of broadband acoustic systems along with some analysis of the data collected in Horsund Fjord. Overall, this work is worthy of publication with some significant revisions. My primary concern is with the paper's structure, the amount of redundant information, and the readability. With the proper corrections, this paper could expand the audience for broadband acoustic systems for glacial fjord research.

## **Significant Revisions**

There are too many introductions spread out throughout the manuscript. I realize, after reading this, that Reviewer 1 shares the same structural concern as I do. The most clear examples of this are from the first paragraph in Section 4.3 (lines 463 - 470), most of the first paragraph of Section 5 (lines 585 - 599), Section 5.1 (lines 613 - 620), and most of Section 5.2 (640 - 670). Summarizing these sections and incorporating them into the introduction will enhance the manuscript's readability and make it more concise.

## **Areas requiring clarification**

I appreciate the author's work in explaining broadband echosounder data for the non-experts. Figures 3 and 4 (particularly Figure 4) are the most significant contributions from this manuscript, in my opinion. However, I am very familiar with ice-ocean interactions, but I am not familiar with echosounder data, so Section 4 and the subsequent subsections are particularly targeted towards scientists like myself.

My main concern here is that there are clear “low-level” descriptions on how echosounders collect data, but little attention is given to how exactly to interpret Figures 3 and 4. As expanding the use of broadband acoustics is one of the main goals of this manuscript, this concern requires clarification.

What do high and low levels of Sv (dB re 1/m) mean physically? I appreciate that the authors explain the several sources of interference with the data, but providing a low-level explanation for how to interpret these units in the context of ice-ocean interactions will give readers a much better understanding of the data and the echosounders themselves.

**Line-by-line comments:**

Title: “High frequency” should be hyphenated

L10: “High frequency” should be hyphenated

L11: “high resolution” should be hyphenated

L18: “terminus” should be termini or use add an “a” before dangerous

L34: The introduction of broadband active acoustic systems comes out of nowhere here. Why are these better suited for answering outstanding questions than other methods? Introducing why broadband active acoustic systems are better suited for high-latitude coastal regions, after the second paragraph, makes this flow better and less confusing for the reader.

Put the sentence from lines 34-35 at the end of the second paragraph?

L51: “Active acoustic systems can provide these measurements.” This reads very choppy. Consider removing or rephrasing.

L65: “high latitude” should be hyphenated

L106: “crucial” doesn’t sound right here. Consider removing.

L109: Add a period after “estimation”

L111: “Sect. 3” to Section 3. Here and elsewhere, be consistent with what you abbreviate

L119: “Hornsund” should have “fjord” following it. This makes the language more straightforward and less colloquial. This should be corrected for other uses of “Hornsund” as well.

L121: “constitute” should be “constituting” with the current sentence structure and tense.

L125: Something is missing here. “which is among” instead of just “among”?

L126: “focused on the glaciated bay of Hansbukta” is wordy. Consider rephrasing.

L135: Having all the links in the data availability statement will make this much easier for the readers to find what data were used in this manuscript. Please remove this link and place it in the data availability statement with a description.

Figure 1: With the current layout of this figure. It makes more sense to have the top figure as "A" and the bottom figure as "B". Then, change the caption to mention the new figure labels.

The bright yellow mixing transect in the legend is hard to see. Adding a border or changing the color will help.

L155: “3D printed plate” -> “3-dimensional (3D) printed plate”

L158: Are these all the parameters?

L165: Same as the comment on line 135. Remove this link and place it in the data availability statement.

L172: Something went wrong with the latex I imagine for the “ $\chi_T$ ”. Double check the substrip here.

L174: Move the URL to the data availability statement here and elsewhere.

Figure 2: This is probably just me misunderstanding something, but why is there a gap between the sensor and boat in panel D? Should something be connecting the two structures?

Also, this figure caption is a tad confusing. I suggest describing each panel with its own sentence or two. For example, (A) is the ctd used ..., etc. This makes it easier for people who are simply looking at the figure to obtain the necessary information quickly.

Be consistent with your use of “3D” or “3-D”

L189: This sentence should be removed. There is no need to repeat what the section title already states.

L191: I truly appreciate the authors' efforts to engage with an audience unfamiliar with underwater acoustics. As one of my main points in “Areas requiring clarification”, please expand on more of the interpretation of the data here. There is hardly any discussion on how to interpret the figures provided, namely Figures 3 and 4.

L211: “(<150-m)” Sometimes units are hyphenated and others are not. I would consider removing the hyphen here for consistency.

L221: In your list of objectives, the authors mention “geophysical parameter estimation” and now state “geophysical properties”. What properties are these? Please explain here.

L223-227: “Broadband echosounder data collected in Hornsund fjord is here used to ...” is awkward phrasing. I'm not sure what describing the subsections here does either. Consider removing this for consolidation and summarizing it more in the introduction.

Figure 3: Similar to Figure 2, changing the caption to have dedicated sentences for each panel will make this caption much more readable. I am also confused about the units for panels A - D. Each panel should have its own letter, too. “(SL” needs a closing parenthesis.

L362: “In high latitude glacial fjords this remote advantage” -> In high-latitude glacial fjords, this remote advantage. There is a missing hyphen and comma.

L363: Since the authors are referring to general high-latitude glacial fjords and not a specific fjord, use an indefinite article “a” instead of “the”  
“such as the submerged ice-ocean interface of the glacial terminus” -> such as a submerged ice-ocean interface of a glacial terminus

L364: “ice bergs” -> icebergs

Figure 4: Maybe I am missing something, but what exactly is the dark blue region outlined by the dashed black (?) line? Please elaborate on this in the figure caption.

L407: “strong backscattering return starting between 75 to 150 meters in range.” The Y-axis only goes to a little past 120 m in range. Either correct this to 120 m or expand the Y-axis in Figure 4.

L409: “peak intensity value of between -45 to -35 dB re one  $\mu\text{Pa}$ .” This unit is different than those shown on Figure 4 (dB re 1/m) and Figure 3. Are the authors referring to panel D in Figure 5? Please clarify.

L446-447: “With the proper deployment geometry, the broadband system can provide direct observations of the subglacial discharge location; however, even” this sentence structure is repeated in this paragraph and used a lot in this manuscript. Consider rephrasing and varying this sentence structure for improved readability.

L448-449: “backscattering signal from the plume higher in the water column can provide important observations related to plume dynamics.” Where are the important observations the authors are referring to?

L463 - 470: As stated in the major revisions, this paragraph is not necessary here. Consider either removing it or summarizing the main points and incorporating them into the discussion.

L488: “tidal cycle (e.g.,” The parentheses were never closed. Please add a closing parenthesis.

L502: “(dark gray region, Fig. 5)” Add a panel to which part of Figure 5 you are referring to

Figure 5: Please increase the thickness of the profile lines in panels A and B. It is hard to distinguish colors with such thin lines.

L543: “Taking the analysis of the acoustic measurements can be one step further”. The wording of this sentence is off. Maybe “The analysis of the acoustic measurements can be expanded upon. For example...”

L564: “Challenges in applying acoustic inversion methods notwithstanding,” This clause is awkward. Consider removing and starting the sentence with 'There is excellent...'

The authors did a nice job of explaining the limitations of acoustic inversion above; no need to reiterate here.

L577: Use future work instead of next step. This is more common and less colloquial.

L585 - 600: Reintroducing broadband echosounders is very unnecessary this late in the manuscript. Again, from my major revision, this can either be removed or summarized and included in the introduction.

L614 - 620: Same as above, this is not necessary here and better suited for the introduction.

L640 - 670: I agree with Reviewer 1. I'm not exactly sure what this section adds. Maybe summarizing the main points of this section and adding it to 5.0 would suffice.

I see the main points as 1) accurate calibration and 2) acoustic absorption.

L665 - 670: Why is this paragraph at the end of this section? Please consider moving this up in the section following the main points from above. This is the only instance where the authors explicitly mention post-processing. The order of this section in its current state is confusing. Explaining the important post-processing steps in Section 5 will succinctly summarize this section and reduce the paper length.

L675: "like those discussed in Sect. 5.2." Remove this and put (Section 5.2) and end the sentence.

L707-710: The conclusions should be about the authors' work. It is unnecessary to discuss the history of the methods from other sources here.

General comments about the conclusions: There were several references to future work in this manuscript. Placing that future work here is better for readers who skimmed the above sections. Either remove the future work references from the above sections and place them here, or briefly mention them again in this section.