

“High frequency broadband acoustic systems as a tool for high latitude glacial fjord research” by Weidner et al. describes the use of echosounders to study important, and difficult to measure, hydrodynamic features in the vicinity of a tidewater glacier. While doing so it focuses on reaching new audience that could benefit from active acoustic sampling. The total amount of study-oriented information in the manuscript is limited, with most of the content focused on advocating for the broader use of broadband acoustic scattering techniques in these environments. The topics covered are interesting, relevant, and are worthy of space in the literature. However, my view is that the manuscript contains quite a bit of redundancy and that it would benefit from some restructuring.

In addition to the structural issues, there are several topics that should be revisited. Most of these are relatively minor grammatical issues, although I also believe there are several unit errors and mistakes presented in the equations that should be revisited. These, and other issues are addressed in the following itemized list of issues that need to be revisited. Other topics worth of revisiting include choices regarding the presentation of equations and the use of specific terminology when it is unnecessary. These include several processing and unit errors presented in the appendices. If these are implemented as the equations are written, then then the processing is incorrect.

My view is that the aforementioned factors collectively undermine some of the stated objectives of introducing this technology to a new audience. However, if these issues are resolved it could be effective in reaching a new audience.

Structure recommendations:

My fundamental concern about the structure of this paper and that it feels like there are several separate introductions and discussions. While some of these do contain different information, there is some overlapping subject matter. I think that readers would be better served by a manuscript with a long introduction, a modest “results” or “observations” section, and a long discussion section. I think that Section 4 (the descriptions of how to interpret echosounder data could go up front with a description of what echosounders and why they are useful). In Sec. 4.1 lines 239-247 could be on the intro. Similarly, I feel the initial portions of Sections 4.2 and 4.3 could, and should, be moved up. In doing so there will almost be considerable space for reducing redundancy.

Other significant (required) revisions:

Appendix B has several issues. I will tackle them in the order they are presented. I admit that some of these comments may be related to misinterpreting what is written so if the author’s feel this is incorrect, it would be a sign that better clarifying the terms would be helpful to the readers.

First, there are several unit errors. Let's start with the units of Sv. Following MacLennan (2005) or Medwin and Clay Sv should have units of dB re 1/m. Looking at Figure 5 I see Sv plotted two different ways and I see a different definition in terms of units on line 765. All for the same variable. If this is simply a misunderstanding on my part, then it would be helpful to clarify these issues in the next.

Next, to the equation for Sv. I think it is acceptable to go with this approach (equation), but this choice in this context has me confused. If the purpose is to encourage more use of these methods by non-acousticians why focus on a manuscript focused on the details of seabed scattering? At a minimum the examples in the cited paper are presenting target strength and not volume backscattering.

These can be reconciled, but I wouldn't expect a non-acoustician to find this easy to navigate especially since the equations you use are not present in the cite paper. Should you choose to continue with this I think several of would improve this section:

1. Explain how and why the equation was modified in more detail (V vs A), stating outright what volume backscattering, total backscattering cross section per unit volume, in m^2/m^3 may be helpful,
2. Similarly, defining the units and variables so that the units actual clearly balance out to 1/m,
3. Focus more on the leading denominator terms and explain its role (again, the audience will not necessarily understand, and this is a stated objective of the manuscript),
4. Note that "C," referred to here as the "main response axis-correction factor but earlier in the paper it is referred to as the calibration offset. Be consistent.

In addition, I would add sentences to other volume backscattering formulations that more clearly define how to approach in a way that is more typical to non-sea bed applications. Formulations including the specific EK80 equations often used (Andersen et al., 2024), Lavery et al. formulations, or Stanton et al. formulations would be logical choices. I think the Andersen one is one that makes the most sense because users to might be working with an EK80 would logically find those equations most common. References if fisheries acoustics (e.g., Simmonds and MacLennan also provide user friendly information). In short, I think it is okay to maintain these equations, but summarizing where this fits in and where readers can find more information to reconcile these issues makes sense in the context of this manuscript.

I also take issue with several things about the volume here. In is well established around the community that conical representations or use of solid angle * r^2 with transducer models. This is done for the frequency domain equation, so why not reconcile these when working in the time domain as well? They are similar but I don't think it is helpful to add to the confusion given the stated objective of the paper.

There is also, I believe, an error in the time domain representation for the broadband signal. Whether equations A3 and A5 are correct is context dependent. Those equations are specifically relevant for narrowband operations when the range resolution is driven by the pulse duration but in broadband mode the $c*\tau/2$ used in the Appendix should be replaced with the

effectively pulse duration. Note also that even if the narrowband approach were correct it is written differently (τ vs T) when presented.

Revisiting the unit issue: The appendix also includes at several references the units for the volume backscatter intensity that are (1) inconsistent with the documented equations and (2) inconsistent with those commonly used. S_v should have a single unit that is consistent with the literature or it should be refined. The text references units of dB re 1mPa/m. or dB re 1 mPa @ 1/m. Please make sure all of these are consistent with the definitions and other literature.

Several references in the text are NOT included in the bibliography. Please revisit the final list and make sure that these are consistent.

Line 195 and 197: The use of the term “split-beam” echosounder is used often, but it is not relevant in most places it is used. In fact, in most cases where it is used a single beam unit could easily accomplish the same thing. I recommend a word search to remove the use of “split-beam” anywhere that the discussion doesn’t require a split-beam echosounder for the processing.

Line 214: The range resolution is calculated incorrect. Assuming a sound speed of 1470 m/s and the transmitted bandwidth (80 kHz) one should calculate a theoretical range resolution of greater than 9 mm (Line 214 says 1.5 mm). In practice this range resolution is probably less than 1 cm due to practical considerations. Please fix.

Line 625-630: I take issue with a few of these comments about surface noise. Rain noise does not inherently decrease as one moves from the surface and the bonus of attenuation at shallow depths isn’t going to buy much. Going to depth with help you if your “ship noise” is indeed your ship, but that’s not necessarily how I interpreted this. What’s missing here is that the electrical noise in many installations is going to be as important, if not more important, than these other issues. I strongly recommend rephrasing this. Following onto the next page I think that much of this is unnecessary as it could be replaced with minimizing vibrations and the impacts of bubble entrained by the vessel help minimize noise and performance degradation. Notable, these transceivers/transducers have multiple stages of filtering that do manage to mitigate some of these impacts so I don’t think I would dwell too much on this.

Is Section 5.2 really needed as this only includes references? I’m fine with it staying in but a few references for those unfamiliar with these issues could go in the intro and this could disappear.

Recommended (minor) revisions:

Below are many recommendations for other modifications to the text. Many reflect personal preferences and can be ignored while others are more substantive.

The title is missing a hyphen in “high-frequency”

I also think that you should also say echosounders or note the systems are active in the title. A high-frequency hydrophone would also be an acoustic system but isn't relevant here. You could also probably drop the “broadband” as even high-frequency narrowband systems could achieve much of what is presented here.

The list of references to acoustic scattering studies presented herein is substantial and covers a broad range of relevant literature. There are several recommendations for citations for coastal research that were not included. Examples of some relevant references that could be included are noted below in response to line 64.

Again, please cross check all references mentioned in the text and ensure they made it into the final reference list, I counted at least two references that were missing,

The word “broadband” is used too many times (in my opinion). A search for it turned up over 60 uses (excluding the references). In many of these situations the word is not helpful as the methods could explain the work. The term “broadband” could be reserved explicitly for times when there is something about the broadband operation that is required or unique. When trying to reach a broad audience it is helpful to be explicit how/when/why broadband is particularly advantageous and, in my opinion, why reserving “broadband” for cases when it is relevant is important.

The following comments are take or leave, but would simplify the language and presentation.

Line 36: Strike “both in terms of sampling rate and spatial scale” and the second use of “observational”

Line 48: Strike “observational”

Line 53: The reference to Stanton and Chu here confused me some as this is typically referenced related to range resolution, but the sentence is referring to along-track length scales.

Line 56: A hydraulic jump is just one type of hydraulic transition. I recommend changing this to hydraulic transitions and note that Farmer and Amri (1989) provide a good example of the transition from sub to supercritical.

Line 64: While I would agree with the statement that echosounders are underutilized in coastal studies, there is still plenty of unreferenced examples that could have been cited here. Geyer et al (2013) [POMA] covers this matter some but misses the more modern examples that include Baschek et al 2006 (British Columbia), Kilcher and Moum 2010 (Columbia River), Geyer et al 2010 & Holleman et al 2016 (Connecticut River), and Bassett et al 2023 (James River).

Heading 1.1.

Very little of this section actual deals with “split-beam” echosounders. This is not defined and the vast majority of what is discussed is easily accomplished using single beam echosounders. I would recommend striking the split-beam in the heading but adding a sentence defining split- vs single beam systems if the goal is to reach a new audience. There is another comment about the use of split-beam references later in the manuscript.

Line 99: Recommend striking “often exceeding 500k” as I think the prior comments are adequate.

Line 106: Strike “crucial”

Line 109: Need period at end of 3)

Line 111: The sentence that starts with “Section 4” is a bit of a mouthful. Consider revising.

Line 119: The first sentence is out of place. I recommend moving to the beginning of the end paragraph where data collection is discussed.

Line 147: Caption. Strike “used in the analysis..., respectively.” Refer back to this in Figs 3 and 5 instead.

Line 150: Replace “acoustic water column data” with “acoustic backscattering data throughout the water column.” Then, for the next sentence, replace “Broadband acoustic water column data” with “Acoustic data”

Line 152: Replace “transmitting through a” with “with a”

Line 153: Missing a “&” in the 7CD model

Line 154: Strike “acoustic” before geometries?

156: Strike “a near-horizontal” and add “relative to the horizontal” after declination angle?

Line 157: Strike “in broadband mode” – already stated

Line 158: I don’t believe the you ever mention the parameters used.

Line 160: Replace “both a” and add “s” after spheres. Also strike “well-documented”

Line 161: Is this supposed to reference Demer et al. (2015) instead?

Line 172: Note χ_t is written wrong (T is not a subscript as written)

Line 205: If the point is reach a broader audience why refer to the “along-ray path” resolution? This could be time or range (typically the vertical). Similarly, if we want to get into details, the beam ultimately diverges and will refract with the sound speed profiles so avoiding the along-ray language is probably beneficial.

Line 208: Replace “pulse bandwidth” with “transmitted signal’s bandwidth”

Line 210: Replace “transducer fire” with “transducer’s pulse repetition” rate (this and other recommendations are more consistent with the rest of the literature)

Figure 3. Plots need labels for units. They are missing in several places. In the caption an instance of SA needs a subscript. There is also a missing “)” at the end.

Line 316: Replace “draft” with “depth plus blanking distance”?

Line 319 (and many following locations): I don’t think that you need to refer to the specific inset boxes in the Figures. Simply reference the figure and let the caption do the work. Looking down at the take this could clean up at least five short comments and make things cleaner.

Line 330: Rework “at the onset and ends of the sills” to just “at the ends of the sills”?

Line 335: I suppose entrained gas bubbles are possible, but that seems like an interesting hypothesis at the seabed (unless there are some seeps in which wouldn’t we expect to see further bubbles rising to the surface downstream)?

Line 359: Why is this limited to high-latitude systems? Note the missing hyphen in the manuscript as well

Line 381: It is easier to just state frequency-dependent attenuation?

Line 382: I would note here that 200 m is good performance for a 200 kHz transducer installation. Many vessels struggle to get this. I’m not sure whether it is worth noting that here, but several reports on echosounder use with the ES transducers show this.

Line 438: after discharge plumes strike “such as the” and replace with “by acquiring data that reveals the”?

Line 463: “even provide remote measurements of geophysical signals.” In some ways this is a bit of a stretch. Is it better to suggest that acoustic inversion may be used to infer parameters of interest (e.g., X, Y) associated with geophysical processes?

Line 475: Strike “well-known”

Line 506: Strike “broadband” as realistically this could be done with narrowband measurements?

Figure 5: Spelling error in characterize. Strike “broadband” before echogram. Unit error on the y-axis? I realize uPa are customary in acoustics, but the units here should be the same as Sv in the echogram unless a different equation is being used. If that is the case, then using a different variable name would be helpful.

Line 558: Fix unit (m^3)

Section 5: As stated with broadband work above, there is a lot of “high-latitude” references in here when, simply put, they aren’t needed. I think it’s fine to say it once, but I don’t think it needs to be repeated (used 5x in the paragraph starting at 585 alone).

Line 607: Echosounders don’t need to be split beam to be calibrated. Rephrase. Echosounders also only need to be calibrated if used for quantitative purposes. There may be many in the audience here that are most interested in the qualitative (as many estuarine oceanographers are).

Line 609: I would rephrase these “corrections” as simply accounting for the underlying physics.

Line 613: Split-beam and broad again. Neither are needed. This is true of narrowband echosounders. I would rephrase this entirely as well. E.g., “Echosounders used in scientific applications have high sensitivity to scattered sound, which allows for the measurement of relatively low intensity acoustic signals.”

Line 622: Strike “as well as... latitude oceans”?

Line 640: This might be the only paragraph in the paper that really requires the split-beam processing, but it doesn’t say anything about them.

Line 655: This refers to Eqn A2, not 2.

Line 665: This could be simplified to “The post-processing pipeline for broadband echosounder data...” and strike “applications”. The “split beam” could also be removed here

Line 670: typo, should say “processing” and split beam could be removed

Line 712: These aren’t increasingly available, they are available to anyone with the finding to buy one.

Line 715: I'm not sure I agree that a WBT + split beam transducer + license is low cost (nominally \$80k+ (USD) depending on what people go with?), so context may be helpful here.

Line 765-800. See major revisions above.

Line 805: The transducer model number is correct here but is inconsistent with the prior model number provided.

Line 838: The italics in MV *Ulla Rinman* are inconsistent.

I stopped documenting split beam at some point, but I strongly recommend searching these are removing those references where they are not needed.

Lastly, I would recommend citing Bassett et al (scattering at a tidal intrusion front) somewhere in this paper. It is probably the closest analog to this work in terms of observations of scattering processes and discussions of their relevance for oceanographic studies.