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

## Summary of manuscript

This study evaluates the use of high-frequency broadband split-beam echosounders as a tool for studying physical processes in high-latitude glacial fjords, particularly near marine-terminating glaciers. The authors demonstrate that these systems can resolve fine-scale thermohaline structure, including Kelvin-Helmholtz instabilities, detect subglacial discharge features near the ice-ocean boundary, and estimate turbulent dissipation rates using acoustic inversion techniques with good agreement to traditional instruments. The authors argue that broadband echosounders can fill critical observational gaps in fjords and serve as a low-cost, versatile tool for capturing 3D structure and mixing dynamics in challenging environments near tidewater glaciers. However, the claim that these systems can be deployed safely and at a low cost in close proximity to glacier termini without acknowledging the substantial safety constraints must be addressed, and I don't think this paper can proceed without being incorporated. It could also benefit from some reorganization for improved readability.

## Reviewer background

My background is in collecting sonar and hydrographic data near marine-terminating glaciers. As such, my review focused primarily on the application of acoustic methods to observing processes at the glacier terminus, particularly in relation to safety, interpretation of acoustic features, and observational feasibility. I did not comment in depth on the technical implementation of the acoustic inversion algorithm or transducer signal processing methods.

## Major Revision

The claim that high-frequency broadband echosounders are a "low-cost, low-effort addition" to experimental field kits (line 19) significantly understates the logistical and safety challenges of operating near marine-terminating glaciers. Actively calving glacier termini are extremely hazardous, and current safety guidelines typically recommend maintaining a minimum distance of at least 200–500 meters for crewed vessels depending on the glacier/location. The suggestion that this system could be routinely used in close proximity to the ice face without acknowledging these constraints is misleading and potentially dangerous. If the goal is to promote glacier-proximal observations, the authors should clearly state that such surveys must be conducted with uncrewed or remotely operated platforms to ensure safety. However, doing so would also require revising the argument about the system being low-cost and low-effort, since deploying autonomous vehicles in these environments is neither trivial nor inexpensive. This issue must be addressed directly to avoid mischaracterizing the feasibility of the method.

## Minor Revisions

The overall clarity and readability of the manuscript could be improved by more clearly distinguishing between background, methods, results, and interpretation. For instance, the section between lines 190–210, which provides helpful background on the echosounder system, might be better suited to a dedicated background or methods section rather than appearing in "Interpretation and analysis." As a reader, I would find it clearer if the results and interpretation were more distinctly separated, or if transitions between observation and analysis were made more explicit. Additionally, some content in lines 525–540 reads more like methodological detail and could be moved to the methods or an appendix. While these changes aren't strictly necessary, they would likely strengthen the manuscript's organization and make it easier to follow.

## Specific Line Edits

**Line 190–210:** Move the echosounder background material into a dedicated methods or background section. It currently appears in "Interpretation and analysis," which is conceptually inconsistent.

**Line 364:** "ice bergs" → "icebergs"

**Line 430:** "Generally agreed…" lacks details → Were the extents the same size? Were they located in the same area? Quantifying this agreement would strengthen the claim (e.g., "Surface expression width was within X% of the width measured acoustically").

**Section 4.3:** Consider moving this section before Section 4.2 to provide context on what geophysical parameters can be inferred from the acoustic signal before discussing plume/ice-face interpretations. I was curious as to what you think is scattering the signal within the plume after reading section 4.3. Do you think it's sediment? Can you see that from the surface expression?

**Line 489:** Missing closing parenthesis after citation.

**Line 525–540:** This section mixes methodological description with results and interpretation. Consider moving parts of this to the methods section or appendix.

**Line 565–574:** Quantify agreement between model and observation ("within a factor of 2"?), and consider plotting predicted vs. modeled.

## Figures

**Fig 3.:**

- Consider adding scale bars to panels showing KH instabilities

**Fig 4.:**

- Can you clarify how SDP extent was determined? Was the outline based on a qualitative echogram interpretation, or was it mapped from surface ice mélange expression and transposed?
- Is it possible that ambient plume signals appear in the echogram around ~250, ~525, or ~720 m along track? Can you comment on these signatures in the main text or caption?