JASA-07398R1
Bhatt, Viquez, Schmidt
Under-ice navigation using real-time model-aided range estimation

Dear editor,

Thank you for the thoughtful feedback on this manuscript and the opportunity to submit for upcoming publication in JASA's special issue on Ocean Acoustics in a Changing Arctic. We hope you find the changes outlined below and in the manuscript satisfactory for publication.

Sincerely,

Dr. EeShan Bhatt

Response to Editor and Reviewer Comments

1. Lines 67-86. This paragraph in the Introduction does not accurately describe the contents of the papers that are referenced.

Thank you for pointing this out. We have amended these statements using the reviewer and editor provided suggestions. Please see 21c for more detail.

2. Various acronyms need to be defined the first time that they are used (including in the abstract).

Thank you, we have made sure to introduce all acronyms the first time they are used in the abstract and manuscript.

3. References. Several of the references are incomplete.

We have addressed each incomplete reference as pointed out in the editor's Word file, and added DOI links where possible.

For better or worse, I could not help making a number of editorial suggestions for you to consider. I converted the manuscript to Word so I could use Track Changes to make it easy for you to find the changes that I suggest as well as the comments and questions that I had as I read the manuscript. The formatting of the converted manuscript is not great, but I think that you should be able to find the various edits and comments. (Some of the insertions may be difficult to see, but you should be able to find them by looking for the vertical bars on the left-hand side of the marked-up manuscript.) The marked-up manuscript includes suggested revisions to the paragraph on lines 67-86. It also indicates the references that are incomplete. The various editorial suggestions are not mandatory for acceptance, but you do need to address the more substantive issues listed above as well as the reviewer's comments. Please feel free to contact me if you have any questions on my suggestions.

We sincerely appreciate the detailed feedback. We have incorporated all editorial suggestions; the large majority verbatim and the remaining with minor differences. For clarity, we list selected comments here with responses.

4. Line 101. I wouldn't say that signals that reflect/scatter from the ice experience minimal attenuation.

Agreed. We have removed this statement.

5. Line 162 "one-tenth of a millisecond resolution". What does this mean? Is this the accuracy of the measured travel times?

We have amended the statement to: "... and a real-time clock features a precision of 2 ppm and a resolution of one-tenth of a millisecond".

6. Line 214. Which version of the WOA? Provide a reference.

We have added the reference.

7. Line 227. Define LAMSS.

We have removed mention of LAMSS – the Laboratory for Autonomous Marine Sensing Systems – as it is an unnecessary detail for the name of the software project. Instead we say the "default value in the ICNN".

8. Line 258 (and other instances). "Predicted" seems an odd choice of wording.

We use "compute", as suggested, when describing the calculation, and "predict" when analyzing the overall process or impact.

9. Line 267. "Time front" is two words in analogy to "wave front". Please see the AIP style guide.

This has been corrected, but referencing comment 21g, we have used OWTT where it is more appropriate than time front.

10. Equation 2. Do you mean "c" rather than "u" in this equation?

This has been corrected.

11. Line 279. You haven't demonstrated the claim that this method is orders of magnitude faster than other methods.

We have recast this statement to emphasize that this method is automated and computationally lightweight for real-time use without comparison to other methods.

12. Figure 5. It would be easier for the reader if this figure were plotted in the same order as Figures 9 and 10.

Thank you, this is a great suggestion. Figure 5 has been "rotated" to match Figs. 9 and 10. **We note that we are happy to rotate all three figures, for a vertical layout, if this suits the printed format better. This correction would only take a few minutes if requested.**

13. Line 312. "In the hopes that the eigenray will converge to the receiver locations for the most realistic sound speed input". What does this mean?

We have removed this line, but what we meant was that we hoped to see more accurate eigenrays estimated in the observed SSP compared to the modeled SSP. In fact it is the opposite due to the shadow zone and the density of the ray fan. We thought the explanation of Fig. 10 was the best place to convey this nuance (see comment 18).

14. Line 328. “Eigenrays for HYCOM and the baseline SSP are visually appropriate”. What does this mean?

Thank you for asking it this way. We have rewritten this statement to be more descriptive, “Eigenrays for HYCOM and the baseline SSP intersect with both shallow and deep receivers. Eigenrays for the weighted SSP show how the surface channel intensifies ice interactions for shallow receivers and how the shadow zone denies reliable acoustic paths to the deeper receivers.”

15. Lines 343–350, last paragraph of Section III.C.3. I don’t understand the point that you’re making in this paragraph.

We have modified this paragraph a bit to be more concise. We hope the point that comes across is that the initial MB approach failed to account for the complexity of acoustic multipath on ranging.

16. Line 358. Have you shown this? I don’t think that this sentence is necessary.

We have not shown this and have removed this sentence accordingly.

17. Fig 9. The red dots are difficult to see. Something needs to be done to make them more visible.

We have made the red dots a bright green, less transparent, and bigger. We feel they stand out more clearly compared to the red dots and are better distinguished from the yellow-orange dots.

18. Lines 429–430. “The increased error for these is most likely driven by the computational artifacts encountered when propagating through the steep sound speed gradient of the lens…” The weighted SSP seems to work fine for the 20 to 90 m transmissions. Shouldn’t that case have the same issues as the 30 m / 90 m pairings?

This is a great question. The 20 m source is in the middle of the LBL network, so ranges to the other ice buoys are much shorter (up to 2 km compared to up to 3 km). Accordingly, the receivers sit just outside or on the edge of the shadow zone, where the ray fan is dense enough to resolve eigenrays.

Reviewer's Responses to Questions

19. **Is the manuscript of good scientific quality, free from errors, misconceptions or ambiguities; does it present original work; and does it contain sufficient new results, new applications or new developments of reasonable enough significance to warrant its publication in JASA? Please indicate in your report (in detailed comments, below) any points which are objectionable or which need attention.**

Reviewer #1: It presents original work. The manuscript is improved from the last submission and the authors have incorporated most suggestions, but the paper would still benefit from more editing.

Thank you. We have incorporated the suggested editorial improvements and had an additional reader comment on syntax and sentence structure as well.

20. **Is JASA an appropriate journal in which to present this work? In this regard, please consider carefully the commitment of JASA to publish work that is within the scope of Acoustics. Does the content of the manuscript, including terminology and the references cited, meet this criterion?**

Reviewer #1: Yes

Thank you.

21. **Is the manuscript a clear, concise, reasonably self-contained presentation of the material, giving adequate references to related work? Is the English satisfactory? Please indicate needed changes in your report.**
    a. The last sentence of the abstract is not a complete sentence.

There was an unnecessary “for” that confused the meaning of this sentence. It has been removed.

    b. The authors have changed “group velocity’ to effective sound speed’ in many, but not all places. Please be consistent throughout.

The “group velocity” term was left in erroneously. This has been changed throughout.

    c. The introduction is improved, but would benefit from some small corrections/improvements. For example, in line 73, the localization error on the order of 100 m of uncertainty in the Van Uffelen et. al. paper seems correct, but I don’t believe there was a kilometer of error that was differentiated from the uncertainty. The Mikhalevsky work was done using a fixed not a floating array (Line 84). Also, in line 76 and following, The Wu et. al. reference lists that they cross correlate acoustic records, but should also say how this was used for localization.

We discuss the references by line item:

- Van Uffelen 2013 states “Least-squares solutions for glider position estimated from acoustically derived ranges from 5 sources differed by 914m rms from modeled positions, with estimated uncertainty of 106m rms in horizontal position.” For clarity, we have changed our sentence to, “For example, measured basin scale acoustic arrivals on gliders equipped with acoustic modems have been later unambiguously associated with

predicted ray arrivals, differing by 914 m from flight model positions, with an estimated uncertainty of 106 m rms."

- We have amended the Mikhalevsky work from "floating" to "bottom-moored", thank you for pointing this out.
- We have added for the Wu et al reference, "cross correlate the waveforms to estimate absolute range between a bottom-moored transmitter and bottom-moored receiver with 150 depths."

d. Personal pronouns should be avoided (line 195) and the style in this section in particular may be a bit colloquial for this journal.

Thank you. We have removed the personal pronoun and modified this section to present as factual narrative.

e. Line 418: The comparison of the sound speed in this profile in March with the summer sound speed referenced in Graupe et. al. seems unnecessary.

We have removed this comparison.

f. Lines 473 and following: Since NB is compared against 6 meters, MB should be too for a direct comparison (from the plot, it appears that the numbers would be the same).

We are not sure what the reviewer means here. From the plot (Figure 11), the NB shows roughly 55% below 3m and cumulatively 80% below 6m. In contrast, the NB shows 20% below 3m and no data between 3 and 6m. This point is further made by the box plot indicating 75th percentile (4.5 for NB and 24 for MB) underneath the histogram. For clarity, we have rewritten this paragraph to directly discuss mean, median, and 75th percentiles.

g. Line 568: I'm not sure it would be accurate to say that your approach sufficiently resolves the acoustic time fronts, as this implies you are resolving the acoustic arrival structure in depth and travel time. I'd suggest rephrasing this.

We have modified this statement to say we are resolving the OWTT.

h. Line 577: This is a pretty broad statement. Just because something is simple does not necessarily suggest that it is transferable. I'd suggest rephrasing to temper this claim.

We have rewritten this statement as, "The relatively simple nature of this approach invites a discussion about how transferable it is to other environments, spatio-temporal scales, and platforms."

i. Lines 596-598 are a bit unclear. Also, internal waves were not mentioned previously, and I'm curious why this type of variability is specified. I'd suggest either expanding on this discussion with references, or removing the statement.

We have removed the specific inclusion of internal waves in favor of perturbations to a known sound speed profile.

22. Are the tables and figures clear and relevant, and are the captions adequate? Are there either too many or too few? If any of the figures are in color, is the color essential for conveying the scientific point?

Reviewer #1: Generally yes. The caption of Figure 11 should be in complete sentences and be more descriptive of the data presented.

We have amended the caption of Figure 11 as suggested.

23. Does the paper make effective use of journal space, or are parts unnecessary, unimportant, or subject to condensation? If so, which?

Reviewer #1: It makes effective use of journal space.

Thank you.

24. Is the title appropriate and the abstract adequate for verbatim reproduction in abstract journals? IMPORTANT: The lead paragraph should advertise the main points of the article and must describe in terms accessible to the general reader the context and significance or the research problem studied and the importance of the results.

Reviewer #1: With the revisions the authors made, the title is appropriate. The last sentence of the abstract needs to be completed. While it is a nice introductory paragraph, the lead paragraph doesn't specifically speak to the work presented here.

Thank you. It seems we formatted the "lead paragraph" as two, and have now joined them. We are happy to make edits to this lead paragraph as suggested.