

Response to Anonymous Reviewer 2

Thank you for the corrections you have made to your manuscript. I found the responses to my review very thorough and believe that the updated manuscript has benefited massively from the changes made. The paper now feels very targeted towards a cryo-seismology and glaciological community who will be able to directly benefit from the method and results published. However, I find the discussion of the paper is still lacking in critically assessing the results that they have published. Therefore, I am happy for this paper to be published assuming the following is addressed.

Thank you very much for your constructive comments and suggestions! We have carefully revised our manuscript accordingly. Please find our point-to-point responses below. The line numbers used in this response letter refer to the manuscript with marks.

Discussion:

1. The author has removed the majority of the text comparison between East and West Antarctic firn, but has kept the figures in comparing results. They have not added any additional discussion on what the firn profile from Dome A actually shows, why it is important for that region or what the results tell us. They do reference what this means for the grain structure of Dome A in the section above, which perhaps could be moved to the discussion.

We described the meaning of the Dome A study in the “Introduction” (Lines 63-72). We also added descriptions about this study in Dome A in the “Discussion” in the revised manuscript as:

“Most of the previous studies in Antarctica report density with either V_{SH} or V_{SV} , we showed that joint analysis of V_{SH} , V_{SV} , and density provides a more comprehensive characterization of the shallow structure at Dome A. It improves our understanding of the transition of snow, firn and glacier ice at this high point in East Antarctica.” (Lines 225-228 in the revised manuscript)

2. The author also acknowledges that they could assess the variation in firn along/across profile but do not do this. This is a shame, and would have been a valuable addition to the paper and formed a relevant discussion on what the results mean for Dome A.

Thank you for your suggestion. In our study, Line 1 is deployed right across Dome A, while the central point of Line 2 is more than 10 km away from Dome A. Our study focuses on the shallow firn structure (~100 m depth) at Dome A. Therefore, we didn't assess azimuthal anisotropy, which represents an averaged value at Kunlun station rather than Dome A.

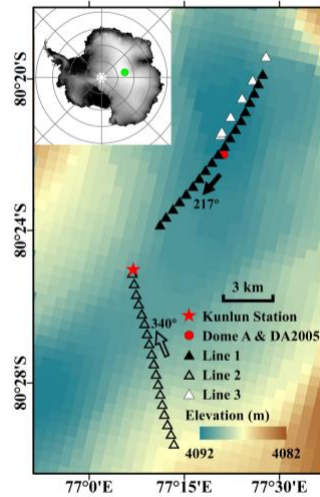


Figure R1 (Figure 1a in the manuscript). Arrays information of Line 1 (black triangles), Line 2 (black hollow triangles), and Line 3 (white triangles). The Kunlun Station (red pentagram), Dome A and the ice core (DA2005) (red circle) are also marked.

3. Currently, the discussion feels very disconnected from the rest of the paper, and a bit irrelevant to the findings. Again, comparing the results from East/West Antarctica does not feel relevant, and the way the author has referenced the results does not pose itself to be a strong enough discussion to justify why the comparison is being made. I believe, if you are going to compare results from different stations/parts of Antarctica, then a comparison between the firm profiles individually should be made, rather than grouping the models into East/West (e.g. perhaps a comment on how the firm profile is thinner/thicker at Dome A than what is expected for the given temperatures/accumulation rate?). I believe you can keep in your comparison of individual sites in antarctica but referencing a sweeping statement of East/west locations is not a relevant comparison.

We followed your suggestion and removed the broad comparison between East and West Antarctica. We focus our discussion on the specific test sites where the referenced Vs were obtained in the revised manuscript. We also removed the East and West Antarctica classification and added the specific regions in Figure 5a.

“Furthermore, we compared several existing S-wave velocity profiles of firm structures from different areas in Antarctica, which indicate relatively higher S-wave velocities at the same depth in the study areas located in West Antarctica.” (Line 27-29 in the revised manuscript)

“Figure 5a suggests relatively higher V_S at the same depth in the shallow regions in the Ross Ice Shelf, the Rutford Ice Stream, the Whillans Ice Stream, and the WAIS Divide camp. The higher V_S may indicate thinner snow layers and a more rapid transition from snow to firm and ice in these areas.” (Line 229-231 in the revised manuscript)

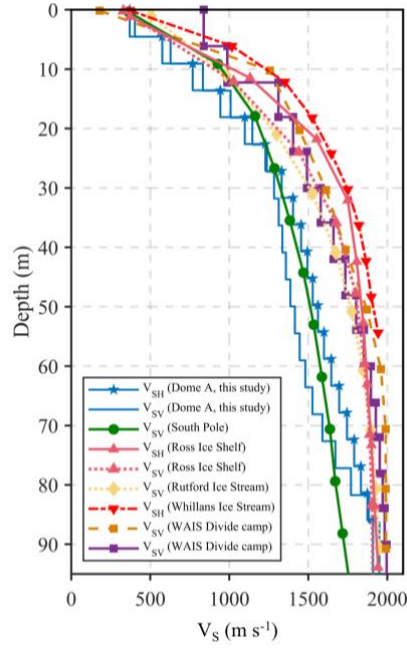


Figure R2 (Figure 5a in the manuscript). S-wave velocity from different areas in Antarctica. (a) V_{SH} , V_{SV} from this study (blue line with pentagrams and blue line), V_{SV} from South Pole (Yang et al., 2024; green curve with circles), V_{SH} and V_{SV} from Ross Ice Shelf (Diez et al., 2016; pink curve with triangles and pink dotted curve with triangles), V_{SV} from Rutford Ice Stream (Zhou et al., 2022; yellow dotted curve with diamonds), V_{SH} from Whillans Ice Stream (Picotti et al., 2024; red dash-dot curve with inverted triangles), V_{SV} and V_{SV} from WAIS Divide camp (Qin et al., 2024, Zhang et al., 2024; brown dashed curve with squares and purple line with squares).

4. Perhaps what would be a better comparison is to compare the ratio of V_{sv} to V_{sh} for each site, so the comparison between firm models can be made irrespective of location. To show how the v_{sv}/v_{sh} ratio is repeatable (or not?) irrespective of location would be a useful discussion.

Most previous studies report either V_{SH} or V_{SV} alone (please refer to Figure 5a, which is shown in our response to point 3). Therefore, we are unable to estimate the V_{SV}/V_{SH} ratio for most sites.

5. Line 90: ‘We deployed a total of 73 three component seismic nodes’ – I do not understand why you do not use all 73 stations in your results. Please add a line to explain why you only use the 19 stations.

In this manuscript, we mainly used data from Line 1 to estimate the radial anisotropy in the Dome A region, as the other stations are located farther from Dome A compared to Line 1. We added an explanation in the revised manuscript (Lines 81-82):

“In this study, we mainly used 19 seismic nodes with a 500 m interval (Line 1, which was deployed across Dome A), to reconstruct the shallow structure at Dome A region.”