RC1: 'Comment on egusphere-2024-2349', Rebecca Sanderson, 18 Sep 2024

Review of "Age-depth distribution in western Dronning Maud Land, East Antarctica, from three decades of radar surveys"

The research uses radio echo sounding data to explore internal reflection horizons (IRHs) and the age-depth distribution of ice across western Dronning Maud Land, East Antarctica. Using various radar systems, the researchers trace nine IRHs and assign ages from a two-way travel time to depth conversion and by employing radar forward modelling based on conductivity peaks from the DML ice core. The article presents a new, useful cryospheric dataset that has been used here to explore the englacial architecture across DML. The work is very well written, meticulously constructed, clearly elucidates all the methodologies employed, as well as demonstrating the possibilities of tracing the same IRH across multiple radar surveys.

While the article presents a very useful data set, I believe that its application could be expanded in places, e.g. the relationship of the IRH depths/normalised depth with current ice velocity or accumulation rates (may only require a figure and a line or two adding in places). This would allow for a science focus rather than a data driven focus. I believe that this can be achieved through minor corrections, as the data is already telling the story. Therefore, I suggested that the paper be published with only minor revisions to account for this.

> We would like to thank Rebecca Sanderson for taking the time to review our paper and we appreciate the constructive suggestions and the overall positive feedback. Below, we address the key aspects raised.
>
> As suggested by the reviewer, we have expanded Section 4.5 to deepen the discussion of the direct implications of IRH depths (or normalized depths) by comparing them to ice flow velocity, bed topography, and accumulation rates. Additionally, we have included a new figure to support this discussion.

Specific comments:

In the first paragraph of 3.2, you need to be explicit that you are talking about traceable IRHs.

> We are not sure if we got the reviewers point correctly, because the first sentence of this paragraph starts with: *"The overall coverage of **traceable** IRHs in this study spans the entire western DML, covering an area of […]". We therefore do not see a need to make further changes here.*

In section 4.2 you link IRH to volcanic eruptions, this is really interesting for the broader picture but for most of the IRH ages, the suggested eruption dates are a couple of

hundred years out, either before or after the eruption. Could you explain the reason for this, e.g. do you think this just a function of dating uncertainty/ radar system resolution?

> We assume that the discrepancies in age between the IRH dating and the ages of volcanic eruptions, whose deposits make the IRHs visible in the radargram, are caused by a combination of the respective dating methods. The example of the dating of the Toba eruption (Svensson et al., 2013) shows that the dating method of volcanic eruptions is crucial. Although we obtain a very precise dating based on the depths of the assigned conductivity peaks at the EDML core, this age refers only to that specific core. It would not surprise us if the dating of IRHs at other cores, using the same method, produced different results, yet still had a small age error at each individual core.
>
> As suggested by the reviewer, we have now included this aspect in the respective section of our manuscript.

I think it would be useful to expand section 4.5 to talk about some of the direct application of your dataset. I think the addition of a more detailed explanation of how the IRH that you have traced in the DML region represent dynamic changes over time would improve the manuscript. This could include links to ice velocity, bed topography, accumulation rates.

> We agree with the reviewer and expanded Section 4.5 to include more direct applications. In line with one of the earlier comments, we have now better illustrated the direct comparison of IRH depths (or normalized depths) with ice velocity, bed elevation, and accumulation rates, as well as the implications for dynamic changes.

Your figures are clear and support the text well, but I found myself jumping around a lot when they are mentioned in the text. For example figure 2 is on page 6 but the first time you refer to it is page 12. Likewise, I am unsure that you refer to figure 3 at all in the text.

> Thank you for spotting this, we now reference Figure 3. We will rearrange the figure position in the text to be in line with the content, however, we believe that the final decision will be made together with the typesetting team.

Line suggestions:

Line 61 Refer to figure 1 here.

> Done.

Line 105 “An additional gain function was applied to the radar data (also known internally as AGG products) to enhance reflections at all depths.” Unnecessary repetition of text at the beginning of the paragraph, delete this?

Done.

Figure 2 caption. Please add the following to be clear as to why you used the frequencies: “Comparison between simulated radar data for 150 and 335 MHz (150 MHz for the EMR profile, and 335 MHz for the MCoRDS wideband profile) based on measured conductivity…”

Done.

Line 148 explain the acronym: “…Finite-Difference Time-Domain (FDTD) method…”

Done.

Line 165: Maybe say “We used a constant dielectric permittivity value of $\varepsilon'_r = 3.145$ and EM wave propagation velocity of $\sim 1.69 \cdot 10^8$ m s^{-1}.” to avoid repetition.

The problem is that these are not two different choices and the EM wave propagation velocity is just the consequence of the choice of permittivity.

Line 231-235: refer to a figure here?

Done.