

We appreciate the reviewers for investing their time and providing constructive comments on our manuscript. Overall, we revised the manuscript according to their suggestions. Below, we explain the changes we have made and present our reasoning for the suggestions we didn't follow. We hope these revisions are satisfactory and the revised manuscript meets the journal's criteria. Our responses are tabbed and in blue and follow individual comments. The line numbers we refer to are those of the marked manuscript.

RC2: 'Comment on egusphere-2025-2037', Anonymous Referee #2, 06 Oct 2025

This article explores the merits of potential ice core sites on 2 ice domes in the Dronning Maud Land region of Antarctica, for extracting an ice core with a high resolution climatic record going back to the Last Glacial Maximum (~20 ka). They present shallow and deep radar surveys over both areas. They carried out a detailed assessment of the topographical setting, deeming the Kamelryggen (KAM) ice dome to be more suitable than Kupol Verbljud. They then applied a simple age-depth model would accounted for both dome and flank ice flow. The model determined the likely age and resolution of ice through the thickness of the ice sheet, concluding that 20 ka ice may be around 80 m above the bed at KAM making it a suitable ice core drill site. The study is detailed and thorough, assessing the area through both observations and modelling. The results and arguments are clearly presented, I especially appreciated Table 1 for easy direct comparison of the ice domes. Therefore, I recommend this paper for publication with a few changes.

We are pleased to hear that the reviewer found our manuscript thorough and found it worthy of publication. We are thankful for all the constructive comments. As described below, we revised the manuscript as guided by the reviewer.

Specific comments

- My first comment relates to the use of the word "reflector". Here, the term "internal reflection horizon (IRH)" is commonly used as in the AntArchitecture review covering radar stratigraphy in Antarctica (Bingham et al., accepted). Therefore using "IRH" could help the community move to more standardised language when referring to these radar phenomena.

Thank you for bringing this up. Sometimes it takes a little nudging to move away from what we are used to to what the community has agreed upon. We have now revised the manuscript to replace the word "reflector" with "IRH".

- It would be helpful to explain fairly early on, that there is a single IRH tracked in the shallow radar used for determining SMB. Then there are several other IRHs presumably tracked in the deep radar used for age-depth profiling. I found it quite difficult to disentangle at various points in the manuscript as they are often just referred to as "the reflector(s)".

Thank you for bringing up this issue. We have now revised the manuscript to clarify which IRHs were tracked from the two datasets.

L125:

"To study the spatial distribution of SMB over the ice rises, we tracked the deepest prominent radar reflector visible in the shallow radar stratigraphy that could be dated using the firn core. .. Additionally, we tracked seven reflectors visible in the deep radar stratigraphy of KAM (approx. depths of ~0.84H, ~0.73H, ~0.65H, ~0.58H, ~0.49H, ~0.43H and ~0.33H at the summit) with the top five continuously tracked over the complete survey, while the bottom two limited to the vicinity of the ice divide."

- The IRHs in Fig 6d are never fully introduced. From their ages I assume they must be from the deep radar system. There should be a paragraph describing how many IRHs were tracked in total, at what depth/fraction of ice

thickness, with which radar system and referencing a figure so the reader can see the coverage. Such descriptions could be added at the end of section 2.1.

Please refer to the previous comment.

- It should then be made clearer throughout the manuscript, whether you are referring to the shallow or deep IRHs. Eg.

- L159-171 - mention that it is the deep IRHs used for this purpose

Corrected.

- L273 - make it clear that here you are talking about the deep IRHs. As in the next sentence you talk about the shallow IRH at KAM

Corrected. Rephrased at L276 as:

"The primary difference in this method from the site-specific modelling (Section 4.1) is the use of the mapped englacial stratigraphy (i.e. tracked deep IRHs) to invert for the divide flow characteristics along the survey profiles and determine the spatial value of df ."

- L278 - age mismatch with the deep IRHs.

Corrected.

- L281 - Mentions "eight reflectors" but there are only 7 in Fig 6a. Would also be good to reference Fig 6a here.

Corrected.

- Figure 7 - There are a few things I could not make out in this figure, even while zooming in on the pdf. I could not see a black curve showing the mean estimate. Perhaps it is the thick dark blue curve that does not follow the colour gradient? In which case it would be good to change this to a thinner black line.

Thank you for bringing this up. The dark curve was indeed the mean. Have updated this in the new figure and included a legend.

- My other comments are based on this assumption. Does the mean age and resolution mean the most probable? Or is it the weighted average age from your 120 results taking into account each profile's likelihood. This should be further clarified in the text (L287-290).

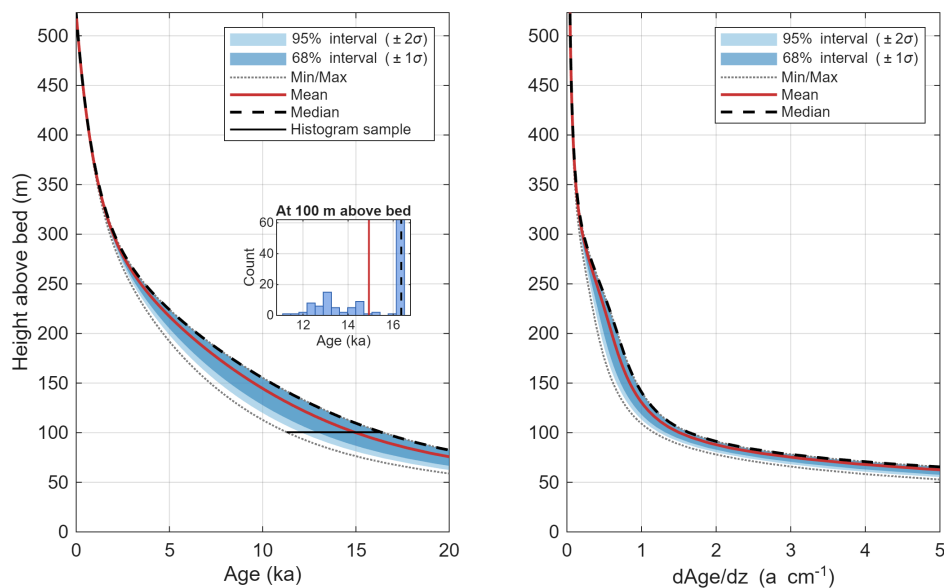
To clarify: this is the unweighted mean of all the 120 ensemble members with each ensemble given equal weight. Each of the ensemble member represents a different plausible scenario through which we propagate the expected uncertainty in our age estimates. The text has been rephrased for clarity (please see our response to the next point.)

- Ignoring the dark blue line which I think may be the mean, it seems as though the gradient (in Fig 7a), and therefore probability, increases towards the upper bound ie. where older ice is shallower. As the probability increases but does not seem to reach a maximum, why were scenarios not tested where the older ice is even shallower?

The figure showed the normalized cumulative density function of the ensemble age estimates with each horizontal slice. So at each point along a depth it gave the cumulative probability, showing the fraction of results that lie to the left of that point. The reviewer's comment prompted us to reconsider our

visualization approach assuming normal distribution, and instead opting for a distribution-free representation as explained below.

In this specific case of age-sampling at the summit, where we expect the ice flow to show “divide flow” characteristics i.e., with the df approaching 1, the distribution is not normal but skewed. To represent these results without assuming any predefined distribution pattern we adopt the method of showing $\pm \sigma$ instead, where σ represents the standard deviation-equivalent percentile intervals: 68% interval (16th-84th percentiles, approximately $\pm 1\sigma$) and 95% interval (2.5th-97.5th percentiles, approximately $\pm 2\sigma$). Percentile bands are distribution-free, with percentiles derived by sorting the ensemble members and selecting values at specific positions. The squeezing of the bands towards the right suggests the clustering of the age estimates towards divide flow characteristic estimate. The revised plot also show the min-max values to show the range of age estimates as well as the mean and mode locations.



Also revised the text at Section 4.2.1 Para 3 (L296) as:

"Age-depth estimates at the summit are shown in Figure 7a with empirical percentile intervals: 68% interval (16th-84th percentiles, approximately $\pm 1\sigma$) and 95% interval (2.5th-97.5th percentiles, approximately $\pm 2\sigma$), alongside ensemble mean and median. At the summit mean and median diverge, indicating skewness in the ensemble results, as expected at the ice divide where df approaches one. Further, we calculate the depth profile of the temporal resolution of the ice core (Fig. 7b). The mean age and resolution profiles suggest an age of 20 ka at ~80 m above the bed at a resolution of ~2.5 a cm⁻¹."

- It may be useful to include an inset in the top right hand corner to zoom in on the deeper section, as this would make the colour gradient and lines easier to differentiate by eye.

We acknowledge the reviewer's concern about visual clarity, and found it more informative to include a histogram of ensemble results at a specific depth slice to understand the distribution better. We also include the mean/median location from the plot in this histogram.

Minor Corrections

- L16 - A radar survey reveals...

Corrected.

- L24 - ~ 20 ka

Corrected.

- L32 - "... often exhibit distinct characteristics from comparable events...". This sentence is unclear as it sounds as though event characteristics which appear very clearly in the Northern Hemisphere, also appear in the Southern Hemisphere climate records. But I think you mean that these events can have different characteristics in Southern Hemisphere records, so this should be reworded to make it clearer.

Corrected. Now rephrased as L(31):

"These events, such as the Last Deglaciation (18-11 ka; Mayewski et al., 1996), the Antarctic Cold Reversal (14.7-13 ka; Pedro et al., 2016), and the abrupt cooling event 8.2 ka ago (Stager and Mayewski 1997), often display characteristics that contrast with those observed in comparable Northern Hemisphere events."

- L48 - sea ice variability

Corrected.

- L58 - the Antarctic coast

Corrected.

- L104 - add a reference for the value of 169 m us-1

Added.

- L131 - the ice's age

Corrected.

- L134 - from your description, it seems to be a steady model, not pseudo-steady but reviewer 1 has already mentioned this in more detail

Corrected.

- L183 - "...until the extent of ..."

Corrected.

- L185 - "...VER has a steep slope just at the summit." From looking at Fig 2d, it is clear what you are referring to but the sentence alone is unclear. It could be changed to something like "... the summit of VER occurs at the edge of a steep slope in the bed."

Corrected.

- L190 - "30 years prior" - this phrasing sounds like age of the reflector was determined 30 years before the current study was carried out, so maybe change to "the age of the reflector is 30 a", if that is the intended meaning or clarify further if not.

Corrected.

- L236 - "mean spatial" instead of "spatially mean"

Corrected.

- Also L236 - "The most critical differences ... are bed topography ..."

Corrected.

- L276 - if I understand correctly, this random value of p is then optimised? So it may be helpful to remind the reader by saying "... assigned a distinct initial value of p ..."

To clarify: the random p values (2-4 range) are not optimized. Each ensemble run uses its assigned p value to calculate initial ages at locations outside the divide region. Then, at each spatial location, we optimize the df to reproduce these initial age estimates. The resulting df distribution thus incorporates the uncertainty associated with the choice of p in the initial sampling step.

- L299 - Figure 7c does not exist

Corrected.

Reference Bingham, R. G. et al. (Accepted). Antarctica's internal architecture: Towards a radiostratigraphically-informed age-depth model of the Antarctic ice sheets. EGU Preprint Repository, 17, 33. <https://doi.org/10.5194/egusphere-2024-2593>
