Response to reviewer #2 for 'Short and long-term grounding zone dynamics of Amery Ice Shelf, East Antarctica' - EGUSPHERE-2025-849

Yikai Zhu, on behalf of the authors,

We thank Reviewer #2 for the insightful comments and helpful suggestions, which have contributed to improving both the scientific content and clarity of the manuscript. The table below presents a detailed response to each comment. The reviewer's comments are shown in the **Comment** column, followed by our **Response**. Changes made in the revised manuscript are referred to in the **New line** column, while the **Line** column corresponds to the original manuscript. The revised manuscript uses blue highlighting to mark all modified sections.

ID	Comment	Line/ Figure	Response	New line
2.1	The present paper can be shortened, some detailed parts (e.g. described in the previous paper) can be moved to Supplement. Instead graphs in the Supplement (S3 – S5) which are discussed in the main paper should appear here. The novelties of the manuscript, the application of DROT method to >1100 km of AmIS boundaries, can thus be highlighted and its originality emphasized.		**Done.** To streamline the manuscript, we have simplified the description of the inverse barometer effect (IBE) correction in Section 2.2 and moved the comparison with two grounding line datasets (previously in Section 3.2) to the Supplementary. As suggested, Supplementary Figure S3 has been relocated to the main text and now appears as revised Figure 4 to more effectively illustrate the short-term migration modes. Figures S4 and S5, on the other hand, have been retained in the Supplementary because they present additional regional examples that support the main conclusions but are not essential to the overarching narrative. We believe keeping these figures in the Supplement helps maintain focus in the main text while still allowing interested readers to access the detailed regional analyses.	
2.2	The Grounding Line is a product of the GCOS ECV Ice Sheets and Ice Shelves and not an ECV by itself. https://gcos.wmo.int/site/global-climate-observing-system-gcos/essential-climate-variables/ice-sheets-and-ice-shelves	23	**Comment.** We have retained the original description of the GL as an Essential Climate Variable. As the GCOS web link provided by the reviewer shows, GL is an EVC product with associated measurement precision requirements. In our experience, the GL has always been referred to as an ECV within the context of international ESA projects, so we have retained the description as it will be understood by that relevant community. The ice sheet (or shelf) alone would not be an ECV because it is not a single measurement variable. It's possible we have misunderstood the reviewer comment, so hopefully this clarification provides useful context.	23
2.3	Add "atmospheric pressure"	43	**Done.**	47
2.4	"Sentinel-1A" and "Sentinel-1B"	117-118	**Done.**	121-122

2.5	The description of the IBE correction is identical to Chen et al, 2023 Section 2. This can be shortened to one sentence with citation.	147-156	**Done.** Line 153: "We applied inverse barometer effect (IBE) corrections using a 1 cm/hPa conversion (Padman et al., 2003) from the fifth generation of ECMWF atmospheric reanalyses of the global climate (ERA-5) pressure anomalies, following the method described in (Chen et al., 2023)."	153-155
2.6	By using point H you can derive the width of the flexure zone, not the width of the GZ. The width of the GZ as far as I see in Fig 2 and explained in Section 3.1 is the range of the displacement gradient where it begins to exceed zero.	174-175	**Done.** Our original intent was to use the inland position where the displacement gradient increases above zero to define the GL, and the seaward location where the gradient returns to near zero as point H. The distance between these two points was used to estimate the width of the tidal flexure zone, not the grounding zone itself. We have clarified this distinction in the revised text. Line 172: "In the seaward direction, the location where the displacement gradient approaches zero again is interpreted as point H (as defined in Figure S1)."	172
2.7	The GZ of MEaSUREs-Programme https://nsidc.org/data/nsidc-0778/versions/1 should be mentioned here or in Section 3.2 to refer specifically to AmIS.	195	**Done.**	263
2.8	Profile 5 seems to have a narrow GZ rather than a wide one (like profiles 14 and 15).	201	**Done.** We agree with the reviewer that profile 5 exhibits a relatively narrow GZ compared to other examples. To avoid confusion and better support our interpretation of wide GZ characteristics, we have removed the reference to profile 5 in the revised manuscript and retained profiles 14 and 15 as representative cases.	200-201
2.9	Labelling the pinning points a to k may be confused with the labels of the subplots in Figures 2 and 4 (and Supplementary S3 – S5). Maybe use brackets for the subplots e.g. (a), (b), etc.		**Done.** We have added brackets to all subplot labels (e.g., (a), (b), etc.) to avoid confusion with the pinning point labels. For consistency, we have updated all figures in the main text and Supplementary materials to follow this unified format.	
2.10	Please be more precise what concerns the "reference lines". Are these the GLs from DDInSAR?	246	**Done.** We have clarified in the revised Figure 3 caption that the reference lines (green, red, and purple) are extracted from the DDInSAR-derived grounding line results. Line 250: "These reference lines are extracted from the DDInSAR-derived GL results."	250-251
2.11	Correct citation (Depoorter et al, 2013b)		**Done.**	Suppl. 87-88

2.12	Section 3.2 is very long. A comparison between DROT and DInSAR was already shown in (Wallis et al, 2024). Starting with line 257 the comparison with the two published datasets (text and Table 2) may be moved to the Supplement or removed. As already mentioned in the paper these datasets do not have the same time stamp as the DROT GLs since they are based on at least 2 decades older data. The discussion on the bias between DDInSAR and DROT GL position should focus on the 2021 datasets. As mentioned above I suggest also to add here the comparison to the MEaSUREs GZ on AmIS.		**Done.** In the revised manuscript, we have substantially shortened Section 3.2 to improve clarity and focus. Specifically, we removed the comparison with the Synthesized GL and MAGv2 datasets from the main text and moved the corresponding table and figures to the Supplementary Material, as these products are based on much earlier observations and are less directly comparable to the 2021 DROT-derived GLs. In accordance with the reviewer's recommendation, we now focus our discussion on the comparison between DROT and contemporaneous DDInSAR-derived GLs from 2021, which provides a more direct and robust validation of the DROT technique. Additionally, we have included a new comparison with the MEaSUREs Antarctic Grounding Zone Version 1 (MAGZv1) dataset over the Amery Ice Shelf, which is derived from Sentinel-1 data acquired in 2018. Although not perfectly contemporaneous, this product offers valuable spatial context for assessing the consistency of grounding zone mapping across techniques. The results of this comparison are now presented in Section 3.2 and Figure S2. Lines 262:" The MEaSUREs Antarctic GZ Version 1 (MAGZv1) dataset provides a comprehensive map of short-term GL migration zones across the Antarctic Ice Sheet using the DDInSAR technique (Rignot et al., 2023). We compared DROT-derived GZ results with the subset of MAGZv1 dataset over the AmIS, which is based on Sentinel-1 data acquired in 2018, to assess their spatial consistency. We first computed the Intersection over Union (IoU), defined as the area of intersection divided by the area of union (Figure S2a), to evaluate the overall spatial agreement between the two GZ products. The comparison yielded an IoU of 0.44, indicating a moderate level of spatial overlap. Notably, the recall reached 0.84, suggesting that the DROT-derived GZ successfully captures the majority of the area defined by MAGZv1. However, the precision was relatively lower at 0.48, implying that over half of the area identified by DROT as GZ lies outside the extent of MAGZv1. This asymmetry reflects a broader delineation of the GZ by the DROT method, potentially capturing additional zones not included in the earlier dataset. We further evaluated the spatial offsets along the landward and seaward GZ boundaries (Figure S2b-c). For the landward boundary, the DROT-derived GZ was positioned on average 459±697 m landward relative to the MAGZv1 boundary. For the seaward boundary, the offset was -255±666 m, indicating that the DROT extend farther seaward	262-294

			into the floating ice shelf (Figure S2c.i and c.ii). These patterns suggest that the our DROT-derived GZ results tends to resolve a broader GZ, with boundaries shifted in opposite directions compared to MAGZv1. We attribute the differences observed between the DROT-derived GZ and the MAGZv1 product to a combination of methodological, temporal, and tidal factors. First, the two techniques are based on fundamentally different approaches. While MAGZv1 employs the DDInSAR method to detect vertical tidal flexure through interferometric phase change, the DROT technique measures displacement from SAR amplitude imagery, enabling GZ detection even in areas with low coherence. However, DROT has a slightly lower measurement sensitivity (a fraction of a range pixel) compared to the sub-wavelength sensitivity of DDInSAR (Joughin et al., 2016). Consequently, the DROT technique tends to position the GL slightly further seaward than DDInSAR technique, consistent with our direct comparison over three representative regions, which shows a mean absolute offset of 0.35-0.42 km with standard deviations ranging from 0.14 to 0.26 km (Table 1). In addition, the two products are derived from different acquisition periods: MAGZv1 for the AmIS is based on Sentinel-1 data acquired in 2018, whereas the DROT-derived GZ uses imagery from 2021. This temporal offset means that some of the differences may reflect real GL migration over the three-year interval, though rates of change in the AmIS region are generally modest compared to dynamic West Antarctic outlets (Park et al., 2013). Lastly, both methods are sensitive to tidal conditions at the time of acquisition, but the MAGZv1 dataset does not provide metadata on tidal amplitude for each SAR acquisition. This limits our ability to directly quantify the contribution of tidal state mismatches to the observed discrepancies. In the absence of precise tidal alignment, apparent offsets in GL position may partly reflect differences in tide-induced flexure captured at different stage of the tidal cycle. Taken together, these differences underscore the importance of method-specific sensitivities, acquisitions timing, and tidal phase alignment when comparing GL or GZ products derived from distinct remote sensing techniques.”	
2.13	Swap *ocean* and *land*. “landward GL” … refer to the GLs closest to the land.	291	**Done.**	Suppl. 46

2.14	Figure 4 and Figure S3 are almost identical. I suggest to add all profiles (those with no clear mode as well) to Figure 4 in the main text where you discuss all patterns (and delete Figure S3 in the supplement). Figure 4 and Figure S3: how is the "0" of the Y-axis defined?	344-345	**Done.** Figure S3 has been moved to the main text as part of the revised Figure 4, which now includes all profiles. We have also clarified the meaning of the Y-axis zero in the new Figure 4 caption: Note that a GL migration distance of 0 km represents the location of the seawardmost GL observed in each profile, which is used as the reference point for calculating relative migration distances.	324-334
2.15	Figure S4; Figure 4l R^2=0.83 while in Figure S4q R^2=0.84; I suggest to mention that the profiles 7,8, and 17 were selected due to their different migration pattern.		The discrepancy between the R^2 values in Figure 4l and Figure S4q was due to a typographical error — both should be 0.84, and this has now been corrected. Since the revised Figure 4 now focuses solely on short-term migration, we did not include this figure in the main text. Regarding the suggestion to mention that profiles 7, 8, and 17 were selected due to their different migration patterns. We would appreciate further clarification regarding the intended distinction.	
2.16	… it then transits downstream	371	**Done.**	368
2.17	Correct reference for Freer et al, 2023. Freer, B. I. D., Marsh, O. J., Hogg, A. E., Fricker, H. A., and Padman, L.: Modes of Antarctic tidal grounding line migration revealed by Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) laser altimetry, The Cryosphere, 17, 4079–4101, https://doi.org/10.5194/tc-17-4079-2023, 2023.	665	**Done.**	668-669
2.18	Figure S1 (b): at high tide the GL moves landward, therefore (Fmax, Gmax) correspond to low tide	Fig. S1	**Done.**	Fig. S1