Response to second round of reviewer comments for ‘Change in grounding line location on the Antarctic Peninsula measured using a tidal motion offset correlation method’ – EGUSPHERE-2023-2874

Benjamin J. Wallis, on behalf of the authors.

We thank the editor and reviewer for their time and effort in reading this revised manuscript. We are grateful for the reviewer’s comments and have responded to them here.

The line field refers to the comment’s line in the original manuscript, while ‘new line’ indicates the position of the relevant changes in the updated manuscript with tracked changes. There are no changes to the figures in this second set of revisions.

Reviewer 1:

ID	Comment	Line	Response	New line
1.1	The definition of the GZ adopts something written by H. Fricker, which refers to the ocean grounding zone or the flexure zone. It is a point of importance because some authors have mapped the extent of this zone and call it GZ width. Yet, the grounding line itself is migrating with the tide, atmospheric pressure and long term. How do you resolve that? How will you separate the fact that the flexure zone has some width, always is, typically 5 to 10 km, whereas the true grounding zone, which is the locus of temporal variations of the position of the GL, is something more fundamental, more new - because most folks did not have the data to look at it (See Mohajerani et al. 2021). It is fine to leave it like this, but as satellites provide more and more info on the position of the GL, i.e. the GZ, which is of high importance for model, their definition will become out of date and possibly misleading. Your choice. I am not sure my comment was understood. I hope this clarifies. I can see that lots of people will be - and have been - confused.	36 - 54	We thank the reviewer for clarifying their previous position and agree that grounding line/zone terminology is somewhat mixed within the community since the recent increase in interest in tidal grounding line migration. To address this, we have clarified our definition to distinguish the 'flexure zone' where ice adjusts to HE excluding tides; the 'grounding line tidal migration zone' which is the locus of true GL locations due to tide and IBE; and the 'grounding zone' to mean the combination of these two. We chose to maintain a broader definition of grounding zone, because it is useful to discuss 'grounding zone features' such as pinning points and is less in conflict with older definitions of the grounding zone. By specifying the flexure zone and tidal migration zone, we resolve any ambiguities. We have also tightened up our use of the terms grounding zone and grounding line throughout the paper. The paragraph introducing this terminology now reads: *'Rather than having a fixed location, the grounding line is a transitory feature which constantly changes over short (daily) and longer term (decadal) timescales. It is located within a wider flexure zone (sometimes also called the grounding zone), which characterises the larger area (1 – 10 km wide) where the transition from grounded ice to complete hydrostatic equilibrium occurs (Brunt et al., 2010, 2011; Fricker et al., 2009; Smith, 1991; Vaughan, 1994). The flexure zone is made up of several features; the most inland of these is the landward limit of ocean induced ice flexure, point F, which is located slightly inland of the true GL, point G, due to the elastic properties of ice (Padman et al., 2018; Rignot et al., 2011; Vaughan, 1994). In the seaward direction this point is followed by the break in surface slope, point Ib, and the landward limit of stable hydrostatic equilibrium, point H. Additionally, in locations where there is an ice plain at the flexure zone, point Ib may be located inland of the GL, point G (Brunt et al., 2011; Corr et al., 2001). Schematics showing the cross section of the grounding line are*	36 - 63

			widely available in the literature (Brunt et al., 2010, 2011; Dawson and Bamber, 2017; Fricker et al., 2009; Friedl et al., 2020; Smith, 1991; Vaughan, 1994). The true grounding line is a sub-glacial feature, so cannot be directly detected by satellite remote sensing measurements, which must instead measure surface expressions which are proxies for the GL or are used to deduce the GL position. Additionally, the true GL where grounded ice loses contact with the bed can migrate with changing sea-level caused by ocean tides and atmosphere pressure variations by the inverse barometer effect (IBE). This range of short-term tidal grounding line migration has also been referred to as the grounding zone by recent publications (Mohajerani et al., 2021; Rignot et al., 2024). The extent of this migration is also controlled by bed topography, ice thickness and ice rheology (Brunt et al., 2010; Jonathan and R, 1994; Padman et al., 2018) and further complicated by non-linear tidal migrations, which can show threshold and hysteresis behaviour (Freer et al., 2023; Milillo et al., 2022). For the purposes of this study we use the following terminology: 'flexure zone' to describe the features of ice flexure relation to the transition from grounded to hydrostatic equilibrium, excluding tides; 'grounding line tidal migration zone' (TMZ) to describe the locus of true grounding line migration due to tides and IBE; and 'grounding zone' (GZ) to encompass the combination of these. We use 'grounding line' (GL) to mean the inland limit of the grounding zone identified by remote sensing methods, as this is the focus of this study, and we are explicit about which grounding zone feature this refers to where required.'	
1.2	Speckle tracking is 10 x times less accurate than phase mapping. This difference in performance has been thoroughly and extensively documented for velocity mapping in peer reviewed publications and is valid for a range of SARs. There is no reason to expect a difference in performance when mapping grounding lines, i.e. a differential motion. Speckle tracking has an intrinsic resolution of about 350 m because you have to average many pixels to get the offsets. The authors claim that they pick the GL within 400-500 m. This seems hard to believe and quite optimistic. I do not expect a precision to be better than 1 km, which is still useful	311	A very similar point to this was raised in the first round of review by reviewer 3. Please see the round of response to reviewers document comment 3.2. In response to this comment, we extended the discussion of errors in section 3.2 of the paper (reproduced from previous response to reviewers). We believe the changes made to reviewer 3's comments also adequately address this reviewer's comment. Firstly, the reviewer's assertion that GL position could only be determined to within 1 km is most likely based on a single offset tracking result, ie in differential range offset tracking (DROT). We have explicitly acknowledged that offset tracking is less sensitive than DInSAR in the manuscript: *'There are several limitations of DROT; it is around an order of magnitude less sensitive vertical motion than*	

			DInSAR' (Line 130). Our approach, however, is based on a time-series of offset tracking results over two years, improving the quality of the measurement compared to DROT. Secondly, the figure of 490 m uncertainty on the grounding line position is based on an extensive evaluation and intercomparison exercise described in section 3.2 of the manuscript. We believe this gives a transparent and fair evaluation of our method's performance against established datasets. Providing an uncertainty estimate based on comparison to contemporary DInSAR measurements gives readers an understanding of the performance of our method based in the accuracy of comparable established techniques. In our opinion this is the best way to communicate the performance of our method. The original response to reviewer 3's first round comment is reproduced below: *As the reviewer suggests we have included the measurement error associated with DInSAR grounding line delineations, using the figure of ± 100 m quoted by Rignot et al., 2011. Combining this uncertainty in quadrature with the bias plus standard deviation of our method gives an accuracy for our TMOC method of ± 490 m.* *We have added the following text to describe this:* *'Assuming that the 2019 DInSAR GL is the best dataset to accurately validate the performance of the TMOC GL method, we estimate that TMOC places the GL 185 ± 295 m seaward of the DInSAR GL location. When the upper limit of this bias and variability is combined with a standard error of DInSAR GL delineations of ± 100 m (Rignot et al., 2011), we estimate the TMOC method can locate the grounding line position with an accuracy of ± 490 m.'* For these reasons we have not modified the manuscript in response to this comment.	