

The Cryosphere Discuss., referee comment RC2  
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## Comment on tc-2022-129

Anonymous Referee #2

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Referee comment on "Grounding line retreat and tide-modulated ocean channels at Moscow University and Totten Glacier ice shelves, East Antarctica" by Tian Li et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-129-RC2>, 2022

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This study uses a suite of remote sensing datasets and techniques to delineate the grounding line, or a grounding line proxy, at Totten and Moscow University glaciers, and to calculate change in grounding line position over time. These datasets include Sentinel1 a/b SAR interferograms, and ICESat and ICESat-2 along-track surface elevations. They find that grounding lines have retreated by 3-13 km at varying rates among the different study areas. They describe a newly identified tidally-modulated ocean pathway between Totten ice shelf and Moscow University ice shelf that could contribute to future mCDW interaction with deep grounding lines and continued retreat down retrograde bed slopes.

Overall, I find the study impactful and rigorous, and worthy of inclusion in this journal, although I have some moderate concerns. I think they can be addressed by some restructuring within the methods, results, and discussion sections.

In the Methods section, it becomes difficult to follow which GL/GZ positions were generated in this study vs which were used for comparison, although historical GLs are correctly attributed. There is no mention in Section 2.1 of the attempt to replicate the 1996 ERS-1/2 GL, nor in Section 2.2 of the comparison between the 1996 GL and the ICESat-derived GZ discussed at the beginning of Section 3.1. (Was replication of the 1996 GL also attempted for TGIS?) Furthermore, the 1996 and the Mohajerani GL positions are repeatedly compared to ICESat-2-derived GZ positions, although the methodology of this comparison is not present in Section 2. This could be improved by including a description of how the flowlines were selected and how calculations of retreat rates between and among different datasets are unique, perhaps in a new section entitled "Grounding line/zone migration rates".

I feel that the analysis of the annual cumulative iceberg calved area vs velocity and GL retreat would work best if confined to the discussion section, as the authors are using existing datasets to contextualize the new GL/GZ maps. Specifically, Section 3.3 reads to me entirely as (important!) discussion material rather than novel results. Furthermore, I

think readability could be improved by creating subsections within the discussion similar to the sections in the results.

Overall, I think the main text figures are chosen and developed appropriately and that they contribute meaningfully to the results and conclusions. In general, I think the figures throughout could be improved by ensuring that consistent colors/symbols and/or axis labels are used for the same datasets or types of data (e.g. historical GLs, flowlines, color scales for dates, etc.). I have highlighted some discrepancies in the minor comments below, but there may be more.

#### Specific Comments:

L 12 - 13 - This sentence indicates retreat from 1996-2020, but above it says that GL locations from 2017-2021 were mapped, and the main text also indicates that GL positions were mapped from the ICESat era. Please revise to include either only the data in the 2017-2021 period, or mention that the 2017-2021 GL positions were compared to historical GL positions.

L 91- It is difficult to keep track of which GL positions are generated in this study vs which are historical datasets used for comparison. It might be helpful to include the historical GL position datasets in Section 2.6 to make this abundantly clear.

L 127-130 - Is this the description of the methodology in Li et al 2020, 2022? Please make this clear. Furthermore, not all 1387 RGTs have coverage in this region, and the distinction between the six single-beam repeat-track data groups and three beam-pair repeat-track data groups is unclear - could you reference the specific RGT numbers shown in the figures here?

L 125 - 132 - This entire paragraph is difficult to follow. It might be helpful to include more references to explanatory figures, or consider omitting if it is entirely a summary of Li et al., 2020 & 2022

L 177-178 - Please consider including more details about how the tidal ranges are obtained from the tide models, especially since in the results it is mentioned that the tidal ranges are also obtained at GZ positions obtained from ICESat-1/2. Please also consider including a description of the historical GL data here in Section 2.6.

L 182-185 - it is not clear at this point why you use the cumulative iceberg calved area in your analysis. See general comment above about restructuring to include this information entirely in the discussion section.

L 200-201 - Please specify between which two interferograms the 2.53 km migration is observed, as Table S4 doesn't specify the GL shift between each cycle. To me, it is unclear whether the "GL retreat since 1996 along ice flowline in Figure 2" in Table S4 is the mean or median GL shift since 1996 among the three acquisition dates in each line, or whether each line of Table S4 represents a different interferogram created from three Sentinel 1 scenes (so the interferogram dates in Fig. 2 are nominal based on t2 in Table S4). Please clarify.

L 256-257 - Please specify why both a range in GL retreat and an uncertainty are reported (e.g. from 1996 to different dates in the year 2020?)

L 259-260 - "We directly measured the tidal amplitudes..." - Please specify this in the methods section, and please specify how the tidal range in Fig. 5b is derived/is different from the tidal amplitude, and how it differs from  $|\delta \square \square \dot{h}|$  in Fig. 3.

L 275 - It is not clear in Fig. 6 that the GL has been continuously retreating since 1996, or between 2018-2021, and Table S5 indicates that the GL advanced between some cycles. Please revise, and consider using a color scale/different symbols for the DInSAR dates for the GL lines in Fig. 6a

L 301-302 - Please consider including a description of how the channel is identified in the interferograms

L 318 - What is meant by "might not deflect adequately?". Including a description of how channel is identified in interferograms may help

L 424-425 - Please specify how deep the MUIS GZ is compared to those in Reeh et al, 2000

Technical Corrections

L 31 - Including the definition of the GL here makes this sentence a bit awkward; consider revising

L 44 - "Despite the importance of this region, this is the only study..." - which study is "this" referring to? Li et al., 2016?

L 53 - Would be helpful to reference the specific figure in Fricker & Padman, 2006 or include diagram labeling GL proxies in supplement

Fig. 1 - For consistency with later figures, consider using same color for DInSAR 1996 GL

L 80 - sentence is a bit awkward

L 82 - include DEM acronym definition

L 82-83 - "We differenced the two interferograms..." which two interferograms are you referring to?

L 89 - include the number of usable interferograms for each of MUIS West, TGIS East channel and TGIS east branch ice stream, and reference boxes from Fig. 1. Please consider including a table or adding to Table 1 the number and nature of derived grounding line positions for each location (e.g. # of interferograms, whether GL position is a single point as in case of ICESat/-2 or a curve as in case of interferograms)

L 101 - Include track number(s) here

L 104 & 107 - are the saturation correction and tide corrections included with GLAS data? Please include reference

L 114 - Consider including ICESat ground track on Fig. 2

L 126 - is ocean-loading tide included with ATL06 data? Please include reference

L 132 - please ensure that supplemental and main-text figures are referenced in order in the text

L 135 - why is "elevation anomalies" in quotes? Is it defined differently from in the previous section?

L 153 - should section title read "CryoSat-2 elevation change rates..." ?

L 170-175 - Please define  $h_f$  in the text

L 202 - absolute tidal range is defined as  $|dh|$  here but  $|\delta h|$  in figures - please review for consistency

Fig. 2 - Mention flowline in caption and consider placing subplots b-g in chronological order. Please also consider differentiating the DInSAR GLs in (a) by dates from (b-g) by color/symbol/etc for easier interpretation

Fig. 4 - Please specify in the caption that the zero mean tidal amplitudes from CATS2008b are on the bottom panel of each plot. It is also unclear why for 4 a & d the "manually defined reference GL" (is this defined elsewhere?) is specified and for b & c the "DInSAR ice shelf" is specified. Please consider placing subplots in order from furthest upstream to furthest downstream (or vice versa)

L 250 - Mention which zoom box in Fig. 1 corresponds to the TGIS southern lobe

L 273 - Mention which zoom box in Fig. 1 corresponds to Totten East branch

Fig. 6/L 285 - the caption indicates that the Mohajerani GL is shown in all plots, but it is only shown in 6a. Please revise.

L 313 - Mention which zoom box in Fig. 1 corresponds to MU western ice shelf

L 368 - Please define "zero mean annual ice velocity changes"

L 395-396 - "...maintained stability"?

L 414-419 - Consider revising for clarity by describing the effort of Konrad et al., 2018 (L 417-418) before comparing it to your results, and please check sig figs

L 479-481 - Please specify the time periods over which retreat was observed and which metric of retreat is used (maximum, mean, median?)

L 485-486 - Please revise "...interferogram time series also discovers..." - I suggest "...time series allowed us to discover.." or "...time series revealed..."

L 493 - "...unable to identify the exact time stamps of GL retreats" - you do identify retreat over as specific as 6-day periods and successfully link it to tidal motion, so the reason for this phrasing is unclear to me. Please clarify.

L 503 - typo in ESA url