

Interactive comment on “Marie Byrd Land glacier change driven by inter-decadal climateocean variability” by Frazer D. W. Christie et al.

Anonymous Referee #2

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Summary

The authors present an analysis of changes in grounding line position for the Marie Byrd Land Sector using a well established method of detecting the break in slope from satellite remote sensing imagery (Landsat & ASTER). Over the 2003 - 2015 period they find that 33% of the grounding line underwent retreat, with the greatest rates found over the Getz Ice Shelf grounding line region. These results are consistent with the ice shelf thinning rates presented in the paper and previous studies in the literature. In addition, they conclude that the variations in retreat rate between the ICESat and CryoSat-2 era are due to inter-decadal changes in ocean forcing.

The paper is well written and (as the authors state) provide much needed insights on a region of West Antarctica that has previously suffered from limited observations. The

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sectors increasing contribution to the total Antarctic mass loss make these findings particularly relevant to the community and therefore appropriate for publication in TC. I believe however there are some points that need addressing, particularly in the discussion of their findings before it can be accepted for publication. These are outlined below.

General Comments

The title and the main arguments in the paper suggest the primary driver of change in the region is due to an inter-decadal climate-ocean variability. Whilst evidence of this is provided in the text to support this, it seems to give the impression that it is the sole dominant driver of change in the region. The text also states other factors such as geological controls and the effect of increased basal melt from neighbouring ice shelves on modifying the CDW. Unless it can be quantitatively proved that the impacts of these are minimal compared to the climate-ocean variability, then I think the emphasis placed on this sole factor needs to be better balanced with other potential drivers. I would also suggest revising the title to reflect this.

In the method section detailing the Swath SARIn processing of CryoSat-2 data and subsequent dh/dt calculations, it is stated that the plane fit following McMillan et al (2014) was used (P5, L18). This plane fitting approach was applied to POCA data and therefore includes a coefficient to account for firn penetration of the altimeter from ascending and descending passes (Supplementary material equation 1, McMillan et al 2014). As the Swath SARIn processing chain differs, is this approach still applicable? If the plane fit equation used in this instance differs from that in the McMillan paper, then it should be included in the main text (or as part of the supplementary information).

Technical Corrections

P1 L26 - "Projecting contributions" I would rephrase this to something like "accurately projecting the contribution of the West Antarctic Ice Sheet to global sea level rise".

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P1, L25 - An extra reference should be added here as ice mass losses over the ASE have been measured from multiple techniques, not just the mass budget/IOM method. I would recommend adding Sutterley et al (2014), which shows mass losses over the region from separate techniques since 1992.

P1 L29 & L30 - Would it not be appropriate to put the Paolo et al (2015) reference with those regarding ice shelf melting as opposed to inland dynamic thinning?

P3, L17 - "Final lb products were smoothed using standard GIS tools" - The specific tool or method should be stated for reproducibility purposes. Do the smoothing processes used change the position of the grounding line? Or is the extent of movement caused by this tool below the resolution for which the grounding line can be detected from Landsat 7/8 or ASTER?

P 10 L29 - P11 L2 - Is there any way to quantify this or explore this in more detail? As this implies that whilst the ocean-climate forcing is a major driver, at the local scale other factors could play a governing role in the rate of grounding line change.

P11 L13-15 - A recently published paper by Paolo et al (2018) looks at the impact of ENSO forcing on the West Antarctic Ice Shelves and seems to support your suggestions, so may be useful to add a reference to it here.

P15 L15-20 - This seems to suggest that inter-decadal climate-ocean variability is perhaps not the sole driver of change in this region. Is it possible to expand this discussion or quantify this effect? Otherwise a change of emphasis may be necessary to encompass these varying effects (see general comments above).

P15 L28-L29 - I don't think this statement can be made without quantitative analysis of other factors (as discussed above). I think this should be reworded to encompass this explanation is part of variety of factors affecting the Getz (particularly at the local scale).

P17 L10 - I would rephrase "RACMO2 and IMAU-FDM models used in the CryoSat-2

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swath processing chain" as the models are not used in the generation of the swath data itself, but in determining ice shelf dh/dt .

P19 L15 - Fretwell et al reference does not list all paper authors

P23 L11 - Shepherd et al reference does not list all paper authors

Figure 1 - The scale bar in the bottom right hand corner is difficult to read against the background colour scheme, I would suggest changing it another colour (perhaps white).

Figure S1 - A scale bar should be added to this plot. In addition, I would suggest changing the ice shelf front position colour/line to make it more prominent compared to the grounding line delineation.

Figure S5 - The jet colour bar on this figure should be changed to avoid readability issues. This colour bar also clashes with the contour lines, making them difficult to view. The contour lines however could be kept as is, depending on choice of new colour table. Additionally, the colour bar needs to have a label stating what it is representing and the units.

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