

## Reviewer 2

In this manuscript by Miles et al., the authors explore the connection between surface ice velocity acceleration and calving events for Denman Glacier, East Antarctica. Particularly, to explore this connection, the authors apply several tools ranging from remote sensing observations to ice sheet modelling to grasp which mechanisms might explain the acceleration and ground line retreat of Denman Glacier.

The manuscript is very well written and flows quite smoothly in the description of the methods and the used ice sheet models. As a remote sensing expert, I really liked the contribution brought by the historical remote sensing data, which are generally very difficult to find. The main hassle for me was going through all the figure. The absence of system coordinates makes very difficult to go from one figure to the other and make connections and comparisons between the figure. Therefore, I recommend the paper to be published after major revisions. In the following, some additional comments.

*We thank the reviewer for both the positive comments detailed above and for the constructive suggestions suggested below. We respond to each point detailed below.*

Line 11, identifying Denman glacier as the largest is really vague. For a reader, it would be nice to specify that e.g. this glacier is the largest contributor to sea level rise in East Antarctica (after Totten Glacier)

*We have amended the sentence to state that Denman is the largest contributor to sea level rise in East Antarctica after Totten Glacier.*

2. One of the major statements of the paper is that to explain the acceleration pattern of Denman Glacier it is required to have a combination of grounding line retreat, changes in ice shelf thickness and unpinning of ice from Chugonov Island (lines 331-334). I am wondering if the unpinning of Chugonov Island comes from observations. Did the authors observe the unpinning in their data?

*We do observe the unpinning of Denman's ice tongue from Chugonov Island. This is shown in Figure 4d & e and is described in the results section 3.3: 'Lateral migration of Denman's ice tongue':*

*'In 1974, the ice tongue was intensely shearing against Chugonov Island, as indicated by the heavily damaged shear margins (Fig. 4d). However, by 2002 the ice tongue made substantially less contact with Chugonov Island because this section of the ice tongue migrated westwards (Fig. 4d, e)'*

3. Line 94-95 and line 109-112. Have the authors quantitatively determined the uncertainty of surface ice velocity obtained from historical data? Instead of providing a ball park number, it would be nice to have a section in the supplementary describing how they quantified this uncertainty.

*We now include an additional figure in the supplement (Fig. S2) detailing the quantification of the velocity error for the historical imagery. This is done by comparing manually tracked rift displacement at various locations across the Denman system to computed displacement values from the Cossi-Corr algorithm. The median value of the difference between the manually tracked rift displacement and the Cossi-Corr values is  $\pm 29 \text{ m yr}^{-1}$  ( $\sim 0.5$  pixels), thus justifying our estimated error.*

4. To my understanding, to perform their analysis the authors have used the Measure grounding line product for Denman. Do you know to which sensor and which year this grounding line belongs to? Also, have the authors tried to include more recent grounding line products?

*We use the grounding line position from the BedMachine (v1) dataset, which in turn matches the grounding line position of the MEaSUREs dataset. The grounding line in the MEaSUREs dataset was derived from the ERS sensor in 1996. More recent grounding line products (~2017) over Denman have been made as of April 2020 (Brancato et al., 2020). We have not tried to include this more recent grounding line data into our models in order to retain consistency with the ice thickness calculated in the BedMachine product.*

5. I find really difficult to go through all the model experiments that the authors have performed. Is there a way to visually summarize them in the manuscript, e.g. using a table?

*We appreciate the multitude of modelling experiments is somewhat challenging to summarize in text, so we now include a table which visually summarizes the seven experiments (Table 1).*

6. To explain the acceleration of Denman glacier, in Section 5.2 the authors discuss whether this is driven by warm water intrusion (e.g. ice-ocean interactions) or calving events. I find this section a bit confusing especially because it introduces a lot of elements which have not previously discussed in the manuscript. Do the authors simulate with their ice model the effect of the ice-ocean interaction? Also, does the model take into account the effect of basal melt of Denman ice shelf?

*In our numerical modelling experiments we perturb both grounding line position and ice shelf thickness. These perturbations are extrapolated from modern observations of change (Ice shelf thickness; Paolo et al.; Grounding line migration; Brancato et al., 2020). Because both grounding line position and ice shelf thickness are sensitive to ice-ocean interaction, our model does indirectly simulate possible long-term effects of ice-ocean interaction.*

7. As a general comment, ALL figures need to have coordinates grid. For me it was extremely difficult to move from one

*We have added coordinate grids to all figures.*

8. I find the colorbar in figure 1-a to be confusing. Maybe all areas with an elevation over 0 should be marked with the same color, e.g. white.

9. Without coordinates is a bit difficult to link Fig.1b and Fig.1c. I would recommend to highlight the area in Fig.1c using a box in Fig.1b

*Point 8 & 9: In response to the comments from all three reviewers we have made a new Figure 1. This revised figure 1 has reference coordinates and only highlights regions with a bed elevation below zero.*

10. Date of used Landsat images and acknowledgement for the used Landsat product should be included in the figure caption. Please, see USGS website for getting the proper data citation.

*We have added the dates and acknowledgement for the used Landsat products in the figure captions.*

11. For Fig.2, each panel focus on a different area of the ice shelf. I would recommend to have a bigger picture of the ice shelf on the side and try to help the reader understand on which areas you are focusing/zooming on. Please, include latitude and longitude (or polar stereographic) coordinates for each figure.

*We have amended figure 2 to include a reference image of the wider ice shelf (a) with boxes representing the location of each sub figure. We have also included polar stereographic coordinates on each image for reference.*