The Cryosphere Discussions

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Comment on tc-2021-305

Anonymous Referee #2

Referee comment on "Geomorphology and shallow sub-sea-floor structures underneath the Ekström Ice Shelf, Antarctica" by Astrid Oetting et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-305-RC2, 2021

This manuscript presents unique, hard-won and interesting data. A story about past ice flow in the region, that links sub-ice shelf and marine data together, will build a very interesting history for this sector of Antarctica, where not a lot is known. However, there are many things that could help improve both the presentation and the discussion of the data.

Abstract:

—MSGL end 11 km from shelf break indicating LGM position. That is minimum position but not necessarily max. Make this clear.

--What does beneath ~30 km of ice shelf mean? Is this the outer portion? Just make explicit.

--Till isn't usually 45 m thick. Is this really a single unit or multiple tills? If it is really 45 m, is that unique? Seems like a lot. (See below.)

--Why does lack of over-printing indicate rapid retreat? It could be slow retreat. It simply indicates gradual, continuous retreat, with a lack of pauses along way. It doesn't have to be rapid.

Line 23-24: The sentence " Recent studies have shown that ice shelves in this region are underlain by deep glacial troughs (Nøst, 2004; Eisermann et al., 2020; Smith et al., 2020), indicating ice advanced towards outer continental shelf areas in the past." doesn't make sense. If the ice shelf has a trough under it, all it means is that grounded ice advanced as far as the modern-day ice shelf edge in the past. If showing that ice advanced towards the outer continental shelf in the past, need to say that the trough in fact extends that far, beyond the edge of the ice shelf.

Line 34 (and related to the above): how narrow is the continental shelf? "Narrow" doesn't tell much.

Line 48: "front" of the ice shelf is not especially clear. State seaward or from edge.

Line 52: Not clear exactly what is being measured, from where to where. Annotate the figure and show these measurements so that it is explicit.

Lines 57-58: Did the Grobe and Mackensen paper really claim that the ice extended beyond the continental shelf break? That would be quite extraordinary. I thought they looked at slope records and IRD, but not evidence of actual ice extending that far.

Lines 60-70: In addition to the model estimates of LGM timing here, are there any estimates from dated cores?

- 4.1.2 and Figure 3: Certainly sounds like MSGLs that are being described. However, there is nothing convincing in the figure. Zoom in, show more, consider color, mark with arrows, etc. As it is, the figure is not convincing.
- For comparison of how these sizes compare to other MSGLs, consider: Wellner, J. S., Heroy, D. C., & Anderson, J. B. (2006). The death mask of the Antarctic ice sheet: comparison of glacial geomorphic features across the continental shelf. *Geomorphology*, *75*(1-2), 157-171.
- Or: Newton, M., Evans, D. J., Roberts, D. H., & Stokes, C. R. (2018). Bedrock mega-grooves in glaciated terrain: A review. *Earth-Science Reviews*, *185*, 57-79.
- For comparison of till and drape thicknesses, consider: Shipp, S., Anderson, J., & Domack, E. (1999). Late Pleistocene–Holocene retreat of the West Antarctic Ice-Sheet system in the Ross Sea: part 1—geophysical results. *Geological Society of America Bulletin*, *111*(10), 1486-1516.

- 4.1.3: Many small moraines were noted in Antarctica much before the references cited.
- For comparison of small-scale retreat features like moraines, consider: Shipp, S. S., Wellner, J. S., & Anderson, J. B. (2002). Retreat signature of a polar ice stream: sub-glacial geomorphic features and sediments from the Ross Sea, Antarctica. *Geological Society, London, Special Publications*, *203*(1), 277-304.

Lines 201-202: Calling on a core that is not included in the data of the paper, nor apparently published elsewhere, is not a fair line of evidence.

Lines 203-205: If evidence from slope cores indicates that ice reached shelf edge, but your MSGL data stops 11 km in and therefore you suggested ice maybe didn't reach the edge, how do those agree? Or, conflict?

Lines 236-240: It's a big stretch to say that your measurements of 45 m of till are "similar" in thickness to other places where it has been 15 m or 20m. That is more than 2x thicker, at least. Seems like a big difference! How does such a thickness of till work with the mode of formation of MSGLs? (See for example: Clark, C. D., Tulaczyk, S. M., Stokes, C. R., & Canals, M. (2003). A groove-ploughing theory for the production of mega-scale glacial lineations, and implications for ice-stream mechanics. *Journal of Glaciology*, *49*(165), 240-256.) And, what does the statement about removal of loose sediments from under the ice by water have to do with the general idea of these being MSGLs?

FIGURES

Figure 1: Labels not clear in part a when text over ice boundaries. Define ice edge line in legend; differentiate grounding line from floating margin. Consider making this a three part figure as part a is currently not quite covering a large enough area to show people unfamiliar with Antarctica where the location is, but nor is zoomed in enough to show the region. Make an a and a b that are less/more zoomed in.

Figure 2: Very helpful schematic. Consider making more of the ice shelf under sea level and less of it above sea level. Also, consider moving the label of Ekstrom Ice Shelf out to the left a little, so that it is clearly on the ice shelf.

Figure 7: Make it bigger! So much in there and way too hard to see!