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Interactive comment on "Revealing the former bed of Thwaites Glacier using sea-floor bathymetry" *by* Kelly A. Hogan et al.

Martin Jakobsson (Referee)

martin.jakobsson@geo.su.se

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This paper presents an impressive compilation of multibeam bathymetry that portrays the seafloor morphology in front of Thwaites and Pine Island glaciers beautifully. The seafloor morphology is thoroughly interpreted, specifically in terms of glacial landforms. The paper is well written and illustrated. There are several interesting and important results that warrant publication, e.g. inflow pathways in the seafloor topography for warmer CDW, critical differences between the newly compiled multibeam bathymetry and previously published compilations, and the potential influence of seafloor roughness on the basal drag of the past ice-sheet flow over the studied area. The quantitative roughness analysis is indeed an interesting approach. The paper could benefit from a bit more discussion on the potential pathways of CDW, by for example identifying and

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pointing out depth sills along the potential pathways and include some more on what oceanographic studies have shown in the discussion. I certainly recommend publication after minor revision, even if I have provided many detailed comments below, they are primarily on details. Some are, however, on the scientific content, which I hope can be addressed. The quality of the paper is generally very high, and I look forward to see this published.

Detailed comments Abstract: Line 19: “is a major control”, consider changing to “exerts a major control”

Line 29: “, suggesting a positive feedback mechanism.” Standalone in the abstract, it is difficult to understand what kind of positive feedback this refers to? Can it be a positive feedback for ice-shelf grounding that the ridge is flattened by the ice shelf when it grounds? I am afraid I do not get this.

Line 38: “...without these data calculations, of the capacity of bathymetric troughs,...” insert comma after calculations.

Line 58: “Obtaining direct sea-floor measurements...” perhaps consider “Geophysical mapping at marine....”

Line 61: Consider moving Fig 1 ref to the end of the sentence since Pine Island Glacier is also shown on the figure.

Line 71: “...ice sheet instability”, change to “...ice-sheet instability”

Line 73: Consider avoiding the term “collapse”, perhaps “retreat” is more appropriate here.

Line 86: “...hydrographic data”, consider using “oceanographic data” to avoid confusion, as hydrographic data also is used for seafloor bathymetry.

2. Geophysical datasets: Consider changing this heading to the classical “Methods”, since it is not only the geophysical datasets that are described. Perhaps also some

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parts of how the roughness analysis would fit here, such as what kind of tools were used, Matlab or?

Line 115: Information on the navigation/motion-system is missing

Line 128-129: Consider using the acronyms CTD and XBT since they are standard across several disciplines.

Line 138: Add version number also for QPS Fledermaus, and earlier for MB System, to be systematic with that version number is written for ArcGIS.

3. New Bathymetric compilation....: This is where the results begin, consider making all of this under a heading called “Results and Interpretation”.

Line 174: The pinning point on H2 is seen in Fig 3, as a the former grounding line, but consider putting some arrow or other indicator so it is readily seen when looking for it after reading the text.

Line 194: The semi-circular moats – crescentic scours are not in the legend of the Figures, nor pointed out. While I see them, I think readers not dealing with seafloor morphology should be guided.

3.2 Trough and channel metrics The description of the troughs and channels is good, but I do lack a bit on the oceanographic perspective on how they can act as present routes for the CDW flow towards the glaciers. There is a last sentence about potential pathway for CWS, but more information could be added, for example if there are critical sills along the troughs. If this could be expanded, it would help the oceanographic community to readily make use of the results.

Line 279: “In addition, their long-profiles have negative slopes (i.e., deepen consistently down the flank of the highs)...” I find it very hard to envision what this means, and how I can see this in the imagery? What else can a gully do that deepen down the flank? I miss something here.

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4.1 Spectral analysis of bed roughness This section presents an interesting approach to analyse the sea-floor topography. It is technical, but important if one like to follow exactly what has been done. I would even encourage that some additional bits and pieces are added in order to make it even easier to follow the approach (see below). Perhaps consider a flow chart that illustrate the approach?

Line 304: The applied theoretical expression for form drag is referenced to Schoof (2002), I would recommend that the expression is shown in the paper and referenced. It would help the reader that really likes to follow the approach.

Line 307-308: This repeats the sentence above, line 303-304.

Line 308: I cannot find which of the bed elevation profiles shown in Fig. S1 that is shown? It only says, “a profile”, but not which one.

Line 310: Which tools are used to implement the Welch method? Was it Matlab, or? I think this could be shortly described in the Methods previously.

Line 316: “in the vertical..:” why not say “random offset of the depth value for each...:”,

Line 317: The figure reference SF4 is presumably S4? I note that also within the Supplementary Information, the figure references are made to SF...instead of only S....

Figure S4: My first interest was to compare the plots for profile 7 with any of the others. First, I thought that that profile 7 was missing from Supplementary figure S4, but it was there although not placed in the order of the numbered profiles 1-n, it is shown in panel p. Perhaps consider placing it in the order, and perhaps showing a comparison between profile 7 across the MSGLs with any of the other profiles in the main article since it will visualize what spectral analyses really show?

Line 346: Presumable “thickness” is “ice thickness”. The results from relating the bed topography to basal drag are intuitive. This is good. It is stated on Line 384 “that features on scales smaller than ðİIJĘðİŚĄ = 150 m would provide sufficient drag to induce vertical shearing within the ice...”. Is it possible to state at which scale range

of the features the basal drag not is affected much by the underlying terrain anymore? What I mean if it is possible to bracket the scales for when undulations in the terrain matter for basal drag? It is now hinted that the MSGL terrain would produce very little shearing. It would be very useful if cut-of numbers could be estimated for ðİIJĘ since then other studies could settle with analysing the frequency component of the terrain and look into this paper regarding the significance with respect to basal drag.

Line 385 induce significant vertical shearing within the ice.

Discussion Line 429: How were the locations of the cross profiles decided? Are they located at a critical sill? I think this is important information, can it be included?

Line 429: Also, the numbers on underestimation of cross-sectional areas using older bathymetric compilation based on sparse data are very striking. Consider including the numbers in the abstract?

Line 522: Again, SF4 is used, while it is S4 elsewhere.

Figure 5. The profile locations in b and c are shown as stippled lines, but it would be good to add X to X′ or something indicating from where to where, so this can easily be depicted in panel a. Right now, it is not that easy to pair the profiles shown in panel a with their proper locations on the maps.

True that a 3D approach to analyse the bedrock's roughness and its influence on basal drag is required form a complete spatial view, I think it is good that this is mentioned. However, this paper make a good progress with the presented 2D approach, and it is much to much to ask to go beyond what the authors currently present in this work.

Figures general: It is a bit hard at first to see what is presently covered by ice since the outline is a bit weak and the ice velocity does not seem to be consistently printed on top of all ice-covered areas, some seems to be grey shaded like the eastern part of TGT. I assume this is just the extent of the data, but if the outline of ice is made bolder and clearer, and this is explained, it will help the reader.

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