**Response to Reviewer 2: tc-2020-25 by Kelly Hogan et al. "Revealing the former bed of Thwaites Glacier using sea-floor bathymetry"**

The comments of the two reviewers and the short comment are listed below with our responses below *in blue italics*.

**Comments by tc-2020-25-RC2: Martin Jakobsson**

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.
*We have rewritten the Abstract (as per R1 general comment 1.) and clarified what the potential feedback mechanism is. The relevant text is: "Spatial variations in the morphology of topographic highs, known to be former pinning points for TG and its floating ice shelf, indicate differences in bed composition that are supported by landform evidence. We discuss links to ice dynamics for an overriding ice mass including a potential positive feedback mechanism where erosion of "soft" erodible highs may lead to ice-shelf ungrounding even with little or no ice thinning."*

Line 38: "...without these data calculations, of the capacity of bathymetric troughs,..." insert comma after calculations.
*This text has been rewritten (see above).*

Line 58: "Obtaining direct sea-floor measurements..." perhaps consider "Geophysical mapping at marine...."
*We have adjusted the text as suggested.*

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

Line 71: "...ice sheet instability", change to "...ice-sheet instability"
*Adjusted as suggested.*

Line 73: Consider avoiding the term "collapse", perhaps "retreat" is more appropriate here.
*Adjusted as suggested.*

Line 86: "...hydrographic data", consider using "oceanographic data" to avoid confusion, as hydrographic data also is used for seafloor bathymetry.
*Adjusted as suggested.*

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 C2 parts of how the roughness analysis would fit here, such as what kind of tools were used, Matlab or?
*We acknowledge these comments on the structure of the paper. However, we feel that the two parts of the paper should remain separate (bathymetry and spectral analyses) mostly to*

*help lead the reader through the spectral analyses section (also a comment by R1), which would be harder to follow if separated into Methods/Results/Discussion in the traditional way. We suggest a compromise structure where the paper retains the two parts but that each parts has its own Methods and Results section, with the Discussion bringing both components together. Therefore, the proposed revised structure is:*
*1. Introduction*
*2. Methods I: Multibeam echosounder datasets (MBES)*
*3. Results I: A new bathymetric compliation for the inner Amundsen Sea Embayment shelf*
*3.1 Glacial Landforms*
*3.2 Troughs and channel metrics*
*3.3 Bathymetric highs and ridges*
*4. Methods II: Bed roughness and basal drag*
*4.1 Spectral analysis of bed roughness*
*4.2 Relating bed topography to basal drag*
*5 Results II: Assessing roughness and drag contributions for palaeo- and modern glacier beds*
*5.1 Bed roughnesses*
*5.2 Basal drag contributions*
*6 Discussion*
*6.1 Implications from the new bathymetric compilation*
*6.2 Implications from sea-floor morphology*
*6.3 Implications from the new bed roughness data*
*7 Conclusion*

Line 115: Information on the navigation/motion-system is missing
*We have added information on navigation and vessel motion system (Seapath 330) used alongside the MBES during cruise NBP19-02.*

Line 128-129: Consider using the acronyms CTD and XBT since they are standard across several disciplines.
*We have added the acronyms at this point in the methods to make it accessible to those from other 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.
*We have added the version number of Fledermaus.*

3. New Bathymetric compilation....: This is where the results begin, consider making all of this under a heading called “Results and Interpretation”.
*See the above comment proposing a new structure. IN the revised structure, this section would become Results I.*

Line 174: The pinning point on H2 is seen in Fig 3a, 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.
*We have labelled this on Fig 3b ad Fig 4 also.*

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.

*We have revised Figure 3b to show the mapped crescentic scours and we have provided a close-up view in the new Fig S1d which shows type examples of the main landforms discussed in the text. We have also now referred to this new supplementary figure in the text in Section 3.1.*

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.

*We have added a paragraph in 3.2 about along-trough pathways, critical sill depths, and channel widths at the sills (shown in new Fig. S5). The paragraph reads: "Long profiles from the T2-T4 troughs (Fig. S5) identify sill depths along the pathways of the troughs that may act as important constrictions for ocean circulation, in particular if they impede CDW inflow towards the Thwaites grounding zone (cf. De Rydt et al., 2014). T2 has a smooth long profile with a prominent sill at 710 m depth at about 107°3'W, 75°3.6'S whereas T3 has a rugged profile with three bathymetric sills in its northern (ice distal) part with depths of 750-760 m, and several other sills further south (ice proximal) around 780 m water depth. The bathymetry around T4, east of the EIS, is generally deeper (>1000 m) than most of T2 and T3, so the main constriction on this trough seems to be between the NE-SW trending sea floor ridge in Pine Island Bay (Fig. 2a). At this location, around 105°24.4'W, 74°35.4'S, there is a sill at 780 m depth. Channel widths at these locations are 5000 m for the T3 sills and 2500 m for the T4 sill; widths were measured at 500 m depth as this is taken to be a reasonable top-CDW depth for the area (based on oceanographic measurements; B. Queste, pers. comm.). The bathymetry of the highs around T2 is all >500 m depth meaning that CDW could effectively "flood" over this topography rather than be constrained to the trough; however, if it was topographically routed (cf. Nakayama et al., 2019) through T2 then the channel width at the sill is 4700 m (at 640 m water depth)."*

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.

*This sentence was added at the request of a non-geomorphologist to explain the form of gullies. Having added a type example of gullies in Fig. S1f to aid the reader, and referred to this in the text describing the gullies, we have removed this sentence.*

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?

*We take this point on board, it is similar to a comment also made by R1. In the revised version we have provided more linking text to help guide the reader through the analysis –*

*see response to R1 general comment 2.*

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.
*Although we acknowledge this comment, it is difficult to simply insert the Schoof equation because he uses non-dimensional quantities whereas we use dimensional quantities because we want to relate our parameters to physical quantities e.g. length scales. We have rewritten the spectral analyses sections further explaining the relationship to Schoof (2002) as well as many of the important parameters which hopefully should aid readers particularly interested in the approach.*

Line 307-308: This repeats the sentence above, line 303-304.
*Now that we have moved the methods to its own section (5.1) this repetition is avoided.*

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.
*We have added the profile name and specific part of Fig S1 to clarify this (e.g. profile 6 in Fig. S1a).*

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.
*Yes, Matlab R2020a; this is now fully described in the new section 5.1 (bed roughness methods).*

Line 316: "in the vertical..:" why not say "random offset of the depth value for each..:",
*We have altered the text as suggested.*

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....
*We have corrected these all to e.g. S4 as per TCD formatting.*

Figure S4 (*now Fig. S7*): 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?
*We have placed the profiles in order in Fig S7 and also in Fig 7 as requested and we direct the reader to Fig 7 in the main text which shows profile 7 alongside along-flow profiles from the Thwaites MBES dataset.*