We appreciate both reviewers' insightful comments on our manuscript "A Simulation Approach to Characterizing Sub-Glacial Hydrology". These will were helpful in improving the final product.

The reviewers' original comments are listed below. A summary of revisions made to the manuscript addressing each comment are listed in *red*:

Reviewer 1 - Major issues:

- The range of material properties for the bed and water used in the study seem too narrow given the literature cited in the paper. For example, Peters 2005 included reflectivity differences between water (including groundwater) and frozen bedrock that differ by 26 dB without invoking any change in bed roughness or geometry. If you look at Christiansen 2016 and Tulaczyk and Foley 2020 (https://doi.org/10.5194/tc-14-4495-2020) these values are also in the 25 - 27 dB range. If the manuscript seeks to diagnose the subglacial water configuration by excluding other hypotheses, then the complex permittivity for both water and the bed explored should span the full range of this literature (and reproduce that range of reflectivities).
    - *In the Discussion, we have added a figure and text addressing the range of possible dielectric constants that were not explored in this study. We provide justification as to why much of this range is unlikely due to the observed reflectivity profile and physical environment. We have also adjusted the language in our Results, Discussion, and Conclusions to indicate that we have eliminated a Röthlisberger channel as the possible source of the bright echo on THW2/UBH0c/X243a. We state that the echo is consistent with canals or a sub-glacial lake, while acknowledging that we have not explored all possible alternatives required to make a conclusive diagnosis.*

- Similarly, the range of bed roughness considered in the study is also small compared to the literature cited by the paper. Again, Peter 2005 shows roughness-based reduction in reflectivities that are as high as 20 dB. For the reasons described above, I'd expect this paper to explore roughesses losses at that scale as well.
    - *In the Discussion section, we detail the limitations of our roughness evaluation in this study. We specifically address the Peters 2005 paper, which calculated theoretical losses due to roughness up to 20dB over very short correlation lengths, but measured roughness over distances exceeding 1km. As the reviewer suggests, more work should be completed to evaluate the impact of roughness on radar returns, which we suggest as a direction for future work. As with the previous point, we acknowledge in the Discussion and Conclusions that we have not explored all possible combinations of material and geometric parameters.*

- The authors present a simulation that is focusable (and focused) which should allow them to probe the specularity of bed echoes for each of the hypothesized configurations. Since, as the paper mentions, this was the key observable in classifying the downstream water system of Thwaites as concentrated rather than distributed, it would seem incumbent on the authors to address whether their interpretations of the (inherently more ambiguous) reflectivity signal would also explain that larger catchment-wide specularity signature.
    - *We have addressed this limitation of our work in the Discussion section. While we concur that simulations replicating specularity content would be helpful, the aperture lengths required (~2km) exceed the capacity of our computational resources.*

- Line 180: The authors state that they "confine" themselves to Röthlisberger channels and flat canals for this study. That is a fine choice to support the claim (if it survives addressing the issues raised above) that the bright spot (and downstream water network) is likely not a canonical Röthlisberger channel. However, in order to claim (as the authors do in their abstract and conclusion) that the wanted body is "distributed" (which has a specific subglacial hydrological meaning and implication for modeling) they would need to also address other "concentrated" water geometries and exclude them as well. These include Nye Channels, Creytes & Schoof water sheets (https://doi.org/10.1029/2008JF001215) an other concentrated/efficient water configurations (https://doi.org/10.1098/rspa.2014.0907). Otherwise the authors should limit themselves to falsifying the hypothesis that the bright echo on THW2/UBH0c/X243a is a canonical Röthlisberger channel and remove language like "We ultimately conclude the bright reflector from our IPR flight line is more likely a broad area of wide distributed water, such as a series of flat canals or sub-glacial lake" which cannot be supported by a study that does not consider other "concentrated " water geometries.
    - *As the reviewer suggested, we have acknowledged in both the Methodology and Discussion sections that other water geometries could exist, which were outside the scope of our study. Our language now indicates that the reflector cannot be a Röthlisberger channel, but is consistent with a distributed geometry such as a series of flat canals or a lake. We leave the possibility open that the reflectivity profile could match other unexplored configurations.*

Reviewer 2 – Major issues:

- If the manuscript aims to identify the subglacial water arrangement by eliminating alternative hypotheses, it is imperative that the comprehensive permittivity values for both water and the glacier bed cover the entire spectrum found in existing literature, thus reproducing the full range of reflectivity associated with these parameters.
    - *This comment is similar to the first issue from Reviewer 1*

- The paper primarily focused on the regional scale of Thwaites' downstream water system. However, it is imperative to acknowledge the broader applicability of the model for a more extensive catchment when considering its practical utility.
    - *We have included language in the Abstract, Introduction, and Conclusions indicating the broader applicability of the simulation technique. We also re-arranged several sections of the paper at the reviewer's suggestion. The Introduction now focuses on the technique itself, while the Thwaites study area is presented much later as an example use case.*

Reviewer 1 - Minor Issues:

- Abstract Line 1: Depending on its configuration water can either enhance or reduce sliding and/or retreat.
    - *We have adjusted the language as suggested by the author.*

- Abstract Line 3: Given the recent paper by Schlegel et al. (https://doi.org/10.1017/aog.2023.2) you may want to consider the use of IPR here.
    - *The nomenclature throughout the paper was changed from "IPR" to "RES" or "Radar Echo Sounding", to be consistent with Schlegel et al.*

- Table 1: 1.71 MW seems like an extremely high value. It's unusual to report a post-processing number for transmit power and presenting it in this way could confuse readers significantly.
    - *We have adjusted the table to reflect both MARFA native and simulated power. A footnote was added to explain the difference.*

Reviewer 2 - Minor issues:

- Line 25: Better to add more recent citations.
    - *We have added more recent citations for the relationship between hydrology, shear stress, and ice rheology as suggested (Line 28).*

- Line 32: Missing citations
    - *We added several citations establishing IPR as a technique in the study of hydrology (Line 35).*

- In the introduction section where the objectives are outlined, it is important to include the potential applications of the model to other catchments, thereby emphasising its versatility beyond the specific case of Thwaites Glacier.
    - *See our response to the second bullet under "Major Issues". We believe the revised manuscript emphasizes the utility beyond Thwaites and the introduces the Thwaites flight line only as an example use case.*

- Providing a dedicated "Study Area" section, rather than including it in the introduction, would offer a more comprehensive understanding of the research area.
    - *At the reviewer's request, a dedicated Study Area section (4.1) was included when introducing the Thwaites Glacier example use case.*

- Additionally, separating the "Results" and "Discussion" sections would enhance the clarity and structure of the paper. It would improve the presentation if all figures and tables were enclosed by borders for a more organized and visually clear layout.
    - *We have re-organized several sections of the paper to be consistent with this comment. The paper now has the following structure:*
        - *Introduction*
        - *Simulation Methodology*
            - *Dielectric Material Model*
            - *Geometric Model*
            - *Surface Roughness*
            - *Simulation Radius*
            - *Channel Geometry*
            - *Simulated Data Processing*
            - *Hypothetical Simulation Cases*
        - *Results - Hypothetical Simulation Cases*
        - *Application to Thwaites Glacier*
            - *Study Area*
            - *Method*
            - *Results*
        - *Discussion*
        - *Conclusions*

- In the conclusion section, it would be beneficial to provide an overview of future work, offering the potential research directions and developments to be pursued.
    - *We added language in both the Discussion and Conclusions sections indicating possible directions for future work.*