

Reply to reviewer Tobias Stål

We thank the reviewer for the insightful comments and the annotated manuscript. We followed the advice and concentrated on presenting the approach of SOMs, giving less emphasis on the geological interpretation. Hence, major changes in the manuscript are in the Introduction, Discussion and Conclusions chapter as advised by the reviewer and added further details by reorganizing the figures, adding a new zoom in for comparison and supplementary figures showing all attributes used for the analysis.

The paper demonstrates several notable strengths, particularly in its methodological approach. The use of self-organizing maps (SOM) stands out as a positive aspect. SOMs are well-suited to combine multivariate data into meaningful clusters. Compared to more traditional methods, SOMs often excel at revealing underlying patterns and relationships. The authors use a reasonable range of attributes to identify such patterns, thereby capturing the nature of the subglacial geology in Wilkes Land, East Antarctica. Furthermore, SOMs operate in an unsupervised manner, reducing potential bias from manual classification and handling noisy or incomplete data more robustly than some alternative approaches. Their transparent structure and intuitive results make them especially valuable for insights into the structure of heterogeneous data, where the interpretability and simplicity of SOMs can be more beneficial than the raw predictive power of deeper, more complex models. The subglacial Antarctica serves as an experimental sandbox for method development, and we certainly urgently need to get a better understanding of the tectonic structure to provide ice sheet models with boundary conditions that define the ice sheet's stability over the coming centuries.

Thank you for your interest in the method. In line with your comments below, we restructured the manuscript to give emphasis on introducing the method of SOM for subglacial imaging.

Another strength of the paper is the decision to (mainly) work directly with flight line data rather than relying on interpolated grids. This approach preserves the original measurement fidelity and avoids the artifacts or smoothing effects. By analysing the flight line topography data directly, the study ensures that its results more accurately reflect the true spatial variability, which is crucial when dealing with complex or heterogeneous terrain. The discussion regarding the attributes and their relationship to geology is insightful and engaging.

Thank you. And we followed your advice to concentrate on explain the approach and not to extend the geological interpretation.

Despite these methodological strengths, the paper currently suffers from weaknesses in its writing and presentation. The manuscript often lacks clarity, making it challenging for readers to follow the narrative. The overall structure feels incomplete, and the paper appears to have undergone insufficient editing prior to submission—it reads more like a first draft than a finished manuscript. As a result, key points and the significance of the findings are sometimes difficult to discern. In particular, the Introduction, Abstract, and Discussion would benefit from substantial revision, while the more mathematically driven Methods and Results sections are in better shape. The figures and tables are generally okay and useful; however, I strongly recommend changing the colour maps, as they are not perceptually uniform.

The color schemes were changed and are hopefully better suited. Regarding the comments on figure 7 in the annotated manuscript, the Colormap is 2 dimensional. We make this choice to be

able to use a SOM which is reducing to 2 Dimensions instead of only to one Dimension. This is rather complex and there is no out of the box solution we could use. We here vary the red and blue channel at x and y dimension respectively, while keeping the green channel at 0. This choice is specifically designed to work for people with red–green color blindness. While there would be other possible combinations in the RGB space, we chose the current one as it appears to provide the best contrast.

To strengthen the paper, I recommend a thorough revision to improve clarity, ensuring that the background, objectives, and discussion are well explained and logically organized, and that any unnecessary digressions are avoided. Careful attention to language and grammar will also help bring the manuscript up to the journal's standards. Additionally, the paper would benefit from a bit more context and justification for the choice of methods, particularly in clarifying how Self-Organizing SOMs) differ from other potential approaches. That said, I agree that an extensive theoretical background is not required here.

We added more explanation on the choice of method and the differences to alternative methods in the introduction and carefully checked the English (US) grammar.

In summary, while the methodological choices are strong, the manuscript requires significant revision for clarity and completeness before it can be considered suitable for publication. I am providing an edited and commented Word file (with apologies for any formatting issues caused by converting from PDF). My suggestions are not exhaustive, but I hope they offer a useful starting point for revising the manuscript and addressing some of the recurring issues. Additionally, some edits may have altered the authors' intentions and should be disregarded, but they are helpful in highlighting where the text is unclear.

Thank you for your comments in the annotated manuscript, which we followed as much as possible. We especially rewrote the Discussion and Conclusions chapters to have a clearer narrative, concentrating on introducing the SOM approach.

In the manuscript with track changes, it will be clear how we implemented these changes to restructure and to rewrite the manuscript, making it hopefully suitable for publication.