*Responses to reviewers – Change in Supraglacial Lakes on George VI Ice Shelf, Antarctic Peninsula: 1973-2020*:

- **Reviewer 1**:
    - Point 1 - We tested supraglacial lake bathymetry and ice shelf topography using the TanDEM-X DEM product. We used this high resolution DEM product to investigate the form of lake basins in order to assess whether they formed in a typical lake basin shape, or the U shape proposed in comments from Reviewer 1. Through our analysis we find no convincing evidence that supraglacial lakes on the George VI ice shelf (GVIIS)form in U shaped depressions, but rather shallow graduated basins and V shaped depressions (in the case of drainage dolines) (response figure 1). In the light of this finding, it is clear that increased melting will increase the surface extent of supraglacial lakes in a somewhat consistent manner, rather than maintaining the same surface footprint until they overspill. This is a result of the lakes being predominantly present in shallow depressions on the ice shelf surface. Hambrey et al., (2015) discusses the surface topography of GVIIS, describing the features between which the lakes form as 'pressure ridges', which reach only up to 5 metres high. As such, we conclude that in the case of GVIIS, surface topography has only an impact on where water pools initially, but as melting continues, water quickly spreads across the surface of the ice shelf. Hence, we see no convincing evidence to lead us to consider surface topography more deeply or adjust the focus of this manuscript.

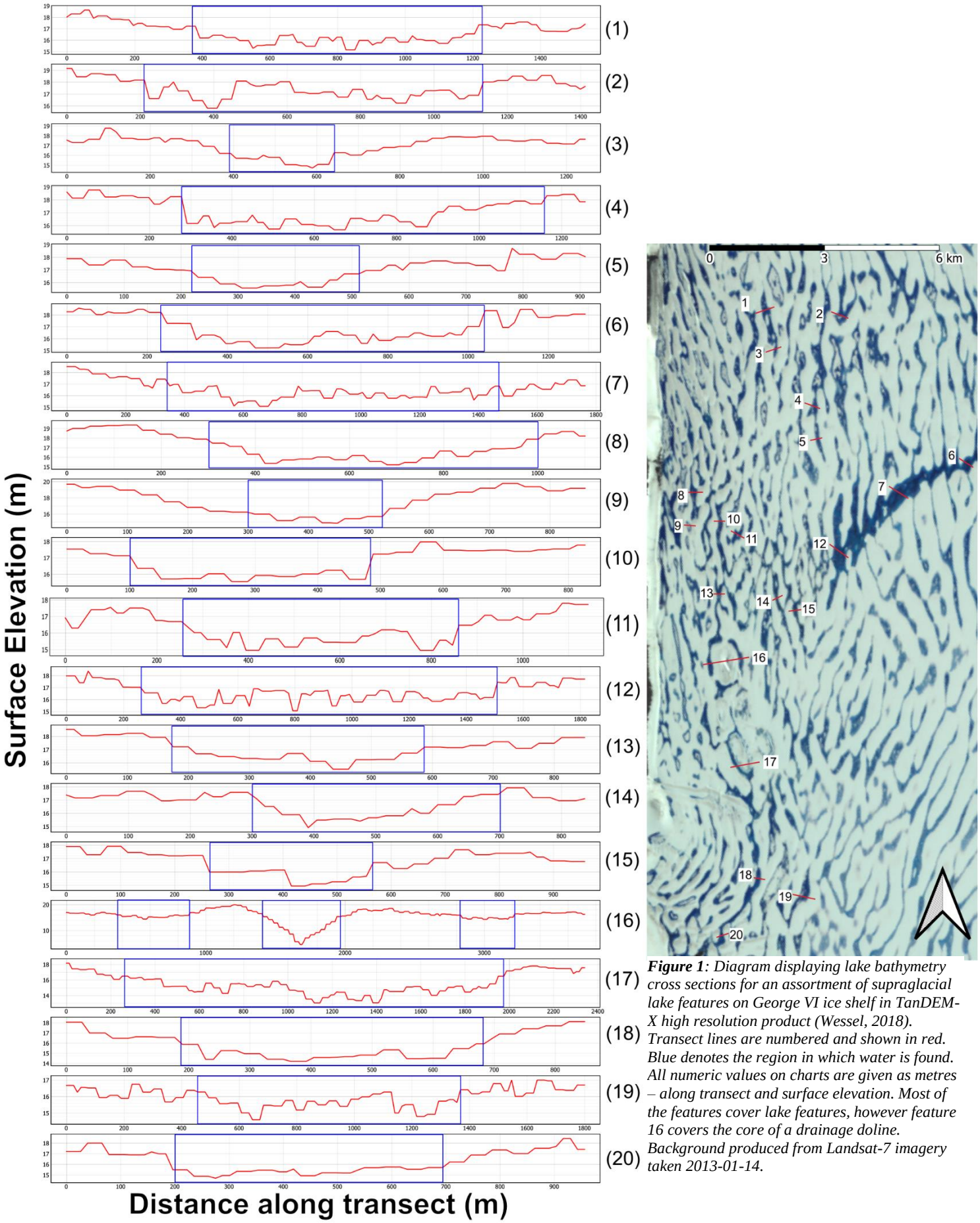


***Figure 1**: Diagram displaying lake bathymetry cross sections for an assortment of supraglacial lake features on George VI ice shelf in TanDEM-X high resolution product (Wessel, 2018). Transect lines are numbered and shown in red. Blue denotes the region in which water is found. All numeric values on charts are given as metres – along transect and surface elevation. Most of the features cover lake features, however feature 16 covers the core of a drainage doline. Background produced from Landsat-7 imagery taken 2013-01-14.*

- Point 2 - Added clarification in text with references determining reasoning behind using Green and NIR methodology. We made use of this method over Red and Blue methodology due to the red blue method excluding areas of water, particularly where lakes were conjoined in the interconnected network of George VI Ice Shelf. The methodology in this paper was based in principle on the work initially carried out by Stokes et al. (2019) on East Antarctica, and hence we aimed to use the same method in the study. Other works have used this methodology in a glaciological setting (for example, Watson et al., 2018), and more contemporary works have used a combination of both methods, as both have different regions in which they excel (Corr et al., 2021). Values in non-Landsat-7 imagery are no longer scaled to be comparable to Landsat-7.
- Point 3 We clarify that gridded MAR was used rather than a single point.
- Point 4 This comment has been addressed through line by line edits, and major edits from both reviewers. Many sections have had added clarification and the abstract has been re-written to more readily fulfil its purpose and give relevant information to the reader as a summary of the manuscript.
- Figure 2 (previously, figure 1) All comments are addressed accordingly. We removed labelled locations and included these in a study area map as a new "figure 1".
- Figure 3 (previously figure 2) Month information added to figures, imagery dates can be found in supplementary table 1. Legend has been altered but kept in the same place due to figure clutter being avoided.
- Figure 4 (previously, figure 3) The scatter plots in supplement are directly associated with this figure and discussed as such in the figure caption. However previously we attempted to include these scatter plots in this figure but the authors decided through discussion that they added no further information to the diagrams, and cluttered the image. Instead, we decided they should be included as additional information in supplement.
- Figure 5 (previously, figure 4) The lack of trend is addressed more clearly in text. We focus on a wider study region with these figures as GVIIS is not a closed system, and is impacted by surrounding climatic changes. The associated in-text section discusses the wider influence of Antarctic Peninsula climate on GVIIS, and thus we consider the wider scale maps to be relevant and appropriate for inclusion in the figure.

- **Reviewer 2**:
  - Point 1 - Abstract has been rewritten to bring up to standard, this was neglected over pre-submission edits.
  - Point 2 – A short section has been added to describe the glaciological setting of GVIIS, including references to literature.
  - Point 3 - Added clarification in text with references determining reasoning behind using Green and NIR methodology. We made use of this method over Red and Blue methodology due to the red blue method excluding areas of water, particularly where lakes were conjoined in the interconnected network of George VI Ice Shelf. The methodology in this paper was based in principle on the work initially carried out by Stokes et al. (2019) on East Antarctica, and hence we aimed to use the same method in the study. Other works have used this methodology in a glaciological setting (for example, Watson et al., 2018), and more contemporary works have used a combination of both methods, as both have different regions in which they excel (Corr et al., 2021).
  - Point 4 – We calculate error for supraglacial lake delineation in manual and automated methods together, due to the inherent connection of automated methods to manual. We find the error value to be ± 9%. Detail of this process and error has been explained in section 2.1, and numeric information added to Table 4.1 in the supplement. In addition, we have referred to the error value in all quoted values present in the manuscript.
  - Point 5 - We took the values used in Stokes et al., (2019) as a benchmark for thresholding, and worked from these. While Stokes et al., (2019) made use of the

same thresholding value for both Landsat 8 and Sentinel 2, we tested both sets of imagery separately for thresholding values. After testing they were found to fall on the same values, in line with findings from previous literature. A different thresholding value was used for Landsat 1 due to the large difference in available bands between this satellite and contemporary satellites such as Landsat 8 and Sentinel 2 (Ihlen & Zanter, 2019; USGS, 1979).

- Point 6 – Addressed by a timeseries chart in supplement (Figure S1.2). No periods use incomplete imagery. Either complete imagery is acquired, or the period is skipped so as to avoid problematic variability in the results.
- Point 7 – Diagrams of lake extent between 2000-2020 have been added to the supplement from the associated Master's thesis, allowing for visualisation of patterns of lake extent for those interested.
- Point 8 – We have made edits to the approach to non-Landsat-7 data in regards to Landsat-7 scaling issues. All values now quoted in the text are true values, rather than those scaled by the 0.78 Landsat-7 scale factor. However, diagrams still represent scaled values to be brought in line with Landsat-7 for the sake of comparability. This information is also now specified in-text to address any misunderstanding.

References:


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Watson, C. S., King, O., Miles, E. S., Quincey, D. J.: Optimising NDWI supraglacial pond classification on Himalayan debris covered glaciers, 217, 414-425, https://doi.org/10.1016/j.rse.2018.02.020, 2018.

Wessel, B., "TanDEM-X Ground Segment – DEM Products Specification Document", EOC, DLR, Oberpfaffenhofen, Germany, Public Document TD-GS-PS-0021, Issue 3.2, 2018 [Online]. Available: https://tandemx-science.dlr.de/ 2018