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Interactive comment on "High-resolution topography of the Antarctic Peninsula combining TanDEM-X DEM and REMA mosaic" *by* Yuting Dong et al.

Anonymous Referee #1

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General comments: I have now gone through the manuscript more than twice. Generally speaking, this is a well-written manuscript with a thorough description of methods and analysis of results. Authors have used TDM DEM and REMA DEM of the AP region and improved the quality by combining them using propagation algorithm. Authors have demonstrated the improvement by comparing using laser altimetry data captured during two campaigns. Authors have demonstrated the improvement in terms of RMSE and clearly showed the improvement in iterative 3-steps of correction. My major criticisms are; (1) Authors have not explained the effect of using multi-temporal datasets captured during two different periods and later comparing them with laser altimetry campaign datasets captured in other periods. There is a significant temporal constraint

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in merging these datasets- I suggest authors describing the effect of using such data and how much error it will introduce in their analysis. (2) Authors generally consider REMA as a ground reference DEM and improve the TDM DEM based on the values of REMA DEM. REMA is about 8m and then they used 100m coarse values where they have voids in the REMA DEM. Propagation algorithm works on two DEMs of slightly different spatial resolution; authors should explain the effect of different spatial resolutions of datasets on the algorithm. Put other words, could you resample your two DEMS on the same resolution and then run the algorithm to find out the performance? From result tables, I can see improvements varying in different steps of corrections and also for different elevation settings which are expected. However, the significance of final improvement has not been justified by authors. How authors can claim this improvement and not random noise? This is mainly because I can see instances in the result tables where improvement is around 2m. (3) My concern is why glaciologists would use the newly constructed improved TDM with accuracies still less than original REMA? REMA accuracies were reported less than 1m and TDM accuracies are reported around 10m. The only advantage I can see in merging is to fill data voids or gaps of REMA. From table 3, it is well demonstrated that there is no significant improvement (w.r.t REMA) in RMSE even after improving the TDM. The achievement of this study is to fill the data gaps in REMA using TDM. Put in other words, why reader can't call it as an improved REMS DEM or gapless REMA DEM as the basic foundation of the algorithm is the REMA and not the TDM? Authors must understand the data circularity created by the methodology and see that REMA was used as a reference to correct TDM values and then it is compared against the TDM and original REMA. In general, glaciologists will use this improved DEM if they find it more accurate than the REMA but this is not demonstrated. How if we simply patch up missing elevation values from REMA by TDM and smooth those gap areas? I suggest authors to suggesting future use of corrected TDM in glaciological applications. I encourage authors to describe this in the discussion section. (4) Authors have not demonstrated the viability of their methods w.r.t published methods of merging DEMs. This should be discussed in

the discussion section.

Section-wise comments are appended as follows:

Abstract: I have carefully read the abstract. It is generally well written, but it is somehow not attractive in the reader's perspective. Authors have failed to mention RMSE in absolute numbers rather they refer percentage. Between line 15-20, I encountered a very long statement which can be shortened. *To generate a consistent, gapless and high-resolution (12 m) topography product of the AP, we combine the TDM DEM and REMA mosaic by detecting and correcting the height errors in TDM DEM through a novel path propagation algorithm and multi-scale height error correction method based on the accurately calibrated REMA mosaic data. *. I would suggest authors to improve the abstract to make it more readable to readers and also boost it with quantitative results at the end.

Introduction: Simplify this: 2020). AP is a complex mountainous coastal glacier system and the mass balance of the outlet glaciers is affected by climate and oceanographic forcing and also by the subglacial and surrounding topography (Cook et al., 2012).

Good to see available DEMs of AP, mostly are Antarctic-wide. Table S1 provides a good overview but unfortunately, authors have missed a few regional attempts of making DEMs e.g. Fieber et al, 2018: https://doi.org/10.1016/j.rse.2017.10.042. Line 35-45, I would suggest authors revisit regional attempts of constructing DEMs of AP region.

Line 45: By analysing all these available DEMs, it can be noted that the DEMs of AP have always suffered from large elevation uncertainty, coarse resolution, wide data voids or incomplete data coverage, which are caused by the complex mountainous terrain and cloudy weather of AP. I think this a very generic statement which is applicable for most of the regions of the continent and restricted to only AP.

I see authors are using the term posting, are you referring to the spatial resolution?

Line 56: To obtain a consistent, gapless and precise DEM product at the high spatial

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resolution of AP, we intend to create a high-resolution DEM of AP by combining the TDM DEM and REMA mosaic, the two up-to-date DEMs with similar posting. Authors should use comparable posting rather than a similar posting.

In general, the introduction section is not fully developed. It gives a feeling of missing information. For instance, authors should mention about the necessity of accurate and high-resolution DEM in the region and previous literature or applications of DEM used in the AP for various glaciological studies. This would provide a robust background on how accurate DEM can improve these existing studies. Authors mentioned about Cook et al. (2021) attempt of improving DEM but they ignore other efforts of combining multiple datasets to generate improved DEMs in Antarctica. To my knowledge, there are established attempts of developing DEMs in the Antarctic by combining two or more datasets- Authors should review those efforts in and then place their study at the end and explain how their effort is different than others.

Experimental area and data: Figure 1: Authors should mention elevation on the colour scale. And may consider naming a few landmark points in the figure to make it more readable. Somehow one yellow box is hidden behind the green coastline. You may consider changing the draping and make the yellow box above the green coastline layer so it is visible. Is the background RAMPv2 DEM or imagery? And you may also consider showing the high-resolution window showing sampling locations. Experimental data: This section is very well written, well done! Minor comment: use the term elevation and height consistently throughout the manuscript.

Methodology: Line 130-135: use the term ground reference and not the ground truth.

Figure 2: In the first section box, I cannot see x and y-axis numbers (Height difference against frequency graph). In section II, what are different shades of blue showing height error regions? Are you missing a colours scale here? I cannot see the text in blue in the Fitted reference surface model of section III. What is this blue line?. Authors should improve the caption of this figure describing the flow process briefly.

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Figure 3: You may consider showing REMA DEM of the same region shown in (a)

Authors have mentioned of using empirical threshold but did not mention much about the process of defining the empirical threshold to execute propagation algorithm. I understood the method of correcting TDM DEM against REMA using propagation algorithm, but I am also concerned about pixel resolution difference between two datasets and then impact of this varying resolution on the algorithm. It is more evident when authors are using 100-m sampled data where REMA has data voids.

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