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Interactive comment on "A new Digital Elevation Model of Antarctica derived from CryoSat-2 altimetry" *by* Thomas Slater et al.

Anonymous Referee #2

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Title: A new Digital Elevation Model of Antarctica derived from CryoSat-2 altimetry Author(s): Thomas Slater et al.

This paper presents a new digital elevation model of Antarctica based on 6 years of CryoSat-2 measurements

To generate the DEM the authors use a different approach as most studies before. Instead of applying an interpolation method like IWD or Kriging a function is fitted on a pixel level to estimate elevation, 2D quadratic surface' and elevation trend at the same time. Empty neighboring pixels are filled at a later stage using kriging interpolation. The final DEM is validated against ICEBridge data and slightly compared to existing DEMs.

The paper reads well and the figures and tables are illustrative and informative. Validation against Airborne data is well explained and scientifically sound.

However, to my opinion, since the paper is presenting another Antarctic DEM a more detailed analysis and comparison to existing DEMs is required. Especially the implications, reliability of the new method compared to widely used interpolation methods is worth to investigate in more depth. E.g. a comparison with the cited CryoSat-2 DEM of Helm et.al. could be used to demonstrate if and where this new approach in combination with 6 times more data is performing better or has weaknesses. E.g. a difference plot between both CryoSat-2 DEMs over whole Antarctica would be very informative to see in which areas the DEMs differ.

I have some concerns about the applied pixel fit method. Since the elevation is generated on a pixel level (neighboring pixel are not 'talking to each other'). This might introduce elevation jumps or artefacts. As example I generated hill shades of the new DEM and the mentioned external DEMs (Fig1). The new DEM shows clearly erroneous pixels, especially in areas of steep topography, close to the Grounding line. I'm wondering if the authors can explain why this is happening and if there is a strategy to avoid this. The other DEMs do not show such artefacts.

In table 3 a comparison of the Differences of LRM/SARIn areas to Icebridge with respect to slope is given. Since the new DEM is a composite of 'observed pixels' and 'interpolated pixels' I would like to see this analysis splitted up (similar to Table 2).

Furthermore, I would suggest to present two figures where the mean difference and respectively the Stddev is plotted against slope (e.g. binned to 0.05°) for the whole DEM, observed and interpolated pixel, respectively. In addition, this Figure should include the same analysis for the other 3 DEMs. Such kind of figure would clearly show the difference between observed and interpolated pixels as well as the stated improvement of the new DEM against existing DEMs.

Is there a way to compare the final slope model (Fig 5) with the 2D quadratic surface

slope, estimated for each pixel?

How robust is this pixel wise 2D surface fit and its sensitivity to the number and distribution of data points within a pixel? One could run the same fit method on yearly subsets of data and compare the elevations of 'observed pixels' of the subset DEMs with the Final DEM. (e.g. generate maps of the mean of the differences between subset-DEMs and final DEM and its stddv).

Please make clear what kind of data you are using as input. You mention that an OCOG retracker is used for LRM data but another retracker for SARIn. Please explain why and what are the consequences (e.g bias based on the different retracker).Are you applying any slope correction to the LRM data? If yes what method is used and which DEM is used for the slope correction? Do you use your newly derived DEM and an iterative scheme? If you use another DEM, please explain why. If you don't apply a slope correction to LRM than I see some inconsistency between the LRM and SARIn regions, since the SARIN data is slope corrected using the interferometric phase. Do you use all data points or do you run a pre-filtering to exclude erroneous data points before running the fit procedure? Are there any filtering approaches used after applying the pixel wise fit?

I also miss a map of uncertainty for whole Antarctica coming along with the DEM which would be required for ice sheet modelers.

P8 L30: Why are you not applying an elevation trend correction to the interpolated areas? This is inconsistent. You could easily generate an interpolated dhdt map to correct for elevation change in interpolated areas.

Fig 8: Why is the median difference below zero in all cases - this would mean that CryoSat is measuring above the laser surface?

Figures (2,3,4,5,6,7,9): please use km instead of m and overplot a Latitude / Longitude grid on top of the polarstereo projection.

Furthermore, I think that the new DEM is shifted by 1 pixel. Difference plots as suggested above show a strange pattern (see Fig. 2) which is not observed between the other 3 DEMs - Do you have any explanation?

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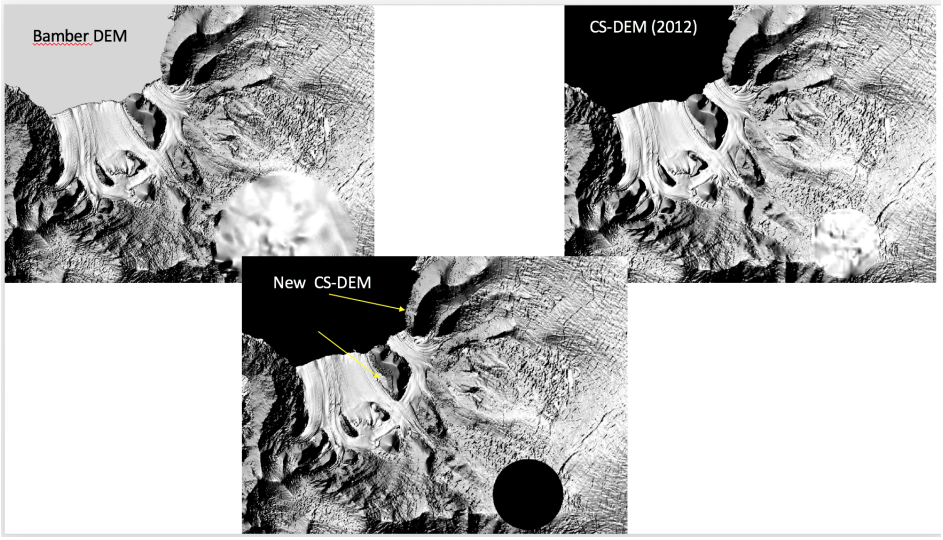

Fig. 1. Hill shades of 3 DEMs. (New DEM Pixel errors e.g. Berkner Island

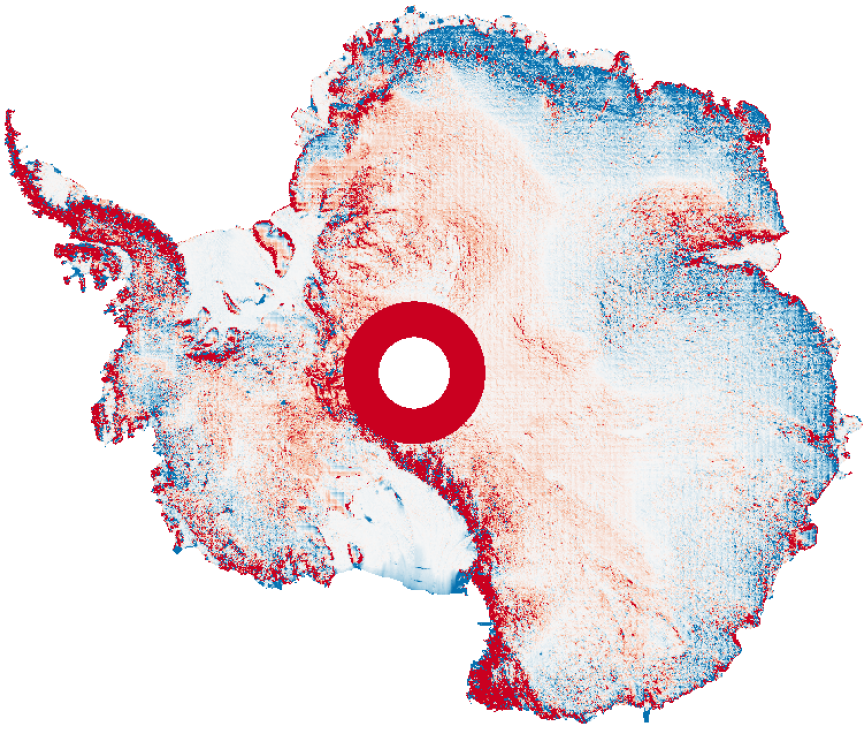

Fig. 2. Difference between IceSat DEM and New DEM (colour scale: -25 to +25)