The Cryosphere
Discussions

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Interactive comment on "The Reference Elevation Model of Antarctica" *by* Ian M. Howat et al.

Anonymous Referee #2

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General

This paper provides the description of the recently released REMA dataset for Antarctica. The dataset is revolutionary, providing high resolution continuous surface elevations for the entire continent. The amount of data processed alone is a remarkable accomplishment, and then combined with the heavy validation performed with ICE-Sat/Cryosat and ICEBridge will ensure the repeated and steady use of this dataset in the future for all Antarctic science. I congratulate the authors for making this possible, great job.

In general, the manuscript is well written, short and concise. In some ways, a bit too short, as there are many detailed processing steps that are somewhat brushed over which would make it difficult to reproduce the complicated merging and mosaicking of all individual DEMs. In light of this, I think it would have been useful for the authors

to also show/focus on some of the pitfalls of REMA showing a few examples of some of the more common problems and artifacts. This would help users of the dataset to easily spot artifacts when using REMA in their own research, especially those that are not accustomed to analyzing DEMs. In addition, It would have also been nice to see some advertising of the beauty of the dataset generated, for example by having a figure that exemplifies the precision using elevation profiles compared to ICESat and TanDEM-X, maybe one over some mountains, and another over the flat ice sheet with moderate topography. As of now, the figures all focus on the compilation of DEMs and their compiled accuracy, but no figures show the actual data at its natural resolution. . .

Here are a few comments towards the methods applied and described. I am particularly confused by the description and quantification of errors. By error (Fig 4a), do you mean the combined accuracy and precision (bias + random error). Maybe it would be useful to provide a final equation for how you attribute error to the individual tiles. This will be absolutely necessary for users to properly acknowledge and understand the abilities and constraints of the dataset. In terms of co-registration, it is often stated "coregistration residuals" which does not make much sense to me. Do you mean the elevation difference residuals after applying a 3D linear co-registration shift? Or do you mean the absolute vector of the co-registration shift. This needs to be clarified and used consistently through the text. Then, in terms of co-registration, the Nuth and Kääb (2011) approach is not solvable on flat terrain as the approach requires some slope and a bunch of aspects to solve properly. I imagine there is some consistent small scale topography of the ice sheet that was useful to use this approach. But in some areas where the distribution of slopes and aspects is limited, then the approach will probably only solve for a vertical bias. It would be useful to discuss this issue briefly, or at least mention it. . . Last, in terms of the correction inferred to derive from Cryosat-2 penetration, Since Cryosat is only used around perimeters in this study while ICESat is used in the interior, then, Do you think your spatial sampling biases the results here?

In summary, this manuscript provides a good description of a revolutionary dataset

for Antarctica, and will thereby be used and cited immensely. While there are limited major comments in this review, I hope the authors will find this useful to make their description even more transparent and clearer in order to help the plethora of users that will eventually integrate this dataset into their science.

Minor Comments P3, L29. I was confused by this header title. I suppose you are not combining individual images into strips, then processing DEMS from the combined strip images? Consider calling this section "Merging single scene DEM into along track strips" as this is what I inferred from this section. Please correct me if I am wrong. P4, L1: What is meant by "co-registration errors" ? Do you mean the magnitude of the vertical shift? How was this determined? P4, L11-17. What type of criteria is used in the visual inspection? And what is needed to pass quality control? Please provide additional details to make this process transparent, even though it is subjective to the inspector. P4, L31- . Was the sample used for this comparison spatially biased? Are all the points in this comparison located in one spot, or generally on the lower ice sheet. Additional details to clarify this would be helpful. Also, I wonder how the selective data approach (L26-27) by removing all strips that had a significant vertical bias (e.g. potential penetration '?) affected the interpretation of bias? If so, it could explain why you observe a "quasi" constant radar penetration estimate in Fig. 2, especially if all those scene residual statistics are spatially constrained on the continent. P5, L15. What is meant by "coregistration residual"? Do you mean the absolute magnitude of the co-registration vector? Did you apply the co-registration as well before filling the holes? P5, L19. Do you mean "absolute" reference? It would be relative reference if the strip was not aligned with ICESat/Cryosat, no? P5, L25-29. I am still confused about the "registration residuals"? If these are simply co-registration vectors, then I do not understand why they are used as residuals? For me, co-registration residuals would be the combined offsets between three or more datasets and subsequent triangulation of the co-registration vectors... (See Paul et. al. 2015) LAST: In such a massive undertaking for automated processing of DEMS and merging into a consistent product for the entire Antarctic Continent, would it not be useful to provide a flow diagram

showing the sequential processing, merging, and then mosaicking processing steps? I imagine that this procedure may happen again (repeat processing), from which others may learn significantly from the pipeline devised and implemented here. . .

References: Paul, F.; Bolch, T.; Kääb, Andreas; Nagler, T.F.; Nuth, Christopher; Scharrer, Killian; Shepherd, Andrew; Strozzi, T.; Ticconi, Francesca; Bhambri, Rakesh; Berthier, E.; Bevan, S; Gourmelen, Noel; Heid, Torborg; Jeong, Seongsu; Kunz, M.; Lauknes, Tom Rune; Luckmann, Adrian; Merryman, J.; Moholdt, G.; Muir, A; Neelmeijer, Julia; Rankl, Melanie; VanLooy, Jeffrey & Van Niel, Thomas (2015). The glaciers climate change initiative: Methods for creating glacier area, elevation change and velocity products.Remote Sensing of Environment. ISSN 0034-4257. 162, s 408- 426 . doi: 10.1016/j.rse.2013.07.043

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