

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-19

Anonymous Referee #2

Referee comment on "TanDEM-X PolarDEM 90 m of Antarctica: Generation and error characterization" by Birgit Wessel et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2021-19-RC2>, 2021

This paper describes the generation of a new 90 m resolution DEM, with virtually complete coverage of Antarctica, from TanDEM-X acquisitions. This DEM features gap filling with new acquisitions, a treatment of noisy areas, and the authors describe a new technique for delineating the Antarctic coastline. The DEM is then extensively evaluated against a series of datasets from different sensors.

Overall I found this study to be very well written – it's clear the authors have put in a lot of effort to make sure the methods and validation are thoroughly described and that the paper is well presented. The DEM agrees very well with the chosen validation datasets; the methods implemented are new and the DEM features several improvements over previously existing InSAR DEMs making it worthy of publication.

General comments

My only general comments are regarding (1) the surface actually represented by the DEM and (2) the comparison between the laser altimetry (both ICESat and IceBridge):

(1) While I appreciate the author's decision to not raise the DEM to ICESat elevations, it leaves me with questions regarding which surface the DEM represents, as my understanding is that it's not the true surface (i.e. air-firn interface) but somewhere below in the firn pack (with spatial variations depending on scattering properties). This unfortunately limits its use for applications in e.g. ice flow models. It would be helpful to add some text explaining this more clearly to the reader and for what applications this DEM is appropriate for.

(2) I find the author's approach inconsistent in that they omit addressing temporal differences between the ICESat data and the DEM, but use them as a justification to remove the majority of IceBridge data available in Antarctica. The well characterised pattern of dynamic ice sheet thinning across West Antarctica is clearly visible in the largest ICESat-DEM differences (Fig 11) but is not addressed. As presented, I feel the reduced spatial distribution of the IceBridge comparison make it not as useful as some of the other comparisons in characterising the DEM accuracy. Regarding the IceBridge data – there have been (to my knowledge) contemporaneous IceBridge acquisitions between 2013-2017 across Antarctica which could be included as they would minimise this

temporal difference. It may also be possible to address this using rates of elevation change (many datasets are available) to adjust for the temporal difference between both datasets.

With these points addressed I think this paper would be excellent and well suited for publication in the cryosphere. Please find more specific/technical comments below:

Specific comments

L4 – Suggest explicitly stating the time period the DEM covers somewhere in the abstract.

L9 – I suggest rewording this sentence as it implies an error characterisation was carried out continent wide for IceBridge, which is not the case.

L25 – Helm et al., 2014 is not based on 2010-2016 data so I suggest rewording here.

L39 – Suggest 'Futhermore' instead of 'Furtheron'.

L48 – I feel it is misleading to characterise Laser/InSAR measurements as 'the same' because there will be other sampling factors beyond the penetration bias, so would suggest rewording – happy for this to be explained to me if I'm wrong and the authors disagree!

L54 – Are there major differences between these baselines? It may be beneficial for the reader new to this data to go into a little bit more here.

L77 – Are these data removed for block adjustment or for validation? If for validation this seems circular to me as the authors would be removing IceSAT data based upon comparisons to their DEM before using it as a validation dataset – can the authors provide more justification as to why this is appropriate to remove the ICESat data if this is the case? Apologies if I've misunderstood.

L80/L86 – It's not clear to me from this section how the 'best 10' or 'most 1000 reliable' ICESat data points are selected. I'd suggest editing the text slightly to help the reader out.

L93 – Suggest rewording this sentence to make it clearer.

L106/throughout – there are lots of locations referenced in the text with no indication of where they are. I feel it would be helpful to the reader to illustrate where some of these locations are to an existing figure or elsewhere.

L114 – Suggest changing 'bridging' to 'bridged'.

L122 – As I said previously in my general comment – I think better treatment and justification is required here as to why the vast majority of the available IceBridge data in Antarctica have not been used here.

L153 – I feel this sentence is unclear – it is implied that ICESat has a penetration bias when it is taken to return from the surface.

L155 – amend 'therewith'.

L158 – I'm not sure what is meant by 'probably' in this sentence?

L166 – I feel this sentence is unclear as to what is meant by 'difficult conditions'.

Fig 5 – A colour scale and indication of where this is in Antarctica might be helpful for the reader.

Fig 6 – it looks to me like there could be new acquisitions used to fill gaps in regions in the Bellingshausen Sea where rates of thinning are high – is this accounted for when the DEM scenes are re-mosaicked, or is it not a factor on the DEM accuracy in these areas?

L238 – I think 'Southern Ocean' instead of 'Antarctic Ocean' is the proper term here

Fig 8 – It may be helpful to add the SCAR coastline to panel (d) to illustrate the difference.

L303 – Fig 11 is referenced in the text before Fig. 10 – may be helpful to rearrange to improve readability.

Fig 11 – As in my general comment – the pattern of dynamic thinning is clearly visible where the differences are purple from the Peninsula all the way across to the Getz region but is not addressed.

L320 – It's not clear to me from the text which area is being referred to as 'West 90'.

L323 – Suggest rephrasing this last sentence so it's clearer.

L324 – I'm not sure exactly what is meant by 'lower and stronger' here.

L327-328 – Suggest rewording this sentence to make it easier to read. These brighter amplitude areas look like they correspond to the Antarctic megadunes to me (in both Fig 10 and Fig 11) – it may be worth the authors commenting briefly on how these structures affect backscatter.

L330 – As in my general comment – apologies if I'm missing something here – I take this choice means the DEM does not represent the true surface height of Antarctica, but the X-band scattering horizon which seems to be variable in space/time. While the dataset is still very useful I feel this does limit it's potential use in e.g. ice flow models where the surface height is needed as a boundary condition and should be addressed in the paper.

L383 – CryoSat is used inconsistently throughout the text – suggest using 'CryoSat-2' everywhere.

L400 – Would suggest rewording – it's clear there is an LRM/SARIn bias here but to me it's not clear whether it's due to penetration or other factors (e.g. footprint)

Best wishes,