Review of Cook et al., ESSDD, June 2012

SUMMARY

Cook and co-authors present a new 100-m DEM of the Antarctic Peninsula North of 70S. This new DEM is an improved/edited version of the global ASTER GDEM. The authors have used an empirical but sound methodology to correct some well-known artifacts of the GDEM over flat texture-less ice-covered areas. The new DEM is evaluated against different dataset, mainly ICESat laser altimetry data for its vertical accuracy and mountain peaks extracted from SPOT5 DEM for the horizontal accuracy.

GENERAL COMMENTS

Making this new DEM freely available to the glaciological (and others?) community is indeed very important as current Peninsula-wide DEMs have a very coarse resolution and a low accuracy. The present paper, describing and validating this new dataset, is well-written although some sections could be clarified and maybe some paragraphs could be shortened. Some tables & figures could also be skipped. My single major comment concerns the need for a more comprehensive validation of the vertical/horizontal accuracy of the new DEM using ICESat.

Improved validation using ICESat data

Vertical accuracy: The authors have limited their accuracy assessment to a portion of the DEM (66 to 68°S) and to only 5 ICESat tracks without real justification (one possible justification could be the occurrence of rapid elevation changes further north, (Pritchard and others, 2009; Shuman and others, 2011) ?). However, I strongly recommend extending the validation to the whole Peninsula and to all ICESat data acquired during the GLAS lifetime over the Peninsula. One co-author of this paper (D. G. Vaughan) was also co-author of a paper using ICESat data (Pritchard and others, 2009). Thus, I assume that the authors can have access a series of "cleaned" (=cloud-free) ICESat tracks from H. Pritchard and could use it to perform a full validation their whole DEM. With a large sample of validation points, the vertical accuracy could be broken down using different classes of surface slopes.

Horizontal accuracy: contrary to what is claimed by the authors, it is possible to check the geolocation accuracy of a DEM using ICESat (purely altimetry) data. It is relatively straightforward and has been clearly described by (Nuth and Kääb, 2011). It would provide a much more comprehensive accuracy assessment than what is currently done based on mountain peaks that are difficult to extract from a DEM so that methodological error extracting these peaks probably leads to overestimated errors on geolocation.

Slope accuracy: It would also be useful to provide an accuracy assessment of the slopes (not only altitude) of the new DEM. I think that this is one topographic parameter for which the new DEM will exhibit a great improvement compared to the unedited ASTER GDEM. Here again the slope assessment could be done along all ICESat tracks (using slopes derived from two successive points along track, for example).

SPECIFIC and TECHNICAL COMMENTS

http://nsidc.org/data/nsidc-0516.html
I could download and open the DEM (geotiff format) safely from the NSIDC website. I have a comment regarding the data description:
"*This data set provides a 100-meter resolution surface topography Digital Elevation Model (DEM) of the Antarctic Peninsula. The DEM is based on Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) data. The GDEM data are accurate for coastal regions of the Antarctic Peninsula, but contain large errors on snow- and ice-covered regions. This data set was developed using a new method specifically for smoothing erroneous regions, and has an elevation difference of approximately 3 meters when compared to data from the NASA Ice, Cloud,and Land Elevation Satellite (ICESat).*"
The authors should make it clear that 3 m is the mean bias but not the precision of the DEM. So the 26 m RMSE should be added to the data description. You may also indicate the "no-data" value in the description.

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P366
Abstract: a suggestion is to include the RMSE from the original ASTER GDEM and final, edited DEM.

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P367
L9. Why citing three papers only from your research group here? In this early part of the introduction, it gives bad impression of self-citation (whereas other relevant references are indeed cited elsewhere in the paper).
L10. Not sure what you mean: (Rignot and others, 2004; Rott and others, 2011; Shuman and others, 2011) have all quantified basin-by-basin mass loss for the Larsen B (and A) region. Or do you mean for all individual basins of the whole Peninsula?
L17. A review paper such as (Nuth and Kääb, 2011) or (Toutin, 2008) may be a more appropriate citation here.
L19. Clarify why a DEM is needed to measure "area" (not clear, area could be derived from nadir Landsat imagery without the need to orthorectify them, or a coarse DEM is sufficient)
L26. "200 m or less": Maybe you can justify the 100 m posting of your final DEM by referring to the 90-m of the SRTM DEM available elsewhere on Earth?

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P368
L3. "widely used" remove the statement or cite papers using it (at least one with e.g., as prefix). I am not sure it can be stated (yet) that its use is wide in the glaciological community.

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P369
L19. "accurate base". Has the horizontal accuracy of LIMA been verified? If yes can you quote its geolocation accuracy? If not, I wonder whether it can be used as a geolocation reference.

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P370
L5. geospatial accuracy of the SPIRIT DEMs. (Korona and others, 2009) indicates "an absolute horizontal precision of 30 m rms". So when you compare to mountain peaks extracted from SPIRIT DEMs, part of the error originates from the SPIRIT DEM not only from your ASTER derived DEM.
L12. "map" rather than "detect" (?)
L17. Here and elsewhere in the paper, make sure you specify the metric (1-sigma confidence interval?) for different accuracy assessments (both horizontally and vertically).

L24. “present”. I think elsewhere in the paper you said 2009, be consistent. (in a few years, “present” could be mis-read so an absolute year is best)

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P371
L16. 1 paper (among others) that could be cited here regarding the difficulty of photogrammetry in texture-less areas: Lodwick, G. H., & Paine, S. H. (1985). A digital elevation model of the Barnes ice-cap derived from Landsat-MSS data. Photogrammetric Engineering and Remote Sensing, 51(12), 1937–1944

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P372
L19-24. Could be skipped. Obvious to most (if not all) readers that these dataset are not reasonable alternatives in term of gridded DEM of the Peninsula.

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P373
Section 4 and 5 could be grouped in a single section. They are both about “Methods”

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P374
L5. “remaining” and in fact the whole sentence are not really clear
L8. Here (or a bit further) could you indicate what is the area (in % of the total area) that was “edited”.
L15. You need to specify that the original GDEM is coded as “integer” (right?) so that the reader understands why conversion to floating points is needed.
L20-22. Unclear in particular “assess terrain contour-fit”…
L26. “generalised” ???

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P376
L14. Wrong. ICESat data can be used to assess the geolocation accuracy. See my general comment and (Nuth and Kääb, 2011).

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P377
L11. What are “low slope”? Provide a range of slopes. In (Shuman and others, 2006) the accuracy assessment is broken down in different slope classes so 14 cm is OK for very low slopes, probably not representative of the range of slopes found in the Peninsula. (Moholdt and others, 2010), in a terrain probably more similar to yours, have a cross-over RMS error of 66 cm.
L12. SPIRIT DEMs are not all from 2007. Can you add the dates of the SPIRIT DEMs in Figure 8?
L29. As you stated it has been already described that SPIRIT DEM have problem in the flat texture-less area (even more problem than ASTER GDEM according to your statistics). However it has been shown that non-interpolated SPIRIT data are more accurate than ASTER DEMs (Berthier and others, 2010, supp material; Korona and others, 2009). Thus I recommend breaking down the comparison of ICESat (and your new DEM) to SPIRIT DEM in two separate cases:

(i) Non-interpolated region of the SPIRIT DEMs only. In this case, the accuracy of the SPIRIT DEMs should be high (to be verified against ICESat) enough so that it can also be used to evaluate your new DEM.
(ii) All areas in the SPIRIT DEMs (as already done) → to show that your new complete DEM is in fact more accurate than the SPIRIT DEMs when all areas are considered.

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P378
L3. “within the RMSE value” –> “within +/- 26 m” (clearer)
L8. “with the file”: unclear
L15. Give mean difference to support the statement that no systematic bias is introduced.
L24. “Only positions”. Geolocation can also be checked with ICESat purely altimetric data.

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P379
L9. (Toutin, 2008) can also be cited here.
L19. Note that the gain of the ASTER sensor has also been optimized for glaciarized terrain thanks to the GLIMS project. Check (Raup and others, 2000).

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P380
L5. A reference dealing with the influence of resolution on mountain peaks and valley is (Kervyn and others, 2008)
L19. Make clear that the GDEM and your DEM share the same geolocation.

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P381
L13. The fact that averaging leads to reduce height is not related directed to the slope but rather to its first derivative, the curvature: for example an area of constant slope over a distance longer than the resolution of the low resolution DEM will have the same altitude in both DEMs. See discussion of this in (Gardelle and others, 2012).
L14. What do you call “topography” here?
L21. There is a gap between seasonal and climatic (> 30 yr) time scales (inter-annual, decadal time scales are filling this gap). Probably the sentence could be reworded.

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P382
The conclusion is a bit too detailed. No need to repeat for example how the underestimate of the peak height was estimated (L15-L22).
L21. Here again what do you call “topography”?

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Tables

Table 1. Is there any good reason to show the statistics for individual ICESat tracks? As said in my general comments, I would increase the density of the ICESat data used for validation and not consider single tracks. In those tables, I would separate SPIRIT data into two categories (i) with interpolated elevations, (ii) without interpolated elevations. Otherwise, we wonder why you use SPIRIT DEM for your validation.

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Figures

Figure 4. What do you show in white? Un-surveyed grounded ice? Were they absent in the GDEM due to errors in the mask the GDEM team used to mask out the ocean?

Figure 6. I do not think all panels are needed (currently they are not discussed individually in the text). Select a representative one and it will improve the focus of the readers on it. Otherwise the lazy reader is depressed to have to check all those similar panels trying to find out himself why 6 different panels were shown…

Figure 7. What is the blue line?

Figure 8. Show dates of the SPOT5 image acquisitions.

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REFERENCE for my review

Berthier, E., E. Schiefer, G.K.C. Clarke, B. Menounos and F. Remy. 2010. Contribution of Alaskan glaciers to sea-level rise derived from satellite imagery. *Nature Geoscience*, **3**(2), 92-95.

Gardelle, J., E. Berthier and Y. Arnaud. 2012. Impact of resolution and radar penetration on glacier elevation changes computed from multi-temporal DEMs. *Journal of Glaciology*, **58**(208), 419-422.

Kervyn, M., G.G.J. Ernst, R. Goossens and P. Jacobs. 2008. Mapping volcano topography with remote sensing: ASTER vs. SRTM. *International Journal of Remote Sensing*, **29**(22), 6515-6538.

Korona, J., E. Berthier, M. Bernard, F. Remy and E. Thouvenot. 2009. SPIRIT. SPOT 5 stereoscopic survey of Polar Ice: Reference Images and Topographies during the fourth International Polar Year (2007-2009). *ISPRS Journal of Photogrammetry and Remote Sensing*, **64**, 204-212.

Moholdt, G., C. Nuth, J.O. Hagen and J. Kohler. 2010. Recent elevation changes of Svalbard glaciers derived from repeat track ICESat altimetry. *Remote Sensing of the Environment*, **114**(11), 2756–2767.

Nuth, C. and A. Kääb. 2011. Co-registration and bias corrections of satellite elevation data sets for quantifying glacier thickness change. *The Cryosphere*, **5**(1), 271-290.

Pritchard, H.D., R.J. Arthern, D.G. Vaughan and L.A. Edwards. 2009. Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets. *Nature*, **461**(7266), 971-975.

Raup, B.H., H.H. Kieffer, T.M. Hare and J.S. Kargel. 2000. Generation of data acquisition requests for the ASTER satellite instrument for monitoring a globally distributed target: Glaciers. *IEEE Transactions on Geoscience and Remote Sensing*, **38**(2), 1105-1112.

Rignot, E., G. Casassa, P. Gogineni, W. Krabill, A. Rivera and R. Thomas. 2004. Accelerated ice discharge from the Antarctic Peninsula following the collapse of Larsen B ice shelf. *Geophysical Research Letters*, **31**(18).

Rott, H., F. Müller, T. Nagler and D. Floricioiu. 2011. The imbalance of glaciers after disintegration of Larsen B ice shelf, Antarctic Peninsula. *The Cryosphere*, **5**(1), 125-134.

Shuman, C.A. *and others*. 2006. ICESat Antarctic elevation data: Preliminary precision and accuracy assessment. *Geophysical Research Letters*, **33**(7), L07501.

Shuman, C.A., E. Berthier and T.A. Scambos. 2011. 2001-2009 elevation and mass losses in the Larsen A and B embayments, Antarctic Peninsula. *Journal of Glaciology*, **57**(204), 737–754.

Toutin, T. 2008. ASTER DEMs for geomatic and geoscientific applications: a review. *International Journal of Remote Sensing*, **29**(7), 1855 - 1875.