Response to Referee 3

We thank the referee for her/his valuable suggestions. They have substantially improved the manuscript. Referee comments are in plain text below, with our responses in bold.

General comments
The authors present a unique and incredibly rich data set that will have numerous applications, some mentioned in the m/s, but many that have yet to be thought of. Essentially, this paper is a brief summary of the DEM with a few statistics related to its accuracy. For a data set of this kind, that is to a large extent self explanatory in terms of its value and relevance, perhaps that's OK but there is useful and important information missing that would benefit the paper and any user of the product. Details of this are listed below but may not be exhaustive and I would encourage the authors to think carefully about what an end-user would benefit from here. A little more thought and perhaps even illustration of the potential applications of a data set of this unparalleled resolution would be welcome. How about some examples of shaded relief subsets where the full resolution can be seen over different types of terrain such as ice shelf rift areas, ice stream regions near the grounding line, and some examples of more rugged terrain around the Transantarctic Mountains and/or the peninsula. These would be helpful and instructive and make the m/s less dry.

Four sample images over varying terrains have been provided in the Supplementary Material.

Specific comments
1. Nowhere do you actually present a plot of the DEM itself. This seems like a pretty big oversight that is easily remedied. I suggest you include a supplementary figure at say 1:3,000,000 or a PDF/jpg version of the paper map that was distributed by PGC at AGU, which I note is available from the website. This can be a relatively large file and one version or other needs to accompany the paper.

The map (blank and labelled versions) are now included in the supplementary material and are referenced in the text.

2. Much of the "missing" information about the data set is available on the PGC website and includes, for example, the strip coverage at 2 and 8 m resolution. Strip DEM files sizes and file format. The fact that the DEM is 45 Tb is rather important for users to know as this present certain data handling and processing challenges.

We have added a new section (5 Dataset Attributes) that summarizes the characteristics of the dataset, including formats, sizes, etc., and include a new figure (9) that maps the 2m and 8m coverage.

3. P6, l9-16. I didn't really follow how the time stamp was generated for each strip: whether it

was the date of the GCP acquisition or the image acquisition. If (as I suspect) it was the latter, then what did you do about any dh/dt trends that would offset your GCP elevations from the time stamp used? Much of the data in the interior seems to have a time stamp of ~2016-2018, almost a decade after the end of the ICESat mission.

This is now clarified to read: "Our method of DEM registration to Cryosat-2 altimetry, described in Section 2.3, accounts for differences in time between the altimetry and DEM acquisitions, yielding temporal constraints on elevation for rapidly changing coasts and areas of fast flow. Even though much of the interior DEMs were registered to ICESat-1 data from late 2008, we retain the strip acquisition time in the date stamp as time-dependent changes in these regions are expected to be small relative to the data error. Areas of local change, such as over subglacial lakes, should be small enough so as not to substantially effect tile registration. Caution, however should be used when assessing changes in tiles registered to ICESat-1. Tiles that are registered through neighbor alignment are given the weighted mean day of the data in the neighboring buffers."

4. Related to 3, I did not understand why you didn't use CS2 elevations from LRM data in the interior? The coverage is much better than ICESat and the accuracy comparable to SARIn mode data nearer the margins. Errors due to slope and effectively corrected in the interior. Requires explanation.

We did not use the LRM measurements because we did not feel confident that, over the 10's of km scale of a DEM strip, the slope-driven error in LRM elevations would reliably average to zero. Although it may be possible to make a correction for this effect, and it may not result in a significant error over the flat parts of the interior, we felt that the errors due the time differences between the Worldview data and ICESat data were easier to understand than errors in the LRM dataset.

We add a sentence clarifying this to section 2.3

5. P3, l12. I think there is an error in the projection details provided. The std lat is most likely -71 degs and central meridian will be 0 degs not 71 degs. Otherwise it's all rotated with a non std pll.

Corrected.

6. P1, l23. Wrong reference to Bamber 2012. Should be Bamber, J. L., Gomez Dans, J. L., and Griggs, J. A. (2009), A new 1 km digital elevation model of the Antarctic derived from combined satellite radar and laser data. Part I: Data and methods, The Cryosphere 3(2), 101-111. Not the NSIDC URL.

Corrected.

7. P4, l31-35. The text in brackets could be better phrased. It's not picking a travel time but picking a point on the leading edge of the waveform that represents the surface. This point is a function of the retracking procedure. With a threshold retracker, the bias is a function of the choice of threshold. If the bias is really due to penetration (=> using a threshold that picks a point below the surface) then this will be a function of snowpack properties and, in particular, density. This may not have a clear relationship with elevation but should correlate with, say, surface density as estimated from an RCM. See, for example, Wang, F., Bamber, J. L., and Cheng, X. (2015), Accuracy and Performance of CryoSat-2 SARIn Mode Data Over Antarctica, Geoscience and Remote Sensing Letters, IEEE, PP(99), 1-5, doi:10.1109/LGRS.2015.2411434.

We have changed the section in brackets to read: "Strips with both Cryosat-2 and ICESat-1 registration within the precision thresholds allow for an estimate of the biases in Cryosat-2 height estimates due to the penetration of microwaves into the snow and firn layer (i.e. the penetration depth), or biases due to the retracking algorithm (i.e. where the retracker identifies a point on the leading edge of the waveform that does not correspond perfectly to the surface)."

We also added text to the end of the paragraph, to read:

The mean difference between the two corrections is -0.39 ± 0.35 m. We expect the bias in the Cryosat-2 data to depend on surface density and surface slope (Wang and others, 2015), but we do not have a straightforward way of predicting the bias, and we did not find a clear spatial or elevational dependence of the CS2-ICESat differences. Therefore, we added a uniform value of 0.39 m to the Cryosat-2-registered heights, regardless of the location of the strips and the surface type.

8. P5, l4. Don't think "elevational" is a real word. Replace with elevation-related.

Changed as suggested.