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The Cryosphere Discussions
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Interactive comment on "Improved retrieval of land ice topography from CryoSat-2 data and its impact for volume change estimation of the Greenland Ice Sheet" *by* J. Nilsson et al.

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We would first like to thank the reviewer for his constructive and insightful comments, which has greatly helped to improve this manuscript.

The reviewer's remarks (line number and question) have been included, while the author's response is indicated by [A] below the remark.

General Comments:

The reviewer has in his analysis of the paper asked for more substantial proof of the sensitivity of the two retrackers used in this study (threshold versus functional-fit) to changes in snow-pack properties. To address this we have merged Figure (2 & 4) and

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Discussion paper

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expanded it to include a local time-series for the NEEM camp, which encompasses the time of the melt event. This figure clearly shows the effect of the change in snow-pack conditions at time of the 2012 melt event, and the subsequent introduction of a clear elevation bias in this case the ESA retracker, with a magnitude of $\sim$1 m, which can be seen in Figure-2

In the case of the residual slope bias/error we have chosen to remove this metric. This was done to make the elevation and elevation change comparison more coherent. In the case of the elevation a clear linear relation, depended on topography and snow physics, can be found (penetration bias and precision in the retrieval of measurements) and easily quantified using a linear model. However, this does not hold for the elevation changes where the bias is mostly related to climatological effects, which may change over time, and further the slope-error is not easily characterized by a linear trend (or higher polynomials). This due to the 2012 melt event effect on the standard deviation in low sloping areas (0-0.3°) for the ESA product. So, we have chosen to remove this metric and guide the reader to Figure-1, where these different effects can clearly be seen and judged visually.

l.12: Expr: This when compared

[A] - Changed the statement by merging it with the previous sentence.

l.41: add brackets around “(e.g. Gardner et al., 2013; Shepherd et al., 2012)”

[A] - Brackets where added around the citation.

l.44: Expr: “the characteristics of which is”

[A] - Removed the expression from the sentence

l.60: Expr: “methods from improving”

[A] - The sentence was changed where “from” was replaced by “for”.

l.77: I think 1° is no “low sloping terrain” anymore for radar altimetry. The switch to

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SARIn happens already at lower slopes (∼0.5°).

[A] - The reviewer has a good point and we have therefore removed the numbers to make the statement more generic.

l.101: In Baseline-B LRM has only 128 bins so I think the interval should end some bins before.

[A] - Perfectly true! This statement belongs to the SIN retracker and was unfortunately overlooked. For the LRM-mode only peak indexes larger than 20 are used in the re-tracking procedure.

l.126: don't use the surname in the citation

[A] - This has been removed accordingly.

l.128: SIN mode allows... repeats more or less the last sentence

[A] - The sentence was re-written to remove any repetitive nature.

l.142ff: This is not totally clear to me. Please explain a bit more in detail what the "coherence range power image" is.

[A] - This was changed to "Coherence as a function of range", e.g. across track coherence (an array of size Nobs*512) for each measurement in the track.

l.205ff: Please use different letters for different variables (not again a0,a1).

[A] - This has also been pointed out by reviewer #2 and has been change accordingly in the entire manuscript.

l.323: I guess no ICESat campaign biases have been applied as in Nilsson et al., 2015b. Maybe the influence of those biases (∼10 cm) on the seasonal amplitude and phase is not too big, but anyways this should be mentioned and discussed when taking ICESat as a reference for the "true surface amplitude" (l.551)

[A] - This is a good point and we have added a paragraph detailing this in the ICESat

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section. Further, a statement was also added in line 577 detailing that the correction has not been applied.

l.407: Why has no attempt been made? Please explain!

[A] - Quantifying the accuracy of the different DEM's is inherently difficult, as they are based on both different types of datasets and acquired over different time spans, many not entirely consistent with the temporal coverage of the ATM data. For this case the interest was to compare them in a relative fashion to judge their quality. It's of course expected that older DEM's would show a larger statistical difference from the ATM data used in the comparison. However, as stated in the manuscript, we do not attempt to provide a full validation framework of the different DEM's, only a relative comparison.

l.425: repetition: processing steps

[A] - Has been removed to improve reading

l.692: remove "by"

[A] - Removed

In Tab.2 as it summarizes results of elevation change I guess the units shall be m*aËĘ-1.

[A] - The units on the table are correct, as we have chosen to multiply it with the time-span of each elevation change data set. This was done to make the statistics/errors more comparable between time periods, as the error is expected to decrease with time.

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