Answers to Referee 3

This article is concerned with the most recent CryoSat-2 processing and dataset version, Baseline-D, which has been operational since May 2019. The paper provides an overview of the main updates and improvements since the previous Baseline-C version, both at Level-1B and Level-2 stages. The discussed improvements at L1B stage are: Transition to the more ergonomic NetCDF file format from EEF; the eradication of anomalously negative radar freeboards at the SAR/SARIn mode boundary; the inclusion of two additional stack parameters; and inclusion of the USO correction to the window delay parameter. Improvements at the Level-2 stage are; transition to NetCDF format; the inclusion of sea ice freeboard data for SARIn mode; a new retracker for diffuse waveforms; improved surface type discrimination with the implementation of the Stack Peakiness parameter; implementation of new slope models for land ice elevation correction; and the inclusion of some additional parameters in the L2 files. The second half of the manuscript offers a series of land ice and sea ice comparisons/validations, either comparing the data with itself (e.g. during ascending and descending passes), with previous Baseline-C data, or with independent observations.

Given that the move to Baseline-D has already happened, it is important that the community understand the main changes since the previous baseline and are convinced that the new data is at least consistent if not improved. This paper offers some important findings to this end but the structure and writing need improving. I therefore recommend the paper's publication subject to the following revisions.

Main points:

1. The paper suffers some continuity issues, where sections can feel a bit disjointed and the use of terminology is not consistent throughout. In particular, the following points should be addressed:
   - I find the subsections of the land ice section (3.2) quite confusing. Section 3.2.1 'Impact of algorithm evolution on land ice products' includes different case examples over East Antarctica and Austfonna. The following sections (3.2.2 and 3.2.3) are then concerned with swath data over Antarctica and SARIn data over Austfonna. Why do these two sections not also fall under 'Impact of algorithm evolution on land ice products'? Perhaps Section 3.2.1 could be broken into a number of subsections, each with a different case example, including sections 3.2.2 and 3.2.3? Also it may flow better if the cases over Austfonna followed each other.

Reply: thanks to the referee for this comment. The suggestions made will be considered in the new version of the manuscript.

   - Move the first paragraph of section 3.3.3 to the beginning of section 3.3.2. Should section 3.3.3 go inside section 3.3.2 since it falls under Baseline-D freeboard assessment?

Reply: thanks to the referee for this relevant comment. The suggestions made will be taken into account in the new version of the manuscript to enhance readability.

   - In the abstract and elsewhere, the processors are referred to as 'Ice Baseline-C' and 'Ice Baseline-D'. However in section 3.3.4, 'IPF1C' and 'IPF1D' appear

for the first time and are used throughout this section. Please choose a name/acronym for the processors, define them in the introduction, and ensure their use is consistent throughout the manuscript.

Reply: thanks to the referee to have spotted this. The processor names will be homogenised through the whole manuscript, in the new version.

- As it stands, the relevance of section 3.3.5 is hard to appreciate. The section refers to re- scaling of parameters between baselines B and C, but makes no mention to the re-scaling of parameters from Baseline-C to Baseline-D, which was presumably necessary and would be of interest to the reader. Since the L2 Baseline-D processor does not use the Lee 2018 method for lead identification, more explanation is needed to tie this section in and relate it to the previous content.

Reply: We entirely re-write section 3.3.5 adopting stack peakiness in lead classification.

2. The article heavily cites documents (mainly ESA documents) via URLs in the text, some of which feel like necessary supplementary material to the main text (e.g. the 'CryoSat-Baseline- D-evolutions' document). Is the permanence of these URLs certain? If not - can they be put on a DOI or provided in a supplementary?

Reply: the cited documents are official ESA documents for which the permanence of the URLs is guaranteed.

3. Page 13, line 245 - You say that "Most of the parameters were found to show a close agreement.." I find this quite vague and expect users would want to know more on how parameters compare between each baseline. Could you include more details or a table?

Reply: We will change the sentence to:

"Most of the parameters were found to show agreement. The parameters showing differences are explained below an listed here: surface mask, attitude (roll, pitch, yaw), sigma0 for all LRM retrackers, slope correction (height, longitude, latitude)"

We found varying sigma0 differences for each of the retrackers as follows: Ocean: 0.6 - 0.75 dB, ICE1: 0.65 - 0.78 dB, ICE2: 0.63 - 0.77 dB

As we checked 100 different parameters for a couple of tracks, the authors preferred to not list them in a table for readability reasons.

4. The validation of LRM data over land ice depends on a comparison to REMA. Please could you provide some details about how REMA is built, e.g. what data is used in its construction, and a justification for why you chose to validate with REMA? Is there any particular reason that this area of East Antarctica was chosen?

Reply: REMA (Howat, 2019) was used as an independent reference elevation model. REMA is one of the most recent and accurate DEMs for Antarctica.

REMA is stated to have an absolute uncertainty of less than 1 m over most areas and was vertically registered using CryoSat and ICESat. It was constructed from optical stereo pairs from WorldView acquired between 2009 and 2017, with most collected in 2015 and 2016, over the austral summer seasons (mostly December to March). We will use mosaicked versions in two different resolutions (200m and 1km).

We selected an area on the Antarctic plateau to demonstrate the differences of the applied slope corrections. We selected the area to cover slopes from 0 to 0.25° as over 95% of the LRM mode data is acquired in low sloped area.

Only one region was selected to visualise the differences instead of showing all Antarctica.

Howat, I. M., Porter, C., Smith, B. E., Noh, M.-J., and Morin, P.: The Reference Elevation Model of Antarctica, The Cryosphere, 13, 665-674, https://doi.org/10.5194/tc-13-665-2019, 2019.

5. Why did you not validate/compare Baseline-D over land ice with an independent observation dataset like IceBridge?

Reply: this is a good suggestion. In this work we used the OIB dataset to validate measurements over sea ice, while for land ice we used CryoVEX campaign data. The use of OIB in land ice validations can be taken into account in future CryoSat ice data products validations.

Minor points

Section 1:

• Page 2, line 27 - "on 8 April 2010" -> "on the 8th April 2010"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

• Page 2, line 30 - Is CS2's repeat cycle not exactly 369 days with a 30-day sub cycle? Not sure what 'quasi' is referring to here.

  Reply: The CryoSat orbit does not exactly repeat after each cycle, as it is usually the case for ocean-oriented altimetry missions. CryoSat's ascending nodes are repeating from cycle to cycle within a few tens of meters in order to have equidistant ascending equator crossings in the reference ground track. The descending nodes are however no longer equidistant due to a residual rotation of the eccentricity vector, therefore fluctuations up to nearly 4 km can still be observed on the descending node from cycle to cycle.

• Page 2, line 50 - "with a factor 2" -> "by a factor 2"

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 3, line 53 - "CryoSat ice Baseline-D" -> "CryoSat Ice Baseline-D"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 4, line 71 - "affecting the Polar Regions" -> "affecting Earth's polar regions"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 4, line 78 - "which are contributing to global sea level rise." -> "which influence global sea level." (variations in thickness can mean thickening which does not cause sea level rise)

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 4, line 83 - "interferometric" -> "Interferometric"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 4, line 88 - "The ice products are currently generated with the Ice Baseline-D processors". Please be more specific here. Since when are they generated with Baseline-D processors? covering which operational period?

  Reply: The transfer to operations of the new CryoSat Ice Baseline-D processors was performed on 27th May 2019 and a complete mission data reprocessing is on-going in order to provide users with homogeneous and coherent CryoSat ice products for proper data exploitation and analysis. This is specified in lines 106-109. We will move this paragraph.

- Page 5, line 106 - "sea ice and inland waters domains." -> "sea ice and inland waters."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

Section 2

• Page 7, line 139-141. Here you mention the findings of Armitage et al. 2014 but they do not relate directly to the next sentence. This sentence could be removed since you discuss the relevance of the Armitage and Davidson study to the anomalously negative freeboards in section 3.3.3

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 8, line 147. Please explain what a Doppler cell is and reference a paper e.g. Raney 1998, rather than an impermanent URL.

  Reply: the reference to Raney, 1998 will be added in the revised version of the manuscript replacing the URL.

- Page 8, line 148-153. Consider merging these two sentences: "At Baseline-D, two additional stack characterisation parameters (also known as Beam Behaviour Parameters) have been added to the SAR/SARIn L1B products: i) the stack peakiness (Passaro2018), which can be useful in improving sea ice discrimination, and ii) the position of the centre of the Gaussian fit......."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 8, line 167 - "the freeboard sea ice processing" -> "the sea ice freeboard processing"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 9, line 169 - "The height value..." - I don't know what height value you are referring to, could you be more specific?

  Reply: this will be rephrased by: "The retrieved height value…"

- Page 9, line 172 - Could you detail briefly this new retracker? Is it physical / threshold etc.

  Reply: the sentence will be changed to:

  "In addition, a new threshold-of-first-maximum retracker is used…"

  And after that sentence, the following text will be added:

  "Retracking is the process whereby the initial range estimate in the L1B data is corrected for the deviation in the first echo return within the waveform from the reference position."

- Page 9, line 178 - "based on the peakiness of SAR waveforms" - add "(see section 3.3.1)"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 9, line 187 - "..to make the correction more responsive.." - What correction? Please be more specific.

  Reply: this is referred to the slope correction. The paragraph will be reformulated.

- Page 10, line 194 - "in addition to the height". What height?

  Reply: This is a typo, the sentence between brackets will be removed.

  Section 3

  • Page 11, line 210 - "...data files was" -> "...data files were"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 11, line 212-213 - "...geophysical corrections were checked to ensure that they were computed correctly". This is a little vague, can you say something more concrete about how they were checked?

  Reply: The CryoSat data products contain many data flags to which provide information and warnings about any inconsistencies present in the data products. For example, the "correction error flags" indicate whether the geo-corrections have been correctly computed during processing. These flags are checked routinely as part of operational quality control activities.

- Page 12, line 222 - "...generated using the Baseline-C are..." -> "...generated using the Baseline-C processors are..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 12, lines 225-229 - Consider moving the sentence starting "To derive mass balance.." to after the sentence ending "..should help to reduce this uncertainty." on line 239 to aid the flow of this section.

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 12, line 231 - "respectively mass change" - I don't know what 'respectively' means here.

  Reply: this is a typo. "Respectively" will be changed in "and".

- Page 12, line 234-236. Please provide a reference for this statement.

  Reply: the reference Gourmelen et al, 2017 will be moved at the end of the sentence.

- Page 12, line 236-237 - "However, a small attitude angle error interpreted as a mispointing error has been observed.." Observed by who? Please provide a reference.

  Reply: This was an issue observed in the previous Baseline-C data, now fixed in the new Baseline-D implementation.

- Page 12, line 241 - "were compute" -> "were computed"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 12, line 242 - "Level 2 "in depth" (L2I) product retracker" - what is this? Is there a technical note or article you could reference?

  Reply: Level 2 "in depth" products are a particular output product of the CryoSat Payload Data Ground Segment (PDGS).

- Page 13, line 247 - are the constant offsets on Sigma0 you list for Baseline-D minus Baseline-C or vice versa?

  Reply: Is referred to Baseline-C minus Baseline-D.

- Page 13, line 247-249. The sentence starting "This needs to be considered..." does not make sense, please re-phrase.

  Reply: thanks to the referee for this comment. The sentence will be rephrased in: "The mentioned offsets need to be considered…"

- Page 13, line 249-250 - "Furthermore, Baseline-D uses an updated surface type mask. This..." -> "A new surface type mask has been implemented in Baseline-D, significantly improving resolution in the ice shelf area...."

  Reply: we acknowledge the referee suggestion and we will implement it in the new version of the manuscript.

- Page 13, Figure 2. Please include a scale e.g. "Orange=Ice shelf, Blue=Ice sheet".

  Reply: this will be added in the figure caption.

- Page 13, Figure 2 caption: "Ronne ice shelve" -> "Ronne ice shelf"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 14, line 255 - "This slightly changes the LRM slope corrected elevation". What does slightly mean? 1% ? 10% ? Please quantify the change.

  Reply: The changes are quantified in Figure 3. We found mean differences to REMA for the slope corrected height of ICE1 retracker:

We excluded outliers which differ by more than +/-20 m.

Baseline-C:

```
-------------------------------------------------------
Mean :     -0.10569497
Median :    0.10062109
Std Dev :   1.7323635
Number of points:   17050710
-------------------------------------------------------
```

Baseline-D:

```
-------------------------------------------------------
Mean :     -0.93375798
Median :   -0.34570312
Std Dev :   2.0853337
Number of points:   17079280
-------------------------------------------------------
```

The slope model used to estimate the slope correction in the L2 product is different between both Baselines. This means that the relocated position (lat/lon) and the slope corrected elevation differs along track. Therefore, a percentage deviation cannot be specified. Figure 3 gives an idea of the spatial differences of the changes one can expect. We changed Figure 3 and show now the full LRM zone, not only a region.
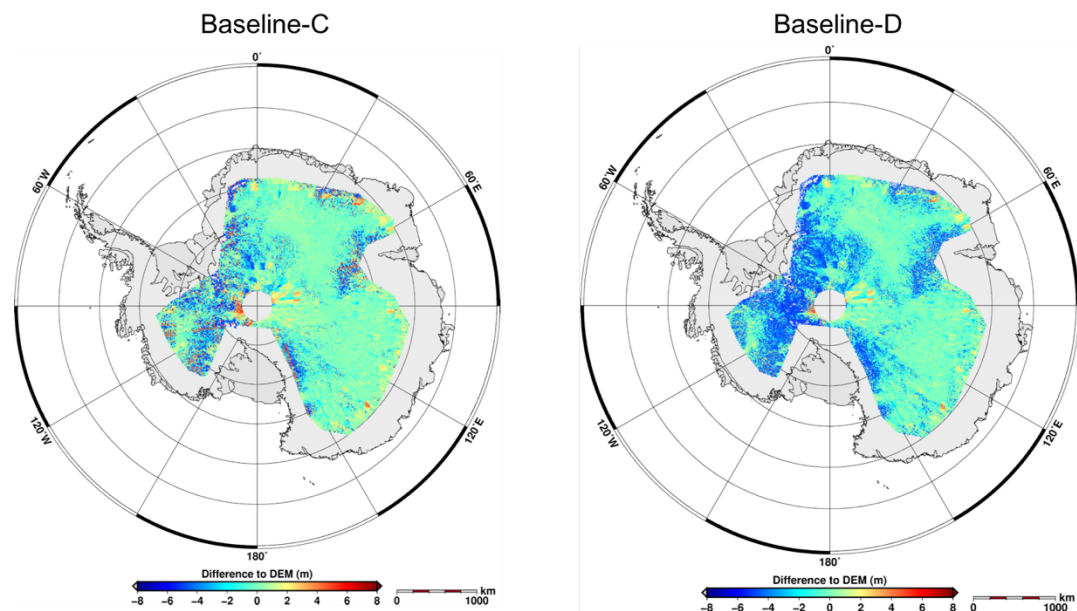
- Page 14, line 256 - "... for a large area in East Antarctica...". Can you explain why you chose this area? Please also include a map of Antarctica or East Antarctica to show where this region is.

Reply: The region was chosen to cover slopes between 0 to 0.25° and to be able to distinguish differences in a figure. If needed we could add another region. We have modified Figure 3, as per previous comment.

- Page 14, Figure 3. Please say in the caption what the numbers are, i.e. "Mean REMA-CS2 difference= +0.13 ± 1.2 m" etc

  Reply: we acknowledge the referee suggestion and we will implement it in the new version of the manuscript.

- Page 14, line 258 - "Differences to an independent Antarctic elevation model..." -> "Differences between slope corrected elevation and an independent Antarctic elevation model..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 14, line 259 - "The differences vary spatially and the overall mean..." -> The differences vary spatially and the overall mean difference (REMA minus CS2)..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 14, line 265 - "...however major improvements" -> "...however offers/implies major improvements"

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 14, line 266 - "...swath data processed for ascending and descending tracks" - For what period?

  Reply: this analysis covers, as for the rest of the manuscript, the test reference period (September - November 2013, February - April 2014 and April 2016 (only SARIn))

- Page 15, line 268 - "The large positive anomaly is a known.." -> "The large positive anomaly (blue area in Fig. 4) is a known.."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 15, line 271 - "(subpanel B) could be reduced". 1) No subpanels are labelled in the figure. 2) I don't know what you mean by "could be reduced"

  Reply: This is a typo. No subpanels are indeed labelled, and "could be reduced" will be changed to "is reduced", as reported in Figure 5. The text will be amended.

- Page 15, Figure 4:
  1. Please add labels "Baseline-C" and "Baseline-D" on the right-hand side and "Ascending" and "Descending" above the sub-panels.

2. Please make the labels of the colour bar larger.
3. In the caption please change "Differences to relative elevation model.." to "Differences between CryoSat elevation and reference elevation model..." or "Deviation of CryoSat elevations from reference elevation model..."

Reply: thank to the referee for the comment. The figure will be enhanced in the revised version of the manuscript.

- Page 16, Figure 5. "Crossovers between ascending descending.." -> "Difference in elevation between ascending and descending crossovers..."

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 17, line 291 - "a point-to-point comparison was performed". Please make clear in the text that you are not comparing Baseline-C points with Baseline-D points as this is how this reads.

Reply: Indeed the point-to-point comparison has been made considering swath elevations in Baseline-C and swath elevations in Baseline-D, as specified in lines 302-306.

- Page 17, line 310 - "...which is included in all comparisons." Do you mean that it is accounted for in the comparison, i.e. subtracted?

Reply: yes, the vertical offset is taken into account in the comparisons.

- Page 18, line 322-323 - "CryoSat operates in the new and innovative SARIn mode..." -> "CryoSat operates in SARIn mode..."

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 18, line 326 - "recommendations from the ESA project, CryoVal-LI, the 2016..." -> "recommendations from CryoVal-LI, the 2016..."

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 19, lines 333-339. "The AWI land ice processing", "NASA JPL land ice processing" and "University of Ottawa CryoSat processing", are these retrackers? or are they processors? Please tidy these distinctions up in the text.

Reply: those are processors which include also a dedicated retracker. It will be made clearer in the revised version of the manuscript.

- Page 20, "...before the dedicated land ice retrackers of AWI, JPL and UoO are reached." I don't know what a retracker being reached means.

Reply: The sentence is misleading, it will be removed.

- Page 20, Table 1. Please change "Mean [m]", "Median [m]" and "Std. Dev. [m]" to "Mean ALS- CS2 difference [m]", "Median ALS-CS2 difference [m]", "Std. Dev. on ALS-CS2 difference [m]".

  Also state in the caption what the numbers in the brackets represent.

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 21, Figure 7. In caption: "CryoVex airborne laser scanning." -> "CryoVex Airborne Laser Scanner (ALS)."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 21, line 362 - "Statistics that describe the power of the stack in CryoSat were...." -> "Statistics that describe the power of the CS2 waveform stack were...."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 21, line 365-366 - "This compares the maximum power registered in the Range Integrated Power (RIP) with the power obtained from the other looks". The RIP of which look? From Passaro, I understand that the Stack Peakiness "compares the power at the zero look angle with the backscatter registered in the other looks", please check your definition.

Reply: The sentence of the draft is correct. The Reviewer cites only an extract of the sentence extrapolated from Passaro et al. The full sentence is "In order to compare the power at the zero look angle with the backscatter registered in the other looks, a new parameter called Stack Peakiness (SP) is defined in this study from the RIP normalised by its maximum value. The assumption is that the maximum return is (or is close to) the nadir position. This is why, as stated in Passaro et al., the application of a window (Hamming window) on the Stack data is necessary, because otherwise: "The sidelobe effects create false leading edges, influence the statistical analysis of the RIP and add backscattering of the same order of magnitude of the nadir return in the look angles closer to zero. These features mostly disappear after the application of the Hamming window, although residual signatures are visible". We agree with the Reviewer that a possible way to improve the Stack Peakiness parameter would be to consider possible inconsistencies between the look where the maximum is located and the exact nadir look. This is also why we reported in Baseline-D the Stack Peakiness as a useful complementary statistic without binding a strict classification criterion to it (exactly as it is done for the other Stack statistics).

- Page 21, line 369 - "..with the highest power (supposedly at nadir) with the looks". Again, it is the power in the nadir beam that is compared with the off-nadir looks. I understand that the RIP waveform is first normalised by its peak value- which may not be at nadir- but this sentence confuses the two steps.

  Reply: This has been explained in the previous reply.

- Page 22, line 372 - "The evolution of the SP over a sea-ice covered area" - I don't know what you mean by 'evolution' here. Evolution in time?

  Reply: Yes, is indeed the temporal evolution of the SP. This will be made clearer in the text.

- Page 22, line 382. Could you re-iterate at the end of this section that the SP parameter is implemented in lead discrimination for L2 sea ice products (as discussed in section 2.2) and mention the thresholds that are used or direct reader to where they can find the thresholds.

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 22, line 386 - "...highlighted important over-estimations in the freeboard values of the ESA CryoSat Baseline-C products relative to in-situ". Is there a reference to support this claim? The URL is just a link to the site for CSN.

  Reply: This study was performed in the context of the CryoSea-Nice ESA project but this specific result was presented during the CryoSat Expert Meeting (CSEM) in November 2017 at ESA/ESRIN and documented in the Summary and Recommendations Report available at https://earth.esa.int/documents/10174/1822995/CryoSat-CSEM-Summary-and-Recommendations-Report.pdf.

  The sentence will be rephrased in the revised version of the manuscript to include this reference in the following way:

  "Previous analyses carried out by the CryoSea-Nice ESA project (https://projects.alongtrack.com/csn/) highlighted important over-estimations in the freeboard values of the ESA CryoSat Baseline-C products relative to in situ data (see the recommendation Rec.9 in [CSEM Report 2017])
  Following these conclusions, modifications have been made to develop the new ESA CryoSat Baseline-D freeboard product.
  We present here the first assessments of this updated version."

  [CSEM Raport 2017] Summary and Recommendations Report of the CryoSat-2 Expert Meeting, CSEM, 2017, ESRIN, https://earth.esa.int/documents/10174/1822995/CryoSat-CSEM-Summary-and-Recommendations-Report.pdf

- Page 22, line 390 - "...Figure 8 present the evolution between two Baselines." I think this figure is simply showing the difference rather than any evolution.

  Reply: yes indeed, it was a typo. The word "evolution" will be replaced with "differences".

- Page 22, line 392-393 - "...the two solutions remain consistent with each other". Could you add a comment on the larger differences in the MYI region north of Greenland?

  Reply: The larger differences in the MYI region north of Greenland are mainly noise at the ice margin. A comparable feature is also detected along the Russian coastline. These differences are statistically negligible but we cannot do further analysis since we do not have access to the Baseline processing chains. In order to specify this point we add the following sentence:

  L393: The small patterns of higher differences (e.g: north of Greenland) are associated with statistically negligible noise at the ice margin zones.

- Page 22, line 393 - "The Root Mean Square (RMS) in each..." Do you mean the Root Mean Square deviation from the average value in each pixel? i.e. the standard deviation?

  Reply: the sentence will be rephrased in: "In addition, the Root Mean Square (RMS) in each 20 x 20 km pixel, which represents small scale freeboard variability, is similar for the 2 Baselines (about 15 cm)."

- Page 23, line 401. Please state which OIB dataset was used - Quicklook / L2 / L4?

  Reply: The OIB dataset used is the NSIDC Quicklook version available at https://daacdata.apps.nsidc.org/pub/DATASETS/ICEBRIDGE/Evaluation_Products/IceBridge_Sea_Ice_Freeboard_SnowDepth_and_Thickness_QuickLook

  To specify this point we have added this URL line 401.

- Page 24, line 407 - "...with a factor..." -> "...by a factor..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 24 line 414-415. I don't know what this sentence means.

Reply: the sentence will be rephrased in "Some additional comparisons have demonstrated that the Baseline-D freeboard solution is within the range values of recent freeboard estimations reported in Ricker et al, 2014 and Guerreiro et al, 2017.

- Page 25, line 418 - "...SARIn mode had positive impacts on sea ice freeboard". The word 'positive' here is ambiguous - do you mean positive as in good? or positive as in greater thanzero? Please clarify in the text.

  Reply: indeed, the sentence here is ambiguous. The sentence will be rephrased:"In addition, the improved phase difference in SARIn mode had positive impacts on the sea ice freeboard estimation from SARIn acquisition, removing negative freeboard heights at the boundary of the SARIn mode mask, as presented in the next section"

- Page 25, line 437. Why is Laxon 2003 referenced here? Laxon does not mention off-nadir leads.

  Reply: This is a typo. The correct reference here should be (Armitage et al., 2014):

  Armitage, T. W. K. and Davidson, M. W. J.: Using the Interferometric Capabilities of the ESA CryoSat-2 Mission to Improve the Accuracy of Sea Ice Freeboard Retrievals, IEEE Transactions on Geoscience and Remote Sensing, vol. 52, no. 1, pp. 529-536, 2014

- Page 26, line 446 - "..responsible to calibrate.." -> "..responsible for calibrating..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 28, line 471 - Why is AWI listed here but none of the other groups?

  Reply: "AWI" word will be removed, leaving indeed only the references, for better readability.

- Page 28, line 489 - "..SAR and SIN modes of the altimeter is shown..." -> "..SAR and SIN modes of the altimeter are shown..."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 29, line 492 - "Its magnitude is increasing.." -> "Its magnitude increases.."

  Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 29, line 505 - "We therefore speculate that the change in power scaling for SIN [...] is the reason...". Please provide further details about this change in power scaling as it's unclear what you are referring to here.

Reply: Thanks to the referee for the comment. This line will be rephrased in: "We therefore speculate that the change in power scaling of L1B SIN waveforms which was twice the expected waveform in Baseline-C IPF1 and now corrected in Baseline-D IPF1…"

- Page 30, Figure 11 caption: "The inner boxed indicates.." -> "The inner box indicates.."

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 32, line 551 - "...discovered that the CryoSat's altimeter.." -> "...discovered that CryoSat's altimeter.."

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 32, line 574 - "respectfully" -> "respectively"

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.

- Page 35, line 597 - "with respect to previous baseline" -> "with respect to the previous baseline"

Reply: Thanks to the referee for the correction. This will be fixed in the revised version of the manuscript.