

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.
  - 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?
  - 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.
  - 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.
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?
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?

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

#### Minor points

#### Section 1:

- Page 2, line 27 - “on 8 April 2010” -> “on the 8th April 2010”
- 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.
- Page 2, line 50 - “with a factor 2” -> “by a factor 2”
- Page 3, line 53 - “CryoSat ice Baseline-D” -> “CryoSat Ice Baseline-D”
- Page 4, line 71 - “affecting the Polar Regions” -> “affecting Earth’s polar regions”
- 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)
- Page 4, line 83 - “interferometric” -> “Interferometric”
- 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?
- Page 5, line 106 - “sea ice and inland waters domains.” -> “sea ice and inland waters.”

#### 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
- Page 8, line 147. Please explain what a Doppler cell is and reference a paper e.g. Raney 1998, rather than an impermanent 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.....”
- Page 8, line 167 - “the freeboard sea ice processing” -> “the sea ice freeboard processing”
- Page 9, line 169 - “The height value...” - I don’t know what height value you are referring to, could you be more specific?
- Page 9, line 172 - Could you detail briefly this new retracker? Is it physical / threshold etc.
- Page 9, line 178 - “based on the peakiness of SAR waveforms” - add “(see section 3.3.1)”
- Page 9, line 187 - “..to make the correction more responsive..” - What correction? Please be more specific.
- Page 10, line 194 - “in addition to the height”. What height?

#### Section 3

- Page 11, line 210 - “...data files was” -> “...data files were”
- 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?
- Page 12, line 222 - “...generated using the Baseline-C are...” -> “...generated using the Baseline-C processors are...”
- 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.
- Page 12, line 231 - “respectively mass change” - I don’t know what ‘respectively’ means here.
- Page 12, line 234-236. Please provide a reference for this statement.

- 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.
- Page 12, line 241 - “were compute” -> “were computed”
- Page 12, line 242 - “Level 2 “in depth” (L2I) product retracker” - what is this? Is there a technical note or article you could reference?
- Page 13, line 247 - are the constant offsets on Sigma0 you list for Baseline-D minus Baseline-C or vice versa?
- Page 13, line 247-249. The sentence starting “This needs to be considered...” does not make sense, please re-phrase.
- 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....”
- Page 13, Figure 2. Please include a scale e.g. “Orange=Ice shelf, Blue=Ice sheet”.
- Page 13, Figure 2 caption: “Ronne ice shelve” -> “Ronne ice shelf”
- Page 14, line 255 - “This slightly changes the LRM slope corrected elevation”. What does slightly mean? 1% ? 10% ? Please quantify the change.
- 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.
- Page 14, Figure 3. Please say in the caption what the numbers are, i.e. “Mean REMA-CS2 difference=  $+0.13 \pm 1.2$  m” etc
- Page 14, line 258 - “Differences to an independent Antarctic elevation model...” -> “Differences between slope corrected elevation and an independent Antarctic elevation model...”
- Page 14, line 259 - “The differences vary spatially and the overall mean...” -> The differences vary spatially and the overall mean difference (REMA minus CS2)...
- Page 14, line 265 - “...however major improvements” -> “...however offers/implies major improvements”
- Page 14, line 266 - “...swath data processed for ascending and descending tracks” - For what period?
- Page 15, line 268 - “The large positive anomaly is a known..” -> “The large positive anomaly (blue area in Fig. 4) is a known..”
- 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”
- 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...”
- Page 16, Figure 5. “Crossovers between ascending descending..” -> “Difference in elevation between ascending and descending crossovers...”
- 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.
- Page 17, line 310 - “...which is included in all comparisons.” Do you mean that it is accounted for in the comparison, i.e. subtracted?
- Page 18, line 322-323 - “CryoSat operates in the new and innovative SARIn mode...” -> “CryoSat operates in SARIn mode...”
- Page 18, line 326 - “recommendations from the ESA project, CryoVal-LI, the 2016...” -> “recommendations from CryoVal-LI, the 2016...”
- Page 19, lines 333-339. “The AWI land ice processing”, “NASA JPL land ice processing” and “University of Ottawa CryoSat processing”, are these retrackerers? or are they processors? Please tidy these distinctions up in the text.
- Page 20, “...before the dedicated land ice retrackerers of AWI, JPL and UoO are reached.” I don't know what a retrackerer being reached means.
- 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.
- Page 21, Figure 7. In caption: “CryoVex airborne laser scanning.” -> “CryoVex Airborne Laser Scanner (ALS).”

- 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....”
- 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.
- 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.
- 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?
- 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.
- 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.
- 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.
- 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?
- 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?
- Page 23, line 401. Please state which OIB dataset was used - Quicklook / L2 / L4?
- Page 24, line 407 - “...with a factor...” -> “...by a factor...”
- Page 24 line 414-415. I don't know what this sentence means.
- 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 than zero? Please clarify in the text.
- Page 25, line 437. Why is Laxon 2003 referenced here? Laxon does not mention off-nadir leads.
- Page 26, line 446 - “..responsible to calibrate..” -> “..responsible for calibrating...”
- Page 28, line 471 - Why is AWI listed here but none of the other groups?
- Page 28, line 489 - “..SAR and SIN modes of the altimeter is shown...” -> “..SAR and SIN modes of the altimeter are shown...”
- Page 29, line 492 - “Its magnitude is increasing..” -> “Its magnitude increases..”
- 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.
- Page 30, Figure 11 caption: “The inner boxed indicates..” -> “The inner box indicates..”
- Page 32, line 551 - “...discovered that the CryoSat's altimeter..” -> “...discovered that CryoSat's altimeter..”
- Page 32, line 574 - “respectfully” -> “respectively”
- Page 35, line 597 - “with respect to previous baseline” -> “with respect to the previous baseline”