

Title: Advances in altimetric snow depth estimates using bi-frequency SARAL/CryoSat-2 Ka/Ku measurements.

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Report#2 global comment to the “authors response to the referee#2 comments”

Dear authors,

thank you very much for your detail responses to my raised issues. I am in general quite satisfied with your made changes and have just some small comments and remarks regarding some of your answers. As I stated earlier, these are of course meant to be challenged as I also would therefore challenge some of your responses.

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Answers to the report#2

We would like to thank once again the reviewers for their careful reading of the manuscript and for the relevant and constructive remarks. We really think that the quality of the document has been considerably improved by your comments. We have done our best to take into account the last comments you have made on the manuscript. We hope that it will meet your requirements.

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Please find below the details on how your general and specific comments have been taken into account. The referee's comments are in bold type, the answers are in italic type, and the corrections to the revised manuscript are in normal type. Note that we have also removed the grey coloured cells as requested by the editor.

Answers to the report#2 : technical comments

20 **Line 137: I think this should be "analysis" and not "analyse"**

This correction has been made in the final document.

25 **Figure 1: I would still encourage to follow my advise but of course this is not mandatory for publication. Nonetheless, I find it a bit weird that this is expected to be such a time costly step... from my own experience, adding these minor changes to a Figure would be a work for an hour tops.**

As requested, we have added the a),b),c)...labels in the figure 1 and modified the caption in consequence.

L165 (question about the Baseline): While I can live with the additional information also put in to the manuscript by the authors, given that there is just now the new release of Baseline E data, using Baseline B/C (up to three "steps"

30 **older data than what is now would be called state-of-the-art) data for a new publication seems really out-fashioned to me. Especially, given that by now pretty much everything is reprocessed by ESA and available (at least Baseline D) and to my understanding there is especially quite some change between Baseline C and D regarding the waveforms.**

Maybe our previous answer was not enough clear. We think that you are talking about the CryoSat-2 SAR mode data !

35 *Indeed, the Baseline-E has just been released for SAR mode data (the authors have participated to the analysis and validation). However, to compute the snow depth, we use the pseudo low resolution mode data (Baseline Ocean) for which the Baseline C is currently the latest Baseline. At the time we wrote the article, the Baseline C was only available from 2017. Since, The reprocessing is now achieved, we have already re-computed the ASD data over the whole period using the latest Baseline C. It means that the latest ASD version now includes SARIN modes for both hemisphere over the entire 2013-2020 period.. Note that a note relating the availability of ASD and this update is planned in Earth Observation information discovery platform*
40 *<https://earth.esa.int/eogateway>.*

The description and explanation of the CS-2 Baselines used to compute the ASD product is described from L161 to L170 in the final version of the article. In order to be clearer, we have modified the final version as follows:

L167-170: Since the latest Baseline-C PLRM GOP product was only available from 2017 at the time we have computed the ASD data, we have used the Baseline B for the period 2013-2016. The next version of the ASD product will be produced with
45 only the Baseline-C PLRM GOP product to include all SARin mode zones.

50 **L185 (question about the smoothing): To my understanding to what I can read out of the AWI manual (<https://epic.awi.de/id/eprint/>) there is no smoothing applied but rather gridding to the 25km grid. I guess this could also be called "smoothing" to an extent as several measurements in a 25x25km grid have to be "merged" somehow into one value, but is in general something different than an additional filter like the authors apply here. I think this has to be justified and is not subjective or a "matter of choice" as stated by the authors. The information by the authors that they also produce data with a 25km smoothing is very interesting. Does this impact their results in a comparison? This also again stresses my differentiation made above between an additional filter/smoothing and the simple gridding. Sadly, these information did not make it into the manuscript.**

55 **L190 (question about the comparison of Crossovers and Maps): This sadly also applies to this reply. Personally, I agree with the authors that this article is already quite long but I think there is quite some important information in your reply. While I do not want to (or can) force the authors to put all this to the public I just generally want to argue for a more transparent work ethic in science in general... Finding these apparently substantial differences could be important to other researchers/users same as the reasoning why to do certain processing steps like the smoothing. If nothing else,**
60 **I would like to encourage the authors to try to improve in this regard in future publications and their work.**

*In our opinion, the most important point when comparing data is the consistency between the space and time resolutions. AWI use 25km grids when we use 12.5 km grids with a additional 25 km radius smoothing. The two approaches should provides relatively equivalent results but, of course, the non-gaussianities have some impacts that we are not able to properly quantify. However, we are quite convinced that it rather be quite small. Note that we still believe that the 25 km is quite a matter of
65 choice, in the sense that it is an expected effective resolution of the satellite data. (In my personnal opinion, i would say that it is very spatially dependent and should be more 50km or even 100 km at some locations.)*

*Compare to satellites, in-situ and airborne data have far higher space and time resolutions. Then, it is mandatory to smooth the external data to provide consistent comparisons. Of course, because data in 25 km sections are rarely gaussians, the smoothong has a mean effect which tends, in this case, to reduce the mean values. This mean effect is important and must be considered to
70 correct potential bias with satellite due to the difference in resolutions.*

To conclude, we completely agree with you on the duty of scientists to be transparent. It is even probably more important nowadays, when scientific studies are easily diverted for headline announcements. We apologize if you felt like we wanted to

hide some parts of the work, be sure that it was not intentional and that we will make our best to improve this in our future works.

75 *In order to consider these comments, we have added the following sentences in the final version of the manuscript*

L189: Finally, a 25 km radius median smoothing is applied to the retrieved freeboards. The reason is that we assume that the ASD product should not be able to provide relevant information at smaller scales. However, additional analyses and comparisons with validation data would be necessary to properly characterize this point. Note that the ability to consistently observe small scales would certainly be significantly improved in the future dual-frequency snow depth products from the CRISTAL mission.

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L321-326: In order to achieve similar spatial scales in the comparisons, we have applied a 25 km window rolling mean to smooth the external data. Due to the non-gaussianities within 25 km sections, we have noticed that the smoothing has a mean effect which slightly tends to reduce the mean value of data. It is important to consider that this allows to correct potential bias that would be induced by a difference in resolutions. Note that the space and time consistency between model and satellite data is also ensured by projection onto similar grids.

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L189: Finally, a 25 km radius median smoothing is applied to the retrieved freeboards. The reason is that we assume that the ASD product should not be able to provide relevant information at smaller scales. However, additional analyses and comparisons with validation data would be necessary to properly characterize this point. Note that the ability to consistently observe small scales would certainly be significantly improved in the future dual-frequency snow depth products from the CRISTAL mission.

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