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Title: Arctic sea ice radar freeboard retrieval from ERS-2 using altimetry : Toward sea ice thickness observation from 1995 to 2021

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We appreciate the reviewer's recognition of our efforts in addressing his questions regarding the roles of altimetry and other parameters in the calibration procedure. We fully understand the nature of referee's last concern, we hope we have address it adequately. Our answer is divided in two parts :

1. In response to the referee's request, we have included the A2 figure for ERS-2 (see Fig.1. Statistics between missions are close except the correlation that falls to 0.07 for ERS-2. Regarding the scatter plot as well as the correlation coefficient, the both radar freeboards (TFMRA50 and NN) can not be reasonably identified as correlated. Furthermore, we would argue that a positive significant correlation would imply (among other things) that the lowest freeboard corresponds to the lowest corrected freeboard, which contradicts the LRM correction.
To our mind, this point is not linked to the usage of 'radar freeboard' in the paper. For instance, correlation between TFMRA50 Envisat radar freeboard and TFMRA50 CryoSat-2 radar freeboard (monthly gridded comparisons) is 0.18, however they are both considered as radar freeboard. (See Fig. 2).

2. We agree that the term 'radar freeboard' used as it can be misleading (less now since we added 'NN', for Neural Network, thanks to your suggestion).To avoid any confusion, every reference to a 'radar freeboard' should explicitly mention the type of radar, its frequency, the algorithm used, etc., for instance : LRM-KU-TFMRA50 radar freeboard in the case of Envisat, but it would not be digest...
We can add 'proxy' before 'radar freeboard' but we are not convinced that it would help reader to understand better the nature of the time series. We suggest adding precision within the paper in order to explain and motivate the choice of the wording 'radar freeboard' for each step/mission.

To justify a bit more:
The definition of radar freeboard is the difference between the measured height over floes and the measured height over leads. However, regardless of the altimeter and mode, the height measurements over leads and floes are subject to various sources of uncertainty. To date, only SAR mode estimates provide consistent heights over floes and leads, that is to say, a consistent radar freeboard with ground-based measurements. As discussed in this paper and in previous reviews, this is not the case for LRM mode, and our goal is to achieve a radar freeboard close to that of SAR for LRM. If we assume (as discussed in the paper) that the height bias over leads between the two modes is constant, we could have focused the correction on the height over floes with SAR TFMRA height over floes as a reference. However, we did not choose this approach as it would require examining only co-located points between missions, significantly reducing the number of available points and introducing substantial data noise, thereby complicating the calibration. Nonetheless, it is an interesting but more cumbersome approach with some other limitations. Since our correction is applied to the radar freeboard, once the correction is determined, we directly correct it. Stephan Paul et al. (2018) employs a similar correction approach on the radar freeboard to determine the threshold of the TFMRA retracker over floes that should have been used if the radar freeboard matched to CryoSat-2 one. However, our approach differs as we aim to work with monthly maps and avoid re-tracking waveforms, particularly for missions such as ERS where the gridding of data helps reduce the residual noise from pulse blurring. Therefore, we correct the radar freeboard, primarily focusing on correcting the height over floes since the bias on the SLA (Sea Level Anomaly) remains constant. The calibration approach can be seen complementary to the re-tracking step; we simply do not subtracted the SLA

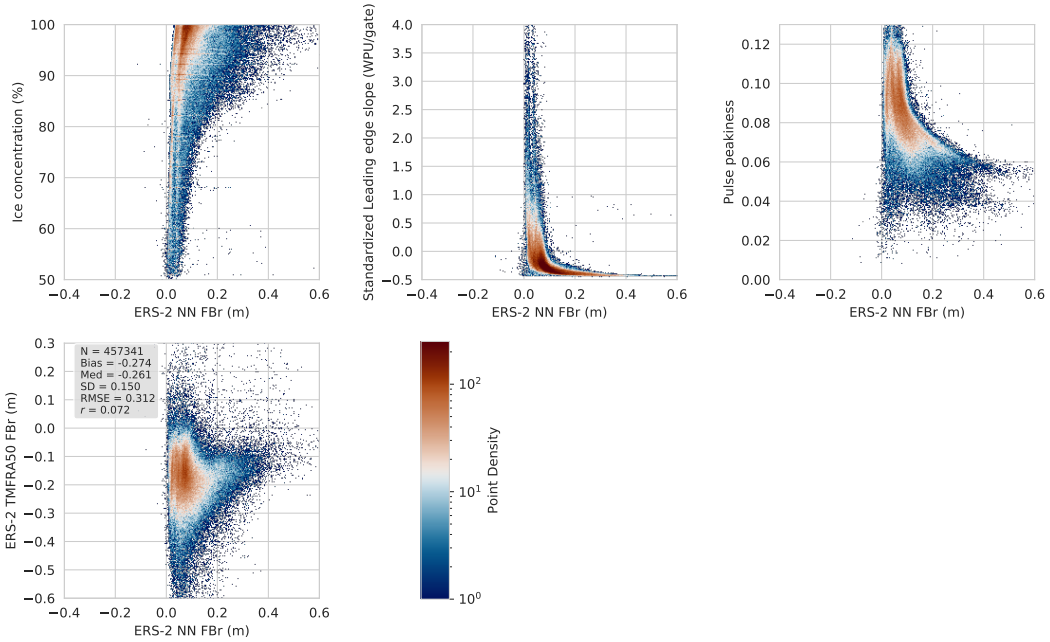

Figure 1. An outline of the link established by the NN between some of the inputs (Standardized LES, PP, sea ice concentration and TFMRA50 FBr) and ERS-2 NN FBr. WPU means Waveform power unit, for ERS-2 correction

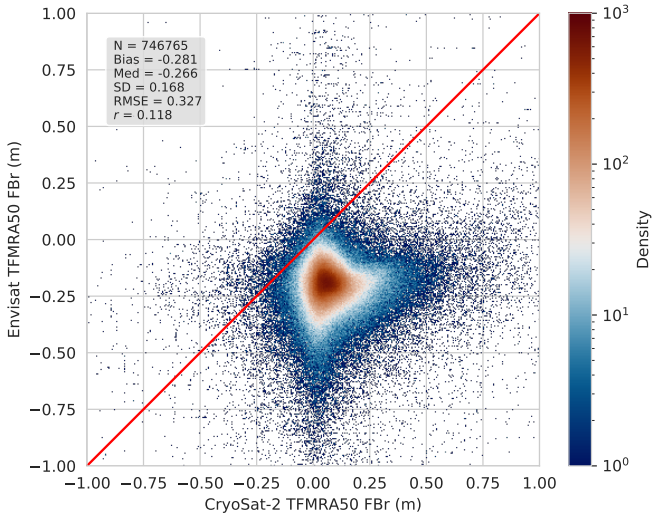

Figure 2. Envisat TFMRA50 radar freeboard against CryoSat-2 radar freeboard

and added it back afterward. Lastly, this radar freeboard is consistent with a SAR KU TFMRA50 radar freeboard, which is coherent with supplementary validation data (in-situ, airborne, etc.) after conversion. This justifies our choice of using the term

"radar freeboard" accompanied by "NN" to indicate that it has undergone a different step from simple re-tracking and height difference. The radar freeboard thus becomes a kind of SAR TFMRA50 radar freeboard, a SAR-like FBr.

We propose adding further details in the introduction and a sentence in the conclusion. We hope that our response will enable us to converge faster.:

In the introduction :

Since this LRM-TFMRA50 radar freeboard will be corrected to be consistent with CryoSat-2 and not conventionally obtained by making the difference of the height over floes and height over leads, it will be specified as NN FBr, which stands for radar freeboard adjusted using the neural network.

In the conclusion :

The final NN FBr does not conventionally result from a difference of two retracked heights, but corresponds to a TFMRA50 SAR-like radar freeboard corrected by a neural network.