The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2018-34-RC2, 2018

The Cryosphere Discussions

Interactive comment on "Consistent CryoSat-2 and Envisat Freeboard Retrieval of Arctic and Antarctic Sea Ice" *by* Stephan Paul et al.

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Received and published: 24 March 2018

This paper describes new procedures to provide consistency between sea ice freeboard records from Envisat and CryoSat-2. This is especially important due to the smaller effective footprint size of CryoSat-2 which needs to be accounted for in the retracking procedure as well as the classification of sea ice lead and floe echoes. The authors have done a good job to attempt to get as consistent record as possible which spans the two records, and much of what is done here is of significant value. But the work essentially treats CryoSat-2 data as a standard data set and adjusts the Envisat record to best match the record. As such, the CryoSat-2 data should be as accurate as possible to tie the records together. However, I did not see that this was adequately done in the paper. In particular I think there are flaws in the CryoSat-2 retracking

procedure which need to be addressed prior to publication, these are noted below. Particularly I note the need to better refine the lead tracking procedure and verify this through direct elevation comparisons between the measurements. Independent validation data of the CryoSat-2 data set through comparison with field campaigns such as CryoVEx or IceBridge are also needed.

Additionally, only freeboard differences are plotted so it is difficult to evaluate whether the retrieved freeboards themselves are accurate. Some maps and statistics of the actual retrieved freeboard are needed. This is especially important for the Antarctic region where due to the complexity of the surface prior studies with satellite radar altimeters have not demonstrated the capacity for obtaining accurate measurements.

Specific comments on the manuscript are given below:

P2, second paragraph: The wording choice is a bit awkward in parts...I'm not sure what quasi-nadir run-time measurement means here. "...which are so accurate" could be rephrased better.

P2 L18: "a the"

P4: If you have daily passive microwave measurements for snow depth retrievals then why is a climatology used for the Antarctic?

P5 L17-19: The use of SAR processing on CryoSat-2 will impact both the leading edge width as well as peakiness, I wouldn't expect these value to be equivalent to a pulse limited radar system for lead discrimination.

Section 2.3.2: Some further details on the k-means clustering is needed. Were the peakiness, leading edge width, and backscatter used here? What exactly is coming from the three clusters?

Section 2.3.3: Same here for the need for further details. What is the training data set that was used, and how was this selected? How was it clear that the method separated leads and floes other than the fact that they had expected values for peakiness

and backscatter? Was any validation done of the results to assess the quality of the classification?

Section 2.4: The need for different thresholds for sea ice leads and floes from CryoSat-2 was shown in Kurtz et al., 2014. This should apply to Envisat since both operate on the same physical principle: the effective geometrical area of the lead return is very small causing a radar return which is close to the transmit pulse shape. As both satellites have the same bandwidth the transmit pulse shape should be very similar for both CryoSat-2 and Envisat. However, for sea ice floes the pulse-limited footprint size of Envisat should require a different threshold than the unfocused SAR footprint of CryoSat-2. This implies the threshold chosen for CryoSat-2 floe returns needs to be adjusted. No matter the methodology used though, some validation of the choice of thresholds needs to be done and I think that is lacking in the manuscript.

Note too that the approach described in this section assumes the threshold used for CryoSat-2 is a control data set to which the Envisat data is tied, this means the threshold selected for the CryoSat-2 data set is of utmost importance. Thus some validation of this to demonstrate it is correct is sorely needed.

P11 L8-14: This test should be done on the retrieved elevations (not just freeboard values) between Envisat and CryoSat-2, particularly for leads. That would more clearly demonstrate whether the differences in the threshold algorithms are properly handled.

P11 L15: How was the optimal value chosen? Was it that which had the smallest mean difference, RMS difference, or something else?

Figures 10 and 13 seem to not match up visually. In Figure 13 there seems to be a far higher spatial coverage of red, indicating a higher Envisat freeboard whereas the distributions in Figure 10 seem to show only small mean differences and a more symmetric distribution. Some clarification on this is needed.

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