**The Cryosphere
Discussions**

Interactive comment on "Simulation of the satellite radar altimeter sea ice thickness retrieval uncertainty" *by* R. T. Tonboe et al.

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The paper investigates the error budget for sea ice thickness retrieval from Cryosat-2 with a focus on the variability of snow and ice parameters within a measurement footprint. This is of importance for the upcoming Cryosat-2 mission and the paper should be published in The Cryosphere with minor revisions. Unfortunately, the authors have not touched existing altimeter data which they could have used for the study. The paper is in general well written. There should be a small modification in the structure: the introduction includes the description of the scattering model which deserves an additional section. The abstract should include the main conclusions with some numbers.

Reply: This paper describes a modelling study; this is clearly stated in the objectives. The primary error sources due to the scattering processes are identified. The analysis

of sea ice radar altimeter data is indeed very interesting and necessary for understanding the scattering processes in depth. However, in my opinion there is at the moment a lack of coincident radar data and a complete description of the snow and ice parameters (these parameters are the input to my model). In particular, the surface roughness, which is the most important parameter for the backscatter intensity is generally lacking. It is my hope that this paper may help in field experiment planning so that these parameters may be available in the future.

Specific comments The title is too general. The term "satellite radar altimeter" should be replaced with CryoSAT because the authors do not investigate the performance of other altimeter systems.

Reply: CryoSat is used as an example, but the method and conclusions are generally applicable to other space-borne radar altimeter systems. We wish to indicate that with the present title.

513/4 replace "are still unknown" with "not well known" Reply: Done.

515/4 add Farrell, S. L., S. W. Laxon, D. C. McAdoo, D. Yi, and H. J. Zwally (2009), Five years of Arctic sea ice freeboard measurements from the Ice, Cloud and land Elevation Satellite, J. Geophys. Res., 114, C04008, doi:10.1029/2008JC005074.

Reply: Done.

516/11 total error 0.76m: where does this number come from? Reply: The 0.76m is from Giles et al. 2007 stated in the same sentence (p. 516, line 12).

516/21-517-13 Put this in an additional section about the model description.

Reply: The model introduction has been put into an additional section called 'Model overview'. The detailed model description is given in chapter 3.

518 Use of SAR imagery: What are the errors due to the choice of the experienced observer? Maybe it would be worthwile to use different realizations of the classification

for an error assessment.

Reply: The two SAR scenes used in the study were selected from a larger dataset for two reasons: 1) they are nearly coincident with ice thickness measurements in the field, and 2) these two scenes represent an area covered near exclusively by thick and ridged multiyear ice and an area covered by both first- and multiyear ice respectively. The larger dataset show that generally, the classification error is smaller than natural ice type variability on time scales of days or weeks in these two areas, and these two scenes represent realistic ice type distributions for their respective regions.

520/2 Eq. (2): It is common to use c for the speed of light.

Reply: To indicate that it is not necessarily the speed of light in vacuum, but the speed of light at 13GHz in air, snow and ice we call it u.

525/15-25: I can not pick the 26 cm underestimation from Fig. 8. Please indicate by a line. The backscatter is not shown in the Figure.

Reply: The readability of the figure has been improved, by indicating the 26cm with a vertical bar and annotation.

527/528 Please give a motivation for this section. It should probably be discussed before section 4.1.

Reply: The motivation and structure of chapter 4 including the Weddell Sea profiles has been added at the beginning of chapter 4.

All figures: Histogram like data should be displayed in a histogram style, not as continues lines. If applicable, theoretical distributions should be fitted, i.e. a Gaussian for the snow density.

Reply: Thanks for the suggestion. The histograms have been plotted in histogram style. Assuming Gaussian distributions for the range variability in figures 5 and 7 we have computed the standard deviation to represent the variability.

C305

Fig. 3 (A) the ice, not the snow density is shown.

Reply: Done.

Fig 12a-d: It is very difficult to understand the meaning of the images. Perhaps, it would be better to exemplify the process within one footprint for a selected set of situations, i.e. to show the influence of ridges and leads.

Reply: Fig. 8 and the description in section 4.5 is such an example where only new-ice and multiyear ice is mixed within the foot-print. It will be important in the final version that the figures 12a and 12b and 12c and 12d are placed next to each other so that they can be compared.

Interactive comment on The Cryosphere Discuss., 3, 513, 2009.