**The Cryosphere
Discussions**

Interactive comment on "A sea ice thickness retrieval model for 1.4 GHz radiometry and application to airborne measurements over low salinity sea ice" *by* L. Kaleschke et al.

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Dear anonymous reviewer,

thank you very much for the useful comments that will improve the quality in the revised version.

1. Introduction. The authors specifically address the retrieval model in terms of the nadir return. What is the estimate of the SMOS 1000 km swath that may be considered to fall within the nadir return region and what is the change in resolution with respect to swath position and incidence angle? We discussed this in more detail.

2. Salinity topic. While salinity is a ratio, the general oceanographic convention is to reference ocean salinity in terms of practical salinity units (psu).

We are afraid that we don't agree about this convention to express ocean salinity in PSU. The usage of the term PSU as a unit is a widely applied bad practice. The UNESCO (1985) report clearly defines the units used in oceanography and recommends their usage. The practical salinity has no unit. It is accepted to simply speak about salinity when referring to the practical salinity scale (PSS). It is recommended to simply write S=35 for ocean salinity. The permil symbol or PSU should not be used as a unit.

UNESCO (1985) The international system of units (SI) in oceanography, UNESCO Technical Papers No. 45, IAPSO Pub. Sci. No. 32, Paris, France. http://www.jodc.go.jp/info/ioc_doc/UNESCO_tech/065031eb.pdf

3. Section 2. It is fortuitous that the model can utilize the large brightness temperature contrast between thick ice and open water, which effectively minimizes other factors. In 1001 from line 17 to 1002 line 8, a good point was made about large thickness variations smoothing out the periodicity so that an incoherent solution can be used. Approximately what is a large thickness variation in terms of the model and how does this value-range of values compare with results shown later in Figure 6? If the rms thickness variation is larger than a quarter of the used wavelength, the incoherent solution is in general applicable. The wavelegnth for 1.4 GHz is 20 cm. A random thickness variation of about 5 cm is therefore a sufficient condition. The condition is probably not fulfilled for nilas and thus may cause problems for the retrieval between 0- 10 cm. Nilas was not detected in the present data. Therefore, our assumption seems to be valid. However, the accuracy of the laser altimeter data is not sufficient to investigate the thickness variability within the radiometer footprint because we can not distinguish between the measurement error and the actual thickness variability which have the same order of magnitude.

4. Yes it would be good to properly order figures. Done.

5. 1004 line 20 and Figure 1. The incoherent solution does appear to converge with open water, while text says it does not. The dashed curve does not converge is this incoherent or coherent line? Regarding Figure 1, the authors should specify which is the incoherent curve in the caption or on figure, since text says it is for 0.1 d value. What is reason to include 20 cm line- is this an coherent or incoherent?? This all needs to be clarified. Done.

6. 1006 line 11 and Figure 3. Concentration is not shown in Figure 3 so should be removed from this sentence. Corrected.

7. I think it would be interesting to include a simple plot of the 1.4 GHz brightness temperature along with EM thickness plot. We included the brightness temperature along with the thickness plot.

8. Regarding the comparisons of the EM data and retrieval, discussed in 1007-lines 18-24 and shown in Figure 6. I also refer back to the EM accuracy over ridged ice discussed in 1004-lines 1-2. Perhaps Figure 6 could be enlarged so that one could see the variations abit more clearly. The Figure can be enlarged in the electronic version.

Also have they really considered ridged ice properly, including in their comparisons? The radiometric signal seems to be not very sensitive to ice ridges which is different from the laser altimeter data. Thus, the EM thickness data which include the laser altimeter surface elevation data capture the ridges while the radiometer does not. A more complex emissivity model which accounts for the sea ice geometry has been developed in the ESA SMOSIce project. The complex model could explain some variability due to ridging but has no advantage for the thickness retrieval as compared to the simple plane-parallel model. As the paper adresses the issue of retrieval we do not want to stress the forward modeling of complex sea ice geometries. With the present data set only very little can be learned about the effect of thickness variation on the emissivity.

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Why are red lines shown that extend above 1.5 m in thickness and are such portions of ice included in those 4 red dots shown in Figure 7? This was an error in the plotting routine. Now the maximum thickness is 1.5m. The red dots indicate EM thicknesses $d_{EM} > 1.5\,\mathrm{m}$.

Also, it would be useful to hear what the authors think might be the reason behind the actually fairly significant differences between the averaged EM and retrieval derivations (0.8 m vs 0.65 m), including in terms of thickness variations. We now mention the skewness in the EM thickness distribution, which is due to ridging. The skewness explains differences in the mean value.

10. References. Specific information should be included for how to access the grey literature references, such as ESA and internal reports, via web or address. Done