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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.

**Anonymous Referee #1**

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Summary:

This paper presents a method to potentially retrieve sea ice thickness using the ESA SMOS 1.4 GHz radiometer. The results indicate that thickness can be retrieved up to 0.4-1.5 m thickness, depending on the type of sea ice. Such a range would be complementary to Cryosat-2 retrievals which have higher errors at such thinner ice ranges. This means that estimates from the two sensors could be combined for data assimilation/modeling applications as well as operational sea ice analyses. The method would also be applicable to the upcoming NASA Aquarius mission.

General Comments:



Sea ice thickness is a crucial parameter for tracking the changes in the Arctic sea ice, correctly modeling the sea ice cover, predicting future sea ice conditions (e.g., seasonal forecasts), and assessing impacts on climate and ecosystems. Thus, the method presented is a potentially valuable improvement in our observation capabilities. However, the method was tested largely in non-optimal conditions (e.g., melt) and there still isn't much validation data. The method seems to make a significant number of assumptions and there appears to be some fairly high uncertainties that need to be investigated further. However, the method represents an important step in obtaining useful results and thus is worthy of publication, with the assumption that further studies will follow that will better assess uncertainties and further refine the method where possible. I recommend acceptance with minor revisions.

Comments:

The main comment is on the assumptions and uncertainties in the method. They are discussed, but some implications seem glossed over. For example, passive microwave data is employed to provide sea ice concentrations. It is stated that uncertainty in PM concentrations is $\sim$5% for central Arctic conditions (pg. 1006, ln. 18-19) and that a 5% concentration error results in a 0.1 m uncertainty for a thickness of 0.5 m. But that is actually a 20% uncertainty, which seems quite high.

In addition, a 5% error for PM concentration is reasonably for thick ice in the central Arctic under non-melt conditions. However, the method is generally constrained to thinner ice, i.e., < 0.5 m for first-year ice. But PM concentration errors may be significantly higher for such ice as the PM algorithms generally underestimate thin ice, at least up to 0.3 m. In such regions, concentrations may be off by 10-20% (e.g., Meier, 2005). Such an uncertainty would seem to potentially render the thickness retrieval method unusable in such situations. I would like to see a plot for sensitivity for ice concentration uncertainties like is done for temperature in Figure 3. And under melt conditions like in the study, the PM concentration uncertainties may even be higher than 20%.

Also, ice temperatures from AMSR-E may have greater uncertainties that +/- 1 K, especially under some circumstances.

Another issue is the spatial scales involved. These are discussed briefly in terms of comparing EM thickness observations with those derived from EMIRAD, but what about SMOS. What is the IFOV of the SMOS instrument? I would assume that is significantly larger than EMIRAD. Thus you will be getting a signal from a fairly large region that likely encompasses a variety of ice types and thicknesses. How might the method work in such a situations?

This effect is clearly evident in Figure 6, where the method clearly missed the small-scale variation. In Figure 6, it looks like there is spatial averaging of the EM observations to match the TB method, but it is not clear and is not mentioned in the caption. I would suggest include the spatial averaging if it isn't there, and if it is, I would mention it in the caption and try to make it more clear in the plot.

I also think it is worth briefly mentioning somewhere, perhaps in the introduction, some of the basic parameters of SMOS and the platform – spatial resolution, spatial coverage (full Arctic coverage – i.e., polar-orbiting satellite)?

Meier, W., 2005. Comparison of passive microwave ice concentration algorithm retrievals with AVHRR imagery in Arctic peripheral seas, IEEE Trans. Geosci. and Rem. Sens., 43(6), 1324-1337.

Minor Comments:

pg. 1002, ln 10-11: "assume. . .assumption" – repetitive

pg. 1003, ln 9: number figures in the order they appear in the text. The first figure reference here is to Figure 4

pg. 1004, ln 11: units for salinity?

pg. 1007, ln 24: define "SMHI"



Interactive comment on The Cryosphere Discuss., 3, 995, 2009.