

Interactive comment on “Arctic sea ice signatures: L-Band brightness temperature sensitivity comparison using two radiation transfer models” by Friedrich Richter et al.

Anonymous Referee #1

Received and published: 2 January 2017

General comments:

This study shows the potential use of brightness temperature data from the ESA SMOS mission for forecast model assimilation, to improve sea ice thicknesses in thin ice regions. Although the application of brightness temperature data rather than a derived thickness product is not a new concept, this is the first time that the usefulness of SMOS data has been explored in detail and the manuscript will be of interest to the observation and modelling communities. However, I have some concerns to be addressed.

The manuscript currently lacks a suitable level of transparency and detail regarding a.) the uncertainties associated with modelled brightness temperature and b.) the limi-

C1

tation of ORAP5 data in the development of a reliable brightness temperature model. The fact that the brightness temperature calculations rely on the quality of the ORAP5 data is only explicitly stated in the Discussion. This should be explained much earlier in the manuscript, and explored quantitatively.

1.) The authors state the assimilation of brightness temperature in forecast models is preferable to a sea ice thickness product due to the “assumptions, parameterizations and auxiliary data” associated with thickness retrievals. However, for comparison with observed brightness temperature data they generate two brightness temperature models that rely on multiple input sea ice parameters from the ORAP5 reanalysis (thickness, concentration, temperature etc.). These in themselves will be derived model parameters with their own inherent uncertainties. The authors should briefly explain how each of these parameters is derived in ORAP5 and state their associated uncertainties. Based on this they should expand on why using a radiative transfer model (which is itself developed from derived parameters) as a forward operator in a brightness temperature assimilation scheme for thin sea ice thicknesses is preferable to using observed thickness data.

2.) An important consideration is the relative impact that the uncertainty in each of the input ORAP5 sea ice parameters will have on brightness temperature. The authors touch on this by carrying out a sensitivity study of their radiative transfer model to identify the most important input parameters for the two models, and display the results in Figure 7. This is the truly novel part of the manuscript and needs to be expanded. An easy and effective way to do this would be to tabulate the effects of the sensitivity study for both models. What effect (expressed as a percentage, for example) does varying each parameter to its minimum and maximum simulated value have on brightness temperature over thinner (say 10 cm) and thicker (say 50 cm) sea ice? This is essentially a tabulated expansion of the explanation given on P16 L2-4.

Specific comments:

C2

P1 L4: It is perhaps more accurate to state that SMOS brightness temperatures have been proven to be valuable in estimating modal thin sea ice thicknesses, not mean. See for example [1].

P3 L30: Why 2 m? 2 m is 0.5 m greater than the maximum SMOS validation thickness.

P5 L27: The assumption of dry snow is oversimplified. Despite this being a necessary assumption made for the model, the authors should comment on the potential impacts of a wet snow layer on brightness temperature. This is especially important, as wet snow is most common on thin FYI, such as that measured by SMOS, even in winter.

P6 L8-19: The relevance of the brief introduction to NEMO and LIM would not be clear to someone who is unfamiliar with ORAP5. I believe ORAP5 was produced from these models, but this is not explicitly stated in the manuscript.

Conclusion: A comment on the potential for a similar approach over thick ice would be useful. If brightness temperature can't be used, what could?

Technical comments:

P2 L1-2: Not great wording. Suggest change to "This capability is especially important as the Arctic Ocean shifts to a new state, in which older, thinner sea ice is being replaced by younger and thinner ice".

P7 L28, P13 L7 and P13 L7: "fairly match", "properly agree" and "decently well". What do these mean? Re-word.

P8 L16: add "the" before largest and highest

References:

[1] L. Kaleschke, X. Tian-Kunze, N. Maass, A. Beitsch, A. Wernecke, M. Miernecki, et al., "SMOS sea ice product: Operational application and validation in the Barents Sea marginal ice zone," *Remote Sensing of Environment*, vol. 180, pp. 264-273, Jul 2016.

C3

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-273, 2016.

C4