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The Cryosphere Discussions

Interactive comment on "Theoretical study of ice cover phenology at large freshwater lakes based on SMOS MIRAS data" *by* Vasiliy Tikhonov et al.

Anonymous Referee #1

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The authors studied L-band microwave emissions over large high-latitude lakes (except Huron) likely experiencing different lake ice phenology phases. The seasonal variations of SMOS brightness temperature were simulated and interpreted using a theoretical model developed previously for sea ice studies. The model-based approach is needed for lake ice studies and there are no major issues with the analysis; however, I do not find major contributions to the current understanding of remote sensing of lake ice either.

Major comments: (1) This is basically a theoretical study but no major improvements or new developments in the microwave emission modelling are found. Section 3 is based on the available literatures and has significant overlap in content with (Tikhonov et al., 2014) (e.g. Eq. 1 and 3, Fig. 7 are presented in both literatures). It is necessary to

review the theoretical basis, but this new study is not supposed to limit to a recap.

(2) Section 3: What about the incoherent scattering from a rough surface of wet snow? How do you consider layered snow and/or ice in the modelling? What about the temperature vertical gradient of snow and/or ice layer, which is not considered in the model or simulations?

(3) The explanations on the brightness temperature patterns of ice, dry snow and wet snow are reasonable as similarly described in other literatures (e.g. Ulaby et al., 1986). The study would be more interesting if more deepened analysis was added. For example, an additional analysis on the quantified differences between multi-frequency (e.g. SMOS vs AMSR) responses to typical lake ice conditions and the implications to lake ice remote sensing.

(4) Fig. 5 compares the simulated and observed SMOS brightness temperatures. Considering a large number of inputs of the theoretical model and limited knowledge of the ground truth (e.g. the snow and ice parameters), such simulations can only be used for qualitative purpose. It would be more rigid to have the model validated first using a controlled or field experiment with thorough measurements of the required parameters. It is also recommended to state the input parameter uncertainties and their impacts on model simulations.

Minor comments: Section 2.2: detailed descriptions of the data sets (e.g. specific parameters; measurement accuracy; spatial and temporal representativeness) used in this study are needed instead of a simple list of data sources.

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