

The Cryosphere Discuss., referee comment RC3
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Comment on tc-2022-85

Angelika Humbert (Referee)

Referee comment on "The sensitivity of satellite microwave observations to liquid water in the Antarctic snowpack" by Ghislain Picard et al., The Cryosphere Discuss.,
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The manuscript is concerned with a study of passive microwave sensing of the water content of snow/firn in the Antarctic. It contains high level extensive simulations of the brightness temperature for a variety of frequencies that correspond to satellite missions. In short – it is a fantastic work. The main critics are to explain the microstructure that is used for the simulations, to present the results in a way that not only radiative transfer modelers understand them, but also firn microstructure and hydrology modelers.

- In general it would be very good to show both, total liquid water content and volumetric water content in all graphs. This can certainly be achieved easily and would be super helpful for people who are working with modelling of snow/firn hydrology that think more in terms of volumetric water content.
- I am missing a section that shows how well the parameter optimization is doing for the particular frequencies. This should be included in the next version of the manuscript either as a subsection of an appendix. But it is important to demonstrate the performance of this.
- The manuscript needs to improve on building a link to microstructure observation and modelling. As an example 'we selected the exponential microstructure representation' is not enough for understanding what type of microstructure is chosen.
- The way the temperature is simulated is problematic. I think the results could be substantially improved by using temperature simulations from snow/firn models. These simulations are provided by regional climate models such as RACMO, MAR and others. Given that the temperature is such a crucial parameter in the modelling, more efforts to get the simulated temperature of the snow/firn right are important.
- The effect of heterogenous pixels: the coarse resolution of passive microwave

sensors/missions, make it likely that the brightness temperature of a particular pixel is a mixture of different snow/firn/ice properties. This could be overcome by incorporating high resolution radar imagery, such as provided by Sentinel-1. In 10-30m resolution the homogeneity of a passive microwave pixel can be assessed. For the purpose of this study, either pixels could be excluded that are not homogeneous or they could be characterized. To this end not a major effort is necessary, as no time series is required (in a first step) but it could help substantially to understand the differences between simulated and observed brightness temperatures.

- The manuscript lacks plots or diagrams showing the SMB, in particular melt rate in the study sites. This would help substantially to understand the results.

Line 35: either peninsula or Antarctic Peninsula

Line 107: +-2K.

Line 164: 'They are likely invalid for high contents' Contents of what? Elaborate more on what basis is that stated.

Line 192: property profiles

Line 204: what are unknown tie points?

Line 235: The why is the seasonal temperature set to 273K? This does not seem to be appropriate.

Line 254: 'Intermediate frequencies have intermediate behaviour' needs to be rephrased with clearer a statement.