Surface melting significantly affects Antarctic ice shelf thermodynamics and stability, but limited observational data restricts firn model accuracy. This work introduces a framework combining microwave radiometry with firn modeling to assess meltwater percolation. This work highlights the fact that higher layer resolution could benefit water percolation modelling. Brightness temperature measurements are used to link strong absorption of the signal to different meltwater event produces by the different model resolution.

AUTHORS: Many thanks for the review. We address each concern point by point below.

However, it is not clear to me what the simulations with MEMLS brings to the paper other than the fact that it can be model… Maybe I missed something.

AUTHORS: The meltwater evolution can be qualitatively linked to brightness temperature trends. However, to improve the model quantitatively using measurements, simulating brightness temperatures with MEMLS (or another emission modelling framework) is a critical step. MEMLS links the underlying melt processes (such as melting, refreezing, density evolution, temperature, etc.) to the observed microwave signature, thereby providing a way to calibrate and improve the physical model. By integrating microwave radiometry with firn modelling, MEMLS enables a more accurate representation of meltwater percolation processes and helps assess the impact of melt events on ice shelf thermodynamics and stability. This allows for better refinement of model predictions by directly linking physical processes to observable data. This study serves as a precursor to future assimilation or other integration of brightness temperature observations with physical models, demonstrating the feasibility and potential of using satellite brightness temperature in this way.

I only have minor comments.

Specific comments:

L16-17: Can you describe a bit more why? I think the abstract could benefit from being a bit longer.

From L15-17: "*These outputs drive the Microwave Emission of Model of Layered Snowpacks (MEMLS) radiative transfer model to simulate microwave brightness temperatures (TB), which we compare with satellite radiometer observations at 1.4 and 36.5 GHz.*"

AUTHORS: The emission simulation using MEMLS is used to quantify the link between satellite radiometer observations and modelled liquid water content. We will expand the abstract to clarify this.

L22-23: Should it be the sentence of the intro? Just a suggestion.

From L22-23: "*The primary drivers of Antarctic Ice Sheet mass loss are basal melt and glacier outflow (Scambos et al., 2000; Bell et al., 2018).*"

AUTHORS: We will reconsider the beginning of the introduction to make it more directly relevant to the objective of the manuscript.

L81: "and other properties"… snow microstructure? Maybe hint that it doesn't so its better introduce for the section 2.4.

From L80-81: "*…capturing the ice shelf structure as well as the snow and firn evolution, including its temperature, density, LWC, and other properties.*"

AUTHORS: We will specifically mention snow microstructure in the sentence.

L87 “models parameters are adjusted accordingly” Which parameters? Please enumerate if possible.

AUTHORS: We will include the parameters in the sentence (layer thickness and forcing temperatures).

L118: “originate from hundreds of meters within the ice”. If dry I assume? It could be good to mention that the signal doesn’t penetrate as deep if wet.

AUTHORS: Correct. We will mention that this refers to dry conditions.

L170: I think you mean coherent…

L170: “to properly account for scattering”. When running in coherent mode, there is no volume scattering, only surface scattering from interface (Wiesmann and Matzler, 1999). In this case, the microstructure would only affect the extinction coefficients and the propagation of the signal. I think this deserves a bit more attention. Are you getting volume scattering from MEMLS in the simulations?

AUTHORS: Incoherent is correct, but the sentence is worded in a bit roundabout way. The default assumption of MEMLS is to treat thin layers as coherent scatterers; in the model’s formulation, this means ignoring scattering within the layers and considering only interface reflections, as the Reviewer noted. However, as noted by Wiesmann and Mätzler (1999), if multiple thin layers are stacked, the assumption needs to be reconsidered, as ignoring internal scattering within the entire stack does not reflect reality. Hence, we included internal scattering and therefore refer to the simulation as incoherent. We will rephrase the sentence to make it clearer.

L172: I would specify its only for ice sheet and not widely used…

From L172: “*The grain size tuning followed a widely used approach in snow simulations*”

AUTHORS: Agreed. We will change the wording accordingly.

L177: “to allow scattering effects to diminish over time”. Can you clarify? It’s usually the opposite for dry terrestrial snow because of ground emission. It is explained pretty well on L225-226, perhaps move it earlier?

From L225-226: “*Refreezing of wet snow forms crusts that enhance scattering, producing very low TB. Fresh snow accumulation between melt seasons gradually buries these crusts, reducing scattering and raising TB.*”

AUTHORS: Yes, scattering diminishes as the crust layer is particularly reflective (more than typical frozen ground in the terrestrial snow case). We will clarify the explanation on L177.

L202: Maybe rephrase to “Because we use MEMLS to” …?

From L202: “*Because MEMLS empirically tunes…*”

AUTHORS: Yes, we will rephrase it like that.

L216: I suggest not using “probe” but measured or sensed instead.

From L215-216: “*The two bands probe different depths: …*”

AUTHORS: We will reword it as suggested.

L247: I cannot find Section 2.4 in Picard et al 2022.

From L247: "*(e.g., Picard et al., 2022; see Section 2.4)*."

AUTHORS: Section 2.4 refers to this manuscript. We will make it clearer.

L267: I think you mean Figure 3d?

AUTHORS: Yes, we will correct it.

L286: Why in supplement? The paper would benefit from having more figures in the text and not in supplement.

AUTHORS: We will consider including more figures in the main text, including Figure S6.