

Review for “A Maxwell-Based Dual-Morphology Wet Snow Microstructure Model for Liquid Water Amount Retrieval in Greenland’s Percolation Zone Using SMAP L-Band Radiometry”

This manuscript presents an interesting dual-morphology framework for wet-snow L-band radiometry retrieval, distinguishing between thin-coated and Tri-C liquid-water configurations. The approach is based on Maxwell equations solutions and on the conceptualization of two main morphological structures of wet snow. The physical motivation is relevant and the sensitivity of effective permittivity to liquid-water morphology is potentially important. However, I think the current retrieval framework relies on several strong assumptions that limit the physical interpretation of the retrieved morphology.

In the following my major concerns and comments:

Several important parameters are fixed or strongly constrained in the retrieval, in particular snow density (400 kg m^{-3}), the assumed range of LWC, and the geometrical properties of the two water morphologies. Since all these parameters affect the effective permittivity, it is important to understand how much they influence the retrieved α , LWC, d_{wet} , and LWA. I suggest including a sensitivity analysis for density and LWC, rather than demonstrating the sensitivity only to α for one representative state. The restriction to LWC below approximately 6% also needs more discussion, particularly during peak melt.

I am also not fully convinced about the retrieved wet-layer thickness. Rather than necessarily interpreting d_{wet} as a physical wetting depth, the authors should show how sensitive SMAP T_b actually is to variations in d_{wet} for different combinations of LWC and α , and clarify whether it should instead be considered an effective radiometric thickness.

I think that the relationship between the retrieved morphology parameter α and LWC should be addressed. According to the physical interpretation proposed by the authors, increasing melt should progressively exceed the amount of water that can be accommodated in interfacial configurations, leading to a larger Tri-C contribution and therefore generally lower α .

This relationship is currently discussed qualitatively but is not demonstrated clearly. A direct plot of α versus LWC would be useful. It would also reveal whether the same LWC corresponds to different α values during melt onset and refreezing.

The thin-coated interpretation seems reasonable during early melt, when the original snow structure is still relatively intact. Later in the season, however, refreezing, grain metamorphism, ice-layer formation, and changes in pore geometry may substantially alter the structure. In that case, the same α may not necessarily have the same physical meaning at the beginning and at the end of the melt season.

Furthermore, I would appreciate a subsection describing the dataset used and in general SMAP and a better description of the NN permittivity emulator, maybe with some information about the uncertainty of such estimates.

About this, since density is an input of the emulator, would it be possible to use some density measurements to improve the estimates?

Finally, This model may be particularly limiting during the late melt and refreezing period. At that stage, liquid water may remain below a refrozen upper layer, while the firn structure and its radiometric properties differ substantially from those present during melt onset. I therefore suggest a more cautious interpretation of the late-season retrieval. What is currently interpreted as residual Tri-C water or a partial return toward thin-coated conditions may also reflect the inability of the two-layer model to represent a vertically heterogeneous and partially refrozen firn column. In this september-october conditions, what would be the meaning of the dwet?

I think the authors could better discuss whether the low-LWC assumption remains valid at all sites. This appears particularly relevant for sites such as KAN_U, where stronger melt conditions may challenge the imposed LWC range.