Empirical classification of dry-wet snow status in Antarctica using multi-frequency passive microwave observations

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Reviewer comment 1

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The manuscript presents a multi-depth snowpack status classification scheme for Antarctica, utilizing multi-frequency space-borne microwave radiometry. The paper is clearly written, and the subject matter aligns well with the scope and interests of the journal.

The use of the full spectrum of passive microwave radiometry for ice sheet melt detection is a relatively understudied area, which has fortunately begun to receive more attention in recent years. This study contributes meaningfully to that growing body of work.

While the approach may be seen as a preliminary or "low-hanging fruit" analysis, the authors' qualitative investigation of microwave signal behavior in relation to melt evolution represents an essential foundational step. This work is critical for advancing future research aimed at extracting more detailed and quantitative insights from remote sensing data.

I consider this paper a valuable contribution to the field and recommend it for publication following minor revisions:

We would like to thank the reviewer for the time devoted to this review. Please, find our answers in blue to the comments hereinafter.

Line 43: Please change "among" to "amount."

Done.

Line 44: Add citations to relevant recent work, such as: Naderpour et al. (2020), Mousavi et al. (2022), Hossan et al. (2024), Moon et al. (2024)

Thank you for the suggestion of these recent works. We will add as follows:

"(...) The algorithms previously developed for higher frequencies have proven effective at L-band as well (Leduc-Leballeur et al., 2020; Mousavi et al., 2022). (...) This unique characteristic has recently been exploited in Greenland to detect perennial firn aquifers with SMAP (Miller et al., 2020) and to estimate the total liquid water amount (Naderpour et al., 2020; Houtz et al., 2021; Hossan et al., 2025; Moon et al., 2025). This new perspective highlights the different information retrieved depending on the frequency. "

Line 125: The choice to define the new melt season starting in mid-autumn is not intuitive. As Figure 5 suggests, late-season melt events may be incorrectly attributed to the following melt season. Please clarify the rationale or consider adjusting the definition.

The period April to April is only used by the detection algorithm to compute the winter statistics (mean and standard deviation). The algorithm is designed to remove all melt events over this period, whenever they occur, without considering a beginning or an end of a season. Any period of 12 months could be used, but it is preferred to have a single winter in this period.

On the other hand, for the presentation and the discussion of the results, we computed all the seasonal statistics and discussed the interannual variability throughout the article using the period from September N to June N+1, as illustrated in Figure 5 of the article.

For clarification, we propose reformulating the sentence in Section 3.1, L125:

"The algorithm determines an optimal brightness temperature threshold in every grid cell and time period from 1 April year N to 31 March year N+1. It considers that any acquisition of brightness temperature higher than this threshold indicates wet snow. "

Lines 139–140: Please cite additional supporting literature, such as: Macelloni et al. (2011), Montomoli et al. (2022)

Thank you for your suggestion. We noted that Macelloni et al. (2011); Montomoli et al. (2022) refer to the L-band frequency while this paragraph address the 19 GHz frequency. Thus, it seems to us that the already cited Picard et al., 2022 and Colliander et al., 2022 support well the use of vertical polarization to detect liquid water with 19 GHz.

Lines 179–180: This statement may oversimplify the L-band response. The response depends on the amount of active melting and liquid water accumulation. Please clarify this dependency here.

We agree that the response depends on the amount of liquid water. We propose reformulating the sentence as follows:

"Note that when liquid water is present in a sufficient amount to be detected at a given level (e.g. at the surface when active melting is occurring), radiation emanating from below is blocked, and no information on the dry-wet status can be detected under the highest level. This blocking effect depends on the amount of liquid water, the thickness of the wet layer, and of the frequency. However, in practice, if liquid water is detected at a given high frequency, it is unreliable to exploit lower frequencies to determine the status below the upper wet level (Picard et al., 2022)."

Line 197: Consider replacing “coherent” with “consistent” for improved clarity.

Done.

Line 235: Correct the grammar: “this possibilities” should be “these possibilities.”

Done.

Lines 297–298: Consider emphasizing the adequate accumulation of liquid water, rather than just the depth, as the key factor influencing the observed response.

We will reformulate in: *"No wet status is detected at 1.4 GHz, suggesting that the amount of liquid water is low and does not affect the snowpack at depth."*

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