

## Overall

- To improve the paper, throughout the text the terminology could be reviewed for clarity when discussing flooding. I have highlighted some instances in the detailed comments. Phrases including ‘surface flooding’, ‘seawater flooding’ and ‘flooded sea ice’ are used, and I would take care to ensure it is clearly articulated that natural flooding occurs from seawater infiltration into the snow atop sea ice (at the snow/ice interface) which is more commonly referred to in the literature generally as ‘flooding’ and instances in the past tense would be for example 'flooded snow' (rather than flooded ice). I would try to be consistent with phrasing throughout.

We acknowledge the lack of clarity with the terminology throughout the document and are grateful that you have highlighted it. We have incorporated the necessary modifications throughout the text, consistently referring to the process by which seawater infiltrates and rises through the snowpack as "flooding". "Flooded snow" is used as a general term for any snow that has been affected by this process. We refer to "slush" as the resulting snow saturated with seawater. Additionally, as mentioned in the paper, we further distinguish the snowpack conditions (Figure R1). "Saline slush", where only a liquid slush layer is present, and "Refreezing", where a slush layer coexists with a transitional layer (slush → snow ice) as it consolidates into snow ice.

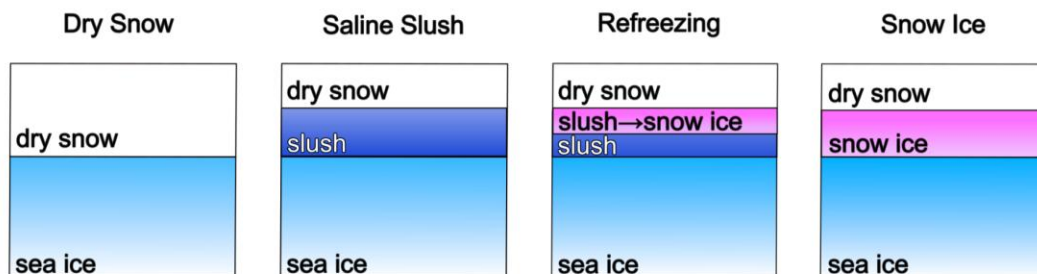


**Figure R1. Schematic representation of the observed snowpack conditions.**

- A clearer explanation could be provided on how the SAR imagery relates to the field data. For example, given the scattered flooded and non-flooded locations at the same sites in the field data, how does this relate to the dates and analysis in the SAR data? I believe this could be explained further in the methodology and linked more clearly in the results.

We have incorporated additional information into the Methods and Results sections to address this point and improve clarity. Figure 3b was adapted to show a timeline of collected samples and SAR acquisitions (Figure R2).

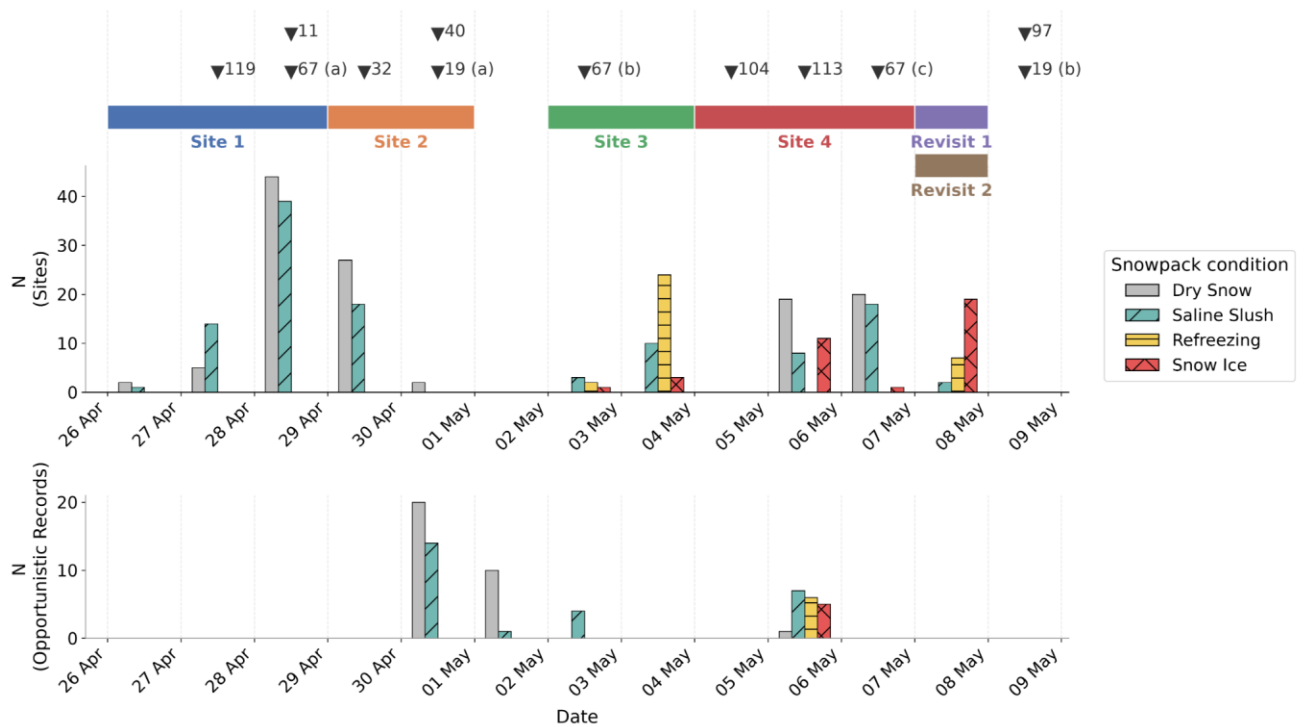


**Figure R2. Number of observations of each snowpack condition found at each site (top) and among opportunistic records (bottom). Triangles indicate the times of SAR acquisitions.**

## Abstract

- Line 17 – Consider rephrasing ‘Seawater flooding from negative freeboard onto sea ice’ as the phrasing is slightly unclear. Make it clear that flooding is the movement of seawater into the snowpack on top of sea ice / of the snow and ice interface, commonly due to negative freeboard.

We’ve rephrased the sentence starting as recommended, thank you.

- Line 19 – In what way do we know SAR is sensitive to saline slush?

Thank you for this comment. We have shortened and clarified the sentence to note that SAR is known to be sensitive to changes in dielectric properties, while noting that limited previous studies have reported diverse backscatter responses to flooding.

## Introduction

- Line 31 – more specifics on the physical properties could be included.

Thank you for pointing this out. We have revised the first sentence of the paragraph to include more details on the relevant physical properties.

- Line 34/35 - Flooded sea ice > this terminology is confusing suggesting the sea ice itself is flooded rather than the snow on top. I would use terms more commonly used in the literature such as ‘flooded snow’ or simply ‘flooding’ e.g. Ackley et al 2020.

We modified the terminology and corrected the sentence accordingly.

- Line 35 – ‘especially when the entire snowpack is not fully inundated’ this would be rare requiring a very thin snow cover or perhaps artificial flooding from geoengineered scenarios where the seawater is added from the surface. I would suggest rephrasing to be clear that it is challenging to detect visually, as it does not usually saturate / wick vertically throughout the entire snowpack, affecting mostly the basal layers.

Good point, thank you. The sentence was corrected to express that flooded snow is normally hidden beneath an unsaturated surface layer.

- Line 38 – Would suggest describing as seawater infiltration into the snow or seawater flooding of the ice surface (slightly confusing to use word infiltrating unless referring to what it infiltrates into).

Modified as suggested.

- Line 41 – would remove word overflow here.

Removed.

- Line 42 – perhaps adjust phrasing of brine channel networks ‘develop’, making clear they develop the sufficient connectedness (as the brine channels themselves already exist).

We modified the sentence by mentioning that “connectivity increases”, replacing “networks develop”.

- Line 44 – would explain what you mean by relevant, or introduce as other mechanisms leading to flooding (alternative to movement through brine channels).

We modified the sentence to clarify the role of lateral seawater movement as another mechanism leading to flooding.

- Line 45 – Similar to earlier notes ‘flooded ice’ > ‘flooded snow’ or ‘flooding’ or ‘surface flooding’ would likely be more intuitive and in line with other literature.

Terminology was modified.

- Line 55 – surface scattering at the snow surface or ice surface?

We modified the sentence to clarify that surface scattering originates from the slush surface (snow-slush interface).

- Line 60 –65 – can you explain this further. Was there a distinction made between non-flooded snow but that had some brine-wicking, and a flooded/slush snow, or are you discussing two flooding scenarios but just of different heights? How was the distinction

made – by wetness level? What do you mean by the brine-wetted snow surface? And here you refer to it having a ppt higher than that of deeper slush, it is slightly confusing if you mean here the 10-14cm slush or slush deeper in the same scenario (further down than the surface you refer to).

The authors in Jeffries et al., 1995 did not explain this well, but based on our interpretation, we believe they collected samples from flooded snow versus non-flooded snow with brine wicked up from the ice surface. They explicitly state: “At the flooded site, a 10–14-cm thick slush layer (salinity 23‰) was at the base of the 31–36-cm deep snow cover. At the other site, brine had wicked up from the ice surface into the 3.5–4.0-cm thick snow cover; the wetted snow had a mean salinity of 25‰, and liquid brine would have been present in the snow at the observed snow temperatures of –12° to –8°C.” (Jeffries et al., 1995). We revised the lines in question to make them as clear as possible based on the information available.

- It would be good to clarify if some of the references in this section also include melt percolation forming slush etc, or only flooding. Perhaps also make clear overall nearer the beginning of your article that slush in this text always means from flooding.

Thank you for pointing this out. Since our study specifically focuses on flooding caused by seawater infiltration into snow and not meltwater percolation, we reviewed information related specifically to this process, and the literature cited in our review refers exclusively to flooding driven by seawater infiltration. To clarify this further, we added a sentence acknowledging snowmelt as another potential source of flooding and clarified that it is not considered in this study. Additionally, we have added slush salinity measurements to the Methods section to show that the flooding was saline, consistent with seawater infiltration rather than snowmelt.

- Line 75 – TanDEM-X abbreviation not defined, and perhaps briefly explain this instrument.

The sentence was modified to specify the X-band frequency rather than the TanDEM-X instrument, as the frequency is the relevant information to highlight.

- Line 76 – consider rephrasing to be more concise.

Thank you, it is much more concise now.

- Line 81 – what is meant by snow water content here? Liquid water content within the snowpack? And why spring rather than all the time (as it may vary) or is this referring to melt specifically?

Thank you, we clarified that it is liquid water content in general.

- Nice few sentences referring to all the complexity in applying such methods to snow and sea ice.

Thank you! We are glad you found it interesting.

## Data and Methods

## 2.1

- Line 109 -115 – Discusses the period slush usually forms, nice to have supporting evidence of coincident snow load, but would the dates rule out non-saline slush from melt? Can you investigate any freeboard data from this time to support further?

Unfortunately, we do not have freeboard measurements. However, to provide additional supporting evidence, we prepared Figure R3, which shows cumulative snowfall by month. The figure shows increased snowfall in May, providing additional snow load during this period. This interpretation is also consistent with local knowledge of the area and was supported by co-author Iqqaqsaq, who indicated that slush formation is commonly observed during this period, and by the Ikirmiut Community Management Committee, whose maps identify ‘massak’ (saline slush) areas in spring. However, although less likely, slush can also form at other times of the season. We have therefore softened the wording to avoid implying that its formation is restricted to April-May. Figure R3 is provided for discussion in this response only and has not been added to the manuscript or Supplement. As mentioned above, we have also added the slush salinity measurements to the manuscript as additional evidence that the flooding was saline.

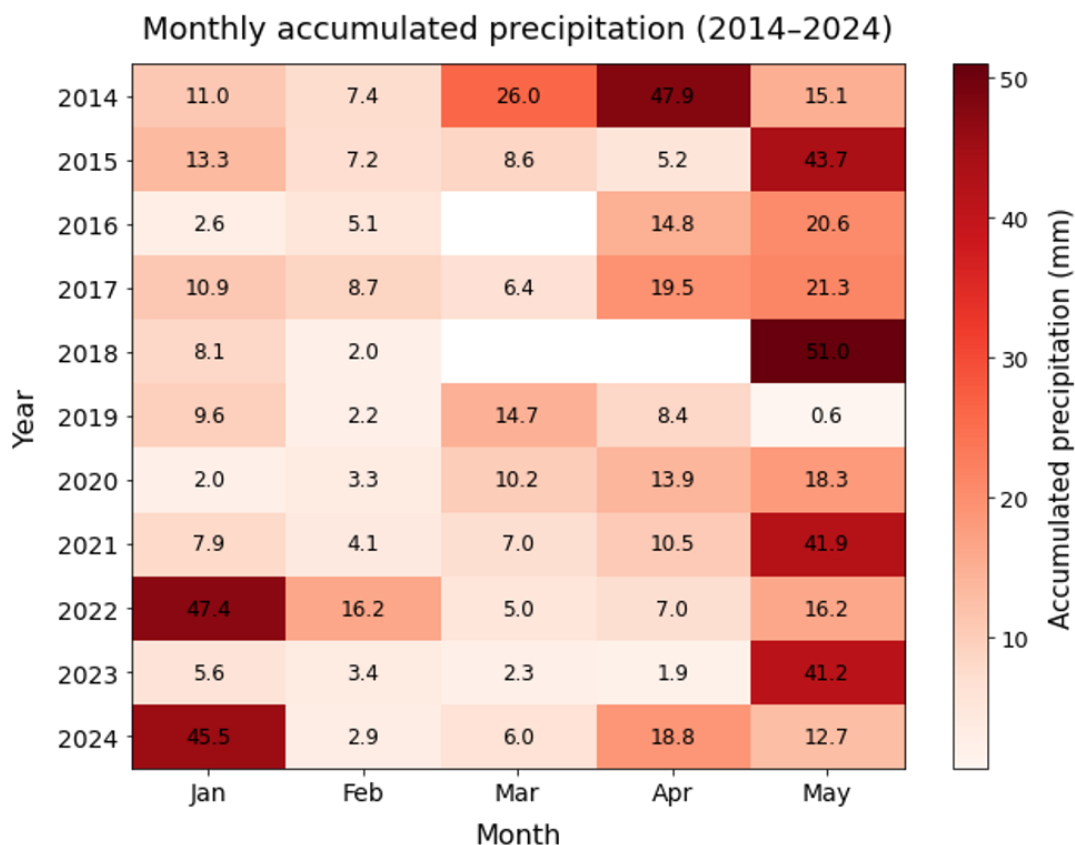


**Figure R3. Monthly accumulated precipitation at the Environment and Climate Change Canada (ECCC) station at Qikiqtarjuaq Airport.**

- Field sampling methods explained well, can you add if the snow pits were sampled along the transect and if the 2-3 was random or at certain distances?

We sampled snow pits along the transects, selecting locations to best characterize the conditions at each site rather than at fixed distances or randomly. At each site we prioritized a snow pit in a flooded area and, where possible, included pits for both flooded and non-flooded conditions. We

have incorporated a figure in the methodology section of the sampling plan at each site (Figure R4), where snow pits are marked with a black point outlined in white.

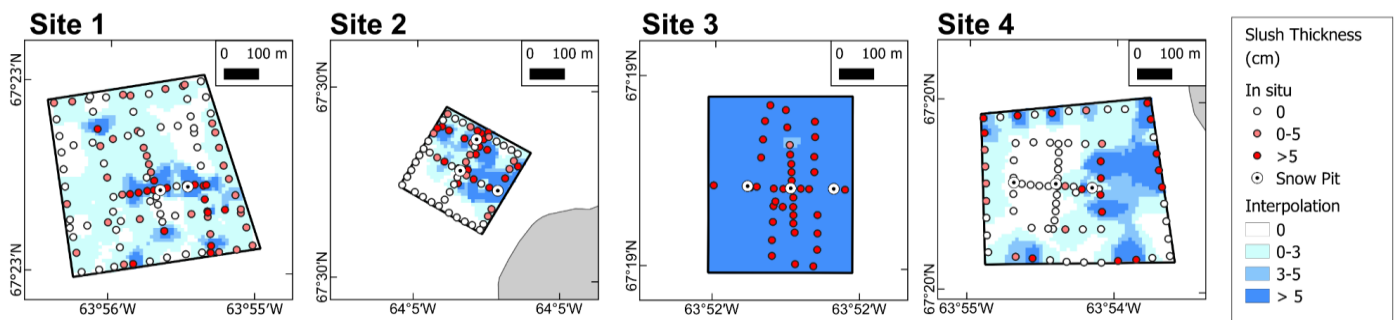


**Figure R4. Locations of samples collected at each site, with their corresponding slush thickness (points). The background represents the slush thickness interpolation (Section 2.6).**

- It may be nice to include an aerial diagram of your sampling plan, particularly to support the understanding of the additional gridded area. This could also be labelled to aid understanding the locations of flooding and no flooding found.

We have added an additional figure to the manuscript (Figure R4 here, and updated Figure 2 in the revised paper), illustrating the sample collection at each site, together with the interpolation used later, to clarify the flooding conditions and methodology.

- Figure 1 – can you clarify what timeframe picture c) is taken at, if it is the same pit as in picture b)? If so, was the slush was left exposed (without dry snow on top)? Or was the snow ice section dug out next to this? How was it characterised to be snow ice (hardness?)?

Picture (c) was taken at a different site (Site 3) and shows a different snow pit from the one shown in picture (b) (Site 1). The photograph was taken while the snow pit was being opened. We added this to the Figure 1 caption in the revised manuscript.

- Figure 2 – text and figures could be larger for visibility.

Thank you, we increased the font size throughout the figure and split it into two figures to improve readability. In the revised paper, Figure 2 now presents the daily average air temperature and snow depth from the ECCC weather station (original Figure 2a), together with Figure R4 here, while updated Figure 3 presents panels b, c, and d of the original Figure 2.

## 2.2

- Line 159 perhaps consider calling this refreezing / transition only (not yet snow ice) in the text and Figure 1, given it is extractable and therefore not at the hardness level of ice yet, and visibly still different compared to snow ice which is difficult to distinguish once refrozen.

We have modified the layer name, it is now referred to as ‘slush → snow ice’ in both the figure and the text, emphasizing its transitional nature (Figure R1).

- Clarify if the top-down refreezing was observed from open snow pits that were dug already, or from new snow pits dug out.

We observed top-down refreezing in newly excavated snow pits. The slush had already refrozen at the time of excavation. We clarified the text to make this distinction explicit.

- Line 167 – typo? Clearing and clear skies.

Thank you for pointing this out. We revised “clearing and clear skies” to “clear skies” to avoid redundancy.

- Line 171 – please elaborate what patchy means in this context.

We have incorporated correct terminology (spatial heterogeneity and homogeneity) and included a reference in the text to the new figure (Figure R4) for visual representation.

- Figure 3 – As well as showing proportions could do so in the layer order typically observed (may be misinterpreted that dry snow is shown at the bottom).

Good suggestion. We updated the figure to show the number of observations instead of proportions, to make the intended representation clearer (Figure R2, see earlier in the comments).

- Table 1 – Again, a suggestion here that referring to a refreezing or transition layer might be clearer than the ‘snow ice layer at the surface’. Additionally, while centimetres and measure being of thickness is noted in the caption, consider labelling more clearly on the LHS panel of the table.

Thank you for the suggestion. We added the thickness units directly to the LHS panel of Table 1 to clarify this information and removed the terminology from the caption, as it could be confusing. The terminology is clearly defined in the main text.

## 2.3

- SAOCOM – define abbreviation.

The definition of SAOCOM has been added.

- Line 186 – to clarify the post-flooding SAR imagery coincides / overlaps with exact dates the field work flooding sites were observed? Consider being more precise in sentence here.

This has been clarified in the text to specify that the t2 images were acquired during the fieldwork period, the moment where flooding was observed.

- Line 186 - Does multiple acquisitions at t2 mean that there was SAR imagery at multiple dates after flooding? It is slightly confusing to describe multiple acquisitions at one time point. The sentence may not be needed as the resulting two sentences are clearer, though perhaps explaining if the multiple acquisitions are relevant to two of the sites or to imagery at multiple dates of the same site, etc., could be useful.

The text has been revised to clarify that the multiple acquisitions correspond to different acquisition dates during the fieldwork period, rather than multiple acquisitions at a single time point. Additionally, we added a reference to Table 2 and to the new Figure R2, which lists the exact t2 dates of each orbit.

- ASTER GDEM – define abbreviation of GDEM.

The abbreviation GDEM has been defined.

- Some further detail could be added on why this geolocation method was more accurate, and why additional steps were applied for Sentinel-1.

We revised the text to clarify the geolocation accuracy and the Sentinel-1 preprocessing steps.

- In describing the specific missions we move to 2.4.1 (rather than 2.3.1), think this is an error?

We thank you for pointing this out. This was an error, and we have corrected it.

- Line 219 – Please more clearly say what was considerable.

We have clarified that the higher values referred to the noise contribution in the cross-polarization channels.

- How was noise for t1 and t2 combined to provide the combined value?

For each acquisition, we compared the backscatter values with the corresponding NESZ, and flagged each pixel as noise when its backscatter value was at or below the NESZ. We applied this procedure independently to the t1 and t2 acquisitions using their respective NESZ thresholds. We then considered the two acquisitions jointly at the pixel level, flagging a pixel as affected by noise if it was noisy in either t1 or t2. We then calculated the noise proportion as the fraction of valid pixel locations flagged as noisy in either acquisition (pixels extracted without duplication across the field sample locations). We used this assessment to characterize the proportion of pixels potentially affected by noise in the SAR data used to derive the change-detection SAR parameters (which use images t1 and t2 together). We have added an explanation of the noise floor in Section 2.4 of the revised manuscript.

## 2.4

- Line 233 – could you more clearly explain the texture and the parameters here? It is not very clear how the final part of the sentence provides the two final parameters. You later refer to it as the GLCM matrix, this could be more clearly explained.

We revised the sentence to more clearly describe how the two texture parameters were derived from the GLCM, specifying that GLCM variance was calculated separately for  $\sigma^0$  and LR. This clarification also provides clearer context for the detailed explanation of these parameters presented later in the manuscript. We additionally added a new sentence in the paragraph where GLCM Variance is described to explicitly explain what it is.

## 2.5

- Could you explain your exploratory analysis further and how this is done at site scale?

We added detail clarifying that the parameter values extracted at the field sampling locations were subsequently visualized and compared between the two classes as part of the exploratory analysis. To formally assess class separability at the site scale, these distributions were then tested using the two-sample Kolmogorov–Smirnov (KS) test, the results of which informed the subsequent feature selection step.

### Results

- Figure 5 – the data on the figures is quite small, especially given the scale of change in dB, in most instances this could be zoomed in further with a finer scale on the axis included. Label missing from X axis.

We agree. We have moved panels e–g to the Supplement, helping make the figure more readable without losing the relevant information from the manuscript. Regarding the X-axis label, each subfigure shares the same one. We have added an X label and changed the description in the figure caption to clarify that all X-axes are in date and time format (local time).

- Figure 6 – the data representation here is a little confusing, can the legend reflect the data more clearly? The legend might suggest a line should be on the plot rather than just a colour difference in the circle and triangular shapes. The filled shapes are not clearly related by the legend at all. The caption adds the context, but the figure should be much clearer independently.

Thank you for highlighting this. We agree that the legend was poorly defined. We have added a general legend to Figures 6 and 8 as follows:

| <b>Form</b>   |                     |
|---------------|---------------------|
| ○             | C-band              |
| △             | L-band              |
| <b>Color</b>  |                     |
| ■             | Non-Flooded         |
| ■             | Flooded             |
| <b>Filled</b> |                     |
| ■             | $t_2$ before 30 Apr |
| □             | $t_2$ after 30 Apr  |

- Figure 7 – x-axis label missing.

The X-axis label was added, and the figure was split into two, keeping panels a–d in one figure and the coherence panels e and h in another one (co-pol channels). Panels f and g, corresponding to the cross-pol coherence channels, were moved to the Supplement, as they provide limited additional information for the main analysis.

- Figure 8 – as per 6.

We have updated the legend as explained for Figure 6.

- Figure 9 – most of the text very small, label missing on gradient scale so unclear what this is referring to, and on x axes also.

We increased the font size and made the axis labels explicit. In addition, the colour scale in each panel has been labelled “D”, indicating the Kolmogorov–Smirnov statistic represented by the colour scale.

- Figure 10 – as the image areas are all the same, it is not clear to me which feature each image is showing – should we be interpreting as a specific feature in each image, or showing different dates, or something else?

We have added titles to the subplots to help clarify this.

- Line 467-469 first reference to polynyas in the text, if supporting this result can you include some literature in the introduction that links this?

Thank you for pointing this out. We have added the relevant reference and our rationale for considering polynyas in the Methods section.

## Discussion

- Line 502 – consider that, while capillary wicking might occur above flooded snow and increase the liquid water content and salinity higher in the snowpack, capillary wicking of brine does not necessarily have to have flooding as a precursor and therefore may impact the volume scattering in non-flooded snow areas (as per Mallett et al., 2024 and additionally Huang et al., 2025).

Thank you for highlighting this point. We agree and have added that capillary wicking of brine is not exclusive to flooded areas, with references included. We have clarified this point and emphasized that flooding introduces a new and abundant source of brine, which may drive a stronger wicking effect and likely result in a greater increase in volume scattering.

- Line 504 – why in C band specifically in non-flooded ones? If it is the sentence that follows consider rephrasing slightly for clarity.

Thank you for this comment. We have decided to revise part of the discussion in this section to provide a clearer interpretation of the observed C-band response. Specifically, we now explain that C-band's higher sensitivity to brine volume, combined with snow redistribution after the 20–24 April snowfall, could explain the reduced coherence in non-flooded areas, consistent with Yackel et al. (2026). We also acknowledge the limitation of the C-band dataset used in this study and the need for further study.

- Line 547, what ice core data? From this study or others?

Thank you for pointing this out. To clarify, this observation is based on field sampling of an ice core extracted as part of this study. We have revised the text to specify this.

## References

- Jeffries, M. O., Sek, C. T., & Morris, K. (1995). C-band radar backscatter from Antarctic first-year sea ice: I. In situ scatterometer measurements. *Antarctic Journal of the United States*, 30, 24-26.
- Morris, K., & Jeffries, M. (1995). C-band radar backscatter from antarctic first-year sea ice: II. ERS-1 SAR measurements. *Antarctic Journal of the United States*, 30, 26-28.
- Yackel, J., Geldsetzer, T., Yendamuri, K., Nandan, V., Tonboe, R., Stroeve, J., Saha, M., Mallett, R., & Lam, H. M. (2026). Observations of Coherence Changes in C-Band SAR Linked to Snow Thermodynamics and Wind Redistribution on First-Year Sea Ice. *Geophysical Research Letters*, 53(7), e2025GL121597. <https://doi.org/https://doi.org/10.1029/2025GL121597>