Reviewer 2

This study has addressed the role of snowpack stratigraphy on the percolation of water through the snowpack, with the specific goal of quantifying the impact of rain-on-snow events on stable water isotope signatures which are highly important as climate proxy records in ice cores. The study carries out a well-planned field campaign to simulate the impact of ROS close to Ny Ålesund in Svalbard, with results that I consider to be significant outside of the objectives of this study too. Specifically, while the experiments simulate a minor ROS event, the results reveal that variables related to the snowpack history plays an important role in determining ROS impacts on the cryosphere – and thus ecosystems that are dependent on snow and snowmelt. Furthermore, I believe that the results also highlight why some ROS events can be more impactful than others despite similar meteorological characteristics. It would be very interesting to see results from a follow-up experiment simulating a longer and/or more intense ROS event which percolates deeper into the snowpack. I consider the manuscript to be well-written and worthy of publishing with only minor changes.

- *Dear Reviewer, thanks a lot for your positive feedback on this study. In the following, we address the detailed suggestions made.*

Minor comments

Line 77-78: "Consequently, the seasonal snowpack covering 60–100% of Svalbard". Typically seasonal snow often refers to the non-glaciated part of Svalbard, which is ca. 40% since glaciers account for just under 60% of the total area. Perhaps consider amending this sentence to specify what you mean by seasonal snow.

- *Thanks for pointing out this lack of precision in language. The other reviewer had a similar comment, so that we updated the sentence as follows: "Consequently, the seasonal snowpack adding up to 40% to the ~60% spatial glacier coverage of Svalbard through the annual cycle (Gallet et al., 2019) is changing. "*

L255-257: "above-freezing temperatures were reached on at least three occasions (5th – 6th, 14th – 15th, and 25th – 26th February 2023) and two day-long warm spells caused near-melting conditions (21st –24th February and 1st – 2nd March 2023)."

Possibly I have misunderstood here, but were the two warm spells from 21-24th February and 1-2 March different to the occasions with "above-freezing" temperatures? Or could you just say that there were five occasions with warm/near-melting conditions?

- *This is a good question. The overarching goal when listing the warm spells of varying degree was to point out phases that could have already changed the pre-existing snow structure in the area before the experiments, enabling a good description of the pre-melt snowpack characteristics in the nivometric context.*

Thereby, we intended to nuance between:
(A) events when temperature definitely reached melting point (T > 0°C), and
(B) other events that were close but didn't reach the threshold yet (e.g. -3 °C < T < 0°C).

This seemed relevant, as we wanted to provide an overview of:
(A) time periods when the conditions were definitely favourable to the occurrence of melting and refreezing, and
(B) not dismiss potential changes of the snow microstructure (i.e. grain shape and size) that look like low-grade melting/wet snow already even when air temperature hasn't widely reached melting point yet.

As stated in Sect. 4.2 (line 360 and following), a detailed matching of melt-like horizons to specific meteorological events is beyond the scope of this study. Nevertheless, we wanted to be precise in our description of the conditions prior to the experiment campaign. To clarify the difference between the near-/melt events, we updated the sentence as follows:

"In the lead up to the fieldwork campaign during February 2023, air temperature reached values above freezing on at least three occasions (T > 0 °C: 5th – 6th, 14th – 15th, and 25th – 26th February 2023), and two sub-zero yet warm periods (-3 °C < T < 0 °C: 21st –24th February and 1st – 2nd March 2023) could have also enabled changes to the snow structure."

L395 onwards. The discussion of the MLRA results is interesting, in particular how difference in grain size at stratigraphic boundaries can constrain the vertical flow but it was not obvious to me whether there were cases used in the analysis where the tracer had percolated deep enough to reach ice layers from previous ROS events/warm spells, and if so how did it interact with the ice layers eg. Does the water pool and refreeze at existing ice layers (thereby thickening them) or do they melt out the ice layers?? I think it was already mentioned elsewhere in the literature that it can be challenging to disentangle the signatures of multiple ROS events in the snowpack and I think this is an important result too since the number of ice layers in the snowpack will not necessarily correlate with the number of ROS events.

- *We absolutely agree with your comments and that observations of melt–ice layer interactions are urgently needed in glacier hydrology research. Unfortunately, none of our experiment tracers reached pre-existing melt layers, so that we can't comment on their permeability and related behaviours here.*

  Regarding the other aspect of difficulties in disentangling multiple ROS events, we already briefly touch on it in Sect 4.3 to the degree that it is evident from our study simulating individual ROS events. "The spatial heterogeneities of melt

lenses and PFPs on a centimetre-to-decimetre scale and internal layering on a millimetre scale (Fig. 6) also demonstrate how challenging it is to structurally differentiate individual melt events or melt-intensive seasons in firn and ice cores (e.g., Alley and Anandakrishnan, 1995; Moser et al., 2024).“ We have added the reference to Alley and Anandakrishnan (1995) and Moser et al. (2024) to highlight that there is a wider literature context for this discussion and added one sentence to point out more clearly: “Moreover, the number of ice layers in the snowpack will not necessarily be equal to the number of ROS events that have occurred during the season (e.g., Pfeffer and Humphrey, 1998).”