Editor's comments:

C: After reviewing the latest round of feedback from referee #1, and examining the revisions made in this version, I share the concerns raised regarding the manuscript's scientific structure and the absence of a clearly articulated science question. Referee #1 has noted that the lack of a science question has led to a disconnection between the outcomes presented in the manuscript and the conclusions drawn which was not well addressed in the revised version. At this stage, restructuring the manuscript around a central science question, as emphasized in the reviewer's comments, would significantly improve the clarity, direction, and overall scientific contribution of your work.

R: We thank the editor for their continuous support. We appreciate the concerns raised by the reviewer and acknowledge the importance of a clearly articulated science question. In this latest version of the manuscript, we restructured the narrative of the introduction which now leads to two science questions (please refer to the reviewer's comments for a detailed description of the narrative and associated science questions). Furthermore, we reformulated the manuscript's conclusions in order to reflect answers to the central science questions enabled by the outcomes of our work (please refer to the reviewer's comments for a full list of outcomes and their corresponding reference in the conclusions text).

Reviewer's comments:

C1: A clearly articulated science question is the only way that readers can understand: 1) what question are the authors trying to answer? And 2) after the experiment, did the authors indeed answer the question? The science question is also essential to judge if the hypotheses are plausible, and often helps to support judgement if the methods and experimental design are appropriate. Importantly, the science question also enables judgement of the significance of the experiment/results. Because it is not defined what question is being asked, perhaps it is not surprising that the results/outcomes of the work do not clearly lead directly to conclusions. If it is not clear what question is being asked, how could we possibly know if it has been answered?

R1: We understand the reviewer's concerns and we have now reformulated the text in the introduction section.

We would like to summarise the structure of the introduction here (line numbers refer to the trackchanges document), highlighting in red areas where we think there is a gap in knowledge and in blue our proposed solution.

L79-L88: Deglaciation and the emergence of soils in the Arctic.

L89-L97: During winter, Arctic soils are experiencing the highest human induced climate warming. Evidence of soil respiration detected during winter and shoulder seasons emphasises Arctic soil vulnerability to a changing climate.

L98-L108: Soil moisture a driver for biological activity. As fieldwork is restricted to the summer period, there is a current gap in soil moisture data due to weather conditions. Also, as soil moisture availability is key for understanding pedogenesis, appraisal of sediments at different stages of development is required.

L109-L121: Emergence of year-round point sensor data. There is a need for 3D data in order to understand dynamic processes such as water infiltration.

L122-L134: Electrical Resistivity Tomography (ERT) method and its applications. ERT monitoring can fill the need for 3D appraisal of soil moisture processes. ERT monitoring technology, such as PRIME, can fill the need for year-round measurements of soil moisture in an Arctic setting.

L135-L142: Science questions.

L143-L155: Description of the manuscript content.

Based on such introductory narrative we formulated two scientific questions (SQs):

SQ1: Considering the need for year-round measurements of Arctic soil properties, and the vulnerability of Arctic soils during winter and shoulder seasons, (a) can geoelectrical sensor technology be used to continuously monitor the coupled heat and water movement (CHWM) in deglaciated sediments year-round? and (b) can we identify and quantify characteristics of CHWM profile in deglaciated sediments during vulnerable periods?

SQ2: (a) Considering the need to understand Arctic pedogenesis post deglaciation, can CHWM differences between sediments at different stages of development since deglaciation be identified? and (b) How do they express in relation to physical properties, location and topography, through processes of freeze-thaw transition and melt water infiltration?

C2: Addressing the lack of scientific structure would help to rectify the problem that the manuscript reads more like a report than a scientific article. My assessment is that the problem has not been corrected – restructuring around a scientific structure that includes a science question and discussion of how that science question has (or not) been answered would help substantially progress away from the 'report' feel that the text currently has.

R2: In order to rectify the lack of scientific structure we have compiled a list of outcomes (O) generated by our work:

1) site-specific Archies Law calibrations
2) soil moisture variations associated with rain-on-snow events
3) site- specific length of the zero-curtain effect
4) site-specific speed, direction, and magnitude of thawing front
5) classification of subsurface regions related to water storage variability
6) older deglaciated sediments experience a longer thaw
7) older deglaciated sediments are dominated by lateral thaw propagation driven by topography and snow
8) younger deglaciated sediments are dominated by vertical thaw

We have now reformulated the text in the conclusions section (L646-669 Track Changes manuscript) in order to reflect our answers to the scientific questions sat out in the introduction. Answers to the two scientific questions are enabled by our results and their interpretation (outcomes labelled when mentioned in text below). The conclusions now read:

"Geoelectrical instrumentation was successful in monitoring the CHWM processes at both sites (i-a). During the Arctic spring, we recorded elevated levels of soil moisture and temperature associated with an anomalous rain on snow event (O2, i-b). During the shoulder period between freeze and thaw, deglaciated sediments experienced the zero-curtain effect. The time the sediments spent around the 0 °C isotherm depends on the snow cover thickness, in this instance determined by the local topography and the site's position on the glacier forefield (O3, i-b). Finally, our ERT monitoring stations were successful in obtaining almost uninterrupted timelapse recordings, which revealed unprecedented 4D images of the Arctic soil freeze-thaw transition. Such records allow one to calculate the speed, direction, and magnitude of the thawing front (O4, i-b). Furthermore, unsupervised k-means clustering proved to be an effective method of classifying regions of the imaged sediment volume according to their electrical

resistivity coefficient of variance, indicating how local site conditions affect water storage variability. Some clusters identified are representative of areas of increased water content whereas others are representative of areas containing higher dense materials, potentially buried ice or rocks (O5, i-b).

Differences in CHWM profiles between sites (ii-a) are underpinned by site specific Archies law calibrations (O1, ii-a) and different thaw front velocities (O4, ii-a). We found that the CHWM profile change between sites is expressed (ii-b) through a different thaw propagation, with older sediments dominated by a longer (O6, ii-b) lateral thaw (O7, ii-b) driven by topography and snow, whereas younger sediments were dominated by vertical thaw (O8, ii-b). Clusters identified at different sites of a similar CV and spatial distribution exhibit a different gradient of average electrical resistivity values, which may again imply that older sediments are subjected to a more time distributed freeze-thaw transition, under conditions closer to thermodynamic equilibrium (O6, ii-b). “

We have further made improvements to the text throughout our discussion sections in order to frame it around the two scientific questions.