The authors thank Prof. Andrew Shepherd for his feedback and suggestions. Our detailed responses are given below.

(1) Title. I find the title to be quite confusing and uninformative; of course wind transport of snow affects radar (and indeed all) signals (sic) over sea ice as it alters the surface height if nothing else! I recommend formulating a title that informs the reader as to what has been found, and not something generic like this.

Although it is common knowledge that wind alters snow properties, the impact on Ka- and Ku-band radar signals of snow-covered sea ice in both altimetry and scatterometry modes are not well-understood and often neglected in satellite retrieval algorithms. Given our unique opportunity to investigate the influence of wind transport on in situ measured Ka and Ku-band backscatter we chose a title that succinctly summarises our investigation. The word "signature" is used since we investigate the effect on radar waveforms, backscatter, and phase difference. Thus, we disagree with the reviewer that the title is confusing. We however welcome suggestions from the community and will revisit the title when changes are made to the paper during revisions.

(2). Novelty. It seem from that the data that the authors have observed that increases in snow density (asscoiated with wind transport) lead to reduced volume scattering. This in of itself is not an especially novel conclusion, and so I am wondering whether it is reasonable to claim that this topic is poorly undestood as the authors state in the abstract.

We show evidence of snow densification and associated increase in snow surface density in the upper layers during the wind events (see Figure 4), and its effect on the radar waveforms and backscatter; an observation that has never been reported during wind events on sea ice. Additionally, we are not aware of any prior observational study into the effect of wind-driven snow redistribution to the contribution of Ka- and Ku-band volume scattering in radar waveforms (lines 80-100) over sea ice. In fact, a large majority of the literature reported in our study have assumed snow redistribution (due to lack of field data) to be a possible factor affecting SAR backscatter and airborne and satellite radar altimeter derived variability in snow depth on sea ice (e.g., Kurtz & Farrell, 2011; Yackel & Barber, 2007). Thus, we argue that this study addresses an important research gap.

Furthermore, for the first time, we combine high-resolution radar and TLS measurements to clearly show both newly deposited and buried snow layers on sea ice modify Ka- and Ku-band radar scattering surfaces (see Figures 6 to 8), backscatter (Figures 9 to 11) and phase difference (Figure 12). All these observations are critical towards accurately modelling radar waveforms and backscatter from radar scattering models such as SMRT. The observations also provide key information to improve retrievals of snow depth and sea ice thickness from satellite radar altimeters on board the AltiKa, CryoSat-2 and forthcoming CRISTAL missions. Therefore, we argue that our findings are novel, fill gaps in our present understanding and can help design future satellite mission algorithms.

(3) Terminology. I am confused by the use of the term "signatures"; what does this mean? It is implicit, not explicit. Do you mean the radar echoes, or some property of them (e.g. backscattered power., range, etc), or something else?

The term 'signatures' is a commonly used terminology in radar remote sensing for sea ice applications and encompasses different parameters such as waveforms, derived backscatter, and phase difference (used in this study. It has been used by our community since the earliest radar studies of sea ice (e.g., Rouse, 1969; Livingstone et al., 1987; Rodríguez-Morales et al., 2021). However, we concede that the term could be more explicitly defined in our manuscript, with reference to the parameters we have investigated. We will address this in the revised manuscript.

(4) Qualitative. As presently written the abstract is almost entirely qualitative, despite there being quite signfiicatn numerical analysis within the paper itself. I recommend using the abstract to summarise the main quantitative conlcusions, which should also support the qualitative conclusions drawn.

We have carefully constructed the abstract to describe what the salient results are. For example, we describe our main result that the KuKa radar was able to clearly detect buried and new snow layers due to wind events and how this resulted in a shift in the Ka- and Ku-band radar scattering surfaces, the increase in total backscatter and shift in phase difference signatures before, during and after both wind events. We cite relevant text from the abstract below

"At both frequencies, snow redistribution events increased the dominance of the air/snow interface at nadir as the dominant radar scattering surface, due to wind densifying the snow surface and uppermost layers and modifying the air/snow interface roughness. The radar waveform data also detect the presence of previous air/snow interfaces, buried beneath newly deposited snow. The additional scattering from previous air/snow interfaces could therefore affect the range retrieved from Ka- and Ku-band satellite radar altimeters."

We also argue that our results are novel due to the one-of-a-kind surface-based radar that mimics key characteristics of satellite radar altimeters. In addition, our results are novel, and they cannot be compared to other results because those directly comparable studies do not exist.

However, we will review the abstract again in the revision phase and refine the abstract in a way that is both qualitatively and quantitatively balanced, keeping the salient results in focus.

(5) Rigour. Despite collecting a robust and valubale dataset, the authors have stopped short and only report the signal they record rather than complete the analysis to assess the significance of their findings. This leaves the reader to specualte as to whether the findings are in any way important. How much wind is needed to impact on radar data? How are the radar data affected? Is the effect more or less important at Ka or Ku? How does this impact on the scattering horizon, range measurement? How might the effect scale to airborne and satellite measumrents? How typical are the required conditions across the Arctic? There is useful data here, but more work is required to make this a

useful contribution to the literature. I recommend that the authors explore the extent to which the changes impact on derived range measurements, for example.

The authors disagree with the reviewer's usage of 'rigour' as a review subheading and suggest that his comments under that subheading are more relevant to ideas of "impact" than "rigour". We would defend both the impact and rigour of our study.

We performed what we believe to be a rigorous analysis combining several in situ observations, starting from (1) how wind redistributes the snow (TLS – Figure 6) and alters snow properties (temperature, density, SSA from snow pits – Figures 3 and 4), (2) how these snowpack and surface roughness changes impact Ka- and Ku-band radar returns, including waveforms (Figures 7 and 8), total backscatter (Figures 9 and 10) and phase difference (Figures 11 and 12). Additionally, the discussion section has a comprehensive description of the significance of our findings with respect to (a) the wind induced snow volume property changes on radar scattering surfaces, backscatter, and phase difference; supported by TLS and CCTV observations, and (b) validity of our study with respect to scales (surface and satellite), and our focus on the process-scale understanding of how wind affects snow properties and radar returns.

The first wind event (WE1 @12 m/s) on 11 and 12 November 2019 immediately impacted the radar signatures as shown in waveforms and backscatter; and is explained in section 3.2 and discussed in section 4.1. Because this study investigated only two wind events, we are not able to deduce how much wind (i.e., wind speed threshold) is needed to impact radar data. This could be a topic of further investigation.

The authors are happy to agree with the reviewer that more context on how typical wind conditions/thresholds in the Arctic (across space and time) can affect satellite radar returns would be useful. We will add a statement on this in the revised version.

Lines 384-405 describe the wind's impact on Ka- and Ku-band frequencies, separately. We agree that this passage could be improved and will amend it in the revision phase.

With respect to the question on the effect on airborne and satellite measurements, we have mentioned several times in the manuscript that this study is focused on a 'process-scale' understanding of how wind affects the snow cover physical and electromagnetic properties and the impact of those changes on its radar backscatter signatures. For example, the discussion section 4.1 (lines 516-521 and 531-554) acknowledges that this study does not replicate airborne and satellite-scale conditions, but our frequency-, incidence angle- and polarization-dependent results demonstrate the potential of improved algorithms which account for snow redistribution over sea ice to accurately derive snow depth and sea ice thickness (lines 620-624). In the revision phase, we will discuss the practical implementation of our results into retrieval algorithms and evaluation as to whether the increase in computation expense is worth the expected increase in snow depth retrieval accuracy where wind redistribution of snow occurs.

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