General Comments

The authors of the manuscript describe the capability of backscatter retrieval using snow microstructure measurements as inputs in a radiative transfer model, SRTM. The paper presents a viable case for a dedicated spaceborne snow mission and explains how the backscatter measurements can be used to characterize snowpack properties. The paper combines methodologies used in previous studies for classification and optimization with novel snowpack measurement techniques to estimate background and snow volumetric backscatter.

The paper is well thought out and constructed, with appropriate references for each step. However, the section describing the radiative transfer model itself could be modified to include more information regarding the model. Some of the methods appear in the results section for the first time, which can confuse readers. Adding a flowchart showing the complete methodology could make it easier to follow.

The results are encouraging, with a low RMSE of 0.9 dB, especially for Ku Band. The paper demonstrates publication quality in terms of conceptualization and execution of the study, but a more detailed description of some of the methodology could be provided.

Line 12: can be “characterized”..

Line 13: I believe this result is important. A sensitivity analysis of soil background roughness on backscatter for different frequencies can be provided. This implies that for a particular snow regime, this value can be used as an initial guess with hard constraints to reduce the number of parameters and simplify the optimization studies done in the future.

Line 25-27: Perhaps it's a case of a misplaced comma, but the statement lacks parallel structure. The first part refers to coarse resolution SWE "products," whereas the second part refers to high spatial resolution "sources."

Line 32: Multiple studies demonstrate the viability of C-band for retrieving wet snow pixels. Perhaps a brief discussion could be added on how Ku-band improves our retrieval capabilities compared to our previous estimates.

Line 158: As SMP measurements are the basis of this study a small paragraph on the working principle of the instrument can be added.

Line 178: How is the stratification done using the combination of a categorical (Land Cover) and continuous variable (topography)?

Line 193: Word “ranging from” can be added for clarity.

Line 204: For improved clarity for those unfamiliar with the model, a concise overview of SMRT along with its input parameters can be provided.

Line 208: The constraints should be discussed along with references in a table for reproducibility.

Line 213 and Section 4.3: The actual effect of snowpack on the high frequency backscatter should be discussed. It is not clear how the effect of snow volume backscatter and ground backscatter were separated.

Line 269: It is a clever way to identify rounded grains and depth hoar layers. A brief description of SVM classification methodology can be provided in the methods section. Additionally, a brief description of the training datasets for grain type identification is important information for various kinds of studies.

Line 282: Why wasn't the mean square slope calculated directly using the Lidar point cloud?

Line 381: Figure no. should be mentioned in the bracket, even though it is mentioned in the starting of the section.

Line 399: Why a distributed, statistical approach is not preferable for SWE retrievals using satellite observations? The results in the reference are not based on scatterometer data.

Figure 2: The study area figures can be improved. The fonts in the legends are small and difficult to read. Maybe the figure

Figure 5: The histograms are slightly difficult to interpret in the overlapping areas. Therefore, if possible, the histograms can be replaced with lines for better interpretability.

Figure 8: I do not understand what is being shown in the figure. Does the dashed line represent the depths where the SMP measurements were made?

Figure 13: The legend can be provided outside the figure and scaled up for clarity.

.