

Reply to Referee 2:

This manuscript presents the analysis of snowpack properties using the observations from multi-frequency passive microwave remote sensing dataset and combination of physically based (mass and energy balance) snow model (SNTHERM) and radiative transfer model (HUT snow emission model). The content of the manuscript is of great importance in microwave remote sensing and snow modeling community. But, the manuscript is too unclear in its presentation. It is difficult to follow the manuscript. The manuscript should be revised to make it acceptable for publication in HESS. Suggestions are listed below.

We would like to thank you for very helpful comments contributed to the improvement of this paper. Please see detailed replies below to each of your suggestions and how we revised this manuscript based on your comments.

Comments/Suggestions

1. Objectives of this paper are not clear. Please clearly state in Introduction.
2. The major issue is the snow grain size and snow density observation. After multiple reading of manuscript, it seems that the snow grain size and density were measured for only one day (10 March 2011). Later, the simulated values of grain size and density (from SNTHERM model) were used to estimate brightness temperature through radiative transfer model (HUT snow emission model). This raises the question about the outcome of this paper; analysis of snowpack properties from microwave remote sensing? All the discussions about snowpack properties (except snowpack temperature) in chapter 4.1 and 4.2 would become purely subjective. Please clarify it clearly. I think this is the key issue of this paper.

We have revised the abstract, introduction and conclusion sections to clarify that the main scientific contribution of the work presented here is the season-length time series of multi-wavelength microwave observations of a snowpack through formation, aging, and melting, which is expected to be augmented in future work by the addition of more in situ snow property data.

We understand that not measuring the snow properties is a weakness of the current work, but this is being addressed in the next stage of the experiment. Meanwhile, the inferred evolution of the snow grain size is not purely subjective, as it is physically consistent with the meteorological and snow temperature and depth observations simulated with SNTHERM.

3. Please specify the dimension of microwave radiometer footprint.

The dimension of footprint is now specified in manuscript.

4. Give details of the 4 point calibration and non-linear transfer function

We have rephrased the sentence so that an association between the two is not implied.

10. Pate 8116, lines 9-10, "increased sensible heat flux of approximately 100 Wm^{-2} brought the snowpack temperature to above freezing level". This sentence is technically incorrect, as snowpack temperature cannot be above freezing level. Please clarify.

We corrected the sentence to say that the snowpack was warmed to the freezing point and melting was initiated.

11. Fig 6: a) Fresh snow (LD) and b) Fresh snow (HD), Please use full form; low depth and high depth for LD and HD

Yes, we revised the figure as per your suggestion.

12. Simulation of T_b – What is the purpose of simulation of T_b ? The authors want to say that the output of SNTHERM can be used for snow emission model in simulating T_b ? Please state clearly in introduction part and in chapter 4.3.

The simulations are intended as an initial check of the ability of current models to capture the main patterns seen, and that this function is served here even though some of the inputs were estimated rather than directly measured. We revised the introduction and chapter 4.3 (now 3.3) as per your suggestions.

13. Table 4 is unclear. Either the authors should provide the simulated and observed T_b in separate columns or the authors should provide bias between these two values.

We agree with you, it was redundant information. Table 4 is revised and we kept the bias only.

14. Page 8119, line 20. Figure 7 should be figure 8. Figure 8 is also too qualitative. Please show the time series of simulated and observed T_b for the entire period (3 phases as the authors discussed in chapter 4.1). Then we can have more insight in the causes of biases between the simulated and observed T_b .

We changed the Figure 8 to Figure 7 and added simulated snow grain size and density for entire period. Further, we simulated time series of T_b for the entire period and added as new figure, so readers get more insight into biases between the simulated and observed T_b .

15. There are a number of grammatical errors that, though minor, together detract from the quality of the manuscript. These need to be corrected before publication. I recommend asking a native English speaker to carefully edit for grammar.

We revised the manuscript with help of native speakers, and simplified various sentences and removed sentences which are convoluted.