RC1: 'Comment on tc-2023-112', Anonymous Referee #1, 15 Sep 2023

The authors present a very exciting and compelling experiment focused on the effect of wind snow surface microstructure. For how simple the question is, this is an incredibly hard problem to work on. We have limited tools at our disposal to make concise measurements of snow microstructure, and it is incredibly difficult to run such an experiment in the field. This group at SLF has succeeded at combining their expertise in snow microstructure and wind tunnel experiments to provide new insights into this intriguing aspect of snow metamorphism.

First thanks a lot for the appreciation of our study and the detailed review of the manuscript. We included basically all your suggestions which were clear and concise, and which helped to significantly improve the article!

My only concern with this research is the significantly unphysical conditions under which snow is being transported. As it stands, I do not see a reason why the rate of change of any snow characteristics in their experiment should be related to any measurements of natural snow undergoing natural transport.

Thank you for this important comment. The particle impact characteristics shown in Fig. 4 indicate a sufficiently developed, physical reproduction of a well-developed snow saltation layer similar to natural conditions in the straight sections of the ring wind tunnel (RWT). In the curved sections, impact forces are comparably small due to the relatively large radius and the fact that the particles are sliding along the wall instead of impacting as we discuss below.

The focus of our study is on linking atmospheric and aeolian snow transport processes to the snow microstructure of the ultimately deposited snow. While we show magnitudes of dependencies between different flow and snow parameters, processes and snow microstructures, natural conditions may be different in the field, depending on the snow type or flow conditions, while the latter is also rarely well developed and stationary for natural conditions. Our reparameterization of existing models aims at providing a connection between our lab results and field parameterization, while our results also show that new more process based parameterizations are required to better represent the effect of air temperature, wind speed or precipitation intensity.

It is unclear if the snow particles actually come in contact with the propeller driving their RWT. A schematic that shows this mechanism would be very helpful.

The propeller is located beneath the lid in the curved section of the ring wind tunnel (Fig. 1a) covering approximately the top quarter of the wind tunnel cross-section. The propellor blades are 90 mm long. As the particle mass flux exponentially decreases with height as shown by Yu et al. (2023) for our RWT, only a negligible part of the snow particles will get into contact with the propellor. A schematic drawing of the RWT and additional figures can be found in Yu et al. (2023) and will be referenced in the revised version.

More importantly, the authors acknowledge that a large portion of snow particles are transported along the outer wall due to centrifugal forces and, among other effects, this causes a measurable impact on density. This is well outside the realm of normal saltation and suspension. Given that v_x is so much larger than v_z, this impact force may be considerably higher than in nature. As well, repeat impacts caused by snow working its way around a corner may cause orders of magnitude more fragmentation.

In the curved sections, particles are mainly sliding along the RWT outer wall, an effect that is certainly not favourable for simulating natural snow transport but inevitable for a compact closed circuit wind tunnel in a cold laboratory of limited dimensions. The centrifugal forces acting on snow particles in the curved section were estimated being two to three orders of magnitude smaller compared to the forces acting on the snow particles during surface impact while saltating. The maximum impact angles of snow particles impacting into the curved outer wall were calculated being around 25°-30° which are comparable to the impact angles α_{in} *on the snow surface in the straight test section (Fig. 4b and d). However, a Stokes number < 0.1 indicates a good flow following behaviour of the snow particles when the air flow gets redirected in the curved section, resulting in actually much smaller impact angles. Based on these results, we conclude that both effects have a similar or smaller effect on particle fragmentation than particles impacting on the surface during saltation. We will add this discussion in the revised version in Section 3.2.*

Given these concerns, could you please address the question of transport around the curves (impact velocities, momentum balance, fragmentation rate, restitution coeff, how many more impacts per second? etc.), or modify the manuscript in such a way that the reader knows while you may have novel measurements of a physical process, this physical process has little relation to what one may expect to find in nature? As it stands, I think the quantitative information provided needs to be qualified or better justified.

Based on the above estimates on centrifugal forces and impact angles it can be assumed that particle fragmentation is dominated by the particle impacts in the saltation layer in the straight sections of the RWT, and that our results are, to a certain degree, comparable to real natural snow transport situations.

There are a few grammatical things that could be improved:

L8- Cover wind speeds? *We change this to: "vary wind speeds".*

L11-In the deposit? *We change this to: "in the deposited snow".*

L20- Is rolling different from creep? *No: we will call it "rolling or creeping"*

L29-Chemical species? *We change this to "Chemical substances".*

L60: Do you mean necessary or inevitable? *We change this to "necessary".*

L161: To make contact to previous studies? *We change this to: "To compare the quality of our particle transport phase to previous studies".*

Other comments

L53-54- At what height are these wind velocities? *We add here the height of 1 m.*

L76-77: Very cool Thanks.

L80-82: Do the particles not come in contact with the propeller? *Only a negligible number of particles gets into contact. The majority of the particles is transported close to the ground in the lowest 5-10 cm. Please also see our response to your previous comment above.*

Figure 2: How did you conclude the jump in RH was from snow particle sublimation? What's the RH of the cold room? *The relative humidity of the cold room varies depending on how often people enter and leave the room. In the morning, the RH is typically low at around 40% - 50%. Therefore, depending on the initial RH before an experiment, a mor or less strong jump in RH is obtained due to sublimation of the suspended particles (Dai and Huang, 2014).*

L258-259: Very cool *Thanks.*

L267-268: Again, how can you decouple this from the effect of particles smashing into walls that are necessarily there in nature? *As discussed above, the forces acting on the particles in the curved section due to centrifugal effects and while impacting on the side walls are estimated being similar at most or smaller than the forces they experience during saltation.*