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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impacts of moisture transport on drifting snow sublimation in the saltation layer" *by* N. Huang and X. Dai

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We'd like to thank Referee #2 for the insightful comments and positive evaluation of our work. We have studied comments carefully and will do our best to revise and improve our manuscript. The comments by the reviewer are repeated and the responds are as follows.

In this study the authors used a 2D model for studying snow sublimation in regards to its capacity to impact saltation layer evolution. For this aim they used a solid particle transport modeling combined with transport equations for potential temperature and specific humidity. The modeling mimics splash and take-off processes as usual. The two way coupling between sublimation and velocity is acted via a rough term inside longitudinal velocity field evolution equation. No four way coupling is introduced. The

paper described clearly how all processes are accounted for.

Reply: We thank the reviewer for the positive evaluation of our work. In this study, a wind-blown snow model that takes into consideration of the coupling effect between wind and snow particles is established to simulate the saltating process of snow particles. Then balance equations for heat and moisture of an atmospheric boundary layer, and an equation for the rate of mass loss of a single ice sphere due to sublimation were combined to study the sublimation rate of drifting snow by tracking each saltating particle in drifting snow. The splash functions for drifting snow used in this manuscript was proposed by Sugiura and Maeno (2000) based on their experiments, which is used to determine the number and motion state of the splashed particles as usual.

Some important points are the following:

The two way coupling has to be more deeply discussed as it is proposed: what are the hypothesis leading to this formulation?

Reply: Thanks. We will modify our manuscript to make our model clearer.

Furthermore even if variation of temperature are low it could be discussed if it could induced some effects on velocity field particularly where there is a large concentration of snow particles. It is relatively easy to add in such modeling these effects.

Reply: Thanks for the insightful comment. The reviewer is right. The variation of temperature could induce some effects on velocity field. However, we found that this effect can be ignored by testing (Fig. 1). In our study, the temperature varies between 261.5 K and 263.15 K. The variation of temperature due to snow sublimation is below 2 K, which is relatively low. From Figure 1 we can see that the effect of variation of temperature on velocity field is very small. Thus, we didn't take this effect into consideration.

Concerning the four way coupling and contrarily to sand it could probably modifies significantly the budget close to the ground. As writen by the authors such modeling is not time consuming in so it would be interesting to time increase the computational runs to observe if the various time evolutions of the shown quantities are stabilised.

Reply: Thanks. As we state in our manuscript, DSS has an inherent self-limiting nature due to the feedback associated with the heat and moisture budgets. On one hand, snow sublimation absorbs heat, which decreases the temperature of the ambient air and the saturation vapor pressure; on the other hand, it will induce the increment in the moisture content of the ambient air. Both of the above two points can increase the relative humidity of ambient air. It may lead to a saturated layer near the surface finally, and thus sublimation may vanish.

Concerning results it would be interesting to plot snow particles concentration profile evolutions.

Reply: Thanks. Following the reviewer's suggestion, we will add a figure to show snow particles concentration profile evolution in the revised manuscript.

I agree that it would be interesting to account for turbulence and to compare with experimental results.

Reply: Thanks for the insightful comment. We acknowledge the comment that some studies (Jasper F. Kok and Nilton O. Renno, 2009; Yaping Shao, 2010) did include the effects of turbulent in their saltation model and it was found that turbulent flow substantially affects the saltation movement of sand particles, mainly the movement of small particles. But the effect of turbulence on larger saltating particles is much less pronounced for their larger inertia and thus smaller susceptibility to fluid velocity perturbations. For example, Shao (2010) showed the effect of turbulence flow for 200 micrometers particles in a logarithmically-profiled airflow (u*=0.5m/s) is small. In our simulations, the diameter of the snow particles is 200 micrometers. Furthermore, this study concentrates on the time-averaged contributions of saltating snow particles to snow sublimation. Therefore we didn't take into consideration of the effect of turbulence in this manuscript. Perhaps we need to include turbulent effects in our future work. Just

like the reviewer and Prof. Yaping Shao, we also think that some measurements are necessary for validation of our simulation results. Unfortunately, the measurement of snowdrift sublimation in the saltation layer is very difficult to conduct at the present stage. Even so, we will try to conduct such measurements in our future studies.

could you check equation (14) (or may be I did a mistake but molecular weight of water have to be taken into account in the first term of the denominator) ? Some details concerning some threshold or constant as the one for take-off have to be given as they are crucial.

Reply: Thanks. Indeed, the first term of the denominator in the sublimation rate given by Thorpe and Mason is related to the molecular weight of water M (kg/mol), as well the universal gas constant R (J/mol/K). But in our study, the gas constant for water vapor Rv (=R/M) is defined with the value of 461.5 (J/kg/K). Following the reviewer's suggestions, we will describe these parameters in detail to make them clearly in the revised manuscript.

However the aim of this work is interesting and also the way to treat it.

Reply: Thanks for the positive evaluation of our work.

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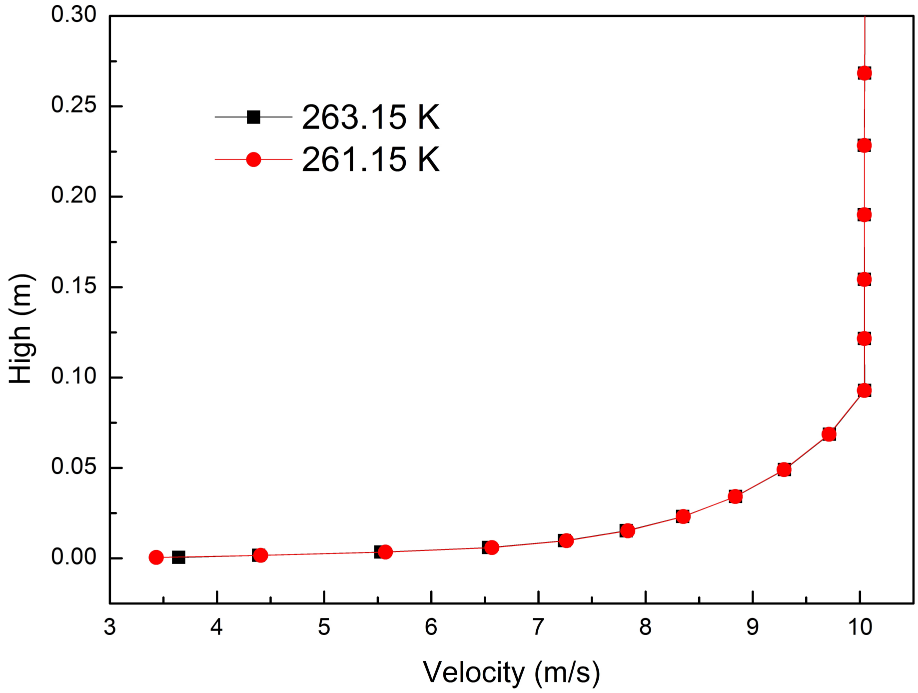

0.30
0.25
0.20
0.15
0.10
0.05
0.00
High (m)
263.15 K
261.15 K
3
4
5
6
7
8
9
10
Velocity (m/s)

Fig. 1.