Authors' Responses to the Comments on the Manuscript

"The role of a mid-air collision in drifting snow"

General Response to the Comments:

According to your comments, we have made a substantial revision to the original manuscript such that a clear description on the research is displayed in the revised manuscript (the directly changes can be seen in the revised manuscript with changes highlights). The detailed responses to comments of referees are as follows (see blue part in this reply):

Responses to Comments of Reviewer#2:

General comments:

[Comment 1] In this paper a process is proposed that should improve the simulation of the transport of blown snow particles. The paper is interesting but as it is submitted to TC, some terms must be defined. Also the role of atmospheric turbulence should be discussed, and not only implicitly linked to the friction velocity.

[Response 1] Thanks for your recommendation. The reported terms in the specified comments are defined or explained in the revised manuscript, see detailed responses below. At the same time, the effect of atmospheric turbulence on the structure of drifting snow is discussed. The description "At the same time, the thickness of the drifting snow layer with atmospheric turbulence is much larger than that without turbulence, which also increases with friction velocity. The reason could be that turbulent vortex brings particles to higher in the air when the local vertical wind speed exceeds the particle's terminal velocity, and turbulent intensity also increases with friction velocity." has been added in line 300-304 of the revised manuscript.

The points of criticism are discussed in more detail in the following:

[Comment 1] In the whole paper: "drifting snow" has different meanings in the

literature so that it must be defined. What is its difference with saltation and suspension?

[Response 1] Thanks for your this recommendations. According to your comment, the definition of drifting snow is added in the revised manuscript, the sentences "Drifting snow in the turbulent boundary layer contains both saltation particles that jumps towards downwind at the near surface and suspension particles higher in the air" have been added in line 35-36 of the revised manuscript.

[Comment 2] p.2, line 18 and p.15, line 261: "particle activity" should be defined.

[Response 2] Thanks for your comment. For a better understanding, the "particle activity" has been modified into "particle velocity" throughout the manuscript.

[Comment 3] p.3, line 44: a reason should be cited why the process is important.

[Response 3] Thanks for your careful reviews. According to the reviewer's suggestion, the description "Inter-particle collision within aeolian snow/sand cloud changes trajectories of saltating grains, and further affects the structures and transportation features of the particle flow. Numerous of investigations have shown that mid-air collision effect plays an non-neglected role in wind-blown sand movement (Carneiro et al., 2013;Dong et al., 2005;Huang et al., 2007;Li et al., 2013). However, this mechanism has been rarely investigated in a drifting snow transport with more suspended grains and smaller particle response time." has been added in line 37-43 of the revised manuscript.

[Comment 4] p.5, line 6: what is the meaning of Fdi ?

[Response 4] Thanks for this comment. F_{di} is the drag force F_D along the *i*-th direction. We have change 'F_{di}' into 'F_{Di}' in Eq. (6), and the sentence "F_{Di} is the drag force component along the *i*-th direction" has been added in line 95-96 of the revised manuscript.

[Comment 5] p.7, line 105: gamma is not defined and lambda is not used.

[Response 5] Thanks for your careful reviews. The expression "$\lambda = (1+e)/\left(d_A^3 + d_B^3\right)$" has been modified into "$\gamma = (1+e)/\left(d_A^3 + d_B^3\right)$" in the revised manuscript.

[Comment 6] p.7, line 119: the surface boundary conditions of the model should be specified.

[Response 6] The suggestion is implemented. The surface boundary conditions are specified in the revised manuscript. The sentence “The bottom boundary is a rigid wall, and the top boundary obeys a stress-free boundary condition.” has been added in line 144-145 of the revised manuscript.

[Comment 7] p.9, line 144: why “obviously”?

[Response 7] Thanks for your careful reviews. In order to make it more clearly, the word “obviously” has been deleted in the revised manuscript.

[Comment 8] p.9, line 149: “critical friction velocity” should be defined.

[Response 8] The suggestion is implemented. We have added the description “(the smallest friction velocity for a drifting snow)” in line 220-221 of the revised manuscript.

[Comment 9] p.9, lines 152-154: the slowing down of the airflow by the blown snow particles is not discussed.

[Response 9] Thanks for your careful reviews. According to the reviewer’s suggestion, the slowing down of the airflow by the blown snow particles is discussed in the revised manuscript. The sentences “At the same time, saltating particles reduce the wind at the near surface, however, mid-air collisions reduce the surface wind speed to a more smaller value, which also implies that the mass flux is enhanced by mid-air collision effect, detailed discussion can be seen in Sec. 4.2.” have been added in line 226-230 of the revised manuscript.

[Comment 10] p.10, line 168: the sentence “The reason could be ...” is not clear; what is the link between the particle activity and the friction velocity?

[Response 10] Thanks for your this recommendations. As a matter of fact, the particle activity indicates the mean particle momentum. In order to make it more clearly, the sentence “The reason could be that particles are more active with larger friction velocity” has been changed into “The reason could be that the mean particle

momentum increases with friction velocity” in the revised manuscript, as shown in line 245-246.

Finally, once again we appreciate you for your good and comprehensive comments. Those revisions according to your comments really make this manuscript improve a lot.

Thank you!

Yours sincerely,

Shuming Jia, Zhengshi Wang, Shumin Li