DYNAMICS OF BLOWN-SNOW PARTICLES DEPENDING ON THE DIAMETER

H. Niiya[1] & K. Nishimura[1]

[1]*Graduate School of Environmental Studies, Nagoya University, Nagoya, 464-8601, Japan*

Key words Drifting snow, Numerical modeling, Suspension and Saltation, Splash process.

Splash process is the collision between a blown particle and deposited particles, and it is an important physical sub-process to characterize entrainments and dynamics of particle in aeolian transports such as blowing snows. However, it is difficult to analyze splash processes individually in the nature transport because the number of blown particles increases near the surface. As one of remarkable studies, Sugiura et al. [1] measured distribution functions for each splash in wind tunnel experiments with snow particles, which were carried out at low wind speeds. So far, we conduct numerical simulations of blowing snow by application these functions to higher wind speeds. Numerical results find some problems; the fine particle can hardly move to upper layer and the coarse particle mainly hop below 4cm. In this study, we modify the splash process of numerical model based on single splash experiments by Ammi et al. [2] to overcome problems in higher wind conditions, and we clearly study the blown particle dynamics depending on the diameter in the monodisperse system.

Our model is improved the random-flight model of blowing snow [3]. Key changes in the model are three: addition of fluid viscous stress, three-dimensional particle motion, and change of splash process. Distribution functions for the splash process are expressed using results of single splash experiments [2], in which dynamics of particles are divided into rebound and splash (i.e., new ejected particle). For the number of splashed particles, fitting parameters in the function are determined by the comparison with experiments [1] to address the snow particle.

In the setup of numerical simulations, particles are entrained from the snow surface with a constant roughness length, and the diameter d is assumed to be a constant. The domain size is a cuboid depending on d: $60d$ length, $30d$ width, and 1m height. The vertical profile of wind speed is formed by the friction velocity u_t^* fixed at the top, whereas the lateral boundary condition for particles is set as the periodic boundary. Also, only two values (d and u_t^*) are independently varied in simulations.

Figure 1 shows particles located near the surface at $t = 1$s, and blown particles are entrained by wind and splash. Each numerical simulation is carried out until the particle transport reaches the equilibrium state. As a result, the total mass flux Q below 1m drastically changes depending on the diameter (Fig. 2). (i) $d = 10\mu$m: Q is consistently maximized because particles are suspended up to the top. (ii) $d = 30\mu$m: the height of suspension increases with increase in u_t^*. (iii) $d = 60, 100\mu$m: the range of particle motion hardly expands despite the increase in u_t^*, thus the increasing rate of Q is low. (iv) $d = 300, 600\mu$m, 1mm: the increase in u_t^* activates the saltation, and the height of saltation exceeds 10cm at $u_t^* = 0.6$m/s.

In the talk, we focus on the splash process of model to clarify the difference in above particle dynamics.
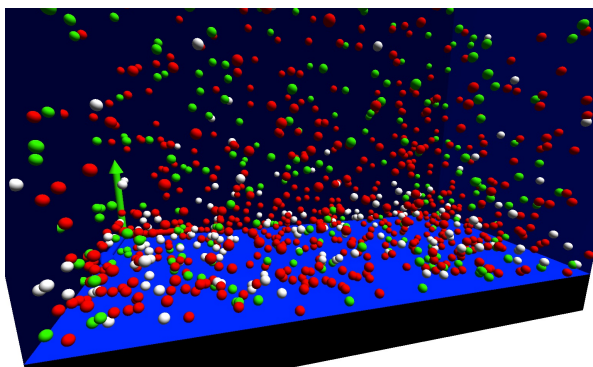
Figure 1. Simulation image at $t = 1$s. (green: entrainment due to wind, white: splash, red: rebound)
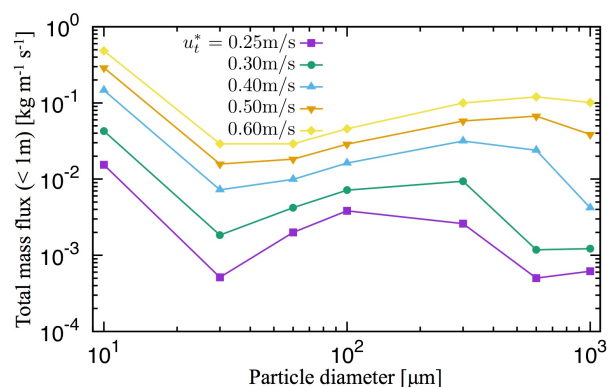
Figure 2. Diameter dependency of total mass flux at equilibrium state. Line colors indicate different top friction velocities.

References

[1] K. Sugiura and N. Maeno, *Wind-tunnel measurements of restitution coefficients and ejection number of snow particles in drifting snow: determination of splash functions*, Boundary-Layer Meteorol **95**, 123 (2000).

[2] M. Ammi, L. Oger, D. Beladjine, and A. Valance, *Three-dimensional analysis of the collision process of a bead on a granular packing*, Phys. Rev. E **79**, 021305 (2009).

[3] M. Nemoto and K. Nishimura, *Numerical simulation of snow saltation and suspension in a turbulent boundary layer*, J. Geophys. Res. **109**, D18206 (2004).