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Development of continuum snow avalanche model

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Nearly six decades of observational and experimental studies reveal that a well-developed dry snow avalanche typically consists of three layers. Those include 1) the dense-flow layer, which can be found at the lower part of the flow. This layer has typical thickness and density of up to ~3m and ~300 kgm-3, respectively; 2) the saltation layer, which lies between the other two layers and has typical thickness and density of a few meters and ~30 kgm-3, respectively; and 3) the suspension layer, which consists of the top layer of the flow and has a typical density of less than 10 kgm-3. Although many works clearly indicate the existence of these three layers, separating into all of these three layers is not necessary happen anywhere: observations of the avalanche deposits, especially their layering, suggest that the saltation and suspension layer may eventually move ahead of the dense flow layer, which has been confirmed by the pressure measurements at the avalanche observation sites. This indicates that the interaction between each layer may involve significant complexities and heterogeneities depending on the location, the event, and other parameters. Therefore, for a precise prediction of the dynamics of snow avalanche, it would be necessary to understand all of the complex natures related to its movement including the relative interactions between all layers. However, from the hazard-prevention point of view, there is an immense requirement to reasonably simulate the movement of snow avalanche in a realistic way. Therefore, in this work, we focus on dense layer, which likely plays the most significant role in the dynamics of the snow avalanche compared with other two layers.

Resistant effects of snow avalanche are basal friction, and friction, collision, rotation, cohesion, and destruction between particles. Numbers of studies discuss about such resistances, however there is no general model which can apply all resistances to any snow avalanche.

We developed a system composed by not only laboratory experiments but also numerical simulations for investigating the practical internal friction. In this system, we perform laboratory experiments using natural snow particles and run numerical simulations with granular flow model which uses Coulomb type friction low. Then we analyze the morphologic patterns by comparing those of laboratory experiments and numerical simulations.