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Extended kinetic theory applied to snow avalanches

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In this work we apply the extended kinetic theory, a three-dimensional rheological model for rapid granular flows, to the two-dimensional, depth-averaged shallow water framework, used in snow avalanche simulations.

Usually, empirical relations are used to determine the basal friction, which represents the material behavior in the avalanche. Here we present an energy equivalent basal friction relation which accounts for energy dissipating processes in the avalanche body as predicted by the extended kinetic theory.

The obtained relation is compared to traditional basal friction relations, e.g. the Voellmy model by conducting numerical simulations with both approaches. As reference, field measurements of runout, affected area and velocity are compared to the simulation results. Two avalanche events, that occurred at the Vallée de la Sionne and Ryggfonn test sites, are evaluated with this method.

It is shown that the kinetic theory delivers a physically based explanation for the structure of phenomenological friction relations. However, the new form of the frictional terms explicitly takes the flow depth into account. As consequence, improvements in finding unified parameter sets for various observation variables and events of different sizes could be achieved.