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A modified Voellmy rheology for modeling rapid mass movements

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Voellmy's rheology was originally developed for snow avalanches in the 1950s. However, it has also been applied to rock avalanches, debris flows, and pyroclastic flows. In its original form, Voellmy's rheology assumes that the effective friction is the sum of Coulomb friction and a velocity-dependent term. While the Coulomb friction term is necessary for letting avalanches stop after a finite time, it causes problems with regard to the long runout of huge rock avalanches. This long runout requires Coulomb friction coefficients much lower than typically assumed for granular media, which finally result in unrealistically smooth morphologies of the deposits. In this presentation, numerical simulations with a recently published modified version of Voellmy's rheology are shown and compared to the conventional version. The modified version assumes two distinct regimes of Coulomb friction and velocity-dependent friction with a transition at a critical velocity derived from the concept of random kinetic energy. The modified rheology explains the long runout of huge rock avalanches without assuming an artificially low Coulomb friction coefficient. Furthermore, it produces hummocky deposit morphologies even with isolated hills similar to toma hills. The question whether the modified rheology is also useful for snow avalanches, debris flows or pyroclastic flows will be subject of future studies.

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