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Linking snow avalanche path characteristics and simulation parameters

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In this work an objective optimization algorithm is utilized to determine adjusted parameter distributions for avalanche simulation in 3d terrain. Multiple documented extreme avalanche events are investigated to emphasize similarities and differences between adjusted parameter distributions and the corresponding event.

A probabilistic simulation setup, using a depth averaged flow model with a simple entrainment and the Voellmy friction law implemented in the SamosAT simulation software, is used to randomly vary the two friction (Coulomb friction, turbulent drag) and one entrainment parameter in their entire physically relevant range.

The simulation results (peak pressures and flow depths) are analyzed in 3d terrain, performing a transformation in an avalanche path dependent coordinate system. The model parameters for entrainment and the Voellmy friction relation are systematically optimized, back calculating each documented event by introducing different optimization variables (runout, matched and exceeded affected area, maximum velocity, mass growth, etc.) and maximizing the degree of simulation-observation correspondence. This trial and error approach leads to distributions representing the optimal parameter settings.

Different avalanche paths are characterized, distinguishing between avalanche size, total fall height, path shape and others. Statistical dependencies between those path characteristics and the optimal parameters are highlighted. We show that investigating dependencies between optimal parameter distributions and path characteristics is indispensable, when a systematic framework for simulation optimization is applied.