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Three-dimensional modeling and numerical simulations of avalanches over a real mountain topography

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For real three-dimensional numerical simulations of avalanches over mountain topography, we have developed a new preprocessor that generates the mesh and sets the initial conditions. In our approach, first we select the region of interest on which the preprocessor creates a colored overlay with possible starting positions, then we choose the initial sliding zone. Afterwards, the preprocessor creates an unstructured triangulated surface. Together with an initial hexahedral mesh, the utility, called the snappyHexMesh in the OpenFOAM software package [1], creates the final mesh. Our second reprocessing utility sets the initial conditions needed by the numerical solver for the avalanche flow simulation.

In the next step, we calculate the flow dynamics with our numerical solver, which is based on interFoam [1]. Different rheological models and parameters can be chosen in this solver. We implement, for the first time, the Coulomb-type internal friction rheology with a Coulomb sliding law at the base in connection to the continuum dynamical model equations for the mass and momentum balances. We show good comparisons between our numerical solutions and published results of small scale laboratory experiments. We also present some preliminary results for avalanche flows down real mountain slopes. When calibrated with field measurements, our numerical simulations (based on the full three-dimensional flow dynamics) can provide a deeper understanding of the dynamics of real avalanches, with applications to proper hazard mapping and improved risk management.

[1] http://www.openfoam.org/