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Testing different concepts of the equations of motion, describing runout time and distance of slow-moving gravitational slides and flows.

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The kinematics of rapid and slow moving landslides is commonly described by equations of motion, which in case of a viscous component are based on the Navier-Stokes equation. They consist of inertial terms related to the change in velocity in time (local acceleration) and space (convective acceleration) and terms related to respectively the gravity, pressure and viscous forces. These viscous resistance forces in the mass balance can be accompanied or replaced by other rheological (frictional and cohesive) terms depending on the liquid/solid ratio of the moving mass.
We designed a 1D and a GIS based 2.5 D model with a numerical implementation for these equations which gave a reasonable simple compromise solution that achieved a desired level of stability, accuracy and controlled diffusion. An explicit finite difference (Eulerian) mesh, i.e. the moving mass was described by variation in the conservative variables at point fixed coordinates (i,j) as a function of time (n). A central difference forward scheme is used for the numerical solutions of the mass and momentum balance equations. A number of case studies of fast debris flows ranging in velocity between 1 and 10 m s-1, carried out in the Faucon torrent French Alps, the Wartschenbach torrent in Austria, near the Turnoff Creek in British Columbia, the Peringalam catchment in SW-India and the Jagüeyes landslide in the Guantánamo province Cuba, showed that the models were able to describe velocity, deposition and run-out reasonable well using different rheological characteristics.
Despite the fact that many authors include an inertial term in the equation of motion for slow moving mass movements it appeared that our 1D and GIS based 2.5 D models were not able to simulate properly the velocity of slower moving debris flows or landslides with velocities ranging from 1 to 2 m min-1 until 30 mm y-1.Deletion of the inertial term related to the local acceleration in the equation of motion, thus assuming that there is a permanent equilibrium between gravity, pressure and Coulomb-viscous forces, produced a more flexible tool, able to describe the velocity, deposition and run-out of mass movements with a wide range of values. Examples of successful simulations in 1-D and 2.5-D exist already. In this contribution we will compare 1D simulations with and without a local acceleration term and analyze the results. A slow moving debris flow which developed on the Super-Sauze mudslide and a slow moving landslide in varved clays near Monestier-du-Percy in the French Alps were selected to test the calibration performances of these two options in the equation of motion.