Geophysical Research Abstracts
Vol. 19, EGU2017-14806, 2017
EGU General Assembly 2017

A depth integrated model for dry geophysical granular flows

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Granular flows are rapid to very rapid flows, made up of dry sediment (rock and snow avalanches) or mixture of water and sediment (debris flows). They are among the most dangerous and destructive natural phenomena and the definition of run-out scenarios for risk assessment has received wide interest in the last decades. Nowadays there are many urbanized mountain areas affected by these phenomena, which cause several properties damages and loss of lives.
The numerical simulation is a fundamental step to analyze these phenomena and define the runout scenarios. For this reason, a depth-integrated model is developed to analyze the case of dry granular flows, representative of snow avalanches or rock avalanches. The model consists of a two-phase mathematical description of the flow motion: it is similar to the solid transport equations but substantially different since there is no water in this case.
A set of partial differential equations is obtained and written in the form of a hyperbolic system. The numerical solution is computed through a path-conservative SPH (Smoothed Particles Hydrodynamics) scheme, in the two dimensional case.
Appropriate closure relations are necessary, with respect to the concentration C and the shear stress at the bed $\tau 0$. In first approximation, it is possible to derive a formulation for the two closure relations from appropriate rheological models (Bagnold theory and dense gas analogy).
The model parameters are determined by means of laboratory tests on dry granular material and the effectiveness of the closure relation verified through a comparison with the experimental results.
In particular, the experimental investigation aims to reproduce two case of study for dry granular material: the dam-break test problem and the stationary motion with changes in planimetry. The experiments are carried out in the Hydraulic Laboratory of the University of Trento, by means of channels with variable slope and variable shape. The mathematical model will be tested by comparing the numerical results with the experimental data.