Tuning of physical coefficients for overall fitting in Saint-Venant flows

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Abstract

The mechanical behaviour of dense flows of granular (visco-plastic) material is important for modelling geophysical phenomena such as rockfalls and rock or debris avalanches. These flows are mostly simulated using two-dimensional, depth-averaged Saint-Venant models to reduce the high computational costs of describing real flows. Predicting natural avalanches and debris flows is difficult due to the complicated mountain topographies associated with them.

Laboratory tests are very important for finding the coefficients of the mechanical model, such as viscosity, internal friction coefficient and cohesion. These coefficients are the input data for the whole model, including the depth-averaged mechanical model and its numerical approach. Furthermore, the results obtained at a laboratory scale are often assumed to be valid at a large geophysical scale. However, the predictions of 'untuned' models (i.e. those with mechanical parameters found at the laboratory scale) are not close enough to geophysical observations. Furthermore, the main assumptions of the averaged model (e.g. geometric description, shallow flow, small tangential stress and small normal velocities) are not satisfied for complex flows. This is why the overall model has to be tuned to fit the data.

In this presentation, we demonstrate that tuning the physical parameters enables the overall integrated model to accurately describe experiments and geophysical phenomena. To achieve this, we carried out two types of experiment (two-dimensional and three-dimensional) on non-planar bottom surfaces using three types of material: water, liquid soap, and dry sand. These materials were chosen to cover a wide range of shallow geophysical flows.