Submarine granular flows and generated tsunami waves : from laboratories experiments to simulation of Montagne Pelée flank collapses

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We simulate here granular flow experiments and the generated water waves as well as scenarios of different volumes for possible event of flank collapse of Montagne Pelée volcano, Martinique, Lesser Antilles. Our objectives are to assess the error made using numerical modeling when trying to reproduce granular flow dynamics and its deposits as well as the amplitude of the associated wave. For the laboratory experiments we try to assess the error without calibrating the models for each experiment and using the parameters suggested in the literature for the used material. Numerical simulations are performed using two complementary depth-averaged thin-layer continuum models because no complete models were available in the literature. The first model, SHALTOP, accurately describes dry granular flows over a 3D topography and may be easily extended to describe submarine avalanches. The second model, HYSEA, describes the subaerial and submarine parts of the avalanche as well as its interaction with the water column. However, HYSEA less accurately describes the thin-layer approximation on the 3D topography. Simulations were undertaken testing a single friction law, fixed friction angles, different debris avalanche volume flows and scenarios. Our study suggests that using the two models we are able to assess the shape and runout distance of the laboratory granular flows with error ranging from 1 % to 44 % depending of the scenario, and the amplitude of the generated waves with error ranging from 25 % to 100 %. We study also show that using a non-dispersive shallow water models for those type of events may lead to important overestimation of the generated waves amplitude. Comparison of simulations with submarine field data support the hypothesis that large flank collapse events in Montagne Pelée are likely to have occurred in several successive sub-events. This result has a strong impact on the amplitude of the generated waves, and thus on the associated risk, in a region known for its seismic and volcanic risks.

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