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Performance and limits of a shallow model for landslide generated tsunamis: from lab experiments to simulations of flank collapses at La Montagne Pelée (Martinique)

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We investigate the dynamics and deposits of granular flows and the amplitude of the generated water waves using the depth-averaged shallow numerical model HySEA, both at the lab- and field scales. We investigate the different sources of errors by quantitatively comparing the simulations with (i) six new laboratory experiments of granular collapses in different conditions (dry, immersed, dry flow entering water) and slope angles, and (ii) numerical simulations made with the code SHALTOP that describes topography effects better than most landslide-tsunami models. In the laboratory configurations, at the limit of the shallow-approximation in such models, we show that topography and non-hydrostatic effects are crucial. However, when empirically accounting for topography effects by artificially increasing the friction coefficient and performing non-hydrostatic simulations, the model is able to reproduce the granular mass deposit and the waves recorded at gauges located at a distance of more than 2-3 times the characteristic dimension of the slide, with an error ranging from 1 % to 25 % depending on the scenario, without any further calibration. Taking into account this error estimation, we simulate landslides that occurred on Montagne Pelée volcano, Martinique, Petites Antilles as well as the generated waves. Results support the hypothesis that large flank collapse events in Montagne Pelée likely occurred in several successive sub-events. This result has a strong impact on the amplitude of the generated waves, and thus on the associated hazards. In the context of the on-going seismic volcanic unrest at Montagne Pelée volcano, we calculate the debris avalanche and associated tsunami for two potential flank-collapse scenarios.