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Landslides and tsunami generation in large-scale flume experiments and numerical particle-following simulations

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Tsunamis generated by highly mobile slides in large-scale flume experiments are simulated with a numerical model called the Particle Finite Element Method (PFEM). The numerical technique combines a Lagrangian finite element solution with an efficient remeshing algorithm, and is capable of accurately tracking the evolving fluid free-surface and velocity distribution in highly unsteady flows. The slide material is water, which represents an avalanche or debris flow with high mobility, and the reservoir depth is varied, thereby achieving a range of different near-field wave conditions from breaking waves to near-solitary waves. Experimental observations of fluid velocity and water surface levels are obtained using high-speed digital cameras, acoustic sensors and capacitance wave probes, and the data are used to analyze the accuracy of the PFEM predictions. The numerical model shows the capability of holistically reproducing the entire problem from landslide motion, to impact with water, to wave generation and propagation. Very good agreement with the experimental observations are obtained, in terms of landslide velocity and thickness, wave time series, maximum wave amplitude, wave speed and wave shape. The results demonstrate the potential of this numerical method for simulating mass flows, impacts with water, and the tsunamis generation process.