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Two and three-dimensional hybrid modeling of landslide-generated tsunamis

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On 10 July 1958, an earthquake of M_w 8.3 on the Fairweather Fault on Alaskaś south coast triggered a rockslide that impacted the Lituya Bay. The generated tsunami waves produced the largest run up measured at 524 m on a spur ridge in direct prolongation of the slide axis. At the time, the tsunami eroded forest and soil to the bed rock; even half a century later the effects of the tsunami is still visible in satellite imagery.

In a two-dimensional setup of the Froude-similarity scaled experiments, Fritz et al. (2001) reproduced the runup and also generated important data sets for validating computer models. These experiments were the first to use a granular material to account for deformation of the slide body as it moves down the slope, impacts into the water, and continues to interact with the water in the early stages of tsunami wave generation. These experiments revealed fundamental differences to experiments with the often used solid wedge. Recently, these experiments were extended to the full three-dimensional domain in the NEES tsunami wave basin at Oregon State University (Fritz et al., 2009).

Over the last decade, computer models have been presented that adequately model the tsunami generation by solid wedges, based upon shallow-water equations with a source term to account for linear-bottom deformation. Freely deformable slides may not be treated in such models due to different material rheologies of the slide masses and the water. We report on the success of using the multi-material hydrocode iSALE to reproduce Fritz et alś Lituya Bay experiments. We found an excellent fit of a wave-gauge recored in 885 m distance from the impact site between experimental and modeled data. Furthermore, we extend this to comparisons of velocity fields (total, vertical and horizontal components). Since the three-dimensional hydrocode simulations are computationally very expensive, we present tentative comparisons of results from the modeling and the experiments as an outlook.

In the context of high-resolution bathymetric and recently gathered data from continental slopes reveals the long history of landslides, of which some had the caliber to produce significant tsunami waves. Computer models, such as iSALE when carefully validated, play an important role in untangling which of the landslides generated significant tsunamis and equip us with a tool to study the hazards that future slope failures and landslide-generated tsunamis might pose to the worldś coastal megalopolises.