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How long does it take to generate tsunami waves by submarine landslides?

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Earthquake and submarine mass failure are the most frequent causes of tsunami waves. While the process of the tsunami generation by earthquakes is reasonably well understood, the generation of tsunami waves during submarine mass failure (hereafter called submarine landslides) is not in terms of the characteristics of the generated waves. Estimates of the energy released during a tsunamigenic earthquake and respective tsunami wave draw a clear picture of the efficiency of the tsunami-generating process. However for submarine landslide, this is not as straightforward because the generation process has never been recorded in nature to directly infer the energy. Hence the efficiency of submarine landslide as tsunami generators is yet to be conclusively determined. As the result of this uncertainty, different equations, derived from experimental data or theory, result in leading-wave amplitude that vary over 6 orders of magnitude for the same initial slide conditions. To arrive at more robust estimates of the leading-wave characteristics, the spatiotemporal dynamics of the coupling between the slide body and water column needs to be investigated. How long is the water surface deformation coupled with the slide motion is essential question to shed light on the energy transfer.

We carry out numerical modeling with iSALE to address the question. In our modeling the slide motion generates a wave crest and a wave trough. The wave trough is of special interest because it deforms as the slide moves. Both the wave crest and trough travel above the slide, but are considered decoupled when the wave trough collapses under gravity above the slide. Initially, the depth of the trough, s, increases quickly, showing that gravity only as a minor influence. Our data analysis revealed that ds/dt is larger than zero. When the ds/dt $\leq$ 0, we define the trough as decoupled then the decoupling time, τ_d, is reached at ds/dt=0. We perform a parameter study to provide an empirical formula for the decoupling time, as a first step to establish a better understanding of the generation processes of landslide-generated tsunamis.