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Numerical modelling of tsunami generation by deformable submarine slides using mesh adaptivity

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Tsunamis generated by submarine slides are often under considered in comparison to earthquake generated tsunami, despite several recent examples. Tsunamigenic slides have generated waves that have caused significant damage and loss of life, for example the 1998 Papua New Guinea submarine mass failure resulted in a tsunami that devastated coastal villages and killed over 2,100 people.
Numerical simulations of submarine slide generated waves can help us understand the nature of the waves that are generated, and identify the important factors in determining wave characteristics. There have not been many studies of tsunami generation by deformable submarine slides, largely because of the complexities and computational expense involved in modelling these large scale events. At large, real world, scales modelling of tsunami waves by the generation of slides is computationally challenging. Fluidity is an open source finite element code that is ideally suited to tackle this type of problem as it
uses unstructured, adaptive meshes, which help to reduce the computational expense without losing accuracy in the results. Adaptive meshes change topology and resolution based on the current simulation state and as such can focus or reduce resolution when and where it is required. The model also allows a number of different numerical approaches to be taken to simulate the same problem within the same numerical framework. In this example we use multi-material approach, with both two materials (slide and water) and three materials (slide,
water and air), alongside a density-driven sediment model approach. We will present results of validating Fluidity against benchmarks from experimental and other numerical studies, at different scales, for deformable underwater slides, and consider the utility of mesh adaptivity. We show good agreement to both laboratory results and other numerical models, both with a fixed mesh and a dynamically adaptive mesh, tracking important features of the slide geometry as the simulation progresses. This is the first step in being able to simulate both the wave initiation, propagation, and inundation within the same numerical model at real-world scales for submarine slide generated tsunamis.