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TWO-LAYER MODELS FOR LANDSLIDE-GENERATED TSUNAMIS

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Abstract Text:

We describe the development of a model for landslide tsunami generation based on a depth-integrated, fully deformable lower layer, and apply the resulting model to several laboratory and field cases. The approach follows on earlier studies where models for the slide layer and overlying water layer are formulated in the depth integrated, shallow water approximation, with kinematic and pressure coupling between the layers. In the present study, we use the 3D nonhydrostatic model of Ma et al (2012) to retain fully dispersive behavior in the upper fluid layer. In perfect fluid applications for shallow or intermediate depth waves, the model has been shown to predict tsunami response to solid slides (Enet and Grilli, 2007) with good accuracy using only three vertical sigma levels, making it computationally competitive with weakly dispersive Boussinesq formulations using a single depth-integrated layer. The effect of non-hydrostatic acceleration effects in the lower, depth integrated layer (resulting from steep substrate slopes) is implemented using the approach of Yamazaki et al (2009), who used a layer-averaged approximation for vertical acceleration to correct the hydrostatic pressure distribution. The two coupled models are formulated using a finite volume, TVD approach. Lateral boundaries of the slide volume may be arbitrarily approached relative to the initial still water shoreline, and thus the triggering event may be either submarine, subaerial, or a combination of the two. In our first implementation, we assume the lower layer to be a simple, viscous Newtonian fluid, following the approach of Jiang and LeBlond (1994) as corrected by Fine et al (1998). An alternate model is also constructed based on a rheology model representing a granular or debris flow supported by intergranular stresses, following Savage and Hutter (1989) and Iverson (1997). Both models amount to the addition of a single mass and horizontal momentum equation to the three-layer perfect fluid model, and hence the added complexity over the solid slide case of Ma et al (2012) is minimal. Each model is then applied to a range of cases, including laboratory measurements of a rapid subaerial slide (Mohammed and Fritz, 2012), and a potential collapse of the the southern Great Bahama Bank platform margin (Schnyder et al, 2013).

Session Selection: Marine Geohazards

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