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# Simulating hydroplaning of submarine landslides by quasi 3D depth averaged finite element method

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Subaqueous debris flows/submarine landslides, both in the open ocean as well as in fresh waters, exhibit extremely high mobility, quantified by a ratio between vertical to horizontal displacement of the order 0.01 or even much less. It is possible to simulate subaqueous debris flows with small-scale experiments along a flume or a pool using a cohesive mixture of clay and sand. The results have shown a strong enhancement of runout and velocity compared to the case in which the same debris flow travels without water, and have indicated hydroplaning as a possible explanation (Mohrig et al. 1998). Hydroplaning is started when the snout of the debris flow travels sufficiently fast. This generates lift forces on the front of the debris flow exceeding the self-weight of the sediment, which so begins to travel detached from the bed, literally hovering instead of flowing. Clearly, the resistance to flow plummets because drag stress against water is much smaller than the shear strength of the material. The consequence is a dramatic increase of the debris flow speed and runout.
Does the process occur also for subaqueous landslides and debris flows in the ocean, something twelve orders of magnitude larger than the experimental ones? Obviously, no experiment will ever be capable to replicate this size, one needs to rely on numerical simulations. Results extending a depth-integrated numerical model for debris flows (Imran et al., 2001) indicate that hydroplaning is possible (De Blasio et al., 2004), but more should be done especially with alternative numerical methodologies. In this work, finite element methods are used to simulate hydroplaning using the code MADflow (Chen, 2014) adopting a depth averaged solution. We ran some simulations on the small scale of the laboratory experiments, and secondly, at a much larger scale of the real subaqueous landslides. Different methods to implement hydroplaning are discussed. The results are compatible to field data, but more should be understood for a proper description of the process.

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