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A two-layer shallow flow model with two axis of integration for submarine avalanches

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In this work, we deal with the simulation of granular avalanches. In particular, we study the case of submarine avalanches, when the beginning of the landslide occurs both completely submerged and in the air media with later immersion in the water. This kind of problems has been treated through averaged models following the pioneer work of Savage-Hutter [3], where a shallow water model is proposed to study dry aerial avalanches. This model has been successfully applied to simulate real and laboratory experiments. In Bouchut et al. [1], a Savage-Hutter type model has been proposed taking into account the curvature of a general bottom. Thus, the avalanche is described using local coordinates in terms of the bottom.

In the case of a submarine avalanche, two layer models must be considered. The description of both the fluid and granular may be developed using only one coordinate system (Cartesian or local coordinates). Nevertheless, this is not appropriate to describe the behavior of both layers at the same time.

The idea of this work is to present the derivation of a new two-layer model of Savage-Hutter type to study submarine avalanches using a depth-averaging procedure of the 2D momentum and mass equations. Our approach consider two different coordinate systems to deal with the modelling of both the fluid and the granular layers over a fixed bottom. More precisely, we start with Euler equations in Cartesian coordinates as governing equations. The fluid layer is described in Cartesian coordinates; based on previous work [1, 2], a change of variables from Cartesian to local coordinates is performed for the description of the granular layer. Coulomb friction law is imposed at the bottom. However, the friction between the fluid and the granular layers is taking into account in order to establish a dissipative energy balance for the final model.

Finally, we check the validity of the model with several numerical tests and, in particular, the results are compared to laboratory experiments.

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References

[1] F. Bouchut, E.D. Fernández-Nieto, A. Mangeney, P.Y. Lagrée, *On new erosion models of Savage–Hutter type for avalanches*. Acta Mech. 199(1):181–208, 2008.

[2] E.D. Fernández-Nieto, P. Vigneaux, *Some remarks on avalanches modelling: An introduction to shallow flows models*. Advances in Numerical Simulation in Physics and Engineering. SEMA SIMAI Springer Series, vol 3. Springer.

[3] S.B. Savage, K. Hutter, *The dynamics of avalanches of granular materials from initiation to run-out*. Acta Mech. 86: 201–223, 1991.

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