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Finite volume methods for submarine debris flow with Herschel-Bulkley rheology

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Submarine landslides can impose great danger to the underwater structures and generate destructive waves. The Herschel-Bulkley rheological model is known to be appropriate for describing the nonlinear viscoplastic behavior of the debris flow. The numerical implementation of the depth-averaged Herschel-Bulkley models such as BING has so-far been limited to the 1-dimensional Lagrangian coordinate system. In this work, we develop numerical schemes with the finite volume methods in the Eulerian coordinates. We provide parameter sensitivity analysis and demonstrate how common ad-hoc assumptions such as including a minimum shear layer depth influence the modeling of the landslide dynamics. The possibility of adding hydrodynamic resistance forces, hydroplaning, and remolding into this Eulerian framework is also discussed. Finally, the possible extension to a two-dimensional operational model for coupling towards operational tsunami models is discussed.