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Impact of topography resolution and accuracy on computational shallow flow models for natural hazards

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Huge efforts have been made towards the development of simulation tools aiming for quantifying the impact of gravity-driven mass movements, e.g. avalanches or landslides. Characteristic to these mass wasting processes is their shallowness, resulting from a tendency of the flow to spread in longitudinal direction. Mathematical models for gravity-driven mass movements exploit this apparent shallowness and model the process in terms of depth-averaged quantities. This gives rise to advection dominated mathematical systems of hyperbolic type, which are closed in terms of empirical basal and internal friction relations tailored to the actual situation. Many different one-, two, and multi-phase shallow flow variants have been proposed throughout the last years. Common to each of these is that acceleration and deceleration of the moving mass are controlled by topography gradients and flow resistance is controlled by a friction relation that depends on empirical parameters. When wanting to utilize the model, e.g. to predict run-out distances, the friction parameters have to be calibrated with data during a parameter identification process.

In this presentation, we will concentrate on the topography interaction in a general shallow flow setting. Our main aim is to show the impact of topography resolution, accuracy and noise on simulation results for common depth-averaged shallow flow models solved by finite volume methods for hyperbolic conservation laws, and to discuss consequences regarding the subsequent calibration process. We will present both an analytical analysis and also numerical results from idealized test cases in synthesized topographies that are disturbed according to realistic accuracy bounds of commonly available DEM products. We will conclude by discussing implications for potential calibration initiatives.