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Coarse grid shallow water simulations of rainfall-runoff in small catchments with modified friction law to account for unresolved microtopography

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In recent years, the fully dynamic shallow water equations have been successfully used to simulate rainfall-runoff in natural catchments. Hereby, the hydrodynamics of the surface runoff is greatly influenced by local topographical features. Thus, it is desirable to use high-resolution models which resolve the topography of the study area sufficiently. However, high-resolution simulations across catchment scales are often unfeasible due to finite computer resources. In this contribution, the shallow water equations are solved on a coarse resolution, leaving significant topographical features unresolved. The coarsened grid size leads to a smaller cell number and therefore reduces computational cost. The influence of the topography is accounted for with an artificial friction source term which is dependent on the inundation ratio, i.e. the ratio of water depth to roughness height, the slope and two additional parameters, namely a dimensionless friction coefficient and a geometric conveyance parameter. Subgrid scale information is used to determine these parameters. The friction approach is applied in two different ways: (1) a global average roughness height for the entire catchment is calculated and used as input, (2) the roughness height is calculated individually in each cell which introduces additional heterogeneity to the model. In two test cases, the individual roughness height-based approach is compared to results of the global roughness height-based approach and to igh-resolution model results. The comparison shows slight improvement in the results if the roughness height is assigned individually, however overall the improvement is negligible. Both models enable to run the simulations about three orders of magnitude faster than the high-resolution model.