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Simplified Storm Surge Simulations Using Bernstein Polynomials

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Storm surge simulations are vital for forecasting, hazard assessment and eventually improving our understanding of Earth system processes.
Discontinuous Galerkin (DG) methods have recently been explored in that context, because they are locally mass-conservative and in combination with suitable robust nodal filtering techniques (slope limiters) positivity-preserving and well-balanced for the still water state at rest. These filters manipulate interpolation point values in every time step in order to retain the desirable properties of the scheme. In particular, DG methods are able to represent prognostic variables such as the fluid height at high-order accuracy inside each element (triangle). For simulations that include wetting and drying, however, the high-order accuracy will destabilize the numerical model because point values on quadrature points may become negative during the computation if they do not coincide with interpolation points.
This is why the model that we are presenting utilizes Bernstein polynomials as basis functions to model the wetting and drying. This has the advantage that negative pointvalues away from interpolation points are prevented, the model is stabilized and no additional time step restriction is introduced.
Numerical tests show that the model is capable of simulating simplified storm surges. Furthermore, a comparison of model results with third-order Bernstein polynomials with results using traditional nodal Lagrange polynomials reveals an improvement in numerical convergence.