A POSTERIORI SUBCELL LIMITER FOR STAGGERED SEMI-IMPLICIT DISCONTINUOUS GALERKIN APPLIED TO THE SHALLOW WATER EQUATIONS

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Recently, several arbitrary high order staggered semi-implicit Discontinuous Galerkin (DG) schemes have been developed for the numerical solution of many systems of partial differential equations (see [1, 2, 3]). This class of high order methods is very efficient due to the CFL condition based on the fluid velocity. Moreover, in general the linear systems that have to be solved are symmetric and well conditioned. However, according to the Godunov theorem also these schemes fail in regions characterized by strong gradients like shock waves. In this framework we develop a novel class of limiter for staggered semi-implicit DG based on the MOOD paradigm (see [4]). At first, at every iteration the unlimited scheme is applied and it gives a candidate solution of the problem. Then, the troubled cells are detected by using physical and numerical admissibility criteria. In the troubled cells a robust central semi-implicit finite volume method is applied to 2N+1 finite volume subcells and the solution is re-computed. The choice of 2N+1 subcell volumes doesn’t influence the stability conditions that remains the same of the pure semi-implicit staggered DG method. We apply this method to the shallow water equations in one and two dimensions. In particular, we show that this scheme works well for the solution of problems where shocks are involved such as Riemann problems both with flat bottom and both with discontinuous bottom. Moreover, for smooth solutions troubled cells are not found and consequently this case corresponds the the pure DG method.

References


