Comparison of discontinuous Galerkin and finite difference for NWP

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We compare operationally used numerical weather prediction (NWP) model COSMO of the German Weather Service and the university code DUNE for solving benchmark test cases that traditionally appear in the NWP community. The focus is on the efficiency and effectiveness, analysing advantages and pitfalls of the both codes with respect to the chosen test suite. The test suite includes the density current [5], the inertia gravity waves [4] and the linear hydrostatic mountain waves [1]. The governing equations are Euler equations in 2d, to which we add enough viscosity in order to ensure the grid convergent numerical solution. On the one side, the DUNE code uses high order conservative discontinuous Galerkin (DG) method for Euler equations without physical viscosity and the CDG2 method, recently introduced in [2], for viscous Euler equations. The time integration for DUNE is fully explicit Runge-Kutta scheme up to the third order. The COSMO code, on the other side, uses finite differences of second order for fast wave and of fifth order for slow waves. The time integration is the split-explicit scheme according to Klemp and Wilhelmson (1978). For the mountain wave test case we need to treat transparent boundary conditions. Both codes use sponge layer technique with similar damping functions. While the optimally expected convergence rate of the other two test cases is attained, the convergence rate for this case was shown to reduce to the first order.

References

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