Mimetic finite element methods for solving the nonlinear shallow water equations

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January 30, 2014

We present benchmarking results from using mixed finite element methods that are consistent with the finite element exterior calculus framework for solving the nonlinear shallow water equations on a rotating sphere. These methods share the desirable mimetic properties exhibited by C-grid finite difference schemes, namely energy conservation, mass conservation, no spurious pressure modes and steady geostrophic modes, but without orthogonality constraints on the grid. These methods are currently being developed as part of the Gung Ho UK dynamical core project.

We will present details of the timestepping method, including stable, consistant advection schemes for both the layer depth (discontinuous) and potential vorticity (continuous) Galerkin fields. These schemes lead to a numerically conserved diagnostic potential vorticity, essential for accurate representation of predominately balanced flows. We demonstrate the accuracy and order of convergence of these schemes using standard test cases.