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Conservation Properties of Numerical Schemes for the Shallow Water Equations

Chris Eldred and David Randall
Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado, USA

The shallow water equations provide a useful analogue of fully compressible Euler equations since they have similar conservation laws, many of the same types of waves and a similar (quasi-) balanced state. With regards to conservation properties, there have been two major thrusts of research: Hamiltonian methods (work done by Salmon and Dubois, primarily) and Discrete Exterior Calculus (DEC; Thuburn, Cotter, Ringler, etc.). In particular, recent work done by Thuburn and Cotter (2011) introduced a generalized framework for energy-conservative C-grid discretizations of the rotating shallow water equation using ideas from Discrete Exterior Calculus. The current research elucidates the connections between the Hamiltonian and DEC approaches, and looks at potential enstrophy conservation in addition to energy conservation. Finally, a generalized framework for mimetic total energy and potential enstrophy conserving discretizations of the rotating shallow water equation in vorticity-divergence form (also using the DEC approach) is developed.