High-order mimetic finite elements for the hydrostatic primitive equations on a cubed-sphere grid using Hamiltonian methods

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It is well known that the inviscid, adiabatic equations of atmospheric motion constitute a non-canonical Hamiltonian system, and therefore posses many important conserved quantities such as as mass, potential vorticity and total energy. However, until recently, few numerical models possessed similar conserved quantities. Over the past decade, there has been a great deal of work on the development of mimetic and conservative numerical schemes for atmospheric dynamical cores using Hamiltonian methods. An important example is Dynamico ([**?**]), which conserves mass, potential vorticity and total energy; and posses additional mimetic properties such as a curl-free pressure gradient that does not produce spurious vorticity. Unfortunately, the underlying finite-difference discretization scheme used in Dynamico has been shown to be inconsistent on general grids. In the case of the rotating shallow water equations, a scheme based on mimetic finite elements has been developed that solves these accuracy issues while retaining the desirable mimetic and conservation properties. This talk will discuss preliminary results on the extension of this scheme to the hydrostatic primitive equations, through the use of tensor product construction (the 2D finite element spaces are extended to 3D using tensor products, in a way that preserves their properties). It is shown that use of the same prognostic variables as Dynamico combined with a Lorenz staggering leads to a relatively simple formulation that allows conservation of total energy along with high-order accuracy.

Références

[1] Dubos, T., Dubey, S., Tort, M., Mittal, R., Meurdesoif, Y., and Hourdin, F., *DYNAMICO-1.0, an icosahedral hydrostatic dynamical core designed for consistency and versatility*, Geosci. Model Dev., 8, 3131-3150, doi:10.5194/gmd-8-3131-2015, 2015

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