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Dynamico-FE: A Structure-Preserving Hydrostatic Dynamical Core

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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. In addition, there are also key mimetic properties (such as curl grad = 0) of the underlying continuous vector calculus. Ideally, a dynamical core should have similar properties. A general approach to deriving such structure-preserving numerical schemes has been developed under the frameworks of Hamiltonian methods and mimetic discretizations, and over the past decade, there has been a great deal of work on the development of atmospheric dynamical cores using these techniques. An important example is Dynamico, which conserves mass, potential vorticity and total energy; and possesses additional mimetic properties such as a curl-free pressure gradient. Unfortunately, the underlying finite-difference discretization scheme used in Dynamico has been shown to be inconsistent on general grids. To resolve these accuracy issues, a scheme based on mimetic Galerkin discretizations has been developed that achieves higher-order accuracy while retaining the structure-preserving properties of the existing discretization. This presentation will discuss the new dynamical core, termed Dynamico-FE, and show results from a standard set of test cases on both the plane and the sphere.