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Mistral: A Structure-Preserving Nonhydrostatic Dynamical Core

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The reversible (adiabatic, inviscid) dynamics of geophysical fluids are Hamiltonian, and this geometric structure underlies key properties of the continuous equation, such as conservation laws. It is possible to retain these properties by discretizing the Hamiltonian structure directly using a mimetic discretization, which produces a quasi-Hamiltonian discretization. This spatial discretization can then be combined with a fully implicit energy-conserving time integrator to yield a fully discrete, energy-conserving model. Simplification of the Jacobian associated with the nonlinear system of algebraic equations that results then gives finally a semi-implicit scheme, similar to existing approaches in the literature (such as the Unified Model). Extending previous work on the hydrostatic equations, this talk will discuss a concrete realization of this approach: the Mistral atmospheric dynamical core. This is a high order, structure-preserving, nonhydrostatic model built using compatible Galerkin methods. Mass, entropy and total energy are conserved to machine precision, including time discretization. Results will be presented from standard test cases. If time permits, current progress on the extension to irreversible dynamics through a metriplectic formulation will be discussed.