

Quasi-Hamiltonian numerical models of geophysical fluid dynamics

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The reversible (adiabatic, inviscid) dynamics of geophysical fluids are Hamiltonian, and this variational structure underlies many of the fundamental properties of the continuous equations, such as conservation laws. It is possible to retain a substantial fraction of properties in a numerical model by discretizing the Hamiltonian structure directly using a mimetic discretization, instead of discretizing the equations of motion. The result model is termed quasi-Hamiltonian. This spatial discretization can then be combined with a fully implicit energy-conserving time integrator to yield a fully discrete, energy-conserving 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.