Title: Characteristic-Based Slow-Wave-Fast-Wave Partitioning for Semi-Implicit Time Integration of Atmospheric Flows

Abstract: Atmospheric flows are characterized by distinct temporal scales corresponding to the flow velocity and the acoustic waves. Explicit time integration methods require time steps that are restricted by the speed of sound; however, the acoustic waves often do not have a significant impact on the flow phenomenon. Numerical weather prediction tools either eliminate the acoustic mode by using a hydrostatic model or use implicit-explicit or fully-implicit time-integration methods to avoid the acoustic stability restriction. In this talk, we present a characteristic-based partitioning of the convective flux in the Euler equations to separate the velocity and acoustic time scales, where the hyperbolic flux is decomposed in its eigen-space. Implicit-explicit additive Runge-Kutta methods integrate the advective terms explicitly and the acoustic terms implicitly. The time step sizes are thus restricted by the flow velocity and not the speed of sound. The acoustic component of the flux is linearized such that the system of equations resulting from semi-implicit time integration can be solved efficiently without compromising the stability limit of the overall algorithm or introducing an error in the discretization. The proposed approach is verified for several benchmark flow problems where the flow velocities are significantly smaller than the speed of sound.

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