Third-Order, Adaptively Implicit Time Stepping for Advection Enabling Long Time Steps

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Abstract

Operational models such as the ECMWFs IFS, UK Met Office's Unified Model, and the NCEP Global Forecast System use a semi-Lagrangian scheme for advection, enabling long, accurate time steps at the expense of conservation. Another option, flux-form semi-Lagrangian schemes, conserve mass but are only efficient for long time steps in one-dimensional sweeps. Therefore, this work focuses on adaptively implicit explicit (AdImEx) schemes that use spatiotemporally variable implicit and explicit Runge-Kutta combinations with the aim to create third-order accuracy in space and time for arbitrary time steps. Combining it with limiting guarantees monotonicity and boundedness. Theory and test cases will be presented.

Keywords: Implicit time stepping, Long time steps, Stability, Third order accuracy, Runge Kutta schemes

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