Piotr K. Smolarkiewicz (National Center for Atmospheric Research, Boulder Colorado, USA):

Semi-implicit finite-volume integrators for all-scale atmospheric dynamics

Abstract:

This talk outlines a novel numerical approach for accurate and computationally efficient integrations of PDEs governing all-scale atmospheric dynamics. Such PDEs are not easy to handle, due to a huge disparity of spatial and temporal scales as well as a wide range of propagation speeds of natural phenomena captured by the equations. The novel Finite-Volume Module of the Integrated Forecasting System (IFS) at ECMWF (hereafter IFS-FVM) solves perturbation forms of the fully compressible Euler/Navier-Stokes equations under gravity and rotation using non-oscillatory forward-in-time semi-implicit time stepping and finite-volume spatial discretisation. The IFS-FVM complements the established semi-implicit semi-Lagrangian pseudo-spectral IFS (IFS-ST) with the all-scale deep-atmosphere formulation cast in a generalised height-based vertical coordinate, fully conservative and monotone advection, flexible horizontal meshing and a predominantly local communication footprint. Yet, both dynamical cores can share the same quasi-uniform horizontal grid with co-located arrangement of variables, geospherical longitude-latitude coordinates and physics parametrisations, thus facilitating their synergetic relation. The focus of the talk is on the mathematical/numerical formulation of the IFS-FVM with the emphasis on the design of semi-implicit integrators and the associated elliptic Helmholtz problem. Relevant benchmark results and comparisons with corresponding IFS-ST results attest that IFS-FVM offers highly competitive solution quality and computational performance.