Implementation of a Non-Hydrostatic, Adaptive-Grid Dynamics Core in the NCAR Community Atmospheric Model

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We report on our implementation of EULAG as a dynamical core in the NCAR Community Atmospheric Model (CAM). Compared to existing dynamics cores in CAM, EULAG has novel advantages. Specifically, it is non-hydrostatic, and it combines non-oscillatory forward-in-time (NFT) numerical algorithms with a robust elliptic Krylov solver. A signature feature of EULAG is that it is formulated in generalized coordinates, which enables grid adaptivity.

A series of aqua-planet simulations are used to demonstrate that CAM–EULAG results compare favorably with those from CAM simulations at standard CAM resolution that use current finite volume or Eulerian-spectral dynamical core options. In further analysis, we exploit EULAG's grid adaptivity to show how horizontal grid resolution in CAM-EULAG strongly affects Inter-Tropical Convergence Zone (ITCZ) morphology as well as the amount of tropical precipitation through its influence on resolved dynamics. The grid adaptation capability of our global model enables simulations that separate the influence of tropical and extra-tropical dynamics on both the ITCZ and tropical precipitation.

The presence of single versus double ITCZs in our aqua-planet simulations depends on the resolution of convectively coupled equatorial waves. When the tropical resolution is sufficiently high to resolve prominent equatorial waves a double ITCZ occurs, otherwise a single ITCZ occurs. In contrast, tropical resolution does not affect the magnitude of tropical precipitation in our aqua-planet simulations. Instead the precipitation is sensitive to extra-tropical resolution, through its influence on the strength of baroclinic eddies and their forcing of the Hadley circulation.