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Implementation of a non-hydrostatic, adaptive-grid dynamics core in CAM3

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We present the implementation of EULAG as a dynamical core in the NCAR Community Atmospheric Model CAM3. EULAG is a non-hydrostatic, parallel computational model for all-scale geophysical flows whose name derives from its two computational options: EULerian (flux form) or semi-LAGrangian (advective form). The model combines nonoscillatory 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. These features collectively give EULAG novel advantages over the existing dynamical cores in CAM. We use a series of aqua-planet simulations to demonstrate that CAM–EULAG results compare favorably with those from CAM simulations at standard CAM resolution that use current dynamical core options. We also show that the grid adaptivity implemented in CAM3-EULAG allows higher resolution in selected regions without causing anomalous behavior such as spurious wave refection.

The grid adaptation enables simulations that separate the influence of tropical and extra-tropical dynamics on both the inter-tropical convergence zone (ITCZ) and tropical precipitation, through resolution changes that effectively filter one or the other type of waves. 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.