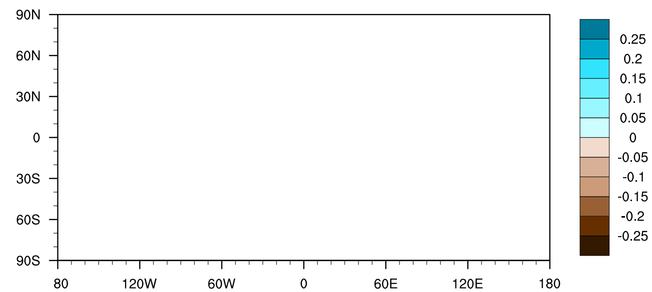
Exploring a global multi-resolution modeling approach using aquaplanet simulations

Objective

Using a simplified aquaplanet setting (no land or seasons, zonally symmetric SSTs), we evaluate the performance of the new Model for Prediction Across Scales atmosphere dynamical core (MPAS-A) in the DOE-NCAR Community Atmosphere Model (CAM) via its kinetic energy spectra, general circulation, and precipitation characteristics. We also explore the variable resolution (VR) capabilities of MPAS-A as a regional modeling tool.



CAM-MPAS-A VR simulation: the high resolution region is outlined in gray. Eddy velocity potential (div by 10e6, $m^2 s^{-1}$) is shown. In the top panel, the aquaplanet run is done with full physics and there is a marked zonal asymmetry. When moist physics are removed (bottom), this response almost disappears. This implicates the CAM moist physics as the source of the asymmetry.

Approach

- Coupled MPAS-A to CAM
- Performed multiple quasi-uniform (30, 60, 120, 240 km grid spacing) and one VR (30 to 240 km grid spacing) aquaplanet simulations.
- CAM-MPAS-A simulations are similar to ones using the default dynamical core in CAM (CAM-finite volume or FV).
- While it captures characteristics of the global quasi-uniform high resolution simulation, the VR simulation shows an undesirable zonal asymmetry (aquaplanet should be zonally and hemispherically symmetric) due to the scale dependencies of the CAM physics.

Impact

The VR simulation highlights scale dependencies in the CAM physics parameterizations and may provide a useful test case to track physics improvements. These simulations have been used by DOE researchers to investigate scale incognizance in the CAM physics, differences in regional modeling approaches, and the roles of resolution and dynamical core in the simulation of the ITCZ. Data from these simulations are publically available. Two other research groups (PNNL, Stanford) are now using MPAS-A.

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