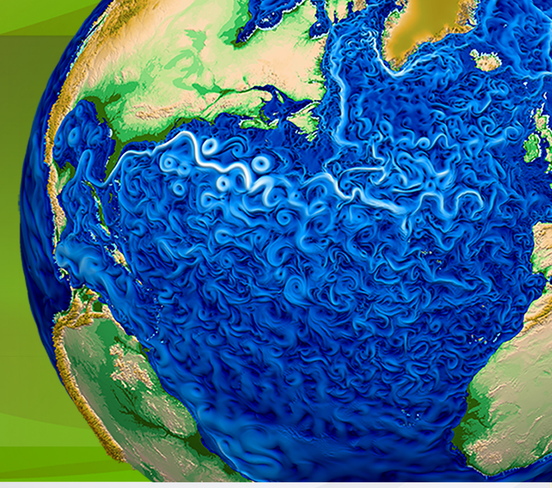
R: Choosing a Convection Scheme for ACME: Preliminary Results

S. Xie, W. Lin, P. Rasch, P. Caldwell, K. Zhang, J. Yoon, R. Neale,
S. Ghan, Y. Zhang, Q. Tang, S. Mahajan, S. Klein, Y. Qian,
P. Bogenschutz, A. Gettelman, V. Larson, S. Park, and G. Zhang



Overview

Motivation

- ACME ~ 0.25^0, too coarse to resolve convective scale motions
- Many systematic errors related to precipitation and clouds simulated by CAM5 or ACME v0.1 are related to deficiencies in its default convection scheme developed by Zhang and McFarlane (1995) (ZM) two decades ago
- Various convection schemes have been extensively tested at a resolution of ~ 1^0 but not at a high resolution of 0.25^0

Candidate Convection Schemes – Most with DOE Support

- UNICON: a single unified scheme for all shallow-deep, dry-moist, and forced-free convections
- CLUBB-Shallow + MG2: a single unified scheme for cloud macrophysics, boundary layer turbulence, and shallow convection, along with a updated MG microphysics
- Various improvements to ZM in terms of convective triggering, closure, relaxation time scale, entrainment, and convective gustiness

Goal

- Choose a suitable convection scheme for ACME through objectively evaluating the candidate schemes under various modeling frameworks in terms of their capability in simulating observed clouds, aerosols, and the hydrologic cycle.

Approach

Utilize Multi-Scale Modeling Testbeds

- CAPT – the short-range hindcast approach developed through the DOE Cloud-Associated Parameterization Testbed (CAPT)
- RRM – The Regional Refined Modeling Testbed developed through the DOE CSSEF project
- SCM – Single-Column Modeling Testbed forced by DOE ARM and other observations
- AMIP – Free-running simulation with prescribed SST and sea ice
- UQ techniques – CAPT-like short simulations with perturbed parameters

Test at Variable Horizontal and Vertical Resolutions

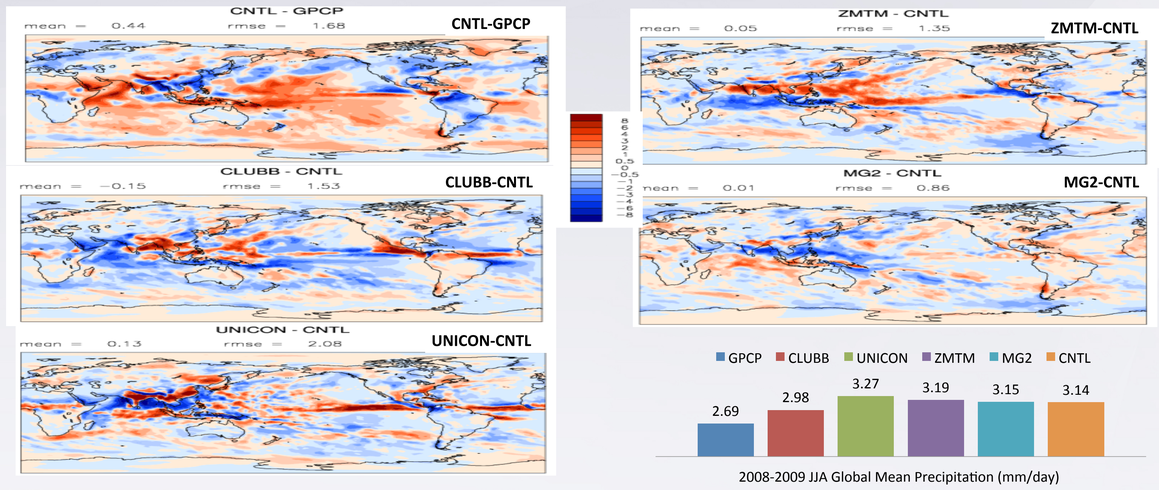
- Two horizontal resolutions: 1^0 and 0.25^0
- Two vertical resolutions: 30 levels and 60 levels
- Variable resolution from 1^0 globally to 0.25^0 at selected regions (SGP, Amazon, …) with RRM

Evaluate with Metrics Specifically for Convection

- Convection characteristics at global and regional scales and over the ARM sites
- Focus on systematic errors
  - Double ITCZ, weak MJO, wrong diurnal cycle, too much weak precipitation and too few intense events, no clear transition from shallow to deep convection, wrong partition between stratiform and convective precipitation
- ACME, CSSEF, CAPT, and AMWG metrics package and satellite and ARM simulators

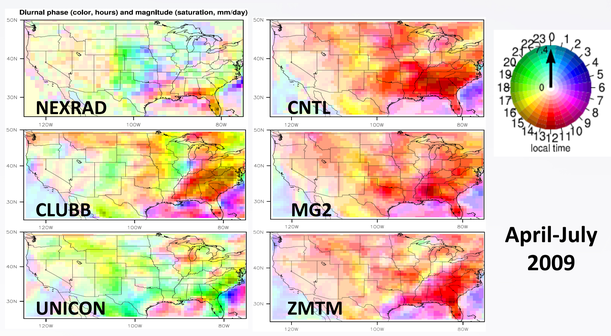
Preliminary Results

Summer Precipitation – AMIP 2008-2009 JJA

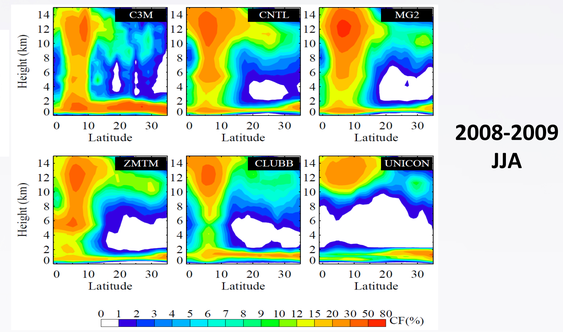


CLUBB appears to broadly improve the precipitation pattern. UNICON and ZMTM's performance are mixed.

Precip 1st Diurnal Harmonic



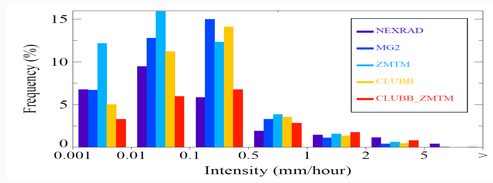
Cloud Transition Along the GPCI Transect



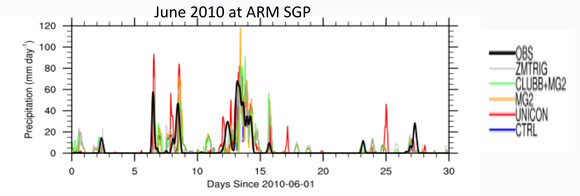
- CLUBB & UNICON: have improved skill in capturing warm season continental propagating convection.
- UNICON: more systematically alters the simulated diurnal phase (mostly for the better)
- CLUBB: substantial improvement in high clouds along the GPCI and Sc-Cu transition with more realistic PBL height
- UNICON: improve Sc-Cu transition and high cloud over Sc regimes while clouds over Cu and Dc regimes became worse

PDF of Pr Intensity – the CAPT Test

Hourly Prcipitation Distribution over (30N-45N, 110W-85W), Day 2 hindcasts

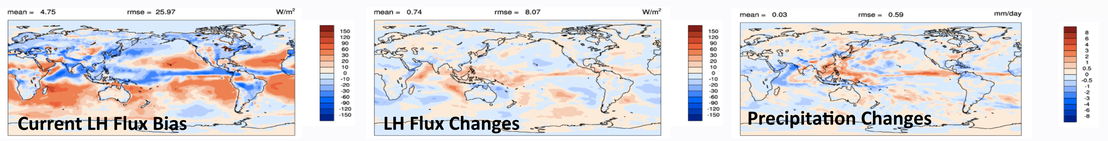


SCM Simulated Precipitation



- CLUBB with ZM-Trigger-Memory (ZMTM) improves the skill in capturing moderate to stronger precipitation events.
- UNICON has much stronger precipitation in its SCM test than others and the observations

A New Convective Gustiness Scheme



- JJA has the largest response, where enhanced fluxes shifts the Monsoon precipitation center to the East. This improves existing biases
- Gustiness should help reduce JJA precipitation biases which are amplified in the high resolution model

ACME Accelerated Climate Modeling for Energy

For additional information, contact:

Shaocheng Xie
Staff Scientist

Lawrence Livermore National Lab

(925) 422-6023
xie2@llnl.gov

climatemodeling.science.energy.gov/acme

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