R: Short Simulations for Efficient Model Evaluation, Tuning and Calibration: *Early Results*

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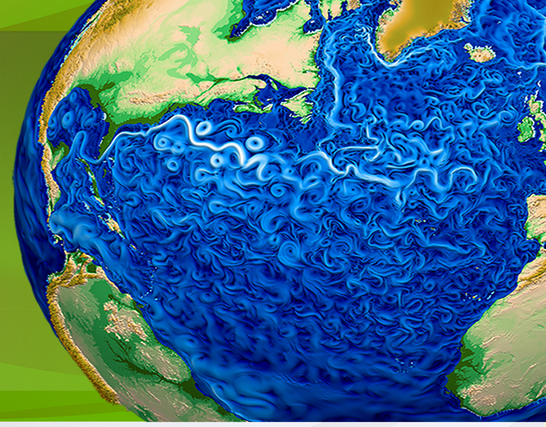


Objectives

- **Determine the strengths and limitations of short simulations**
- **Gain experience to guide the experimental design of CAPT-based auto-tuning**

Approach

CAPT Hindcasts

- 31 hindcasts in July 2008
- Extended simulation length, i.e., 10 days instead of 5 days
- Initial conditions from ERA-Interim and nudged CAM-CLM simulations

Parametric Sensitivity Experiments

- 6 uncertain parameters related to shallow convection and turbulence were perturbed (see Table below)
- 128 points were sampled from the 6D parameter space using the Quasi Monte Carlo method
- A surrogate model, the generalized linear model, was used to analyze model's response to parameter perturbation
- Current focus of analysis is the dependence of model sensitivity on cloud regime and simulation time along the GPCI transect.

Simulation Execution

- CESM/ACME's multi-instance capability was used to bundle independent hindcasts to achieve fast turnaround on Titan (ALCC allocation)
- With help from the performance team, we are working on optimizing the bundling of short simulations.

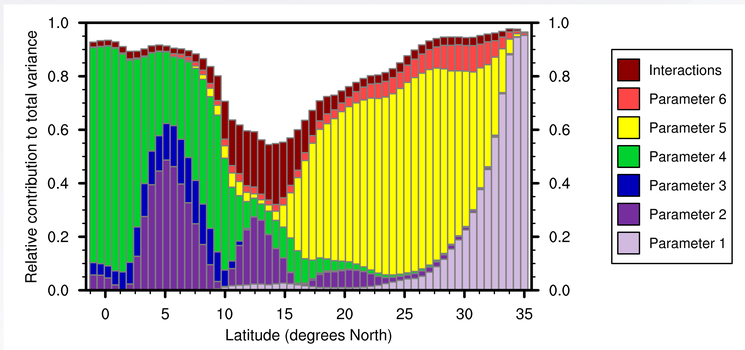
Table: List of uncertain parameters perturbed in the sensitivity experiments.

Index	Parameter	Lower bound	Default value	Higher bound	Notes
1	a2l	10	30	50	Moist entrainment enhancement parameter
2	criqc	0.5E-3	0.7E-3	1.5E-3	Maximum condensate mixing ratio in the updraft
3	kevp	1E-6	2E-6	20E-6	Evaporation efficiency
4	rkm	8	14	16	Fractional updraft mixing efficiency
5	rpen	1	5	10	Penetrative entraiment efficiency
6	rlshdet	6E-6	10E-6	10E-6	Radius (m) of cloud droplet detrained from shallow convection

Key Results

The GPCI transect spans multiple cloud regimes in which the model exhibits dramatically different parametric sensitivities

Figure 1: Relative contribution of individual parameters to the total variance of shortwave cloud forcing (SWCF) as a function of latitude along the GPCI transect. The variance analysis was carried out on the temporal average of all hindcasts and all simulation days. Details about the model parameters are explained in the Table in the Approach section.



Few-day simulations can capture many although not all aspects of model sensitivity

Figure 2 (below): Cloud fraction and cloud forcing along GPCI, and their variation caused by parameter perturbation. Black curves are the averages of all 128 model configurations; Color shading indicates the ± one standard deviation range. Dashed red frames indicate the deep and shallow cumulus regimes that are further analyzed in Figure 3.

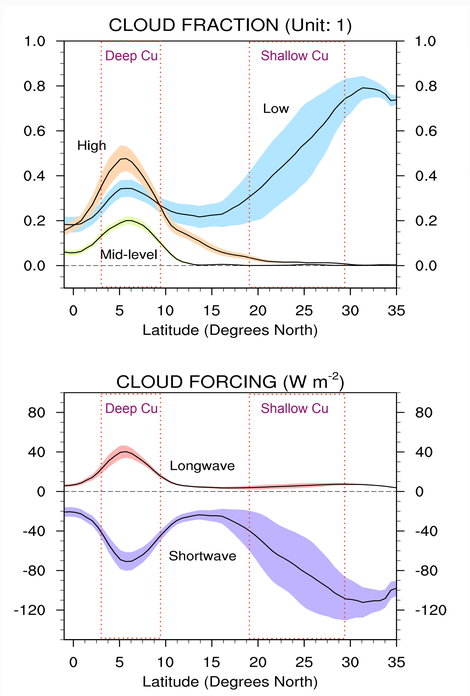
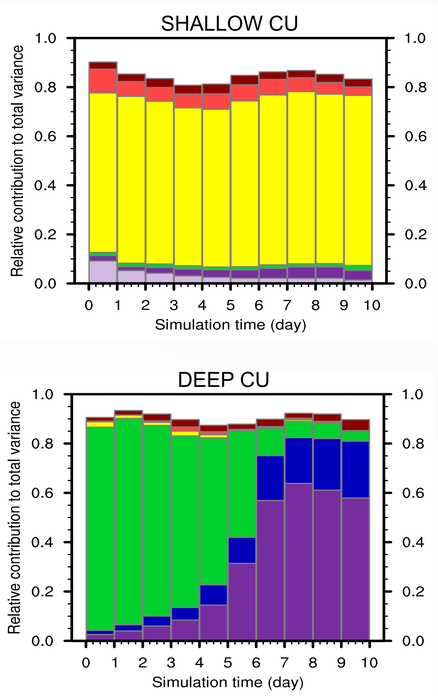


Figure 3 (right): Time evolution of the model's parametric sensitivity represented by the relative contribution of individual parameters to the total variance of SWCF in the shallow (upper panel) and deep (lower panel) cumulus regimes. Color coding is the same as in Figure 1. The variance analysis was based on SWCF averaged over the corresponding latitude ranges indicated in Figure 2.



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