Climate and Cloud response of super-parameterized CAM with additional super-parameterization of low-level clouds

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CRM-MiniLES Prototype Model



- MiniLES allows no condensation above 5000m to suppress deep convection;
- Vertical grids of CRM and MiniLES are collocated with GCM;
- Grids of CRM and LES are NOT attached to GCM grid;
- All communication between CRM/MiniLES and GCM is through ID profiles;
- SP: 32x28, Δx=4000m, Δt=20s
- MiniLES: 32x28, Δx=250m, Δt=20s
- Horizonatl domain of MiniLES is about as wide as a single cell of the SP

The SP-MiniLES model is 70% more expensive than SP-CAM

MiniLES-CRM-GCM Coupling





Schematic for the radiative transfer in the SP+MiniLES framework





Annual total cloud cover change due to MiniLES







Change due to MiniLES



Little change in high cloud cover (expected)

Annual zonal-mean distribution of cloud liquid/ice water



Low-cloud water is still mostly represented on CRM grid rather than on MiniLES grid.

Climate-change Time-Slice Test

- Control (Present): Prescribed climatological monthly SSTs
- Perturbed (Future): Prescribed AR4 IPCC (A1B) composite SST anomalies (with respect to their late 20th century climatology)
- Duration: 3 years + 4-month spinup





SP-CAM with MiniLES has higher climate sensitivity than SP-CAM and positive Cess' cloud feedback



Omega 500 mb PDF change in Tropics (Monthly, 30S-30N)

In warmer climate, in Tropics, both SP-CAM GCMs with and without MiniLES predict robust increase in shallow trade cumulus clouds and reduction in stratocumulus clouds



SP-CAM & MiniLES

omega 500 mb



SP-CAM

Probability of finding Omega (mb/day) at 500 mb (SST climate-change SP-CAM Monthly climatology)

5 < ω₅₀₀ < **25**

25 < ω₅₀₀



0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9





Summary/Conclusions

- 'MiniLES' super-parameterization approach considerably improves climatology of low level clouds in SP-CAM at relatively modest computational expense (~70%).
- Tropical response to 'climate-change' SST anomaly is robust for both versions of SP-CAM, that is to increase area of shallow convection and decrease area of Sc in response to weakening overturning circulation
- Mini-LES in SP-CAM tends to
 - Increase model's climate sensitivity (from 0.5 tp 0.6 K W⁻¹m²)
 - Switch CRF feedback from weakly negative (-0.36) to weakly positive (0.24)