Use ARM SGP data to Evaluate Diurnal Cycle over Land Simulated by NCAR CAM4 and CAM5 in Weather Forecast Framework

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Motivation

Evolutions of CAM-CESM1

Model	CCSM3 (2004)	CCSM3.5 (2007)	CCSM4 (Apr 2010)	CESM1 (Jun 2010)
Atmosphere	CAM3 (L26)	CAM3.5 (L26)	CAM4 (L26)	CAM5 (L30)
Boundary Layer Turbulence	Holtslag-Boville (93) Dry Turbulence	Holtslag-Boville	Holtslag-Boville	Bretherton-Park (09) UW Moist Turbulence
Shallow Convection	Hack (94)	Hack	Hack	Park-Bretherton (09) UW Shallow Convection
Deep Convection	Zhang-McFarlane (95)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)	Zhang-McFarlane Neale et al.(08) Richter-Rasch (08)
Cloud Macrophysics	Zhang et al. (03)	Zhang et al. with Park & Vavrus' mods.	Zhang et al. with Park & Vavrus' mods.	Park-Bretherton-Rasch (10) Revised Cloud Macrophysics
Stratiform Microphysics	Rasch-Kristjansson (98) *Single Moment*	Rasch-Kristian. *Single Moment*	Rasch-Kristian. *Single Moment*	Morrison and Gettelman (08) *Double Moment*
Radiation / Optics	CAMRT (01)	CAMRT	CAMRT	RRTMG Iacono et al.(08) / Mitchell (08)
Aerosols	Bulk Aerosol Model (BAM)	BAM	BAM	Modal Aerosol Model (MAM) Liu & Ghan (2009)
Dynamics	Spectral	Finite Volume (96,04)	Finite Volume	Finite Volume
Ocean	POP2 (L40)	POP2.1 (L60)	POP2.2 - *BGC*	POP2.2
Land	CLM3	CLM3.5	CLM4 - *CN*	CLM4
Sea Ice	CSIM4	CSIM4	CICE	CICE

borrowed from S. Park's talk on Unicon

1. What's the performance of CAM4 and CAM5 to simulate different convection regimes at SGP?
2. Will such evaluation provides working directions for future LES/SCAM runs given reasonable large-scale forcing and boundary conditions?

Data and Methodology

Model output: CAM4 (26 Levels) and CAM5 (30 Levels) at 0.94 by 1.25 (Lat by Lon) run in weather forecast mode for 6 days forecast

Observations: ARM CMBE ARSCL clouds and ARM SGP large-scale continuous forcing data

Analysis period: June to August 2008 and May to June 2009, 153 days in total

Select typical weather regimes based on observations

Clear-sky days: no precipitation, total cloud cover less than 10%, 4 days

Shallow cumulus days: based on shallow cumulus day index, 10 days

Late-afternoon precipitation days: prec rate > 1 mm/d and peaks between 15 to 20 LST, and the peak is twice larger than maximum at other times, 6 days

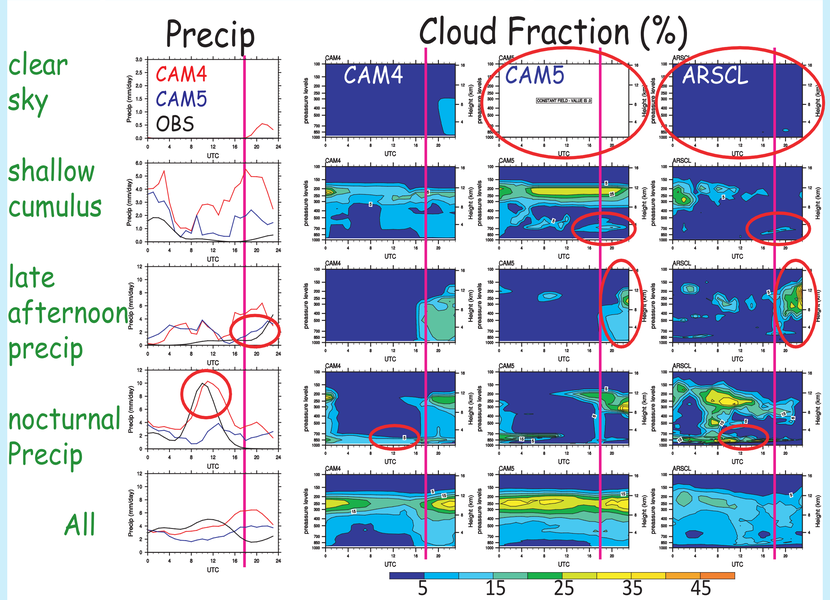
Nocturnal heavy precipitation days: prec rate > 1 mm/d and peaks between 2 to 6 LST, and in the following afternoon prec rate < 1mm/d, 10 days

Summary and Future Work

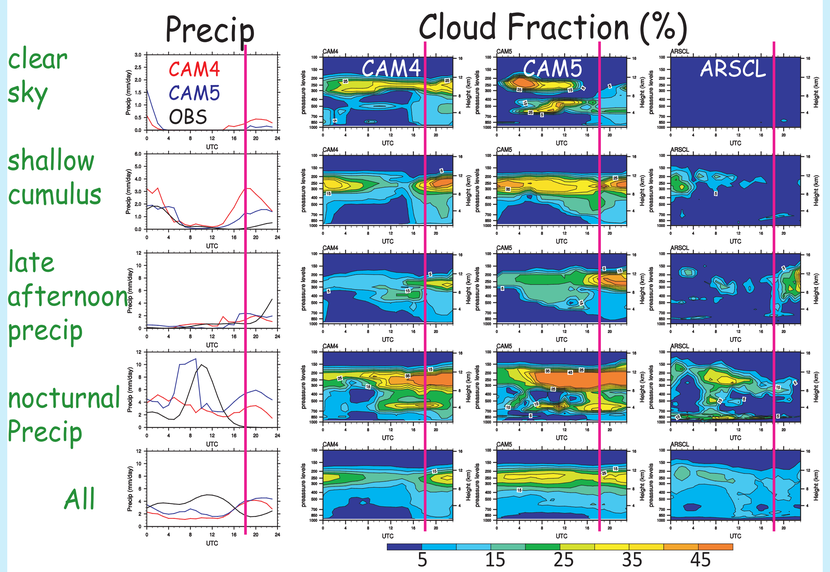
Prevailing high cloud fraction is found with both CAM4 and CAM5 on Day 1, Day3 and Day5 forecast, while Day2 forecast shows a rather better agreement from CAM5 with OBS: clear-sky cloud fraction, daytime low-level cloud fraction on shallow cumulus days, timing of preciptation and cloud on late-afternoon precip days. However CAM4's precip phase agreement on nocturnal precip days seems to be related to low clouds rather than deep convection. Surface warm and dry bias is found with all forecasts so as overestimation in surface radiation and wrong partition between latent and sensible heat which may be related to soil moisture.

We will run LES/SCAM to isolate the probelms related to CAM5 convection and cloud parameterizations.

Day2 Forecast Precip and Cloud

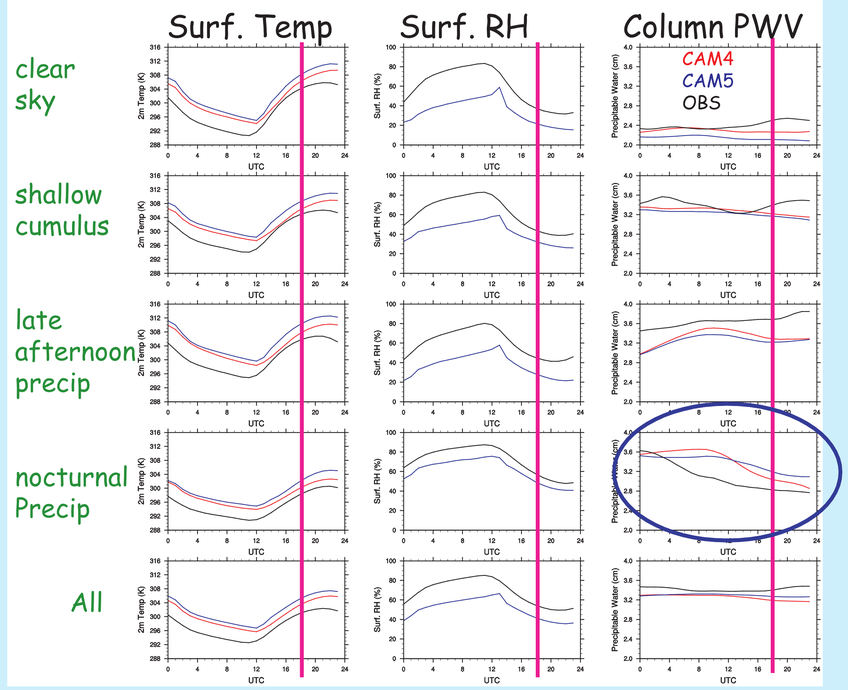


Day5 Forecast Precip and Cloud

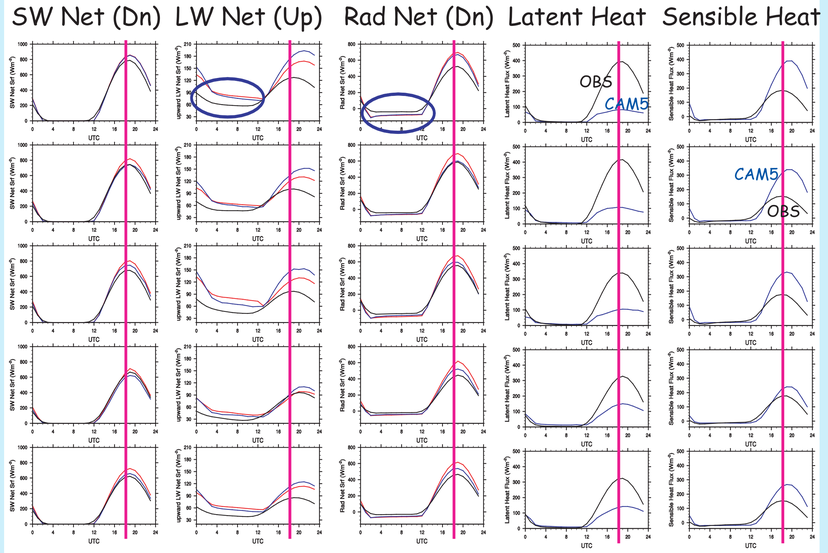


Day2 Temperature and Humidity

Warm and Dry except on norturnal precip days

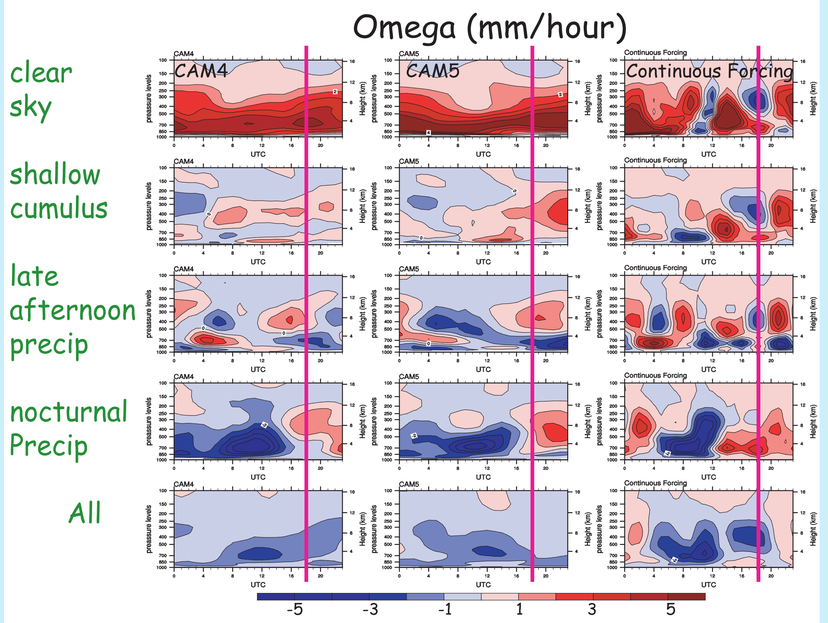


Day2 Surface Radiation & Heat

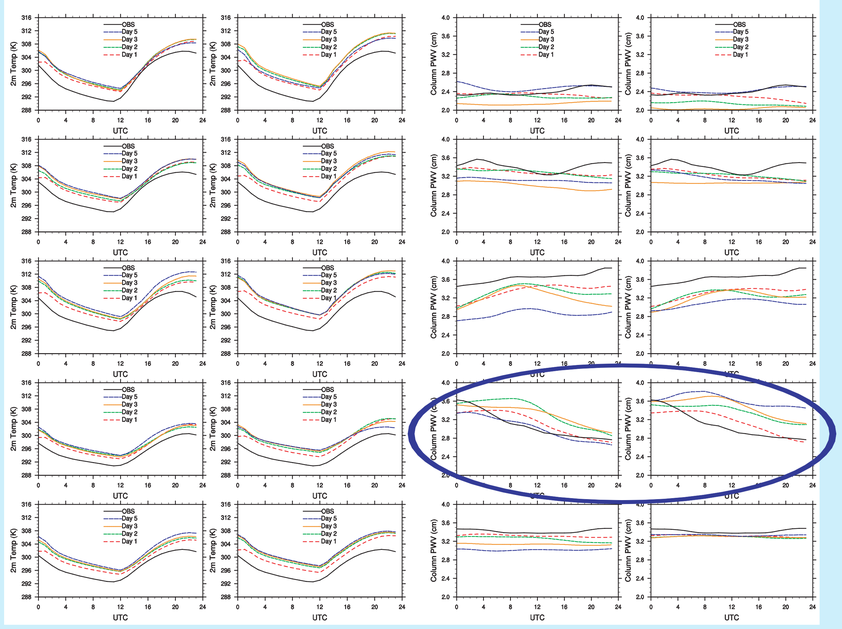


Overestimate in surface radiation in both CAM4 and 5 and Wrong Patition of Surface Heat Flux in CAM5.

Day 2 Forecast Dynamics



Warm and Dry for Day1 to Day5



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