# CAUSES: Warm bias contribution from surface water and energy budgets

Hsi-Yen Ma, Stephen Klein, Shaocheng Xie and Chengzhu Zhang

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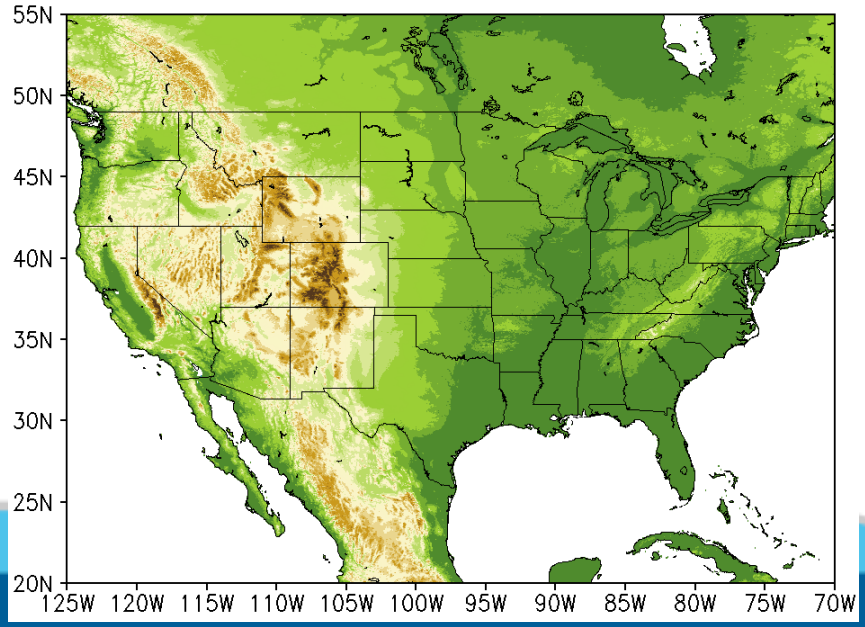
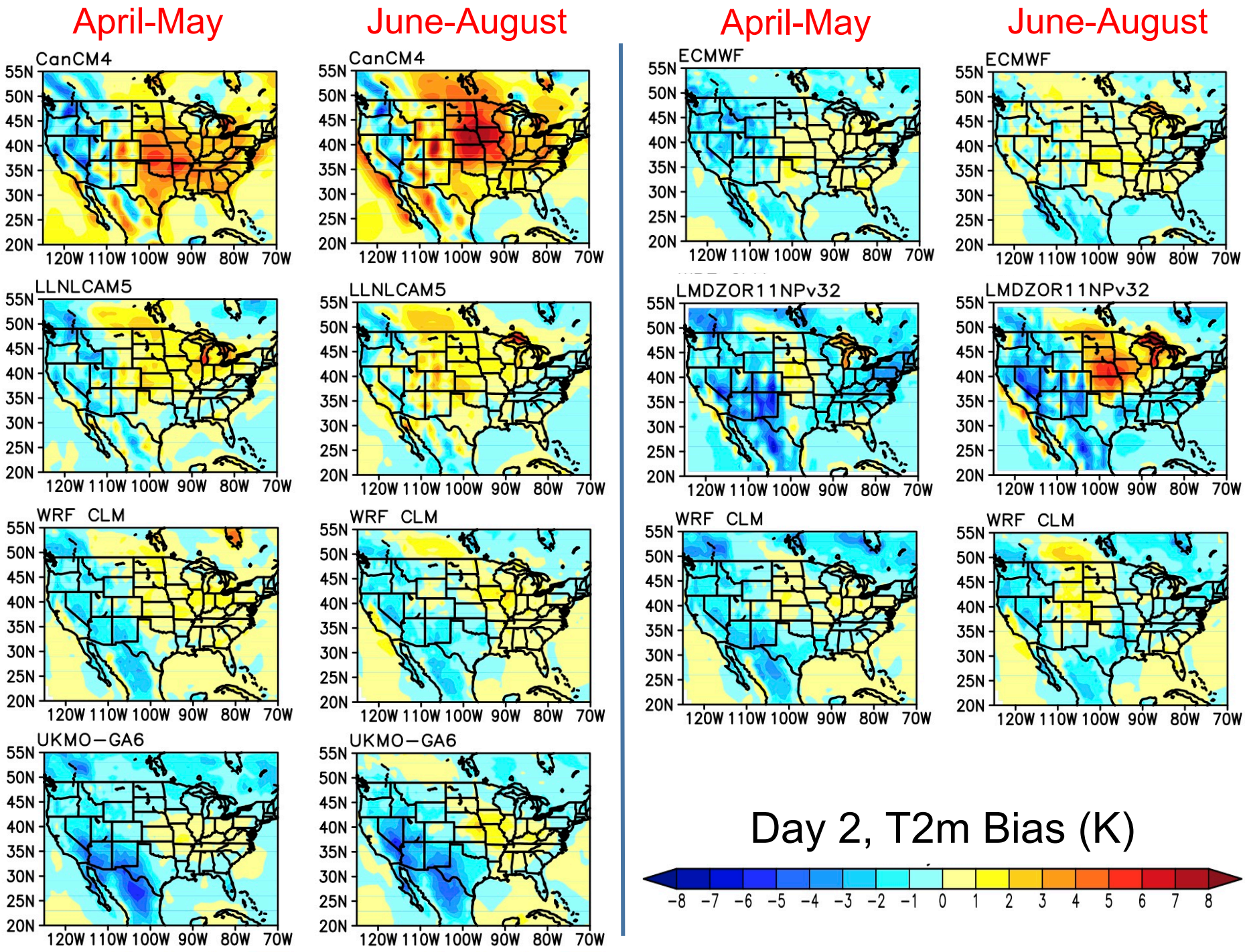
# Science Questions to Address

- What is the role of precipitation and surface energy budget errors in causing the prominent warm biases in surface air temperature over summertime land masses?
  - (1) What is the relative contribution of precipitation errors to the temperature errors?
  - (2) Which type of precipitating convection systems dominate the errors in the surface precipitation?
  - (3) Does this atmosphere provide the correct amount of precipitation for the soil?
  - (4) Does the surface energy balance reveal signs that evaporation is underestimated due to the lack of soil moisture?

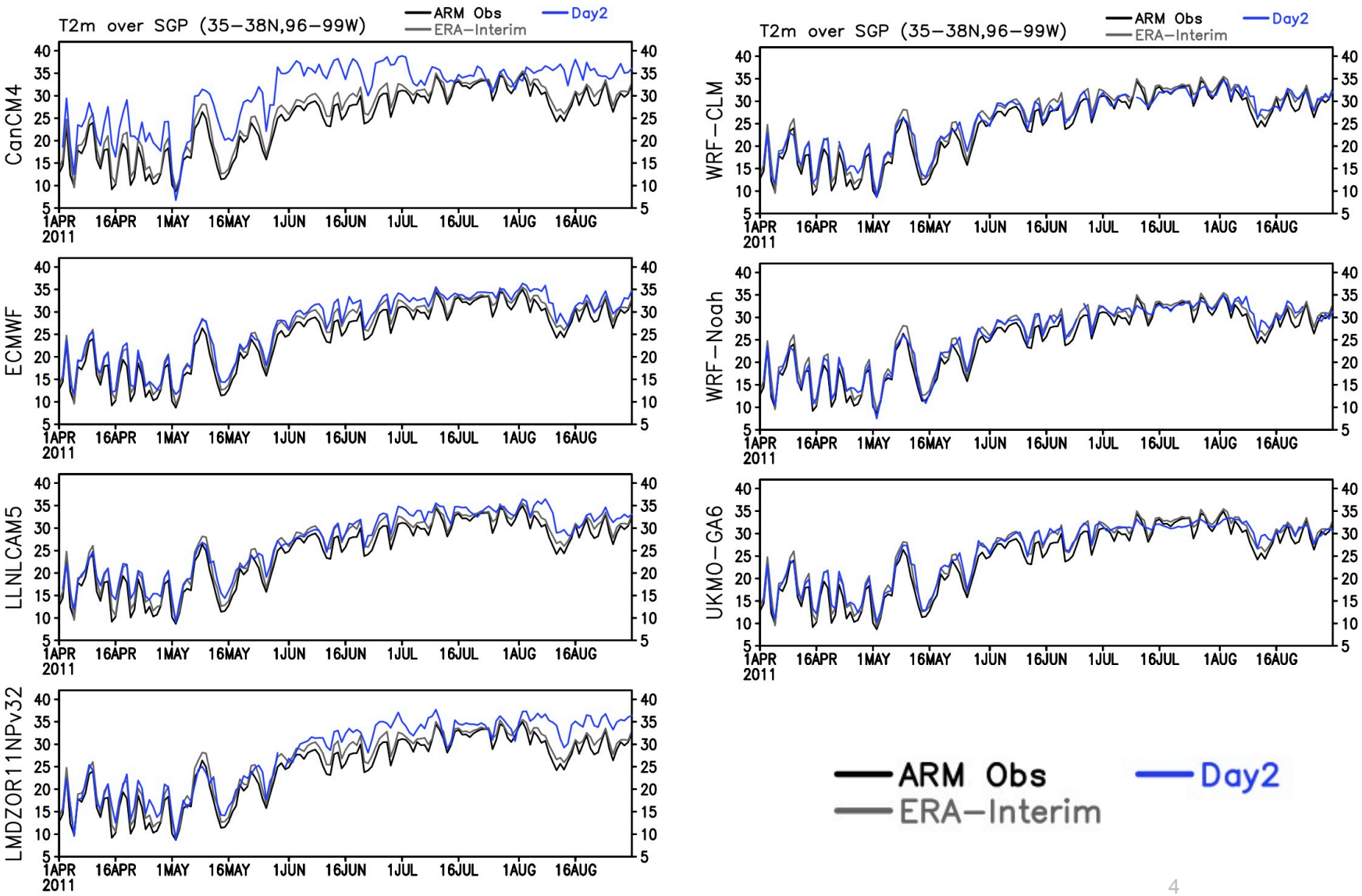
# CAUSES Experiments

- Exp 1d: 5-day long hindcasts for April 01 to August 31, 2011
- Exp 2a: 4-mon long hindcasts starting every 1st day of each month in 2011
- Hourly mean, 1x1 degree, CONUS domain

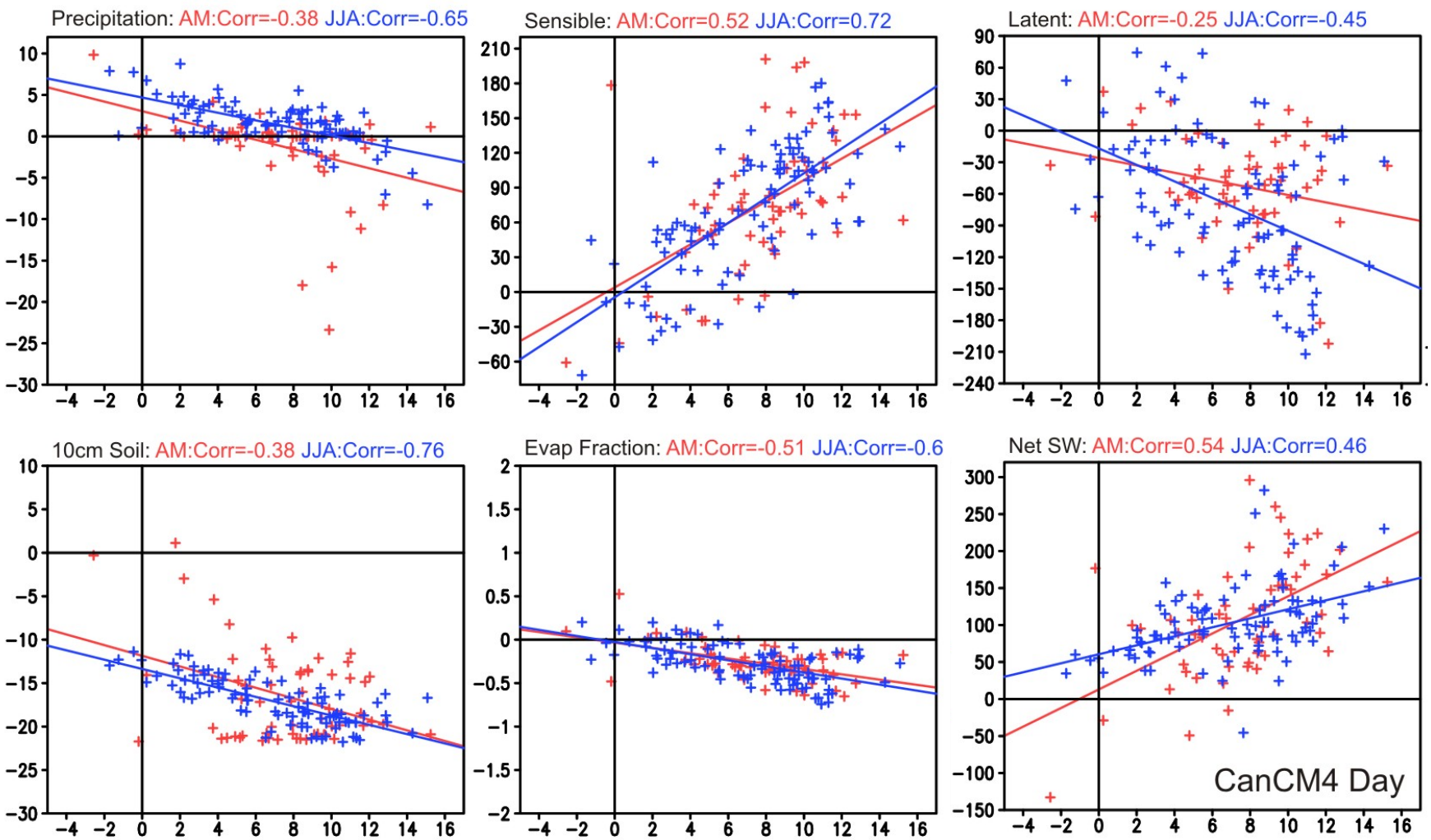


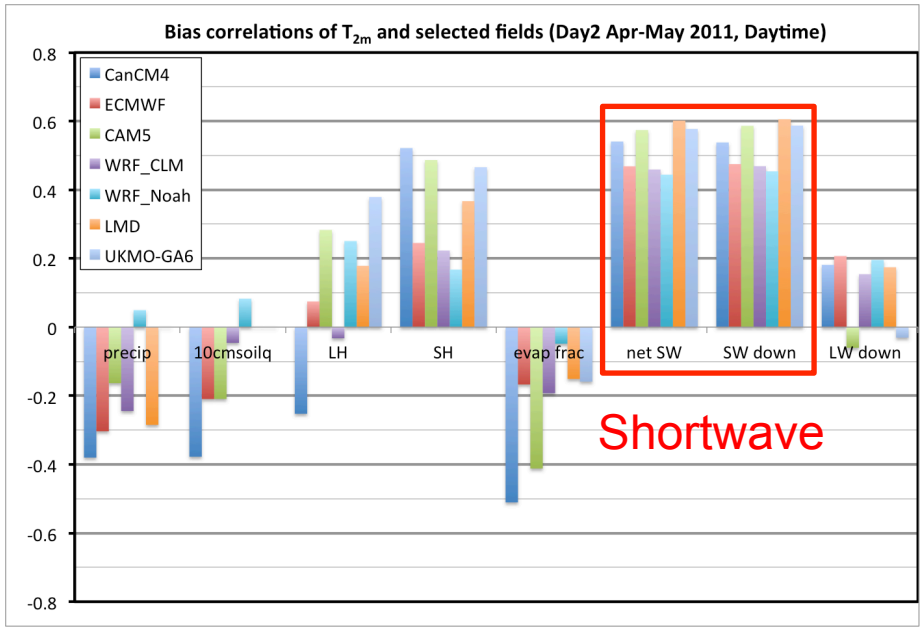

April-May
June-August
April-May
June-August
CanCM4
CanCM4
ECMWF
ECMWF
LLNLCAM5
LLNLCAM5
LMDZOR11NPv32
LMDZOR11NPv32
WRF CLM
WRF CLM
WRF CLM
WRF CLM
UKMO-GA6
UKMO-GA6
55N 50N 45N 40N 35N 30N 25N 20N
120W 110W 100W 90W 80W 70W
Day 2, T2m Bias (K)
-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8

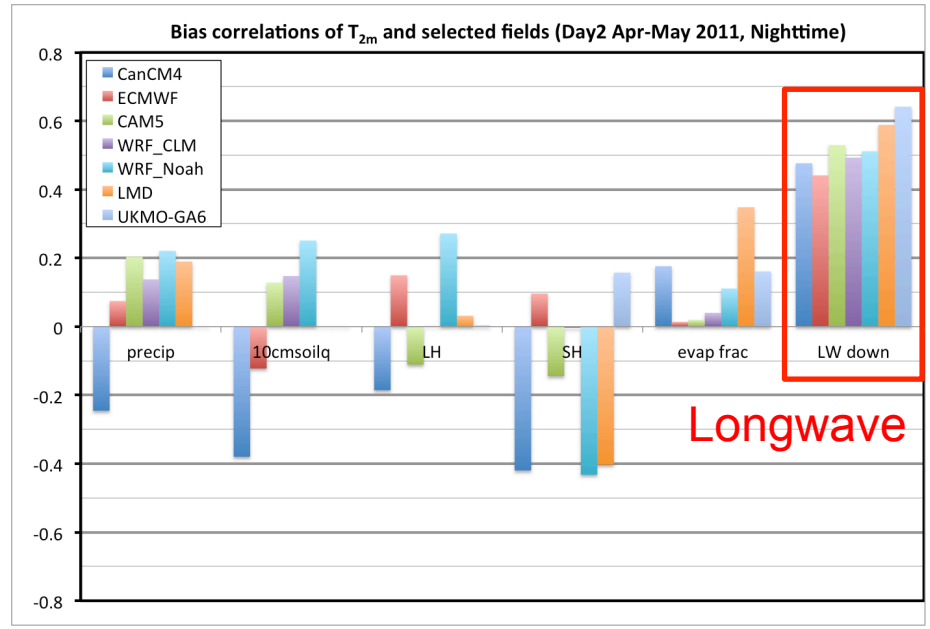
# Daily 2 meter temperature at ARM SGP

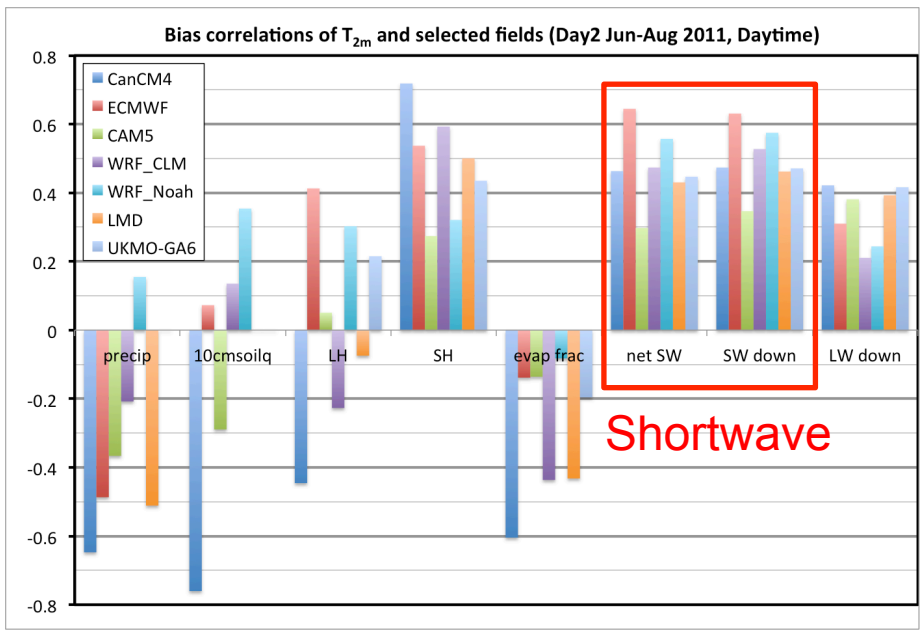


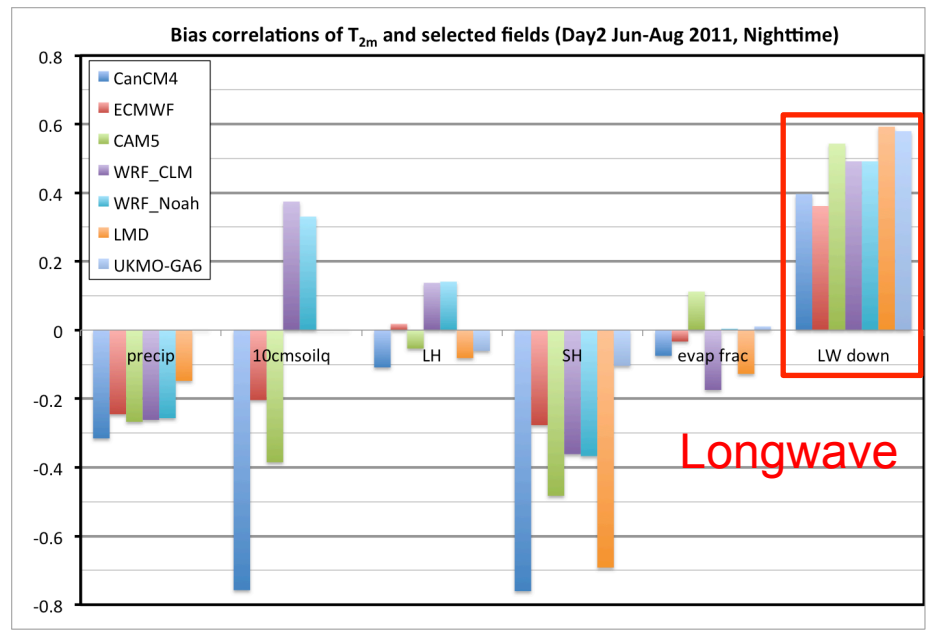
# $T_{2m}$ bias v.s. Precip & Surface Fluxes biases




Bias correlations of $T_{2m}$ and selected fields (Day2 Apr-May 2011, Daytime)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
CanCM4
ECMWF
CAM5
WRF_CLM
WRF_Noah
LMD
UKMO-GA6
precip
10cmsoilq
LH
SH
evap frac
net SW
SW down
LW down
Shortwave

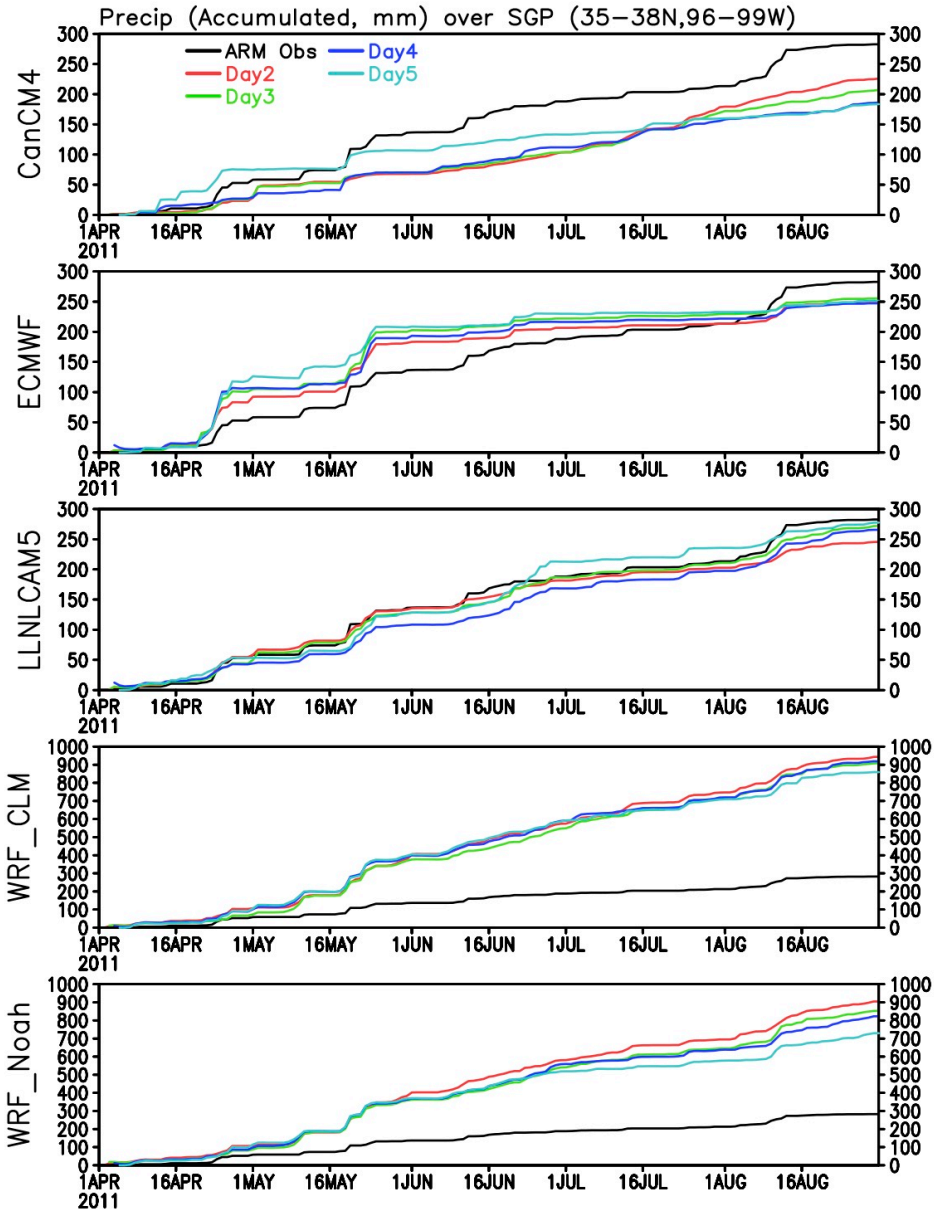

Bias correlations of $T_{2m}$ and selected fields (Day2 Apr-May 2011, Nighttime)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
CanCM4
ECMWF
CAM5
WRF_CLM
WRF_Noah
LMD
UKMO-GA6
precip
10cmsoilq
LH
SH
evap frac
LW down
Longwave


Bias correlations of $T_{2m}$ and selected fields (Day2 Jun-Aug 2011, Daytime)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
CanCM4
ECMWF
CAM5
WRF_CLM
WRF_Noah
LMD
UKMO-GA6
precip
10cmsoilq
LH
SH
evap frac
net SW
SW down
LW down
Shortwave

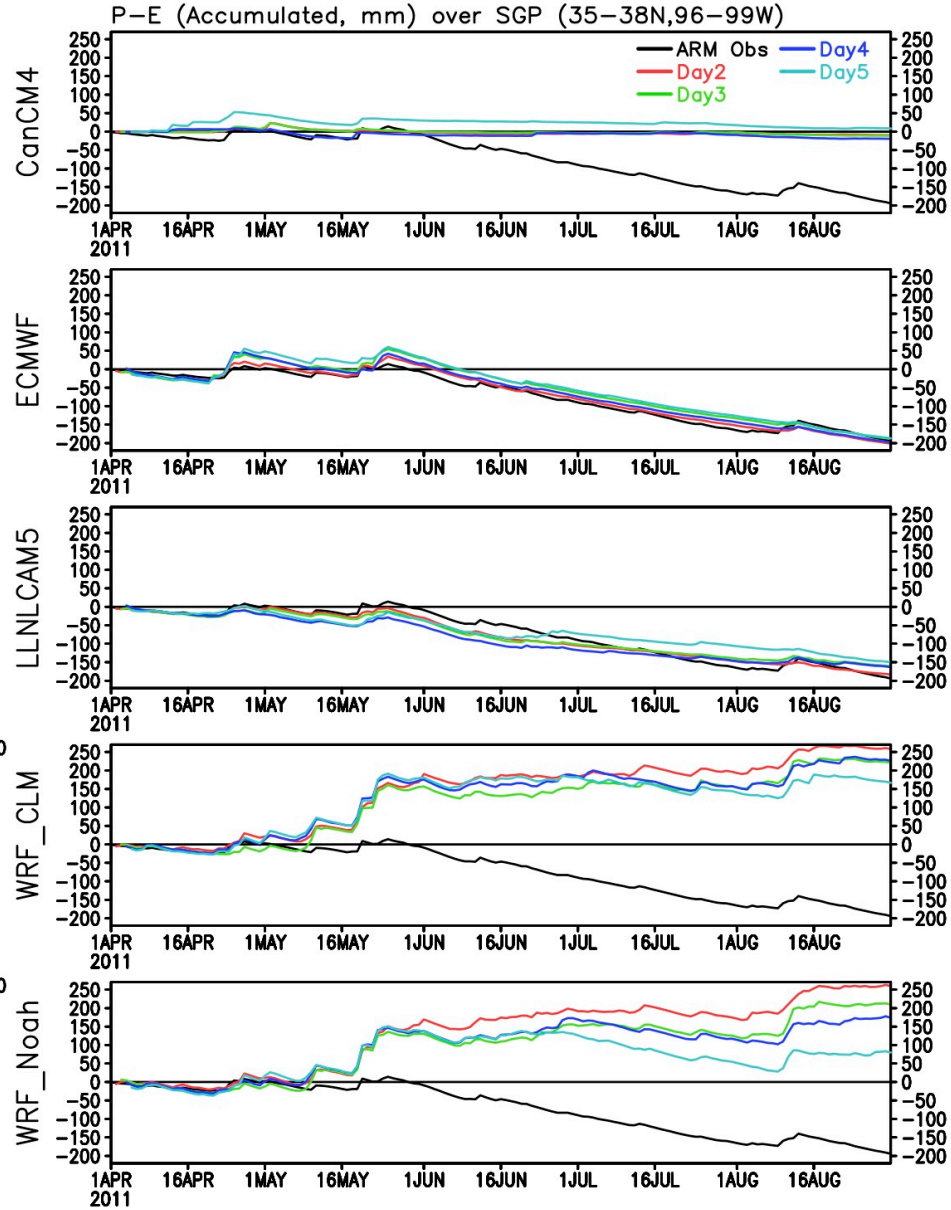

Bias correlations of $T_{2m}$ and selected fields (Day2 Jun-Aug 2011, Nighttime)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
CanCM4
ECMWF
CAM5
WRF_CLM
WRF_Noah
LMD
UKMO-GA6
precip
10cmsoilq
LH
SH
evap frac
LW down
Longwave

# Water Budget Analysis

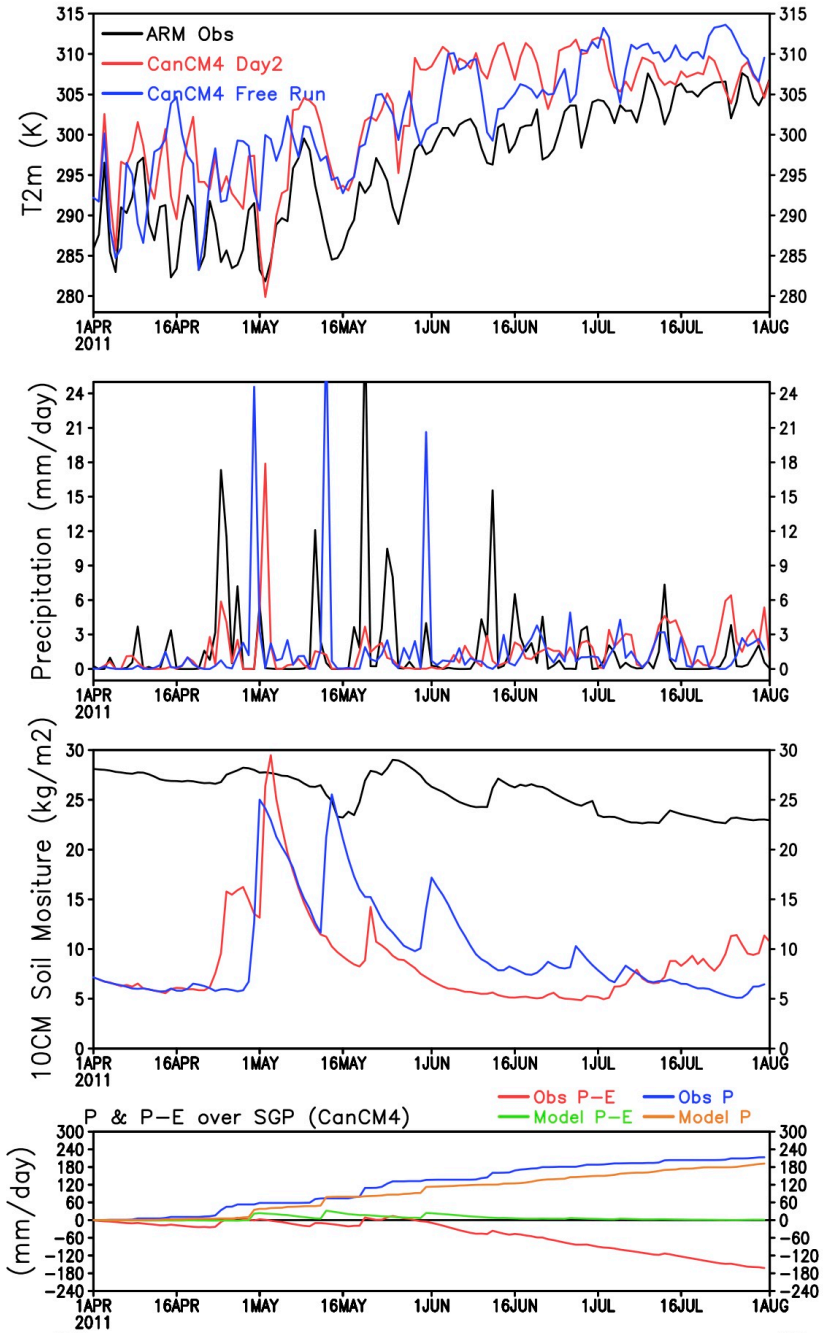
# Accumulated Precipitation



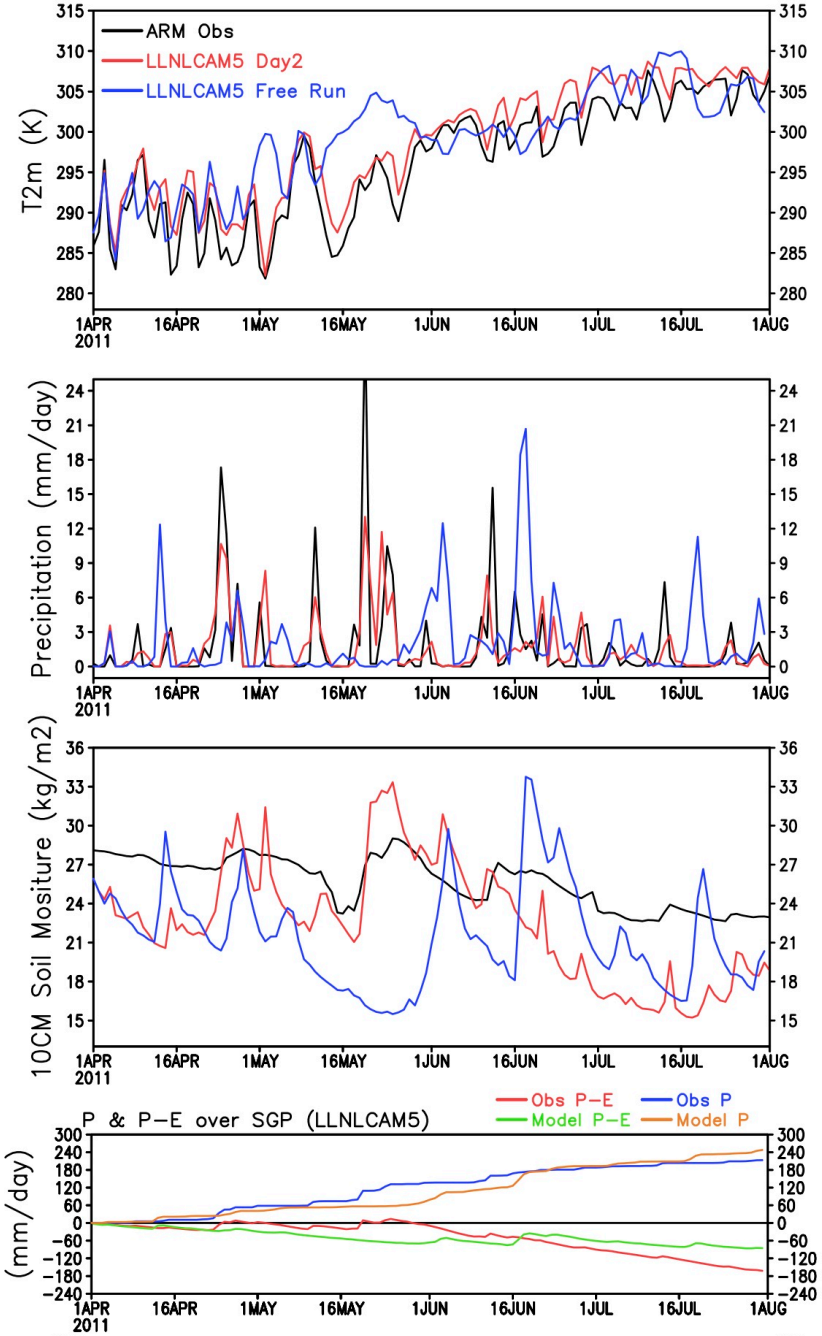

# P-E (Accumulated)



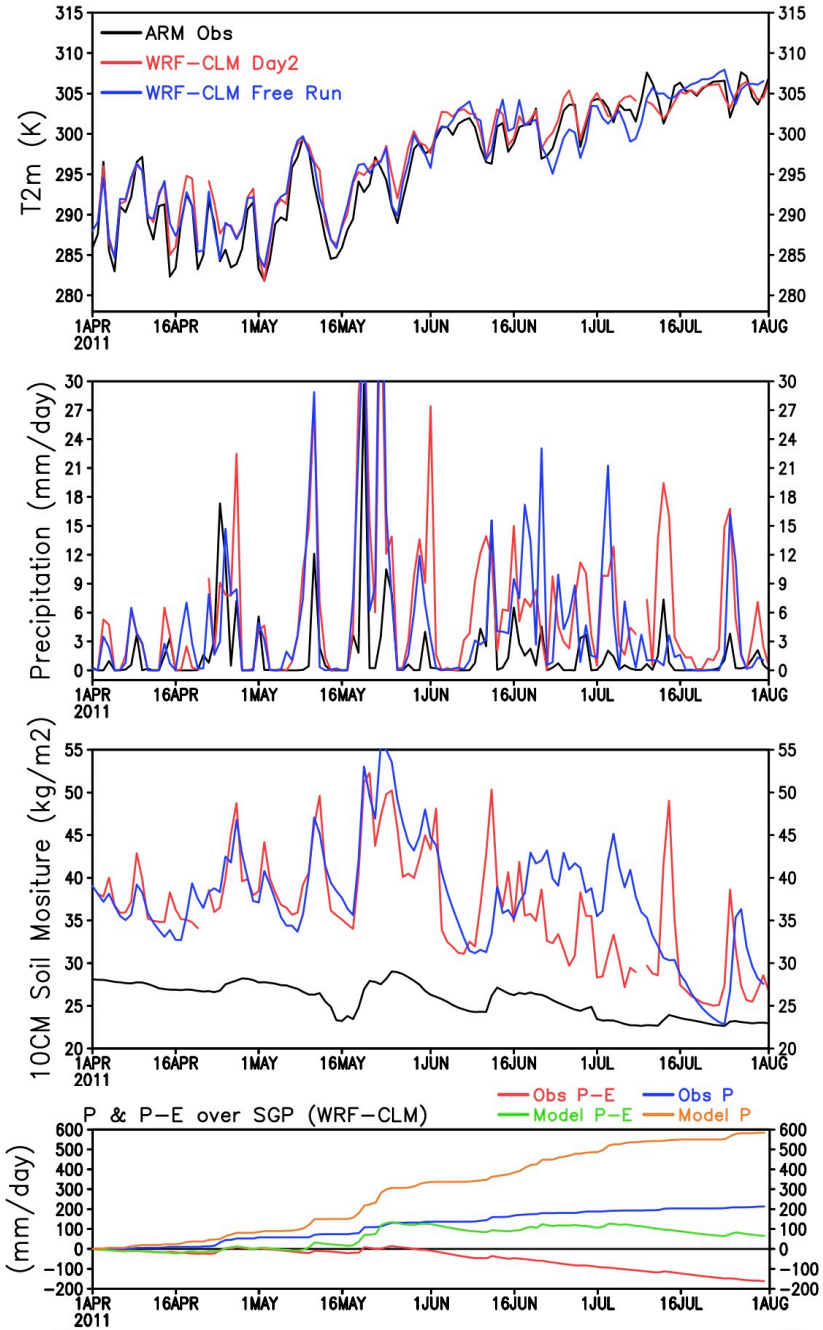
# CanCM4


ARM Obs
CanCM4 Day2
CanCM4 Free Run
T2m (K)
Precipitation (mm/day)
10CM Soil Mositure (kg/m2)
Obs P−E
Obs P
Model P−E
Model P
P & P−E over SGP (CanCM4)
(mm/day)
1APR 2011
16APR
1MAY
16MAY
1JUN
16JUN
1JUL
16JUL
1AUG

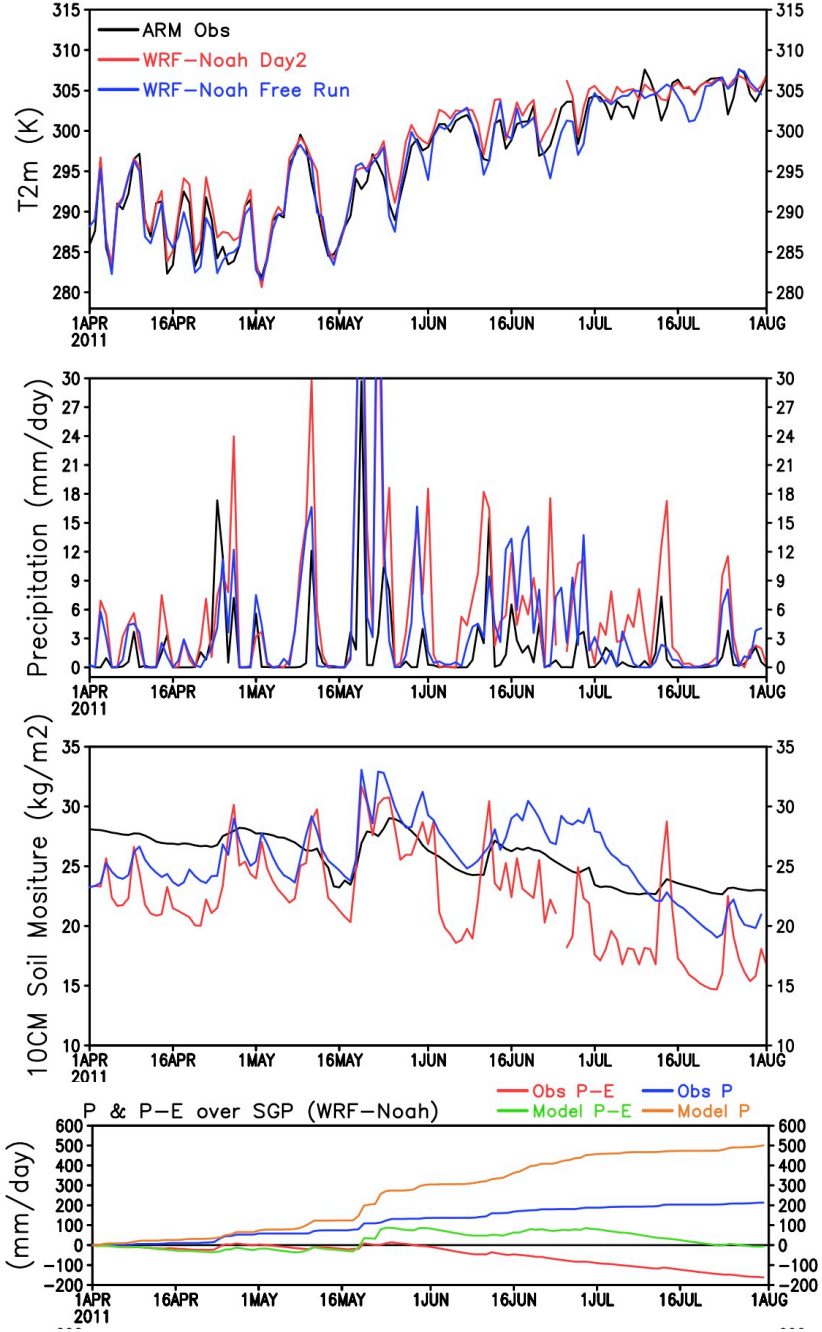
# CAM5


ARM Obs
LLNLCAM5 Day2
LLNLCAM5 Free Run
T2m (K)
Precipitation (mm/day)
10CM Soil Mositure (kg/m2)
Obs P−E
Obs P
Model P−E
Model P
P & P−E over SGP (LLNLCAM5)
(mm/day)
1APR 2011
16APR
1MAY
16MAY
1JUN
16JUN
1JUL
16JUL
1AUG

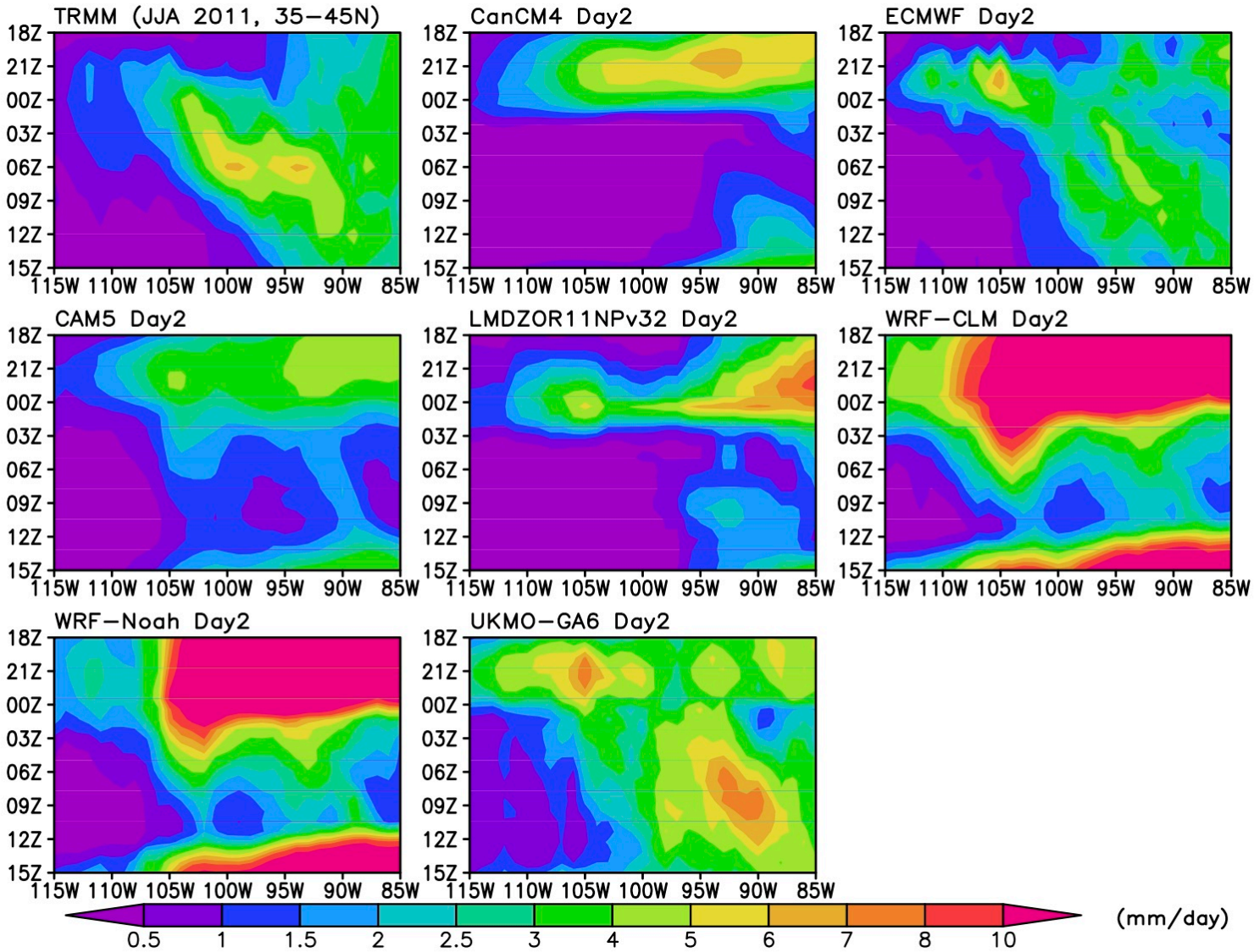
# WRF-CLM




# WRF-Noah



# Diurnal cycle of Precipitation (June-August 2011)



# Summary

- All models simulate surface warm bias by Day 2 over the central U.S.
- Surface shortwave flux bias seems to be the major contributor to the warm bias during daytime. Longwave flux bias seems to be the major contributor during nighttime.
- ECMWF and LLNLCAM5 simulate reasonable accumulated precipitation and P - E. CanCM4 simulate low precipitation and even lower evaporation. WRF_CLM and WRF_Noah simulate too much precipitation.
- Low soil moisture (for CanCM4, CAM5) resulting from biased low precipitation is likely one of the main reasons for surface warm bias in the summer.