The West African Monsoon Modeling and Evaluation project (WAMME) and its first experiment

Yongkang Xue, W. K-M Lau, K. H. Cook, D. Rowell, A. Boone, J. Feng, F. De Sales, A. Konare, T. Bruecher, P. Dirmeyer, L. M. Druyan, A. Fink, M. Fulakeza, Z. Guo, S. M. Hagos, K.-M. Kim, A. Kitoh, V. Kumar, P. Lonergan, M. Pasqui, I. Poccard-Leclercq, N. Mahowald, W. Moufouma-Okia, P. Pegion, I. S. Sanda, S. D. Schubert, A. Sealy, W. Thiaw, A. Vintzileos, E. K. Vizy, S. Williams, M.-L. C. Wu

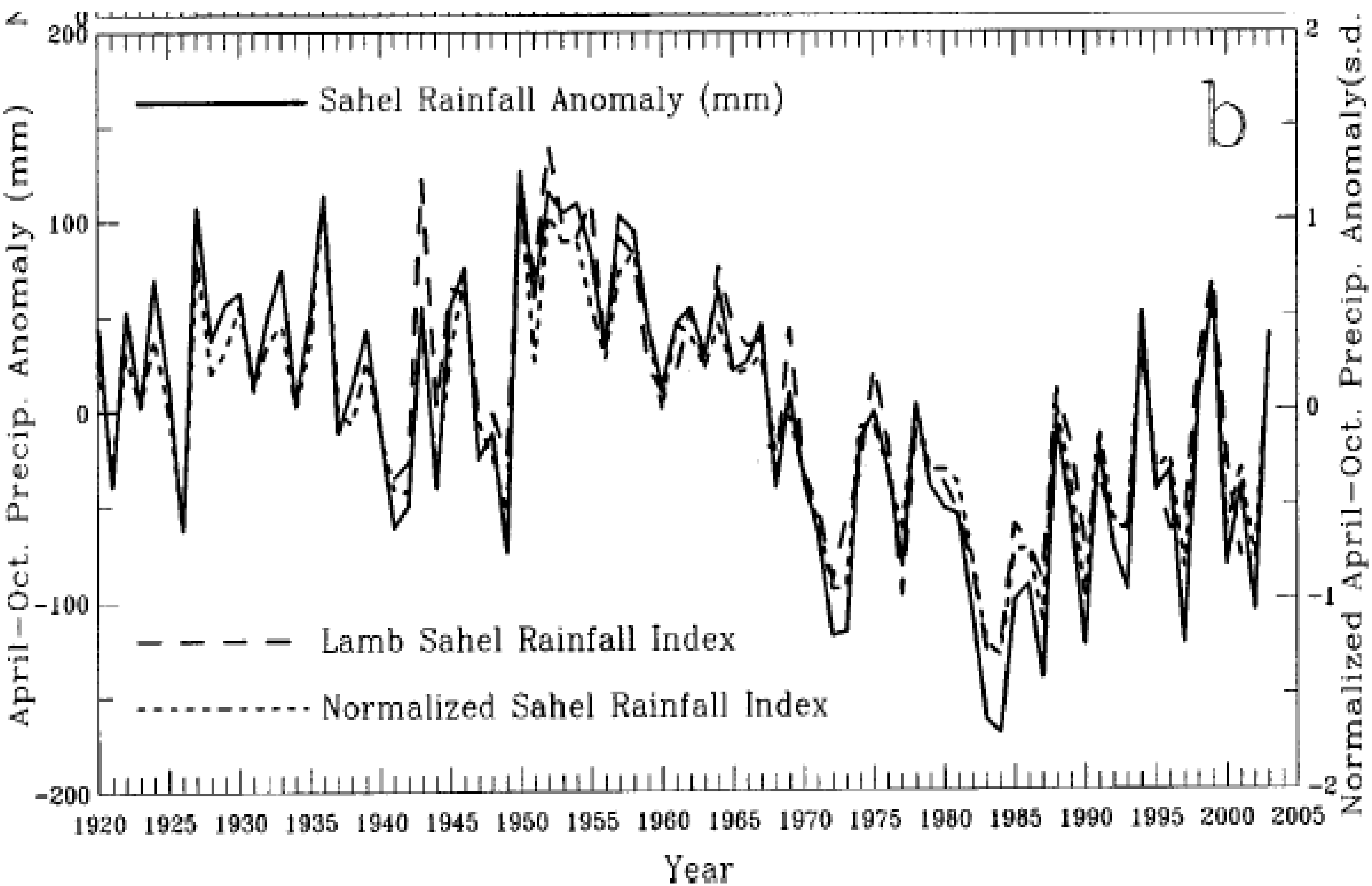
The Second Annual Meeting of the Coordinated Energy and Water Cycle Observations Project (CEOP)

Geneva, Switzerland 15–17 September 2008.

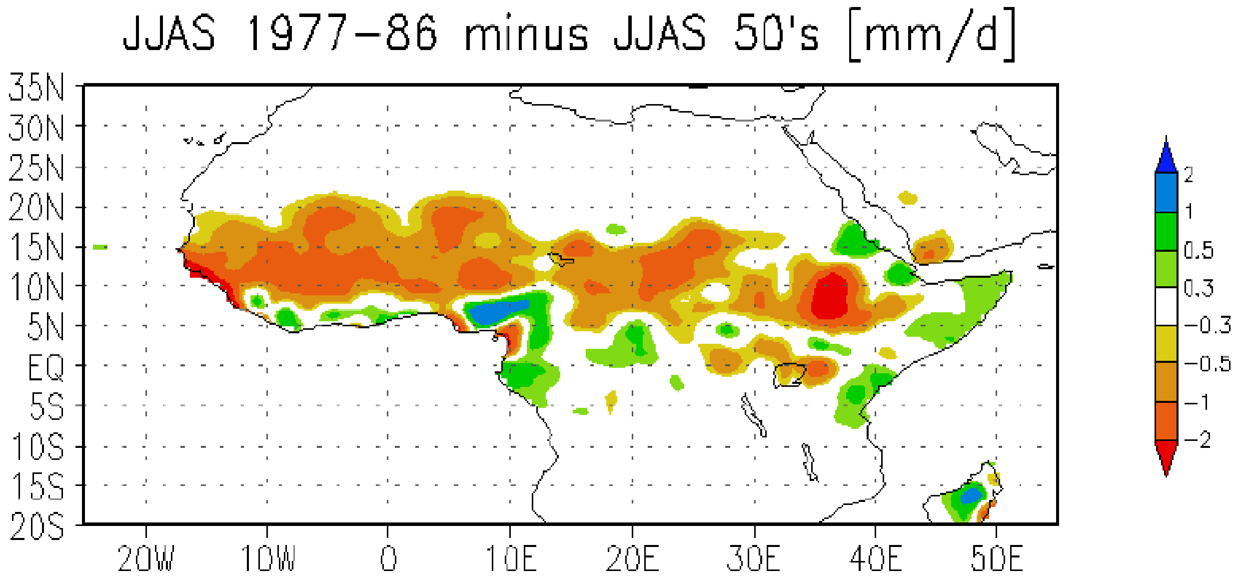
WAMME started in the 2005 Pan WCRP Monsoon workshop, is a CEOP/GEWEX initiative and a test bed for different WAM mechanisms

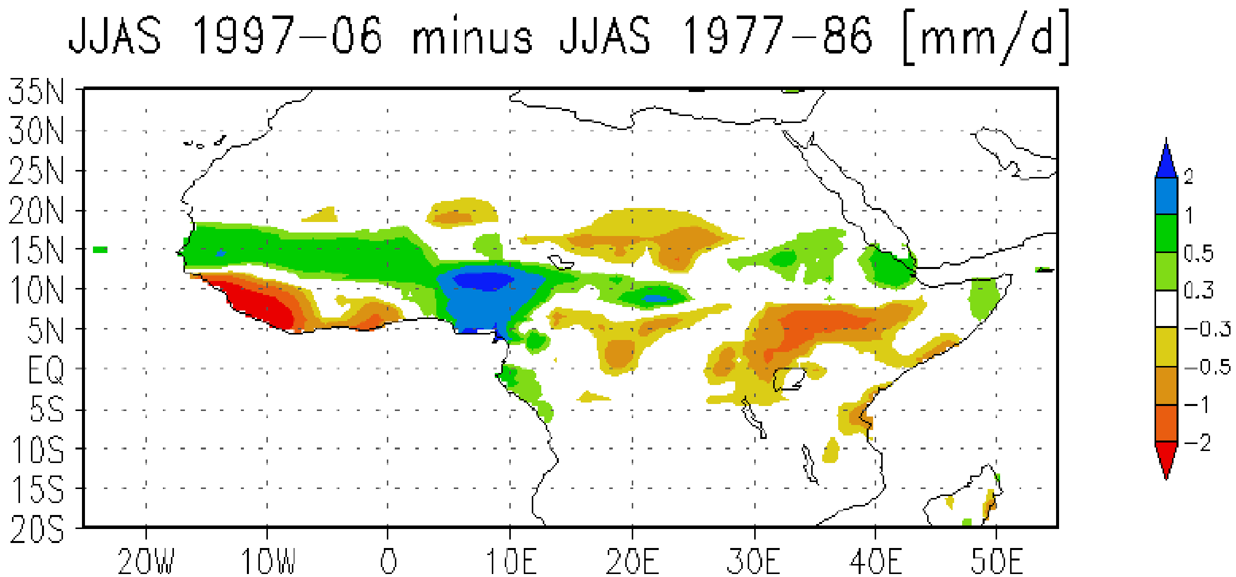
*** Scientific Issues in interactions between West African monsoon , ocean, land, and aerosol**
*** Challenges in their modeling**

Time series of Sahel regional rainfall for April-October

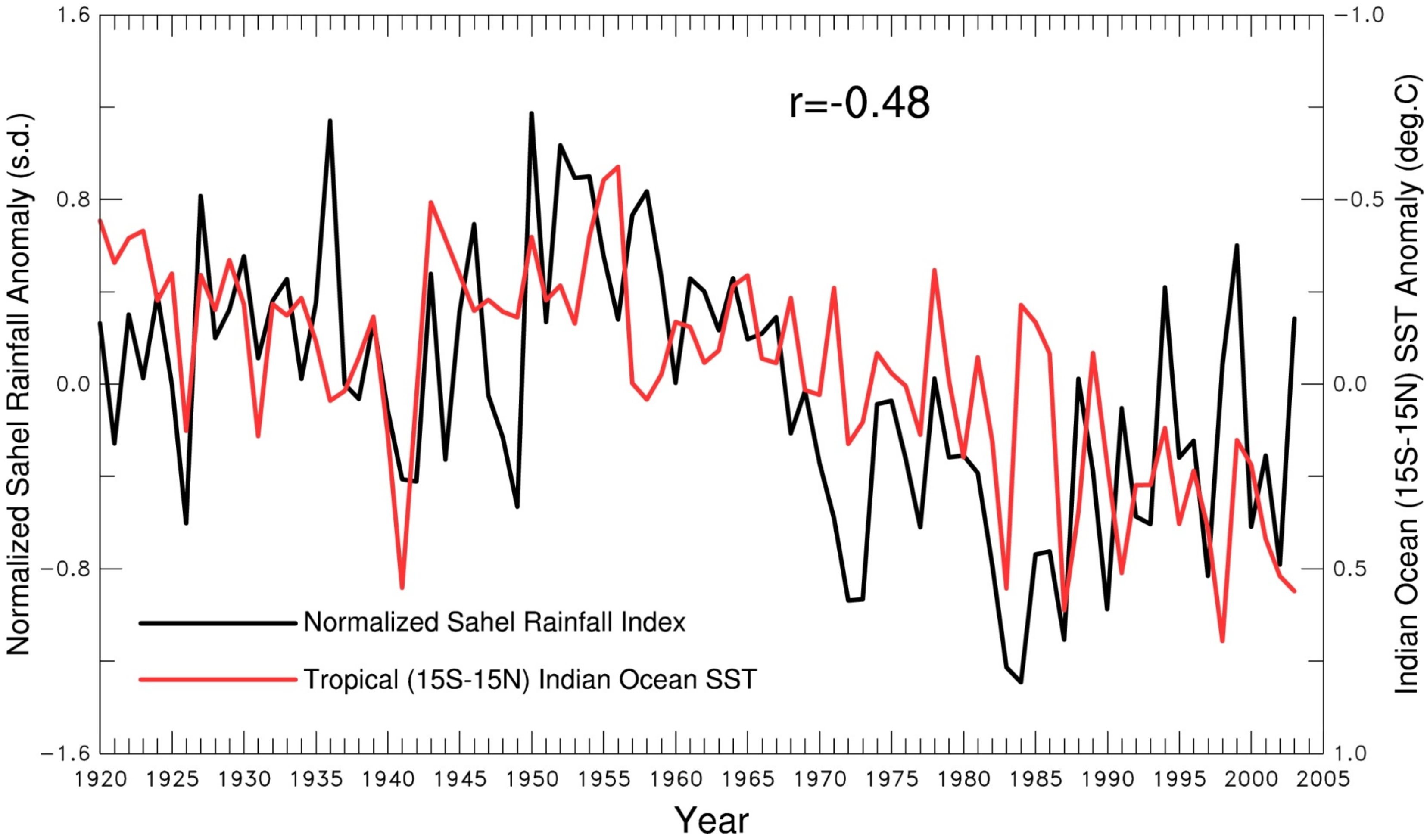


Dai et al., 2004


JJAS 1977-86 minus JJAS 50's [mm/d]
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
20W
10W
0
10E
20E
30E
40E
50E
2
1
0.5
0.3
-0.3
-0.5
-1
-2

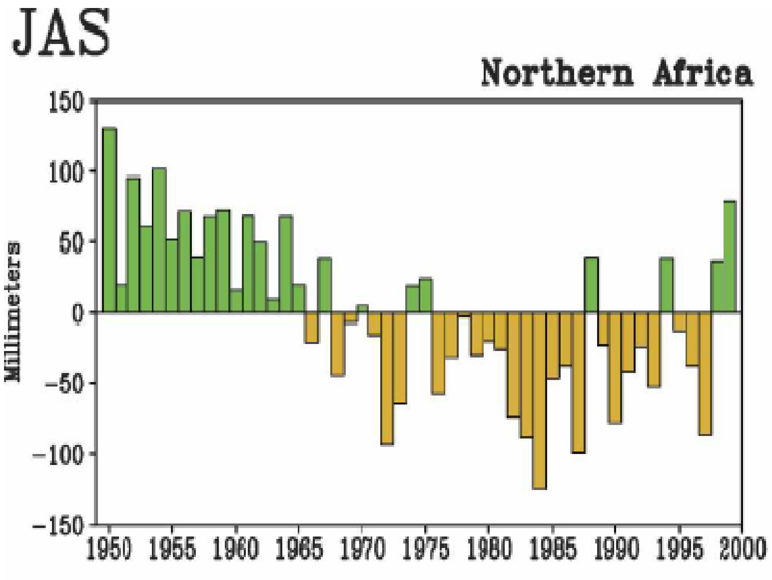

JJAS 1997-06 minus JJAS 1977-86 [mm/d]
35N
30N
25N
20N
15N
10N
5N
EQ
5S
10S
15S
20S
20W
10W
0
10E
20E
30E
40E
50E
2
1
0.5
0.3
-0.3
-0.5
-1
-2

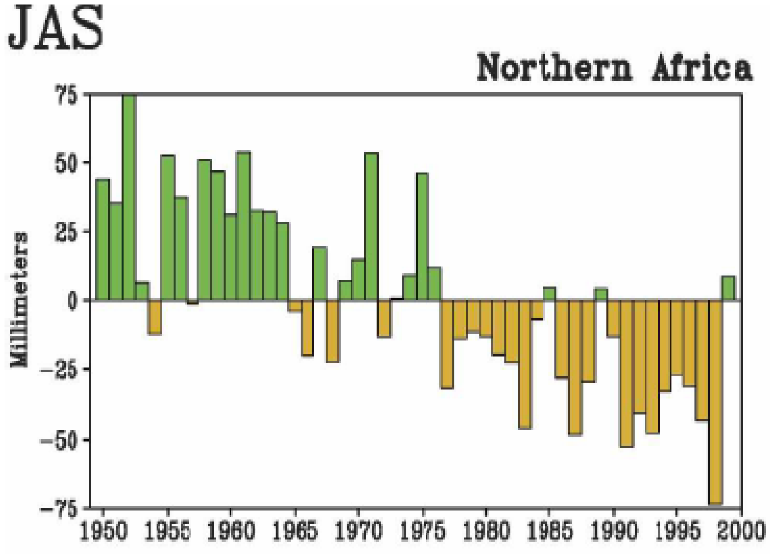
Sahel Rainfall vs. Tropical Indian Ocean SST



Rainfall index from Dai et al.(2004), SST from merged CRU surface temp dataset.
Plot created by A. Dai/NCAR

Simulated 1950-1999 JAS rainfall departure
Hoerling et al., 2006





observation

Simulation

JJA Soil moisture/atmosphere coupling strength

Multi-model average

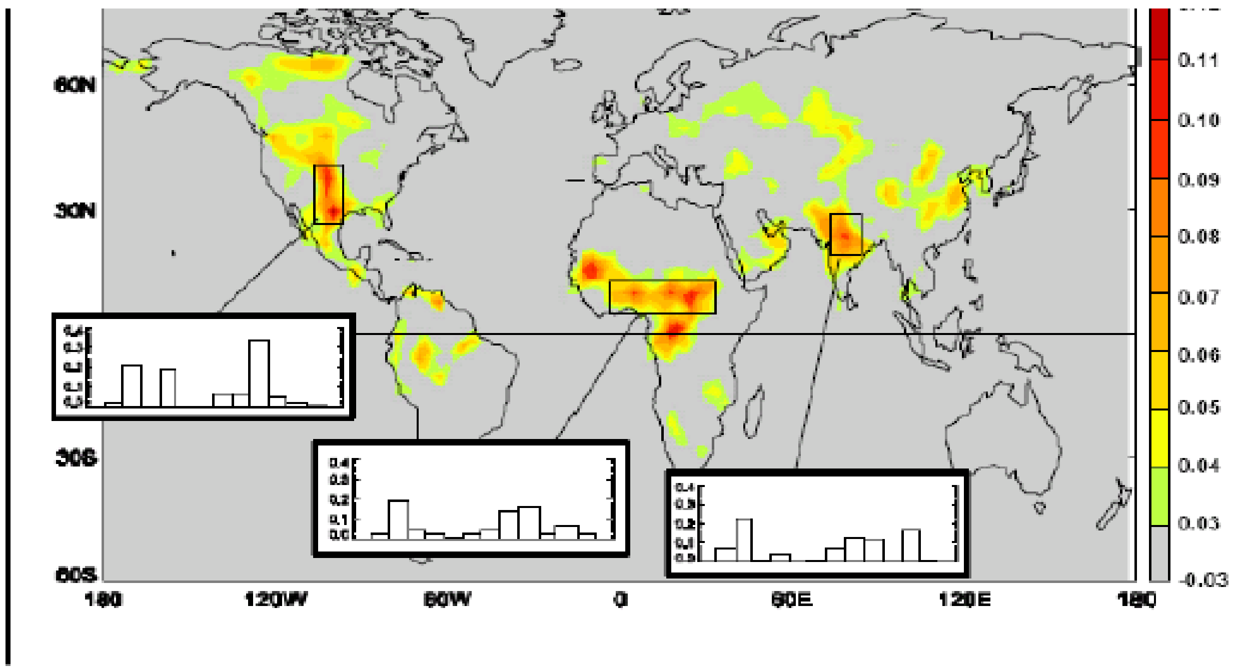
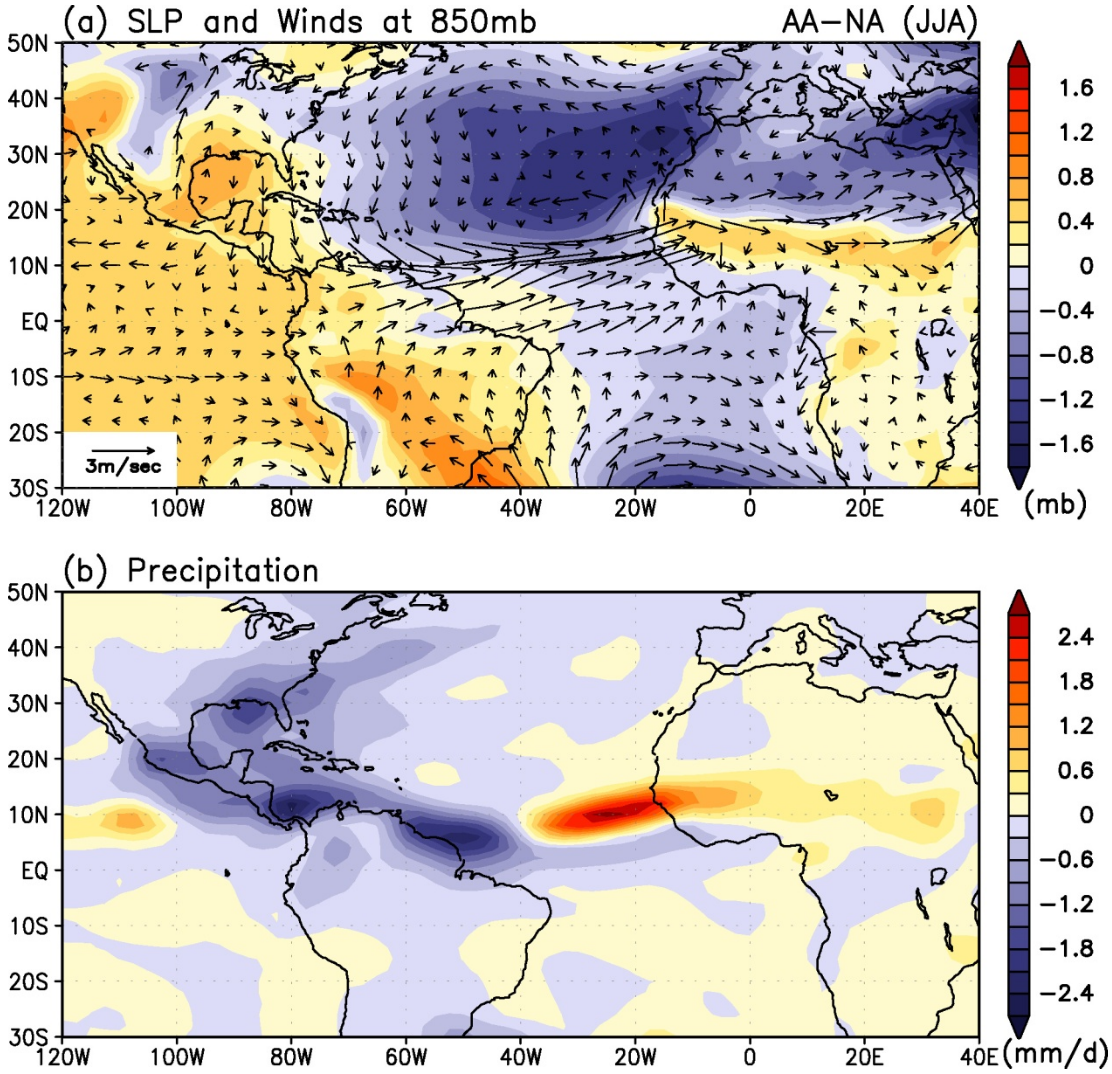


Figure 1. The land-atmosphere coupling strength diagnostic for boreal summer (the Ω difference, dimensionless, describing the impact of soil moisture on precipitation), averaged across the twelve models participating in GLACE. The insets show the areally-averaged coupling strengths for the twelve individual models over the outlined, representative hotspot regions. No signal is seen in

850 mb wind, sea level pressure and rainfall induced by direct effects of dust in the NASA fvGCM



Yoshioka, Mahowald, et al., 2007 (NCAR CAM3)

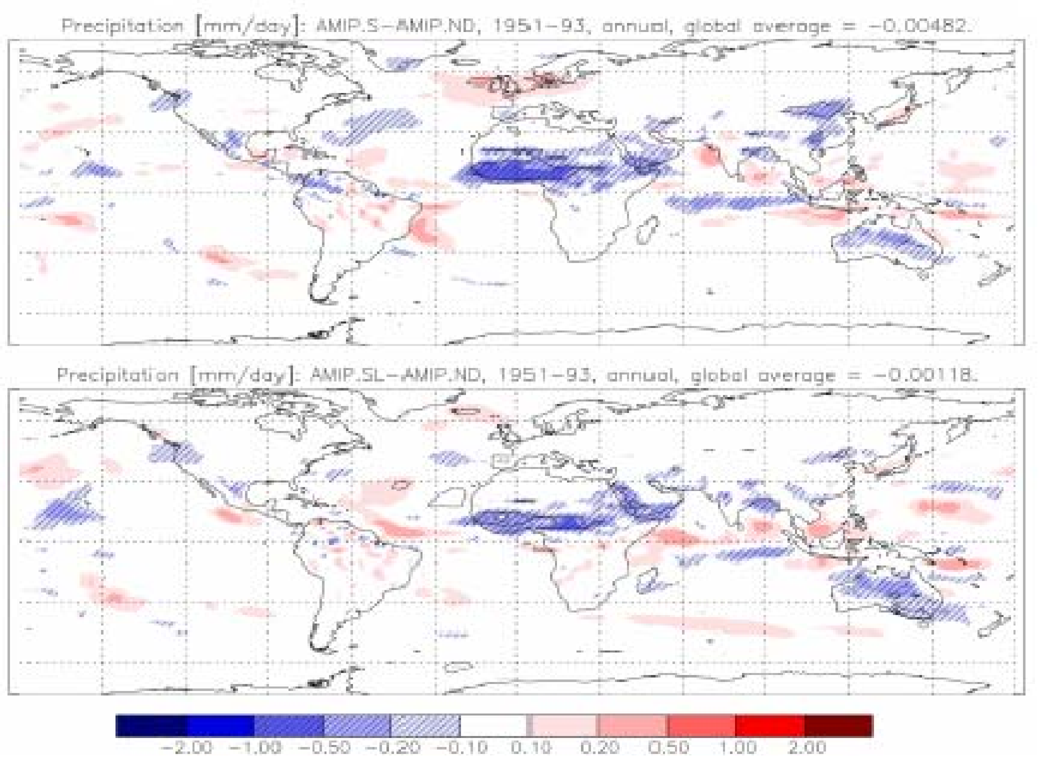


Figure 4a. Differences in AMIP precipitations (1951-93) due to dust radiative forcing and Sahel vegetation (annual).

(The top panel shows AMIP.S–AMIP.ND whole the bottom shows AMIP.SL–AMIP.ND. Solid curves show a statistical significance of differences between cases at 99% level.)

WAMME Objectives

•To Evaluate the ability of GCMs & RCMs in simulating fundamental characteristics of West African monsoon (WAM) at different scales (Diurnal, intraseasonal, annual, interdecadal).

•To identify the common discrepancies, provide better understanding of fundamental physical processes in WAM, and improve WAM prediction .

* To understand roles of oceanic, land, and aerosols in WAM variations at seasonal, interannual, and interdecadal scales, decadal anomalies, as well as WAM onset and withdrawal.

•to demonstrate the utility and synergy of CEOP and AMMA field and assimilation data and remote sensing data in providing a pathway for model physics evaluation and improvement.

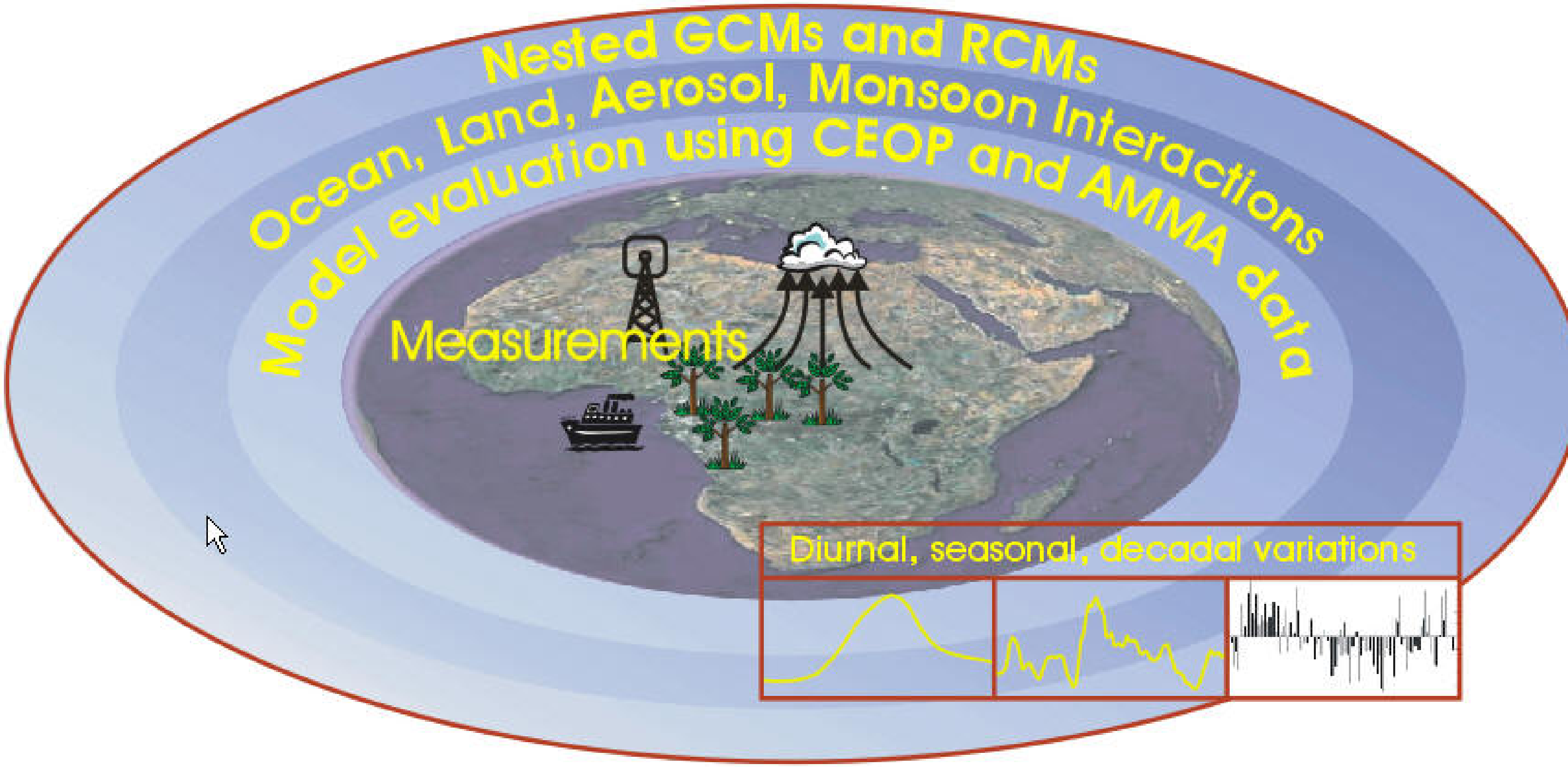
•WAMME uses both GCMs and regional climate models (RCMs). WAMME will evaluate the nested RCMs’ ability of downscaling West African regional climate simulations.

WAMME West African Monsoon Modeling and Evaluation

- Home
- WAMME Initiative
- Experiments
- Documents
- Publications
- Participants
- Forcing and Boundary Data
- Output Data
- Data/Model Output Access
- Models GCM RCM
- Meetings
- Discussions
- Contact Person
- Highlights of new African simulations

WAMME Related:

- CEOP
- AMMA International
- AMMA US
- UCAR Africa Initiative
- ALMIP



WWW.WAMME.Geog.ucla.edu

http://data.eol.ucar.edu//project=WAMME

Table 1: LIST OF WAMME GCMs

Model	Resolution		Model	Resolution
COLA GCM	T62L28		NCEP CFS (AOGCM)	T62L64 (Atmos) 1°x0.3-1°(meri), 40 levels (Ocean)
Cornell/NCAR CAM/CLM3.0*	T42L26		NCEP GFS AGCM	T62L64
MRI/JMA AGCM, Japan	TL959L60		MOHC HadAM3, UK	2.5°x3.75°x19
NASA GMAO/NSIPP1	2.0°x2.5°x34		UCLA AGCM	2.5°x2.5°x17
NASA GSFC FVGCM*	2.0°x2.5°x55		UCLA MRF GCM	T62L28
Cologne ECHAM5 / SVege, Germany	T63L31			

- With Aerosol Package

Table 2: LIST OF WAMME RCMs

Model	Resolution		Model	Resolution
CNR-IBIMET, RAMS, Italy	60 Km, 32 levels		MOHC HadRM3P, UK	0.44°x0.44° 19 Levels
Cornell MM5	50km, 24 levels		Abdus Salam ICTP, Niger RegCM	50km, 18 levels
NASA CCSR/GISS RM3	50km, 28 levels		Univ. of Cocody, Ivory Coast RegCM*	50km, 18 levels
UCLA Eta	50x50 km, 28 levels			

- With Aerosol Package

The Design for simulation

Year: 2000, 2003, 2004, 2005, 2006

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Sea Su ɔ SST/Sea-

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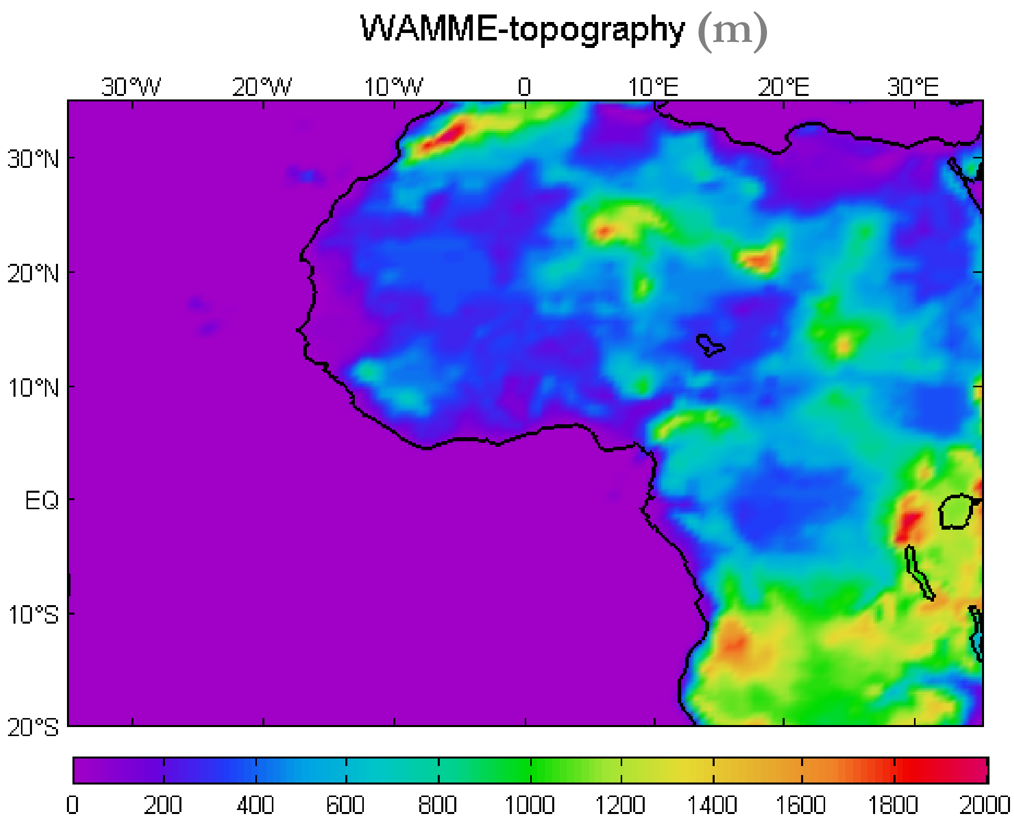
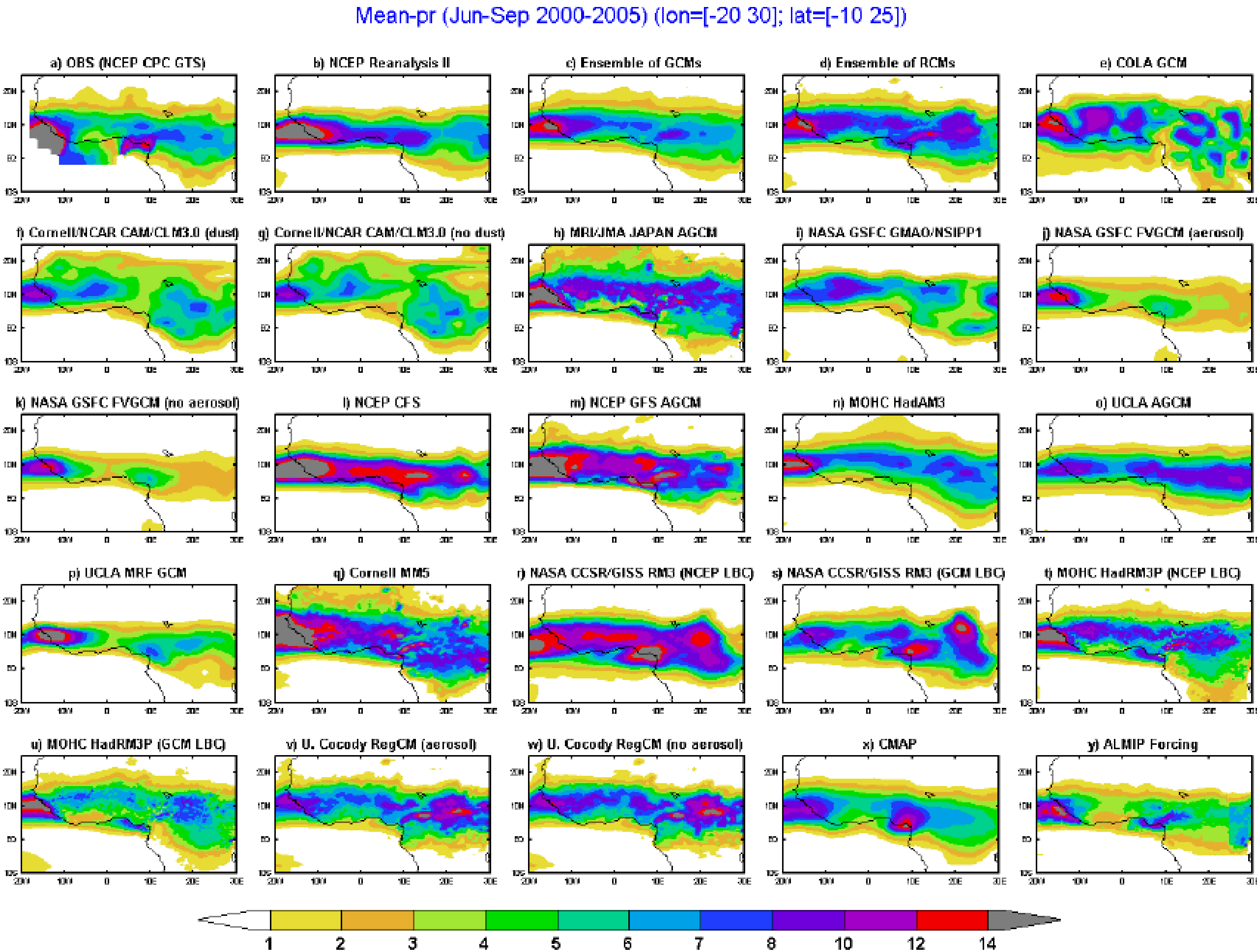
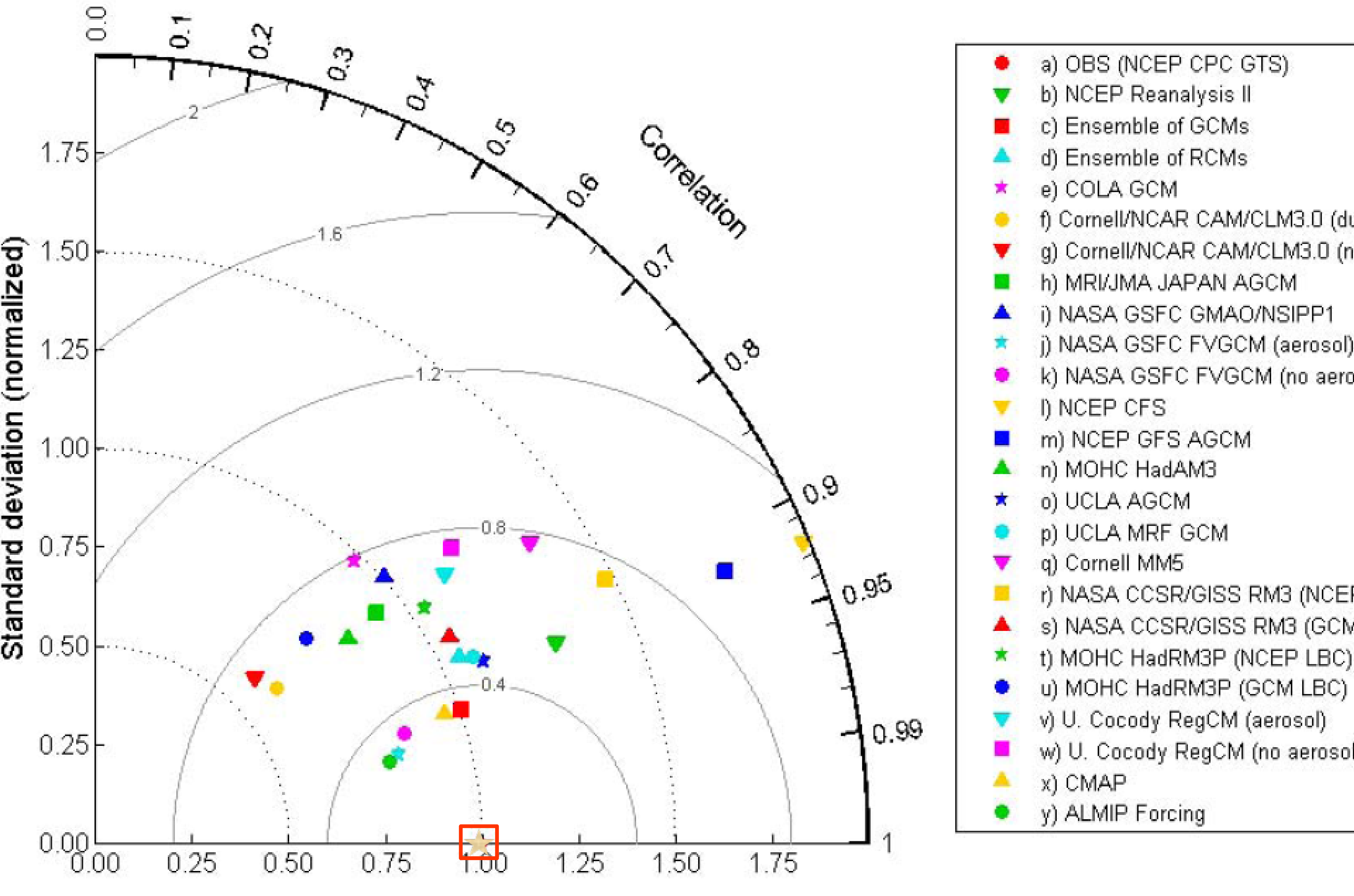
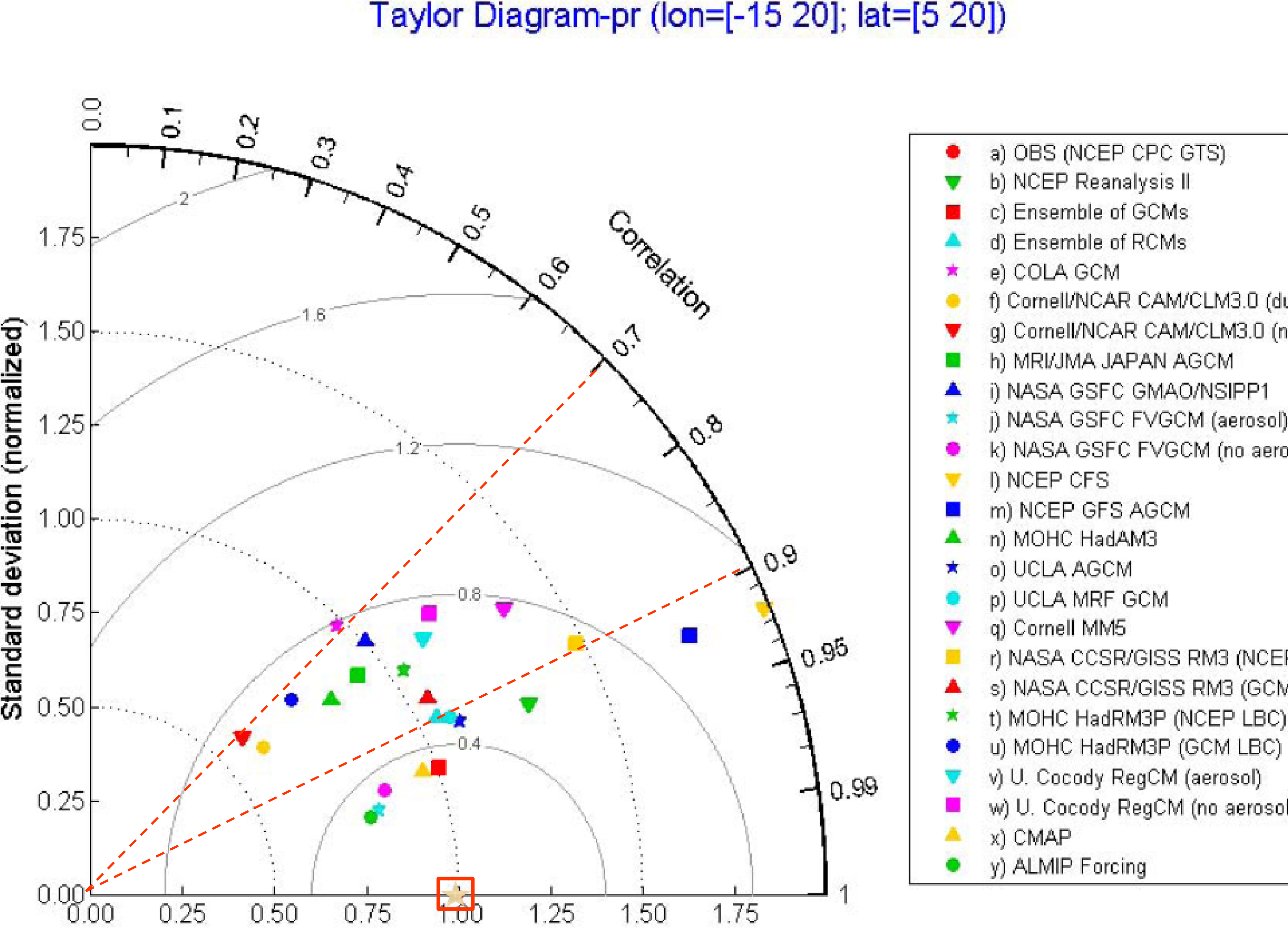


Figure 1. JJAS 2000, 2003-2005 mean precipitation (mm day^{-1}). (a) NCEP CPC GTS data; (b) NCEP Reanalysis; (c-w) WAMME simulations; (x). CMAP; (y) ALMIP forcing.



Taylor Diagram-pr (lon=[-15 20]; lat=[5 20])





Taylor Diagram-pr (lon=[-15 20]; lat=[5 20])
Standard deviation (normalized)
Correlation
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.95
0.99
1
2
1.6
1.2
0.8
0.4
a) OBS (NCEP CPC GTS)
b) NCEP Reanalysis II
c) Ensemble of GCMs
d) Ensemble of RCMs
e) COLA GCM
f) Cornell/NCAR CAM/CLM3.0 (d
g) Cornell/NCAR CAM/CLM3.0 (n
h) MRI/JMA JAPAN AGCM
i) NASA GSFC GMAO/NSIPP1
j) NASA GSFC FVGCM (aerosol)
k) NASA GSFC FVGCM (no aero
l) NCEP CFS
m) NCEP GFS AGCM
n) MOHC HadAM3
o) UCLA AGCM
p) UCLA MRF GCM
q) Cornell MM5
r) NASA CCSR/GISS RM3 (NCE
s) NASA CCSR/GISS RM3 (GCM
t) MOHC HadRM3P (NCEP LBC)
u) MOHC HadRM3P (GCM LBC)
v) U. Cocody RegCM (aerosol)
w) U. Cocody RegCM (no aeroso
x) CMAP
y) ALMIP Forcing

Taylor Diagram-pr (lon=[-15 20]; lat=[5 20])

Obs STD:3.3 mm/d

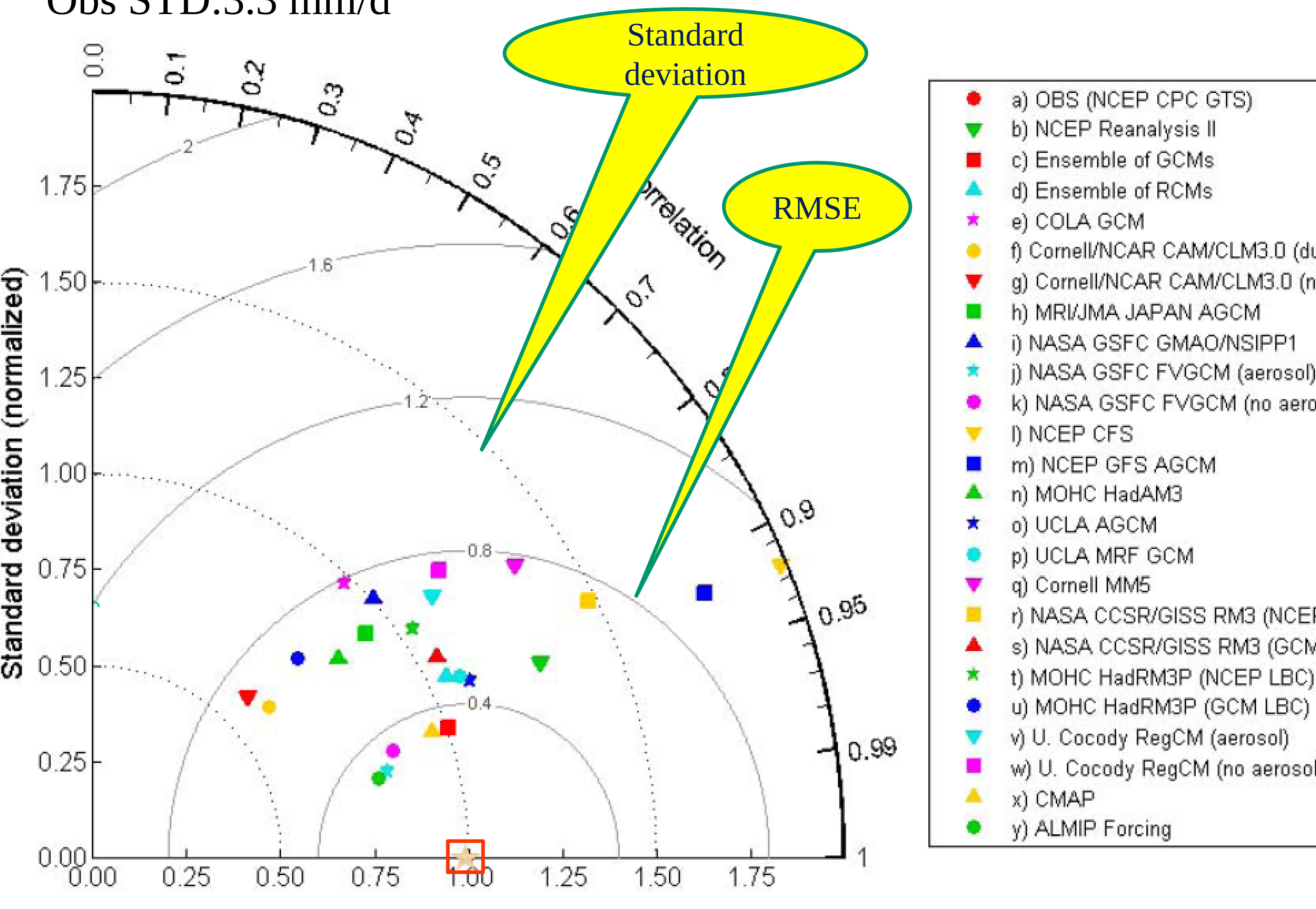


Figure 3. Temporal evolution of the 5-day mean precipitation (mm day^{-1}) averaged over 10°W-10° E from May through October. (a) NCEP CPC GTS; (b) NCEP Reanalysis 1; (c-w) WAMME simulations; (x) CMAP; (y) ALMIP forcing.

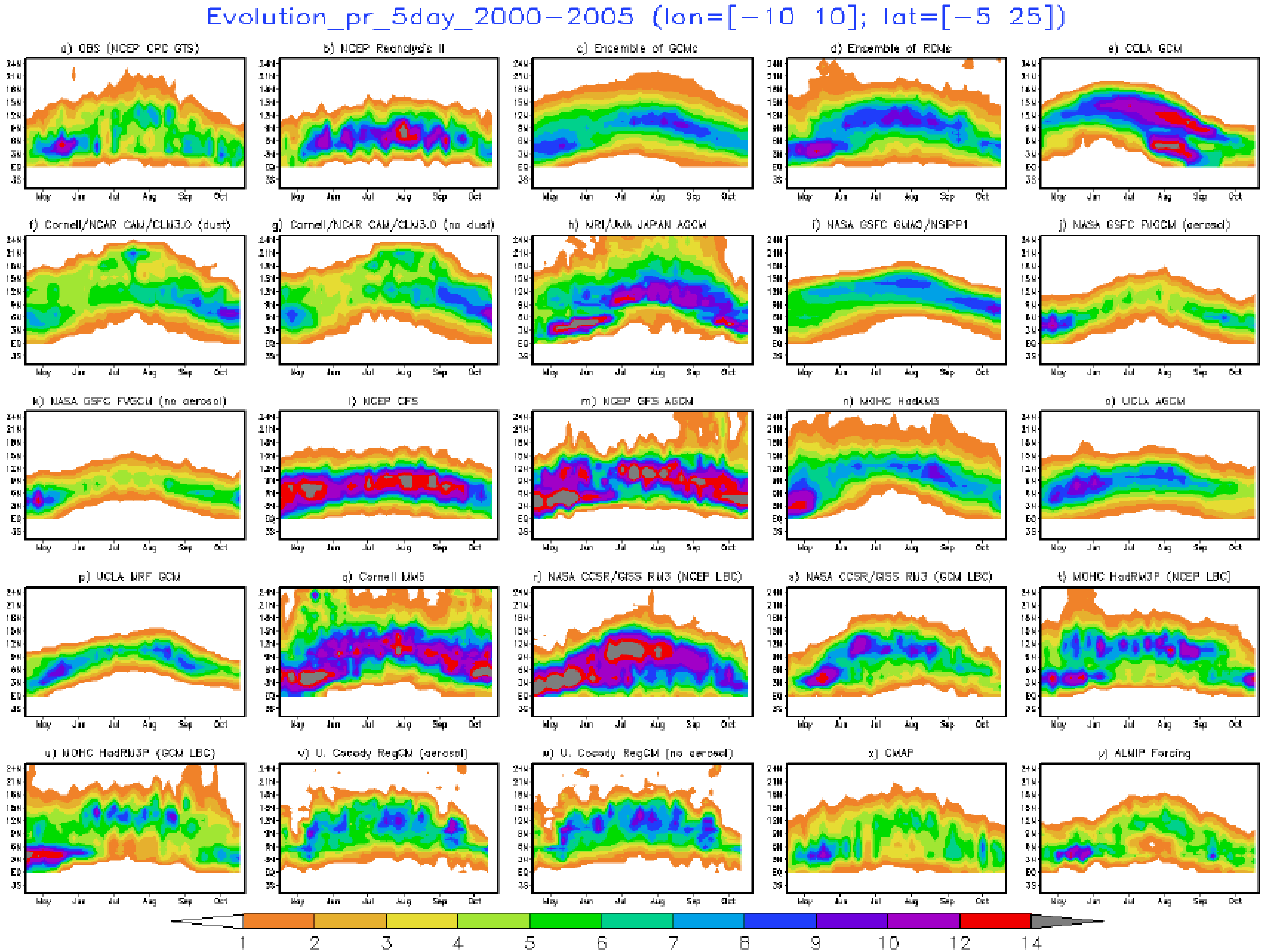


Figure 4. Temporal correlations between observed monthly mean precipitation and WAMME simulations, Reanalysis II, CMAP, and ALMIP.

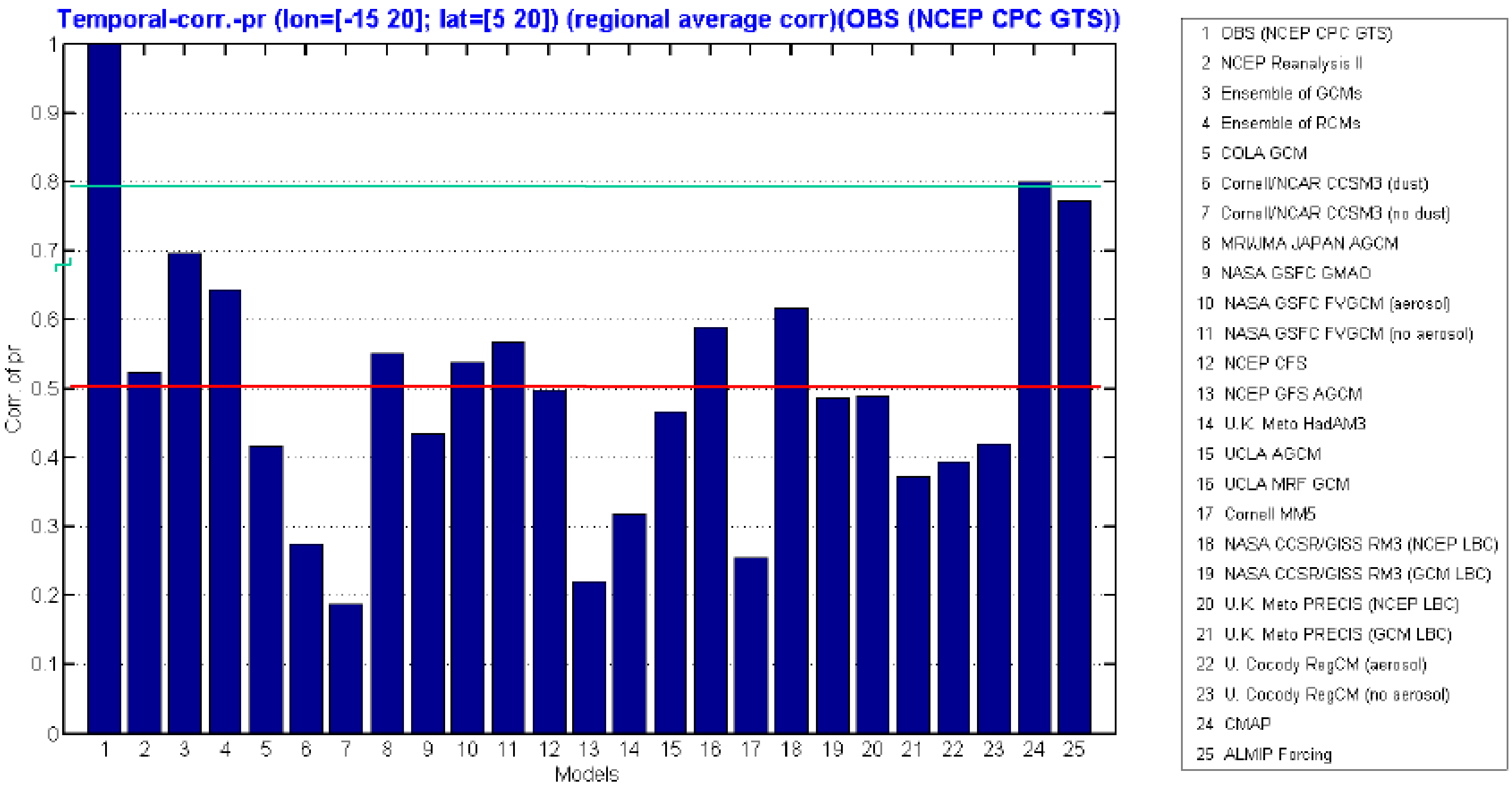
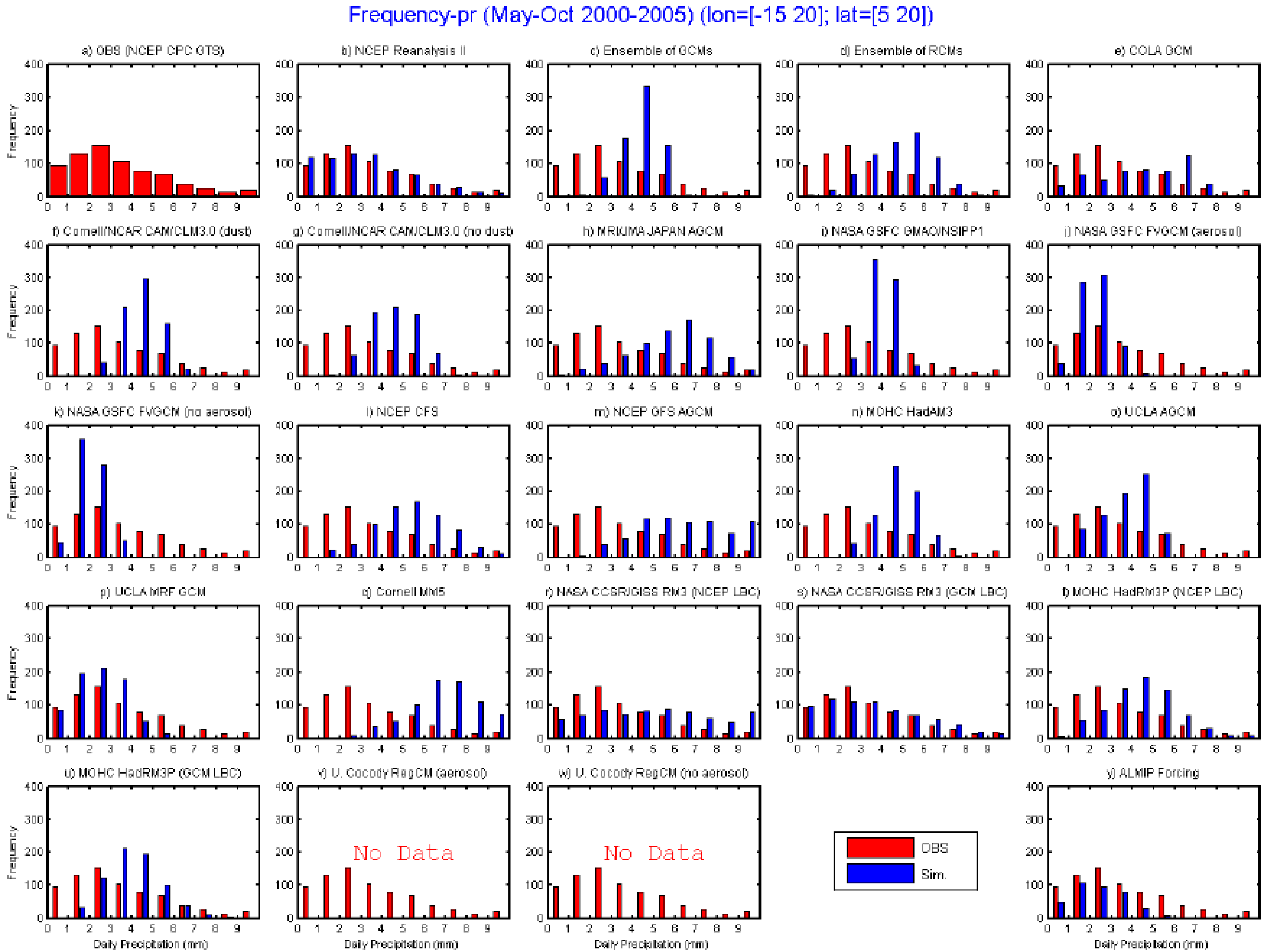


Figure 5. May-October precipitation histogram observations and WAMME simulations over area 15°W to 20°E and 5°N to 20°N.



WAMME Objectives

* To understand roles of oceanic, land, and aerosols in WAM variations at seasonal, interannual, and interdecadal scales, decadal anomalies, as well as WAM onset and withdrawal.

Figure 7. (a) JJAS precipitation difference between NCEP CFS and NCEP GFS (mm/day). (b) JJAS precipitation difference between UCLA/SSiB and UCLA/fixed land (mm/day).

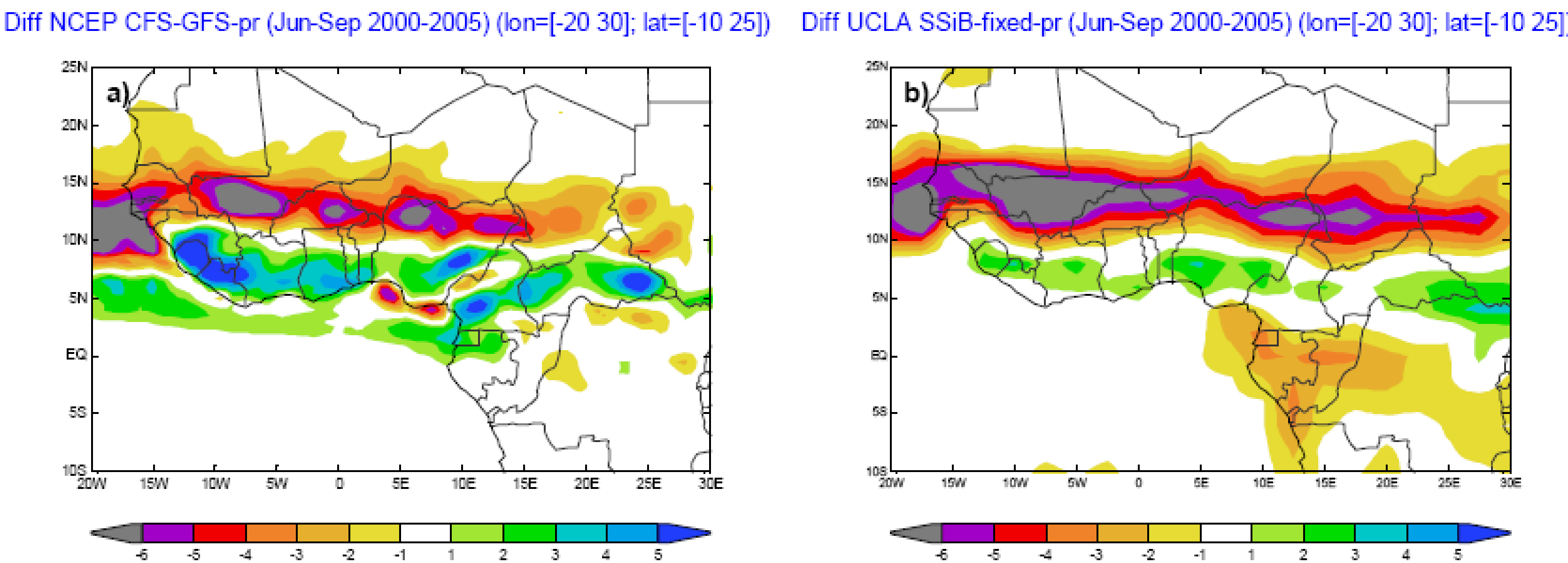


Figure 8 Temporal correlations of monthly mean precipitation and SST over N. equatorial Atlantic.

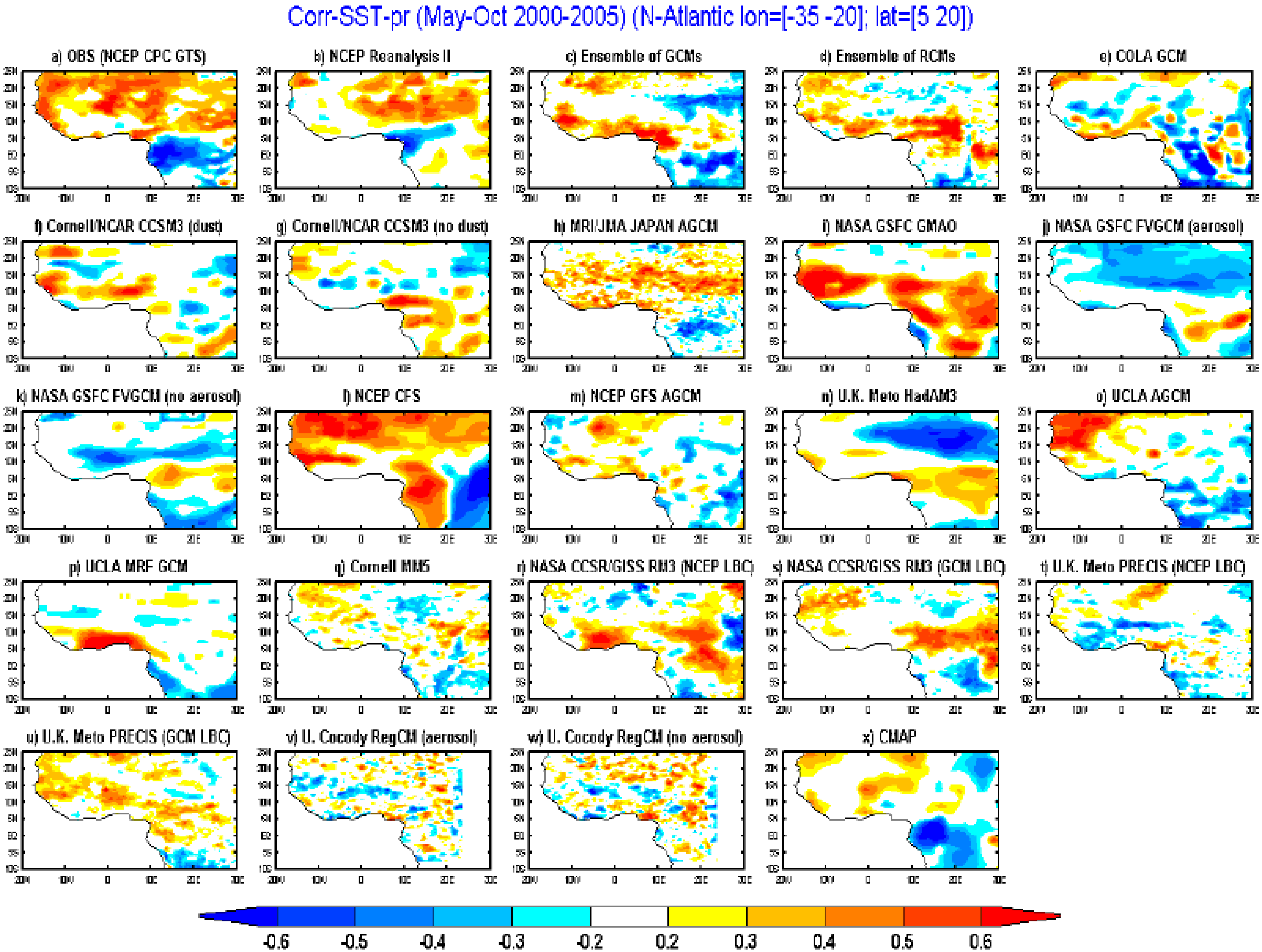


Figure 10. Comparison of spatial correlations of 2005 JJAS precipitation between observation and WAMME simulations and 2005 JJAS evaporation between the ALMIP estimation and WAMME simulations.

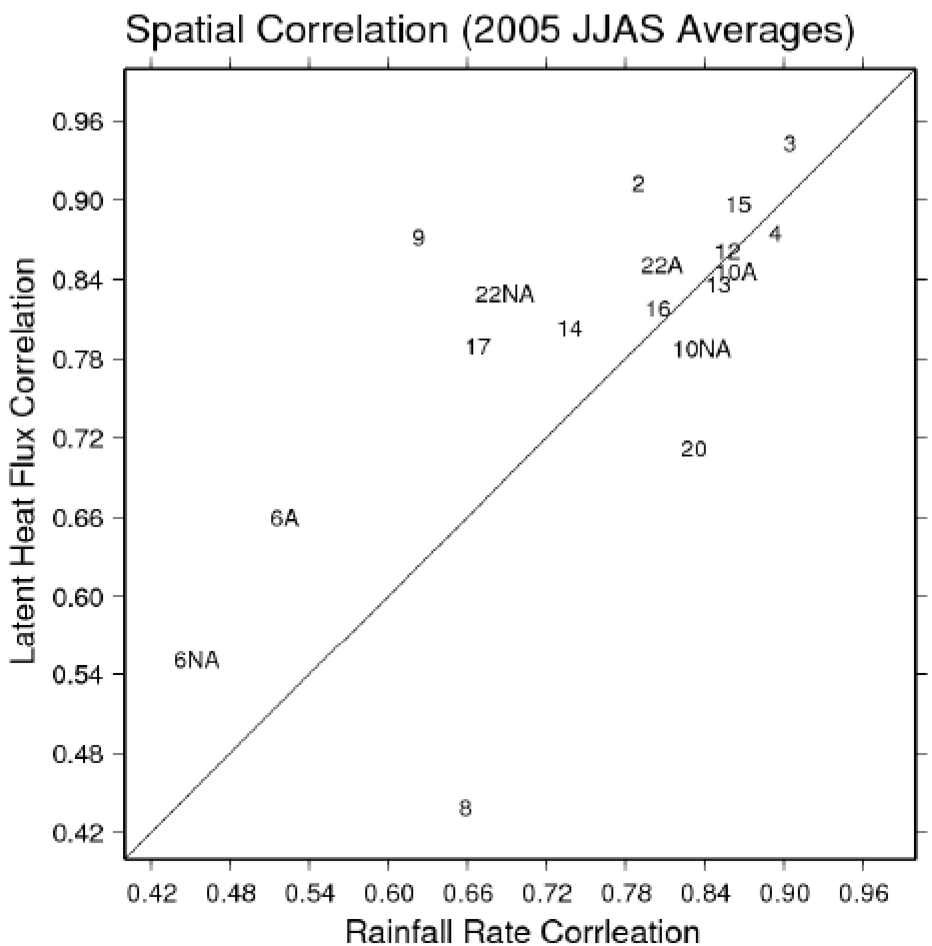
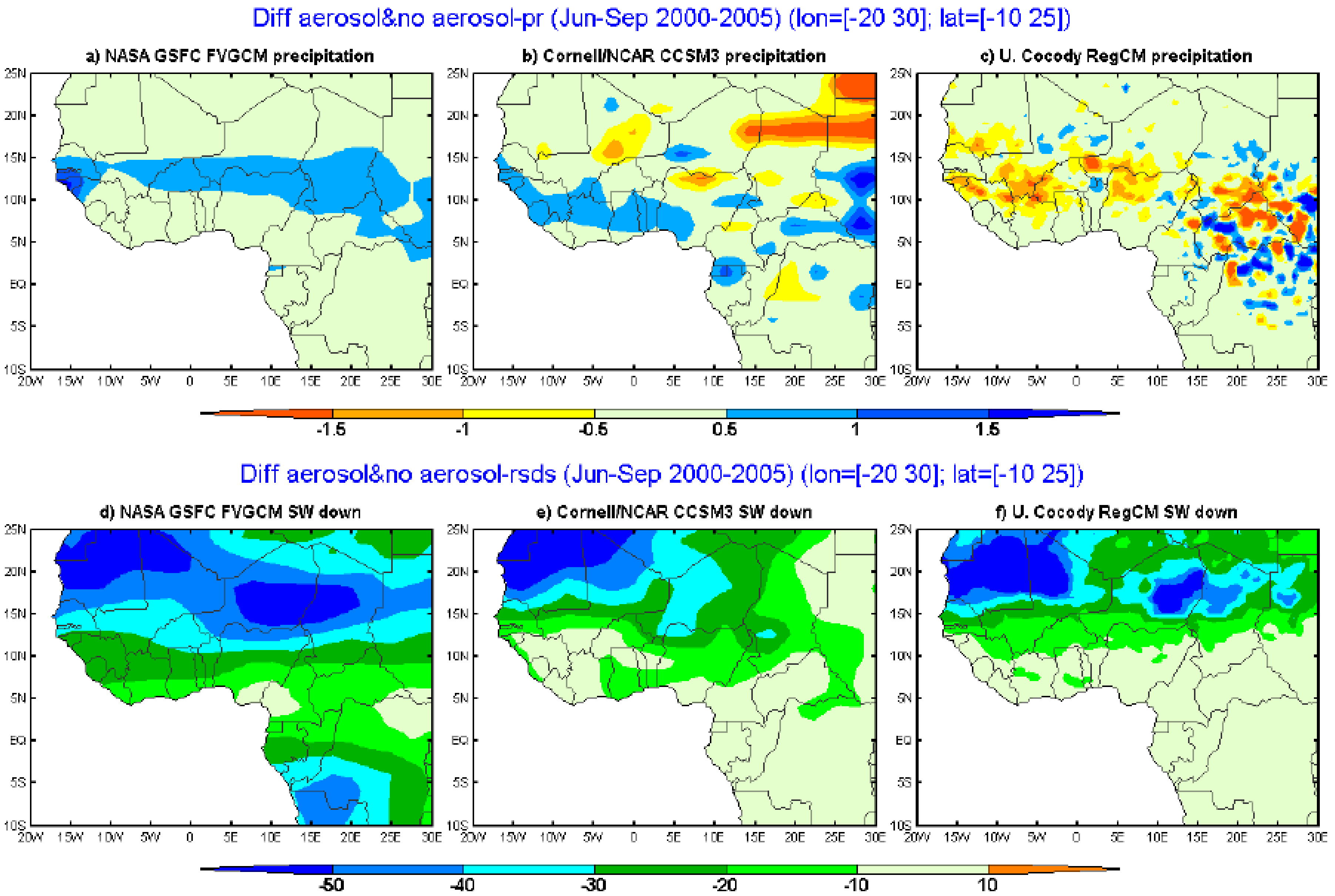


Figure 11. Simulated JJAS 2000, 2003-2005difference between aerosol/dust and no aerosol/dust runs (a) NASA GSFC FVGCM precipitation; (b) Connell/NCAR CCMS3 precipitation; (c) U. of Cocody RegCM precipitation; (d) NASA GSFC FVGCM SW down; (b) Connell/NCAR CCMS3 SW down; (c) U. of Cocody RegCM SW down. Unit: precipitation mm day^{-1}; Short Wave down at surface: w m^{-2}



The West African Monsoon Modeling and Evaluation project (WAMME) and its First Model Intercomparison Experiment

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Submitted to *BAMS*

Paper titles for the West African monsoon special issue in Climate Dynamics

The WAMME paper list:

(1) First phase of multi-GCM comparison in West African Monsoon Modeling and Evaluation (WAMME) project (Authors: Xue, Y., K.-M. Lau, D. Rowell, A. Boone, J. Feng, T. Brücher, F. De Sales, P. Dirmeyer, A. H. Fink, Z. Guo, K.-M. Kim, A. Kitoh, V. Kumar, I. Poccard-Leclercq, N. Mahowald, P. Pegion, J. K. Schemm, S. D. Schubert, A. Sealy, W. Thiaw, A. Vintzileos, S. Williams, M.-L. C. Wu).

(2). Regional downscaling of West African monsoon in the WAMME project (Authors: Druyan L.M., K.H. Cook, Y. Xue, J. Feng, F. De Sales, M. Fulakeza, S. M. Hagos, S.S. Ibrah, A. Konare, P. Lonergan, W. Moufouma-Okia, D. Rowell, E. K. Vizy)

(3) Possible dust effects on variability of the West African monsoon (Authors: K.-M. Lau and K.-M. Kim)

(4). Intraseanonal evolution of dust shortwave radiative impacts on the WAM (Authors: Konare, A., A.S. Zakey, F. Solmon, F. Giorgi, S. Raucher, S. Ibrah, X. Bi)

(5). North African Precipitation and Monsoon Dynamics at the end of the 21st Century: Regional Climate Model Development and Simulations (Authors: Patricola, C.M. and K. H. Cook)

(6). The relative influence of soil moisture anomaly in RCM WAM simulations (Authors: W. Moufoumma-okia, D. Rowell, and R. Jones)

(7). Evaluation of the WAMME model surface variables using observations and results from the AMMA Land surface Model Intercomparison Project (Authors: Boone, A, et al.)

(8). Characterization of intraseaonal to interannual variability of rainfall/vegetation relationship over Sahel by using the WAMME experiments. (Authors: Poccard-Leclercq, I., N. Philippon, Y. Xue, A. Bonne)

(9). Simulation of the 2006 West African rainy season using ECHAM5 coupled to a simple vegetation model (Authors: Brücher, T. and A.H. Fink)

(10). Asian monsoon simulation in the WAMME experiment and comparison with WAM (Authors: Feng, J., Y. Xue, and K.-M. Lau)

(11). West African monsoon in a 20-km mesh atmospheric GCM (Authors: Kitoh, A., M. Hosaka and O. Arakawa)

AMMA paper list:

1. Seasonal reproducibility and predictability of the West African Monsoon in coupled GCMs (Authors: N Philippon, F Doblas-Reyes, L Bouali, PM Ruti)

2. Warm and cold SST anomalies on the Mediterranean basin : impacts on the WAM using the WRF regional model (Authors: P. Roucou, M. Gaetani and B. Fontaine)

3 Impacts of Warm and Cold situations in the Mediterranean Basins on the West African monsoon: observed connection patterns (1979-2006) and GCMs simulations + (1979-1998). (Authors: Bernard Fontaine , P. Roucou, S. Sivarajan, Fabrice Chauvin, S Janicot, PM Ruti, T Losada)

4. Interannual variability of the west African monsoon in CMIP3 coupled simulations. - (Authors: M. Joly, H. Douville and A. Voldoire)

5. West African Monsoon precipitation response to Equatorial Pacific Sea Surface Temperature anomalies. Dynamical Mechanisms (Authors: E. Mohino, B. Rodriguez-Fonseca, C.R. Mechoso, S. Janicot, PM Ruti , F. Chauvin)

6- A multi-model approach to the Atlantic equatorial mode. Impact on the West African monsoon and tropical teleconnections. (Authors: T. Losada, S. Janicot, B. RodrÃguez-Fonseca, S. Gervois, F. Chauvin, PM Ruti.)

7. A regional climate model simulation over West Africa: parameterization tests and analysis of land surface fields (Marta DomÃnguez and Miguel Angel Gaertner)

8.AMMA-CROSS : a framework for climate model assessment over West Africa (F. Hourdin , F. Guichard, I. Musat , F. Favot, P. Ruti , A. Dell'Aquilla, H. Galle, T. Losada P. Marquet, A. Traore and A. Boone.)

9.The AMMA Land Surface Model Intercomparison Project (ALMIP): An overview of multi-model simulations over West Africa for three annual cycles (Authors: A Boone and ALMIP working group)

10.Influence of the West African monsoon variability on summer climate over Europe (Authors: S Bielli and H Douville)

Summary

1). The WAMME is the first project consisting of state-of-the-art GCMs and RCMs to collectively investigate their ability to simulate WAM climatology and the WAM/external forcing feedbacks.

2). Models with specified SST generally have reasonable simulations of the spatial distribution of WAM precipitation but more deficiencies in simulating seasonal WAM evolution; they generally fail to produce proper daily precipitation frequency distribution.

3). WAMME multi-model ensembles produce good WAM precipitation spatial distribution, intensity, and seasonal evolution, better than Reanalysis II in many aspects.

4).GCMs produce smooth development of a monsoon season. Only RCMs and a high resolution GCM are able to produce WAM onset jump.

5). The first experiment demonstrates strong influence of ocean, land, and aerosol on WAM precipitation. But it reveals that ensemble means produce weak correlation between SST and WAM precipitation, discrepancies in simulating land/atmosphere interaction, and large uncertainty in simulating aerosol effects. Further experiments will be designed to further investigate these issues.