The connections of Pacific SST and drought over East Africa

Modathir Zarong
Elfatih Eltahir

Dinder Center for Environmental Research
Khartoum
Sudan

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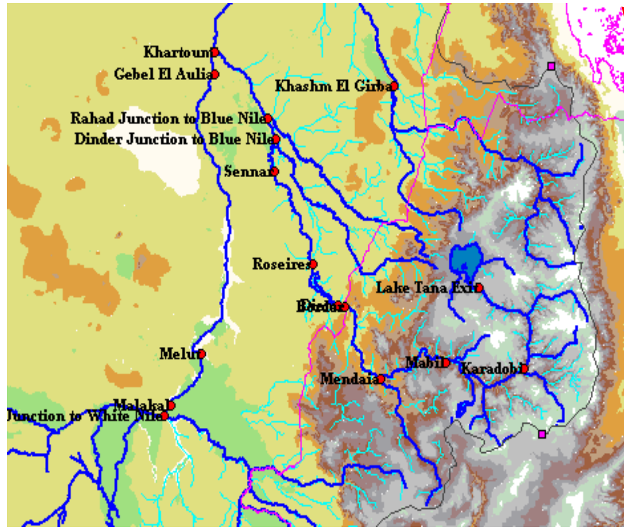
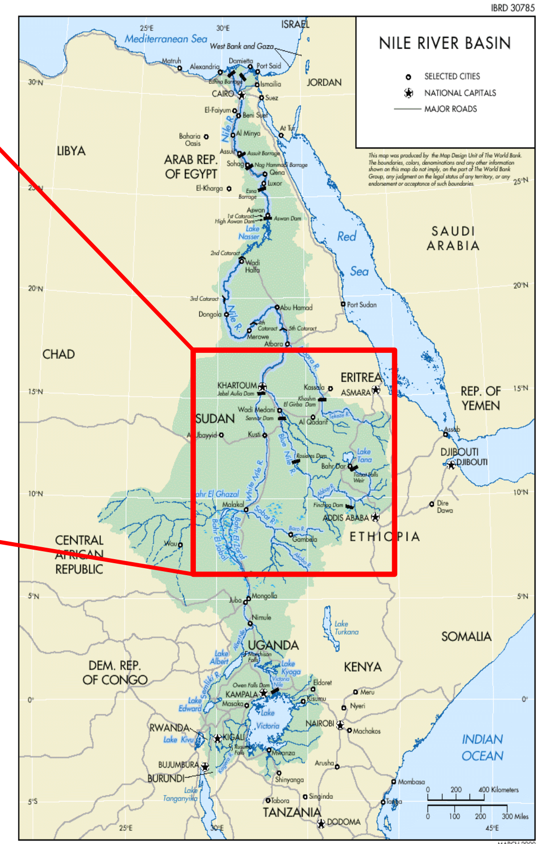
Introduction





- There have been notable droughts in Ethiopia throughout human history (Haile 1988; Degefu 1987; Pankhurst 1966; Nicholls 1993; Webb and Braun 1994).

- Previous droughts and the frequency of rainfall deviation from the average suggest that droughts occur every 3-5 and 6-8 years in northern Ethiopia and every 8-10 years for the whole country (Haile 1988, 90).

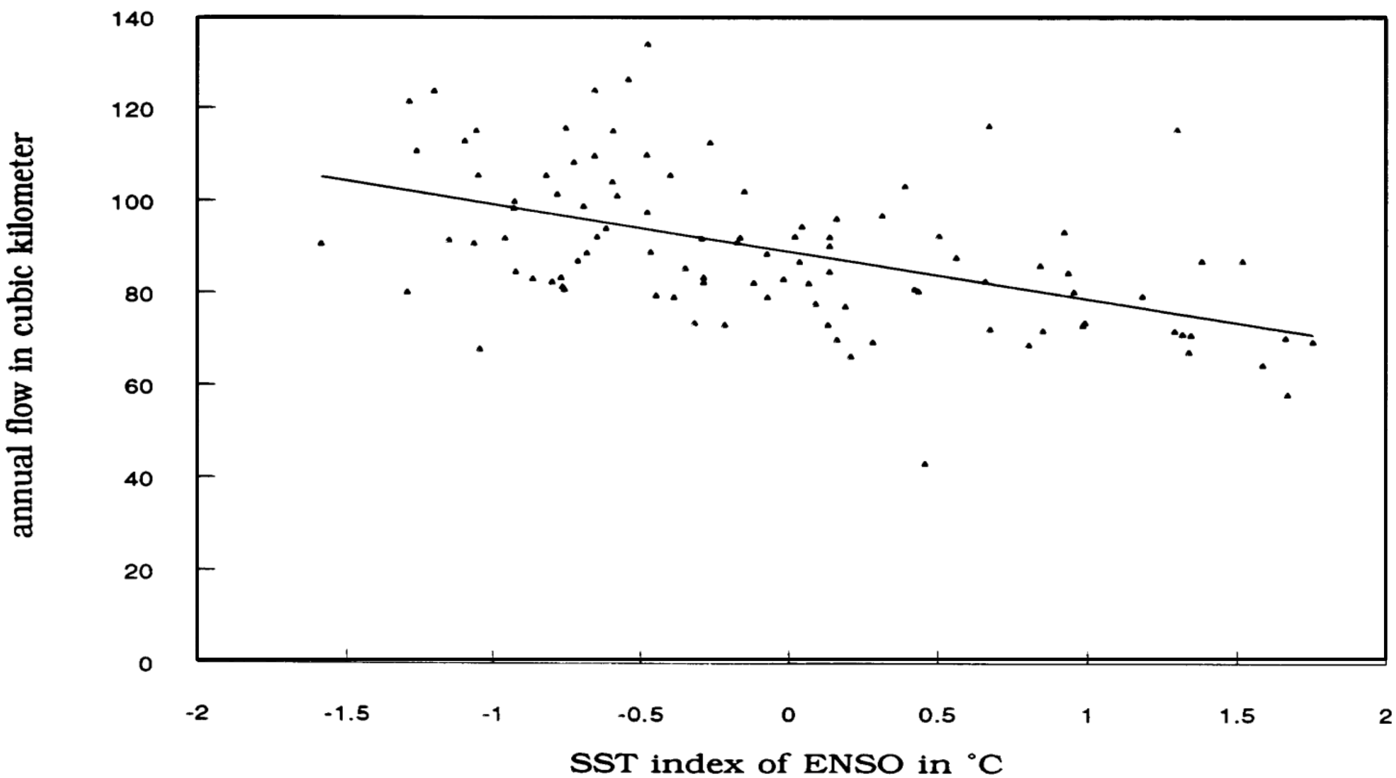
Introduction Cont'

- A statistical analysis by Eltahir (1996) shows that "ENSO episodes are negatively tele connected with the floods of the Blue Nile and Atbara" rivers that originate in Ethiopia.

- Eltahir (1996) also concluded that ENSO events affect flows of the Nile River (indicating drought in highland Ethiopia, which is a source of 85 percent of Nile water) and that knowledge of these events could be used to improve the predictability of its annual flow.

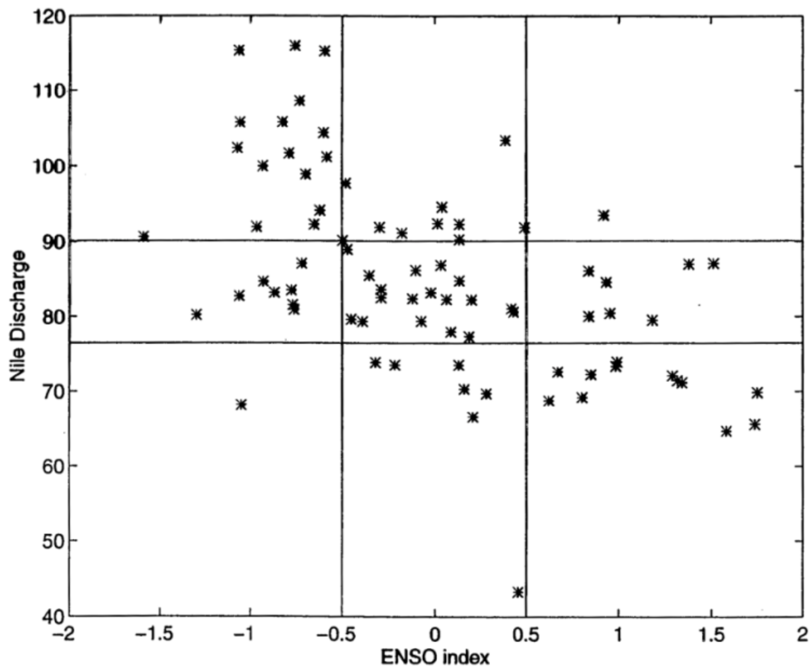
- Eltahir (1998) the ENSO prediction is good enough to be used in Medium to long range forecasting of the Nile flood.

Previous studies



Scatter plot of the data showing the relation between the annual flow of the Nile and the index of ENSO for the months of September, October, and November, for the years 1872-1972. The coefficient of correlation is -0.5. The straight line is the regression line (Eltahir, 1996).

Previous studies Cont'



	Flow		
SST	Low	Average	High
Cold	0.02	0.49	0.49
Normal	0.27	0.58	0.15
Warm	0.58	0.34	0.08

Conditional Probability of the Nile Flood Given the SST Index of ENSO Based on Observations of 1872-1972 (Eltahir, 1996).

Problem statement

- Drought is one of the major environmental hazards in in Africa.
- Recent predictions on climate change suggest this situation may worsen, projecting an increased frequency and severity of drought in these regions, though these predictions are quite uncertain.
- Effective disaster risk management, including the provision of advance warning to drought, and the implementation of effective drought management, offers the potential to reduce adverse impacts.
- Drought preparedness and education can additionally increase resilience of affected societies, allowing them to cope better with drought and its impacts.

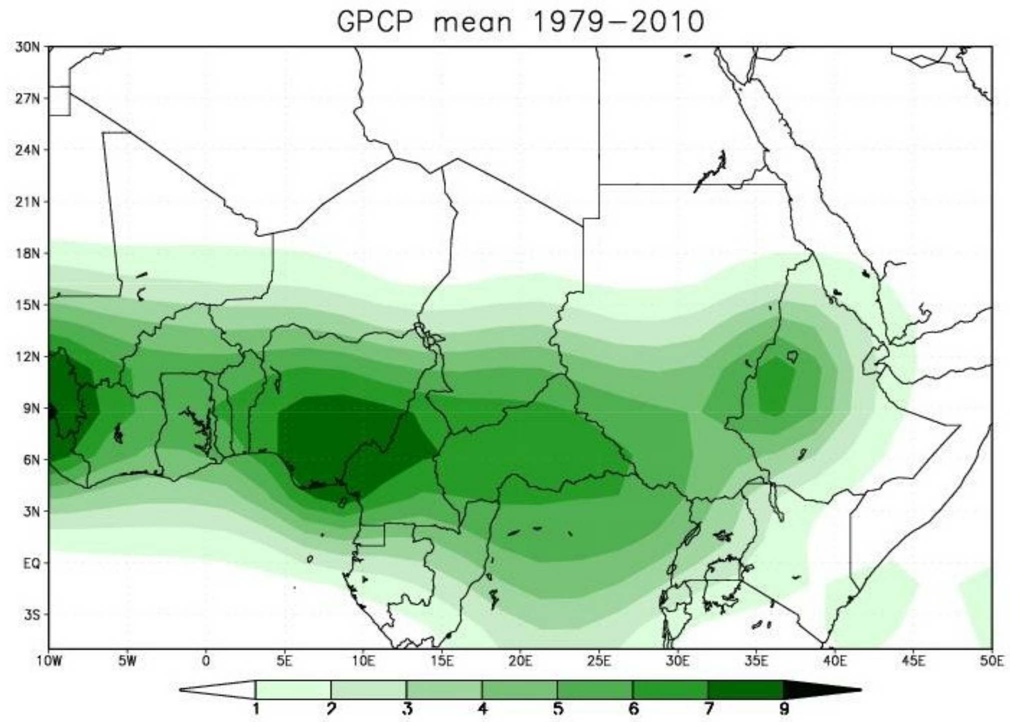
Objective

The main objective is to develop models and methods to map drought hazard at the local, regional scales and to explore the mechanisms of these droughts, and in particular their connection to ENSO.

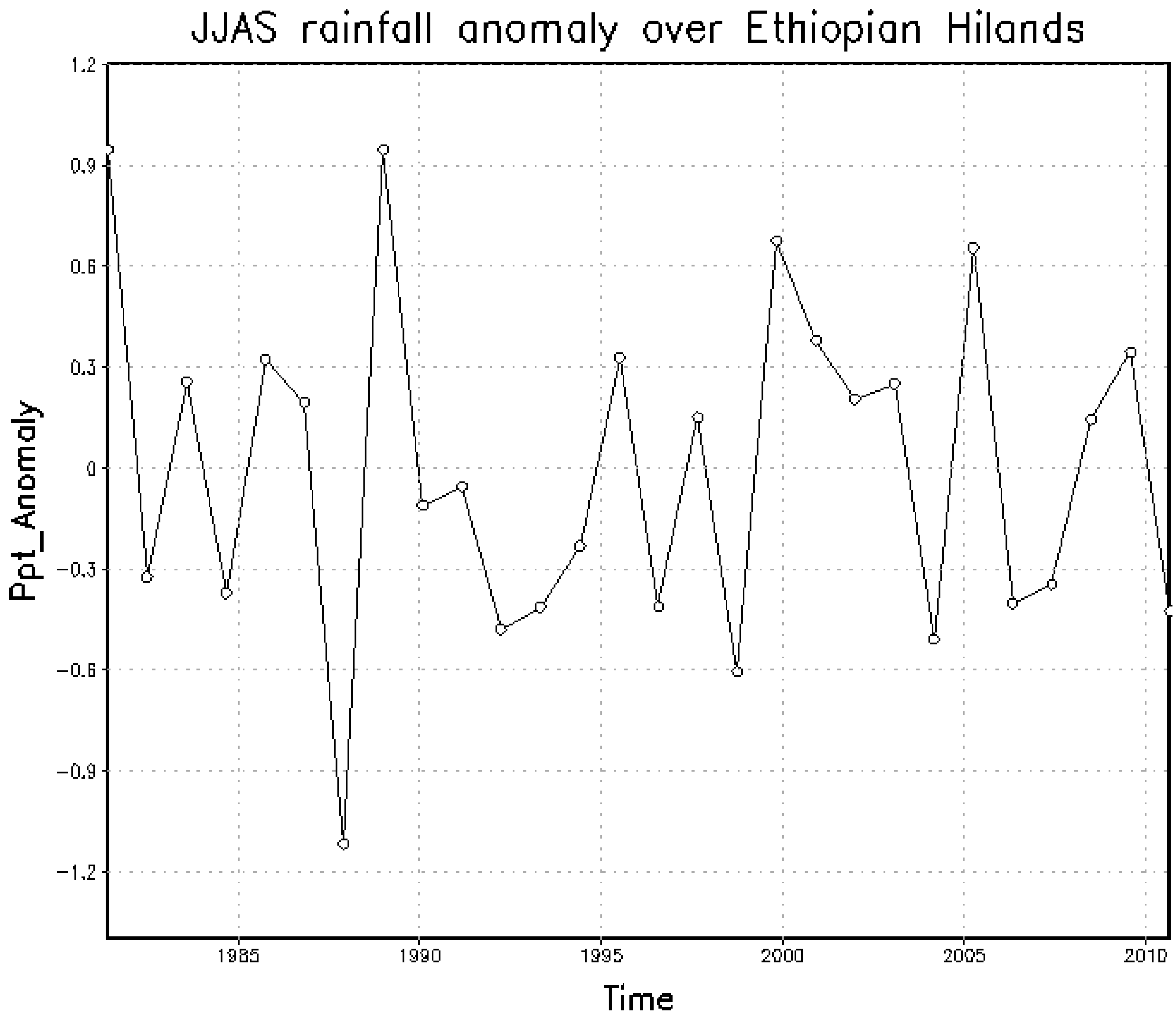
Preliminary test and correlation with observational dataset

Data used (monthly) Precipitation from GPCP from 1981 2008
• SST from **Hadley**

Methodology
• Compute the anomaly of SST during (JFM, FMA, MAM, AMJ) in the Pacific Ocean
70W 120W 5S 5N (Elnino 3.4)
• Compute the anomaly of precipitation over Ethiopian Highland **35E 41E 6N 14N** for summer season (JJAS)
• Correlation between precipitation and each SST



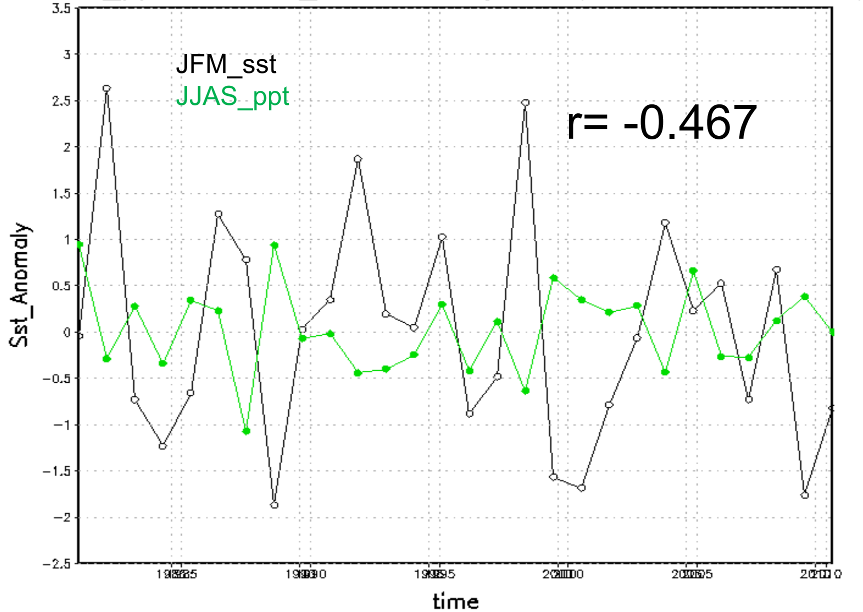
Results



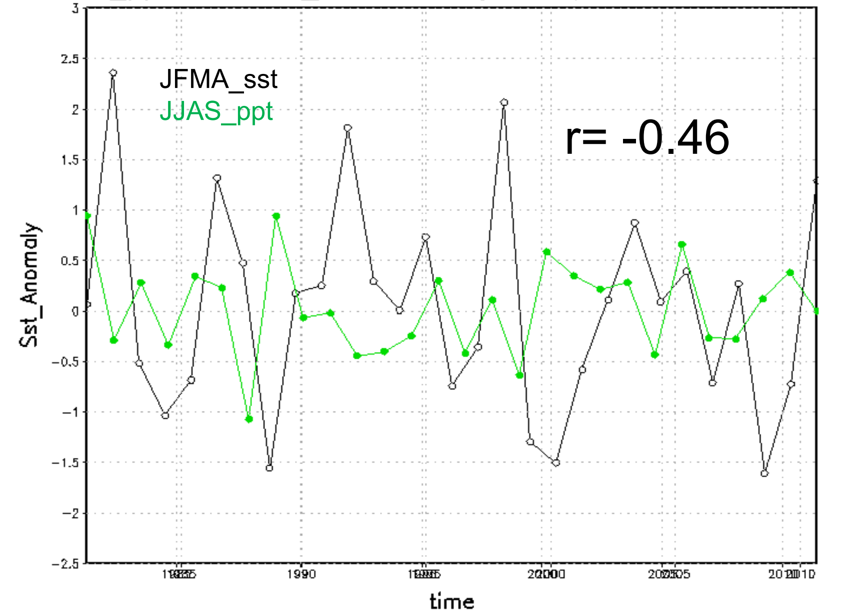
JJAS rainfall anomaly over Ethiopian Hilands
1.2
0.9
0.6
0.3
0
−0.3
−0.6
−0.9
−1.2
Ppt_Anomaly
1985
1990
1995
2000
2005
2010
Time

Results Cont’

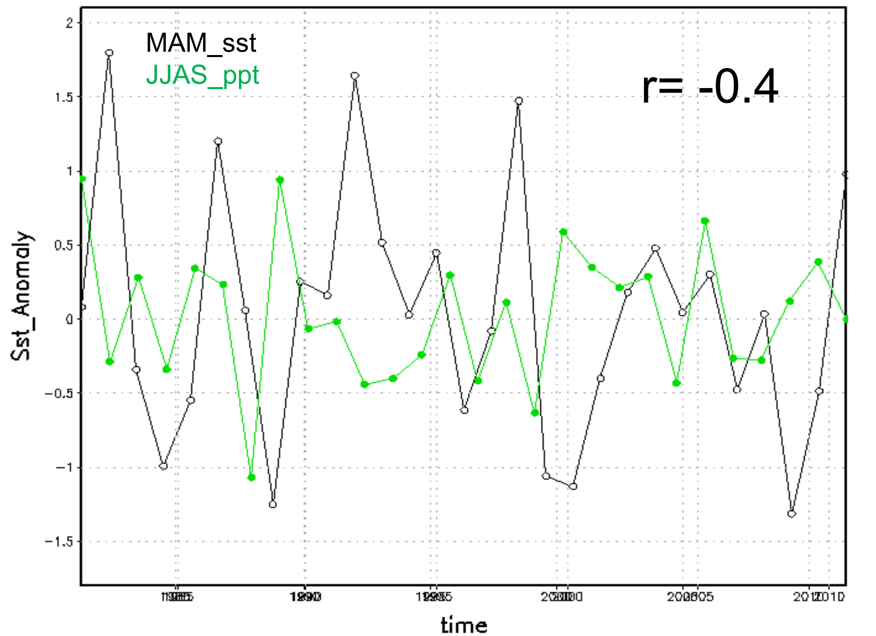
JJAS_ppt and JFM_SST anomaly over(170–120W, 5S–5N)



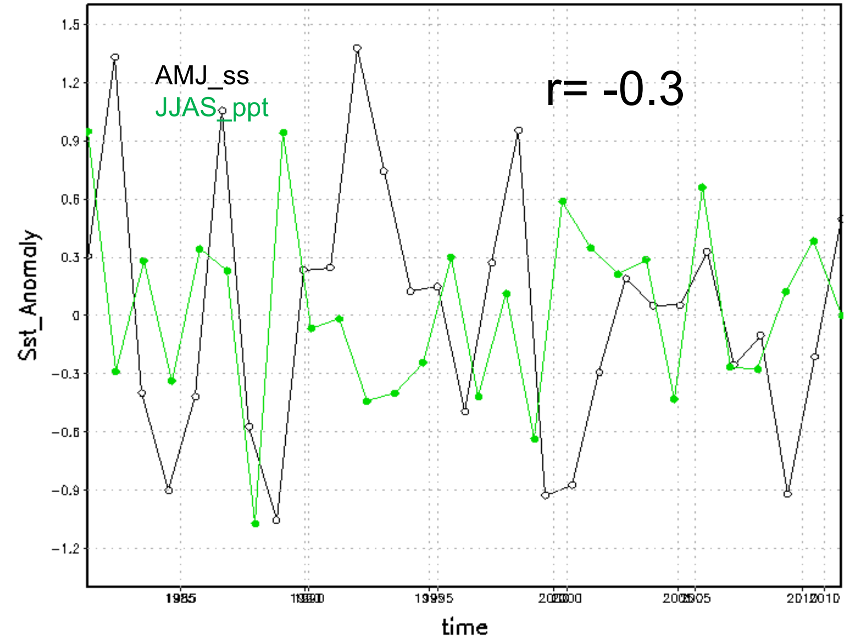
JJAS_ppt and FMA_SST anomaly over(170–120W, 5S–5N)



JJAS_ppt and MAM_SST anomaly over(170–120W, 5S–5N



JJAS_ppt and AMJ_SST anomaly over(170–120W, 5S–5N

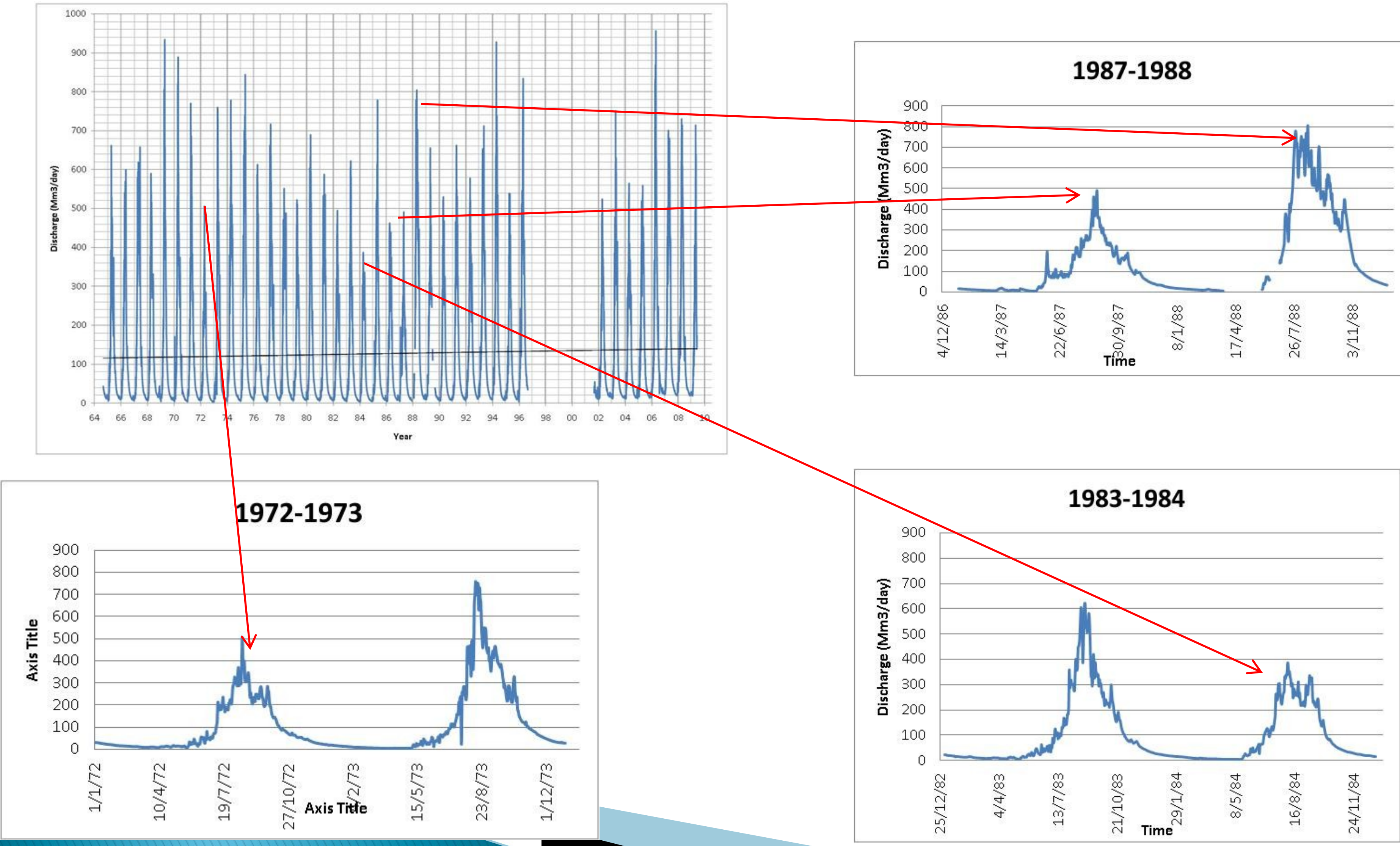


Results Cont'

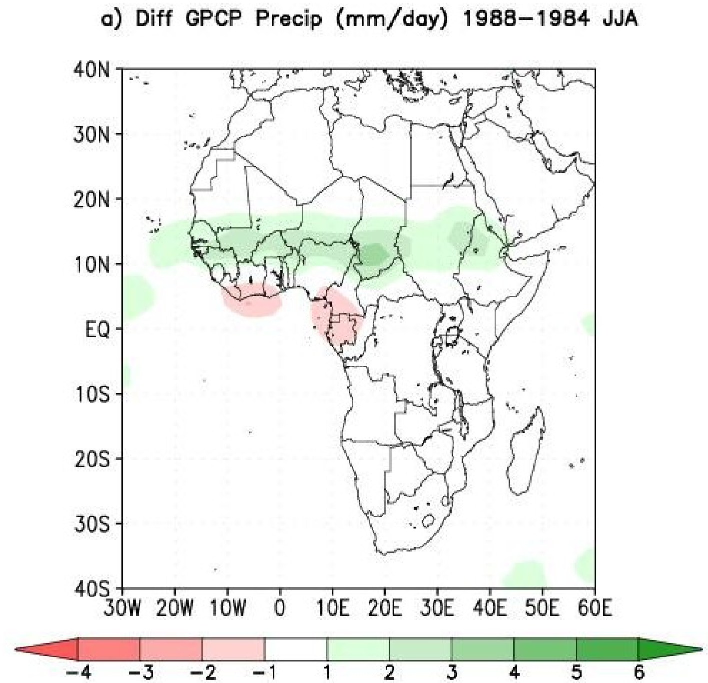
SST over Nino 3.4	Rainfall over Ethiopian Highland from GPCP	correlation
JFM	JJAS	– 0.47
FMA	JJAS	– 0.46
MAM	JJAS	– 0.4
AMJ	JJAS	– 0.3

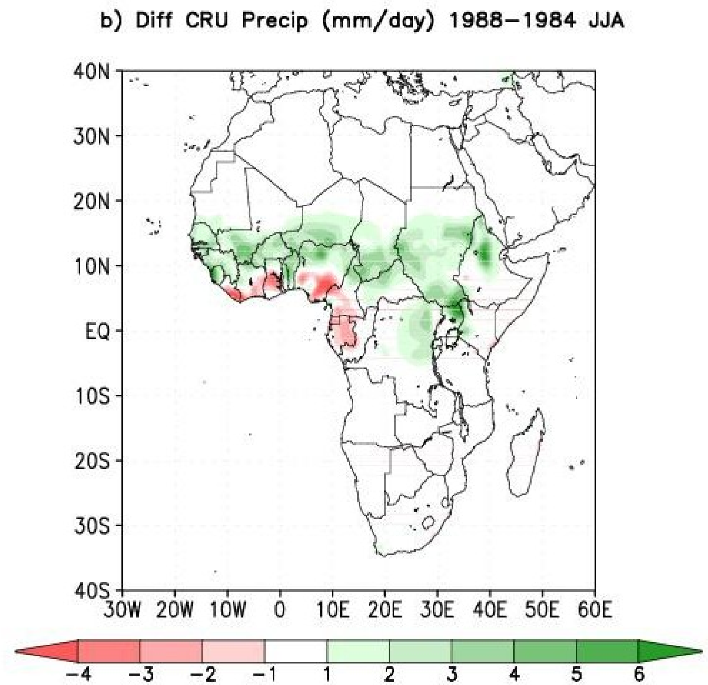
From the above table the correlation is higher in JFM, and it decrease gradually for the next months

Examples of El Nino and La Nina years and their effect in the discharge of the Blue Nile



The difference between Elnino and Lanina years for GPCP and CRU.

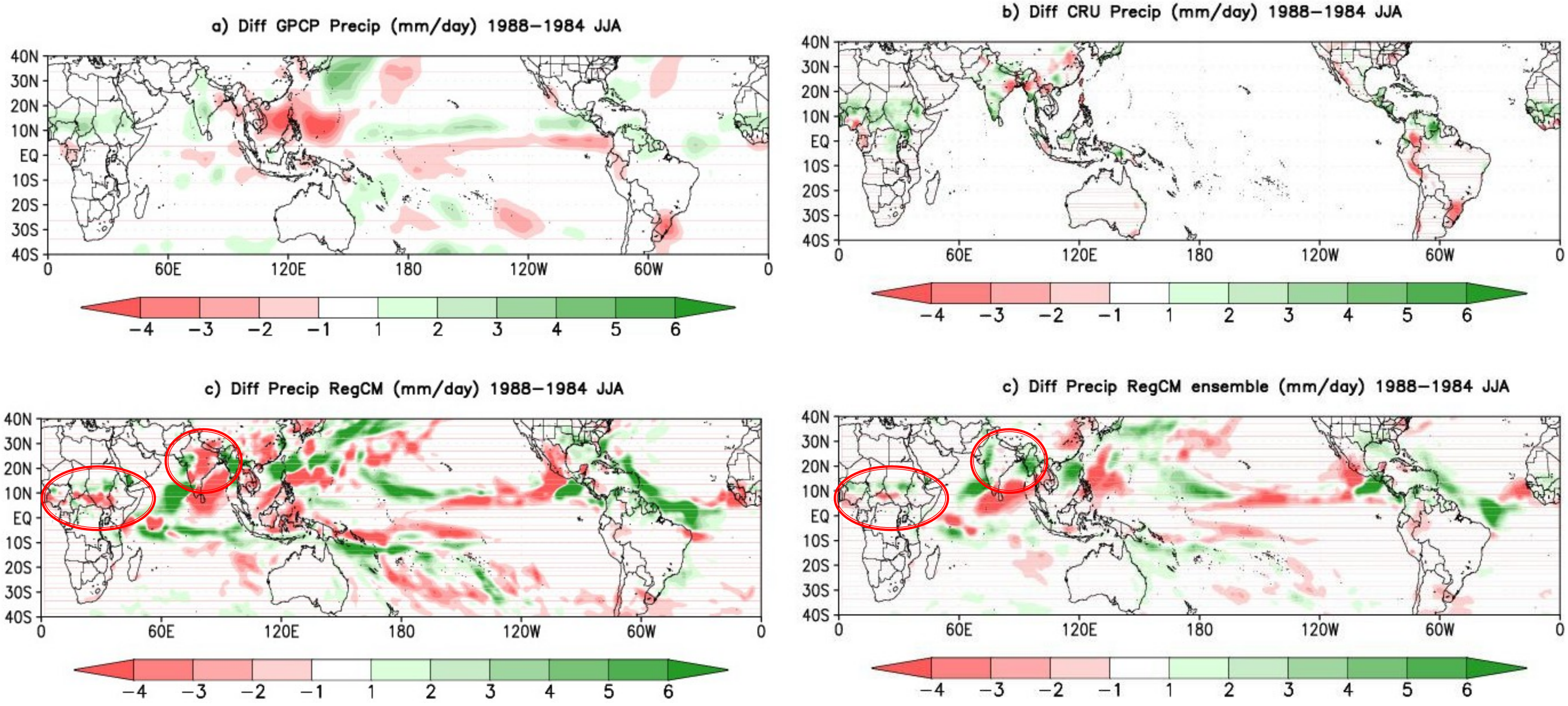




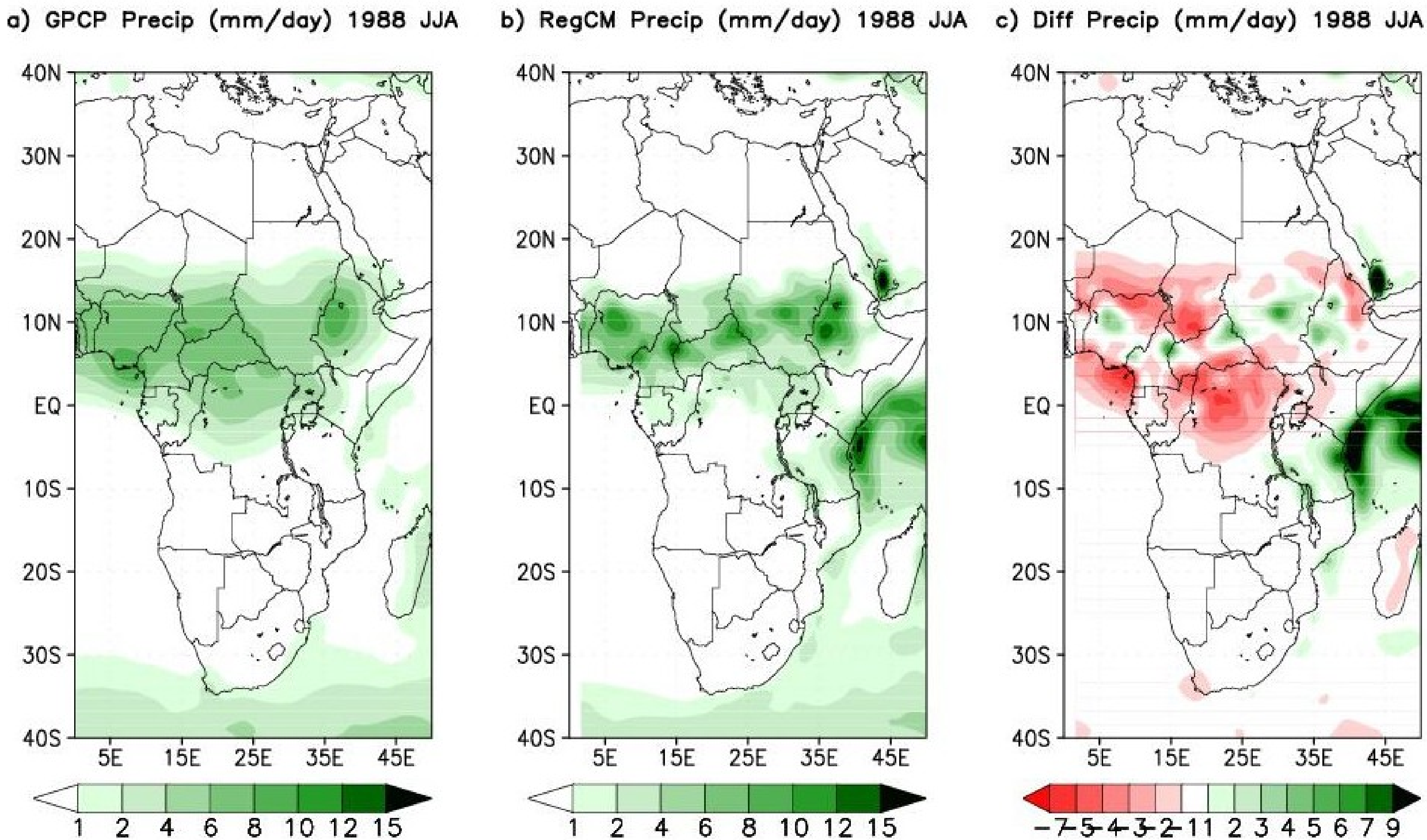
Model description

RegCM4.1.1 (ICTP model) This is a primitive equation, sigma vertical coordinate

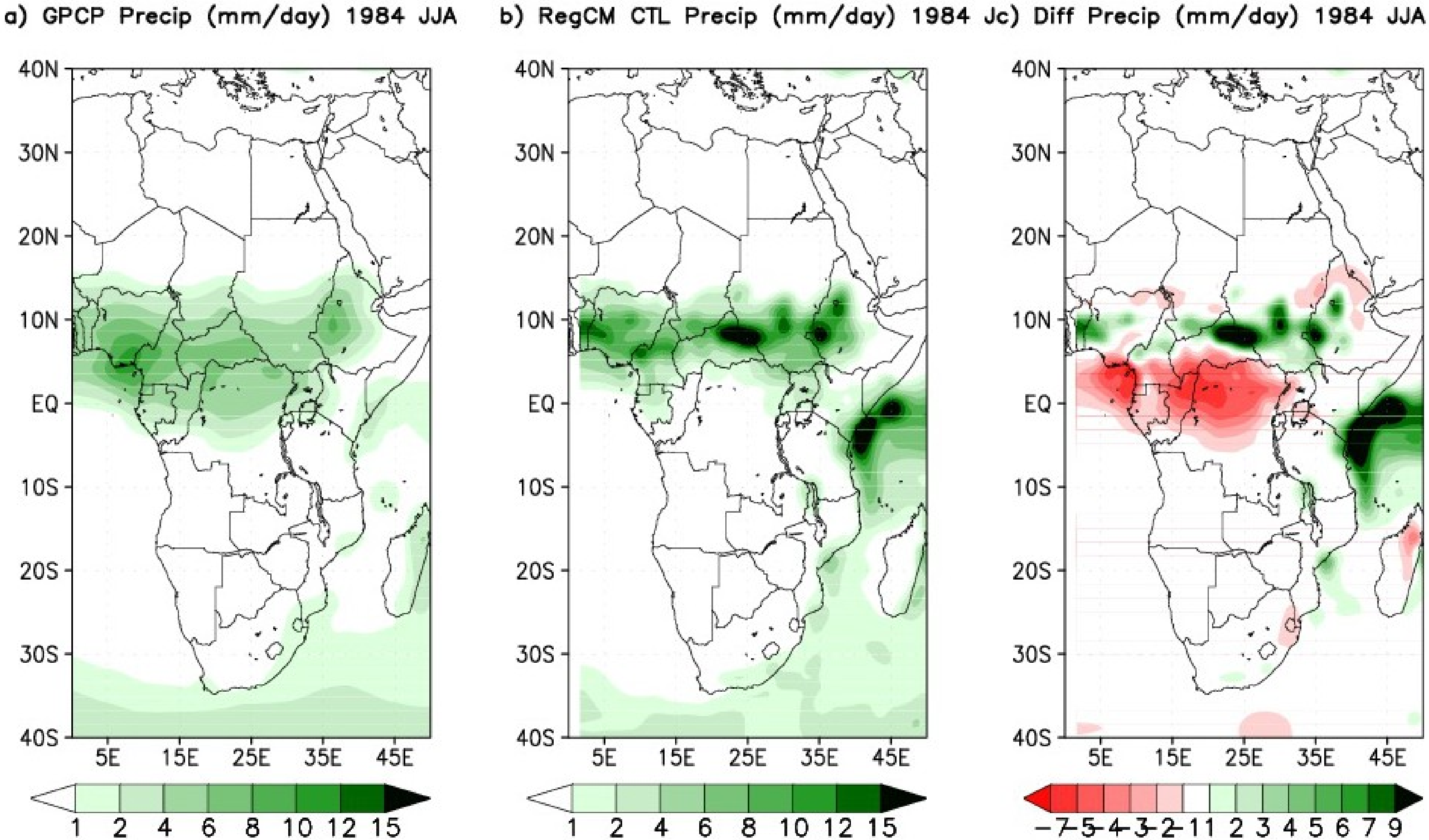
- Band Model
- The convection scheme is Emanuel in the ocean and Grell in land.
- The closure assumption of Fritsch and Chappell.
- Resolvable scale precipitation processes are treated using the sub-grid explicit moisture scheme (SUBEX).
- The scheme of Zeng is used to represent fluxes from ocean surfaces.
- Interactions between the land surface and the atmosphere are described using the Biosphere Atmosphere Transfer Scheme (BATS).
- Radiation is represented by the parameterization of Kiehl et al., (1996).
- the description of planetary boundary layer processes is based on the scheme by Holtslag et al., (1990).



The ensemble made for 27/12/1983, 28, 29, 30, 31 and 1/1/1984 and also for 1988 , the ensemble gives better result



a) GPCP Precip (mm/day) 1988 JJA
b) RegCM Precip (mm/day) 1988 JJA
c) Diff Precip (mm/day) 1988 JJA
40N
30N
20N
10N
EQ
10S
20S
30S
40S
5E
15E
25E
35E
45E
1 2 4 6 8 10 12 15
-7 -5 -4 -3 -2 -1 1 2 3 4 5 6 7 9


a) GPCP Precip (mm/day) 1984 JJA
b) RegCM CTL Precip (mm/day) 1984 J
c) Diff Precip (mm/day) 1984 JJA
40N
30N
20N
10N
EQ
10S
20S
30S
40S
5E
15E
25E
35E
45E
1 2 4 6 8 10 12 15
1 2 4 6 8 10 12 15
−7 −5 −4 −3 −2 −1 1 2 3 4 5 6 7 9

Conclusion

- The highest correlation between the rainfall in Ethiopian highland for the rainy season (JJAS) and the SST in the Pacific Ocean for (JFM).
- This correlation decreases gradually for the next three consecutive months.
- There is an evidence from the observations that the El Nino year is associated with drought in the Nile and La Nina year is associated with flooding in the Nile.
- The tropical band model capture this correlation also and the ensemble year gives a better results.

THANK YOU