

# Monsoon prediction Research in India

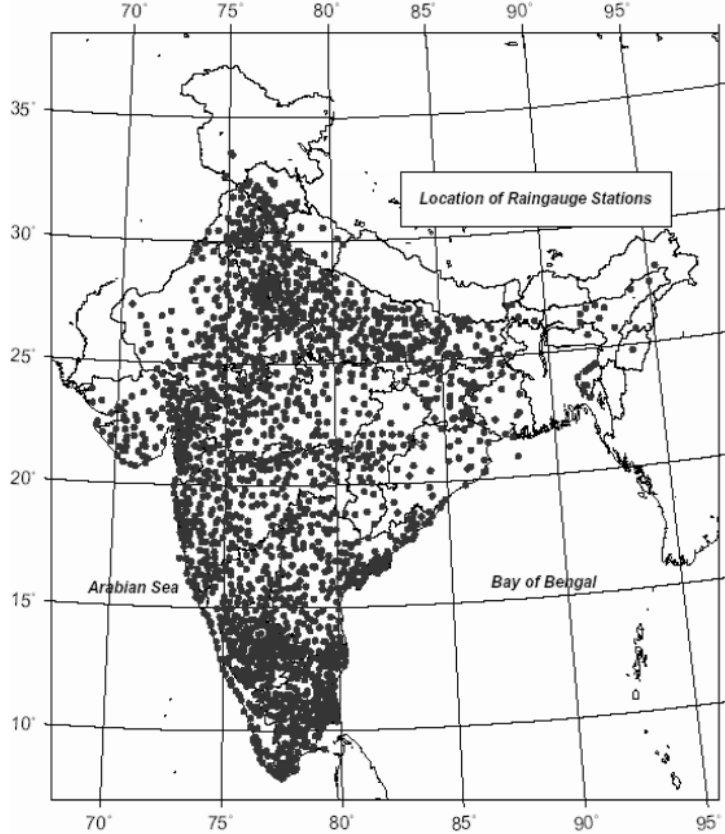
M. Rajeevan  
India

# Outline

- Intra-seasonal variability
  - Active-Break Phases
    - Real time monitoring is very important
  - Prediction efforts, initial stage
  - Understanding the mechanisms
- Monsoon seasonal Forecasts
  - Dynamical model forecasts
  - National Monsoon Mission

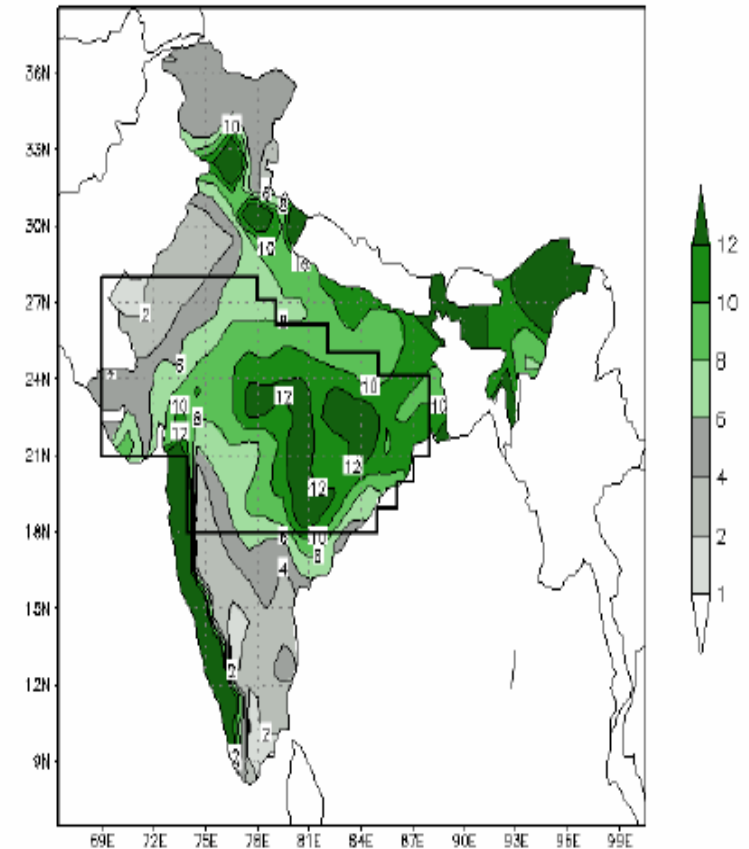
# Acknowledgements

- Dr A.K.Sahai, IITM,
- Dr Suryachandra Rao, IITM,
- Dr Mahesh Kumar, IITM and
- Dr D.S.Pai, IMD

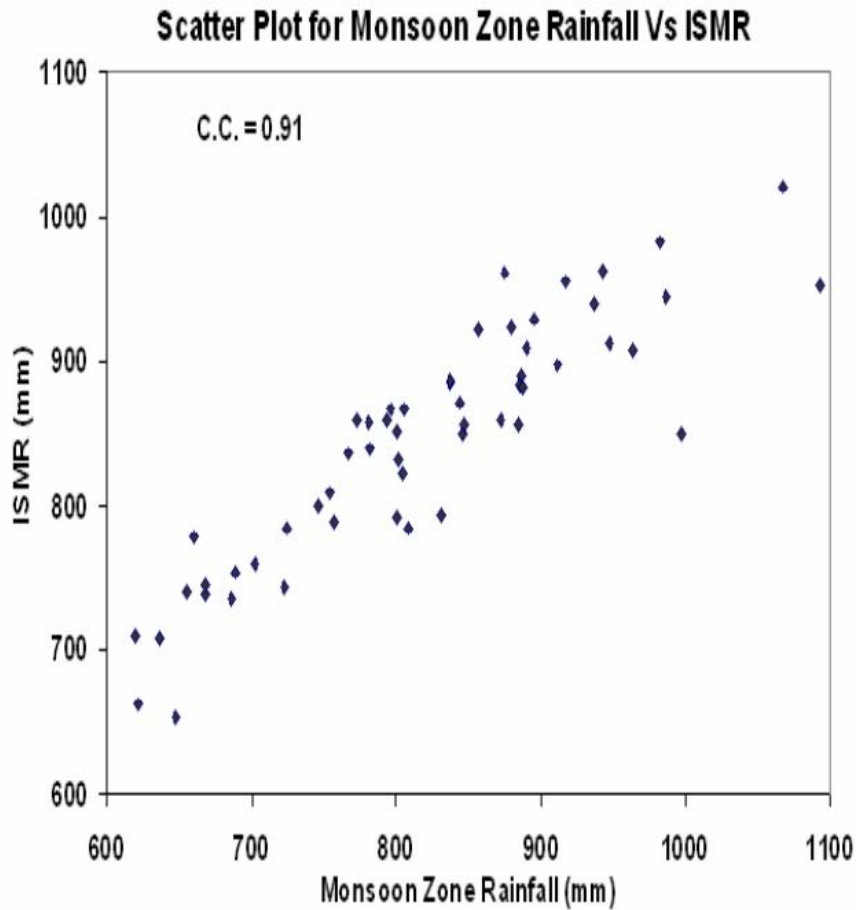


A Break (Active) spell is defined when the standardized daily rainfall averaged over the monsoon core region is less than -1.0 (more than +1.0) consecutively for three days.

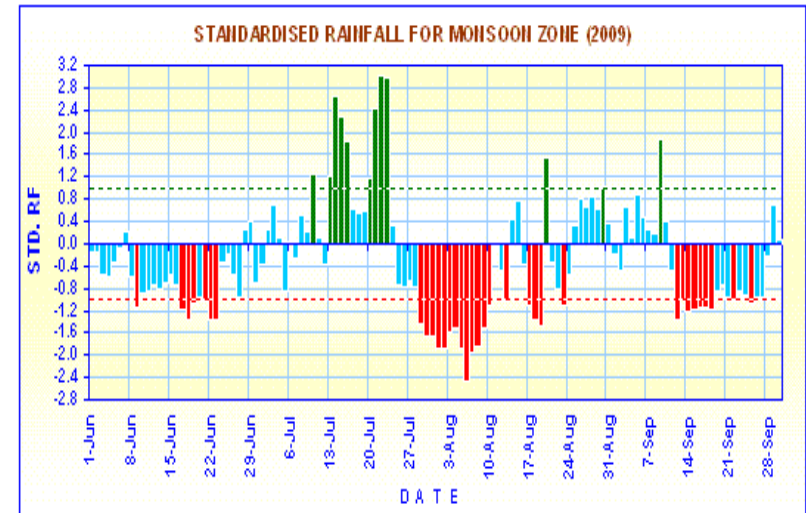
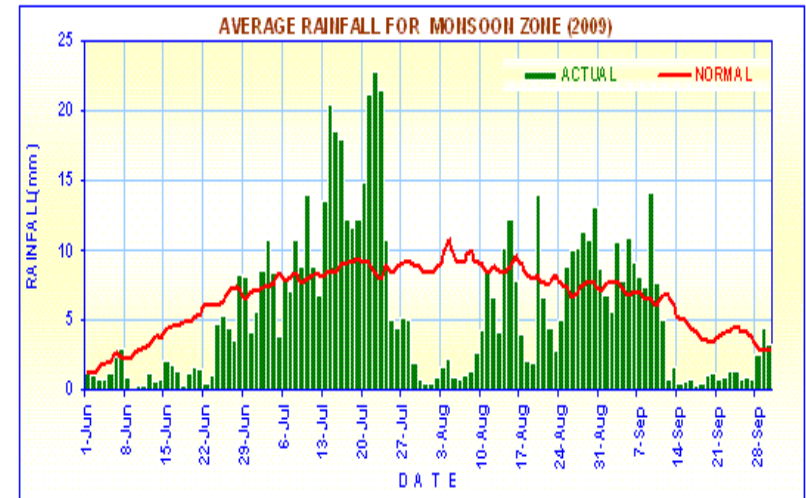
MEAN SEASONAL RAINFALL FOR JUL+Aug (mm/day)



Rajeevan et al. 2010, JESS



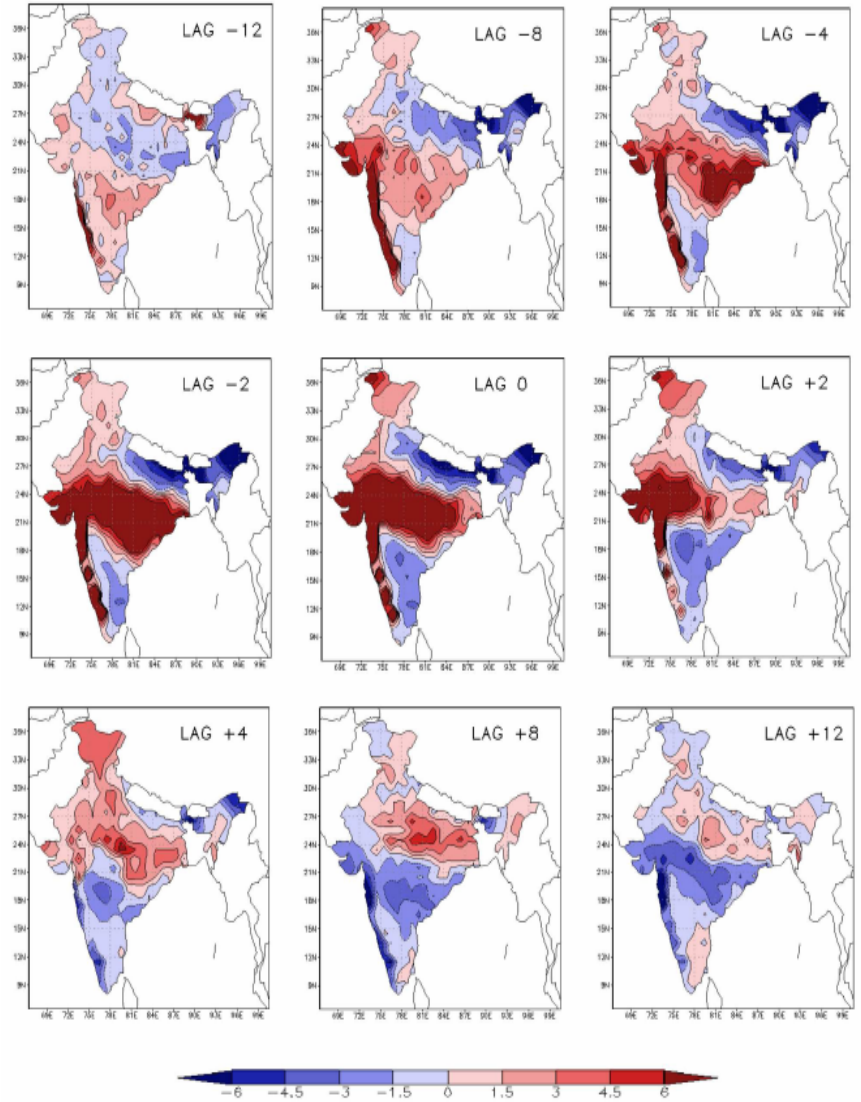
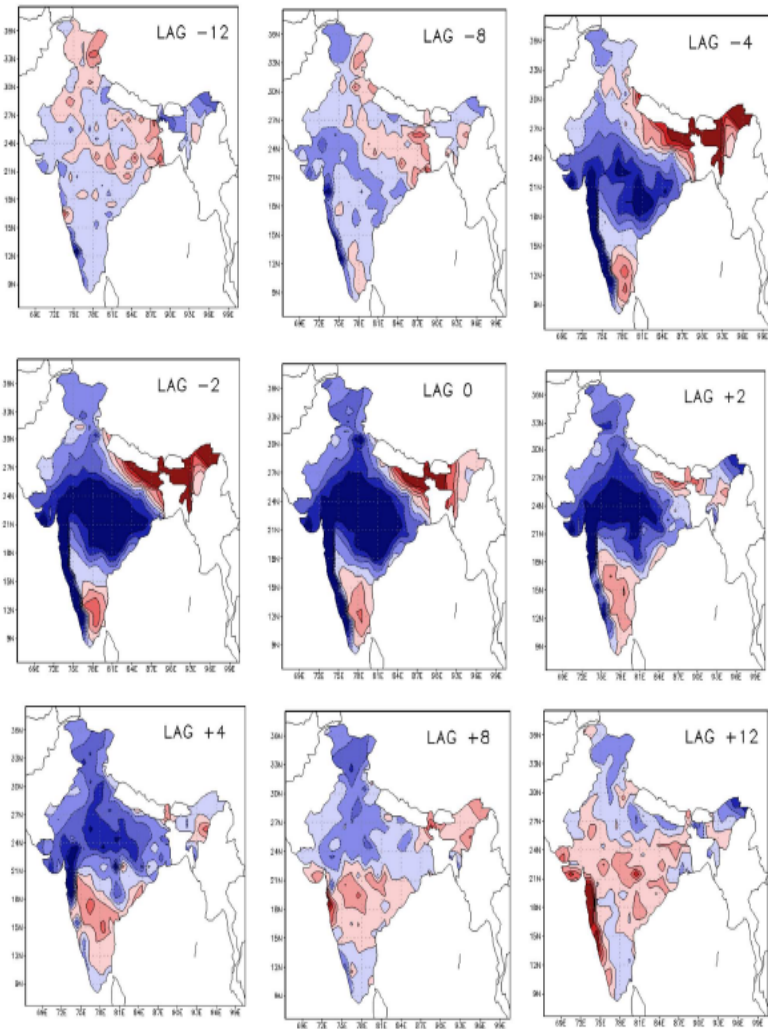
Monsoon zone rainfall is highly correlated to all India monsoon rainfall



Monitoring of the active and break spells in 2009

Lagged Composites of Daily Rainfall Anomalies for  
Break Period

Lagged Composites of Daily Rainfall Anomalies for  
Active Period



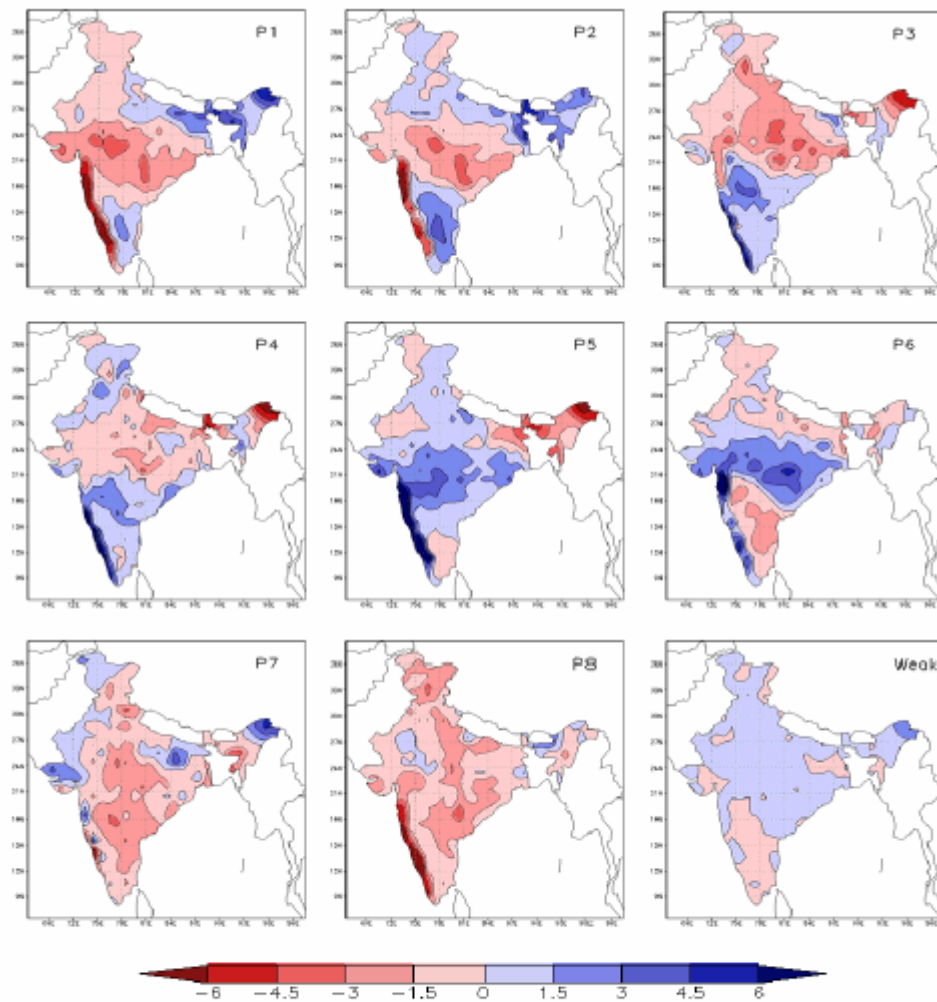
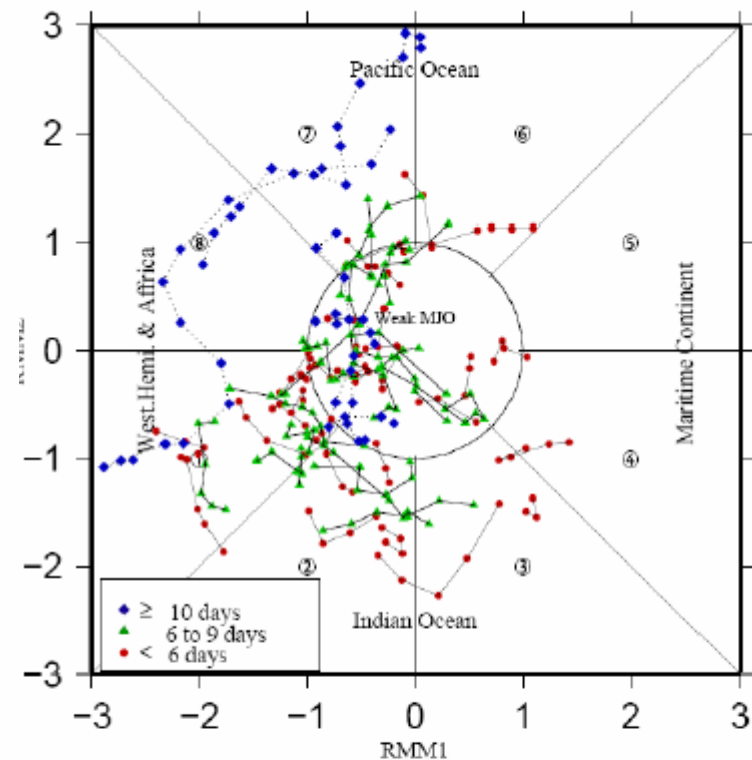


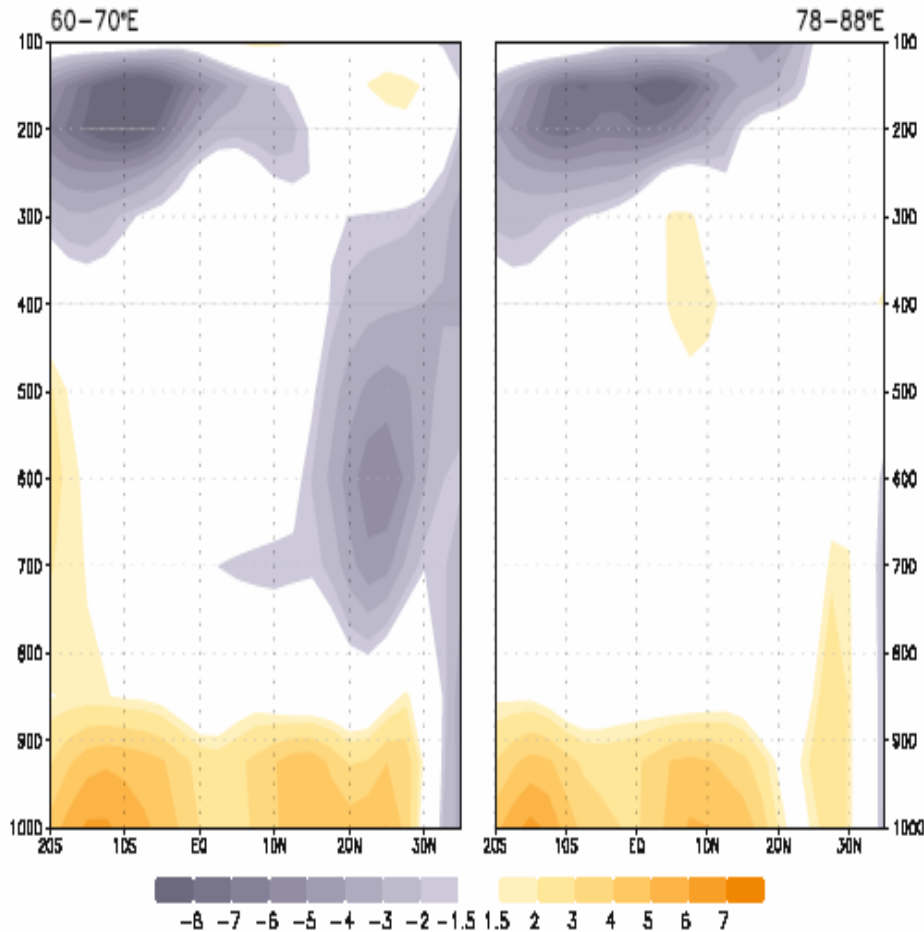
Fig.2 : Maps of composite rainfall anomaly (mm) in respect of 8 strong phases and the weak category of MJO derived using data for the period 1974-2008 (excluding 1978). Maps for the 8 strong MJO phases are labeled as 'P1', 'P2' etc. and the map for weak category is labeled as 'weak'

MJO and Duration of Break Events

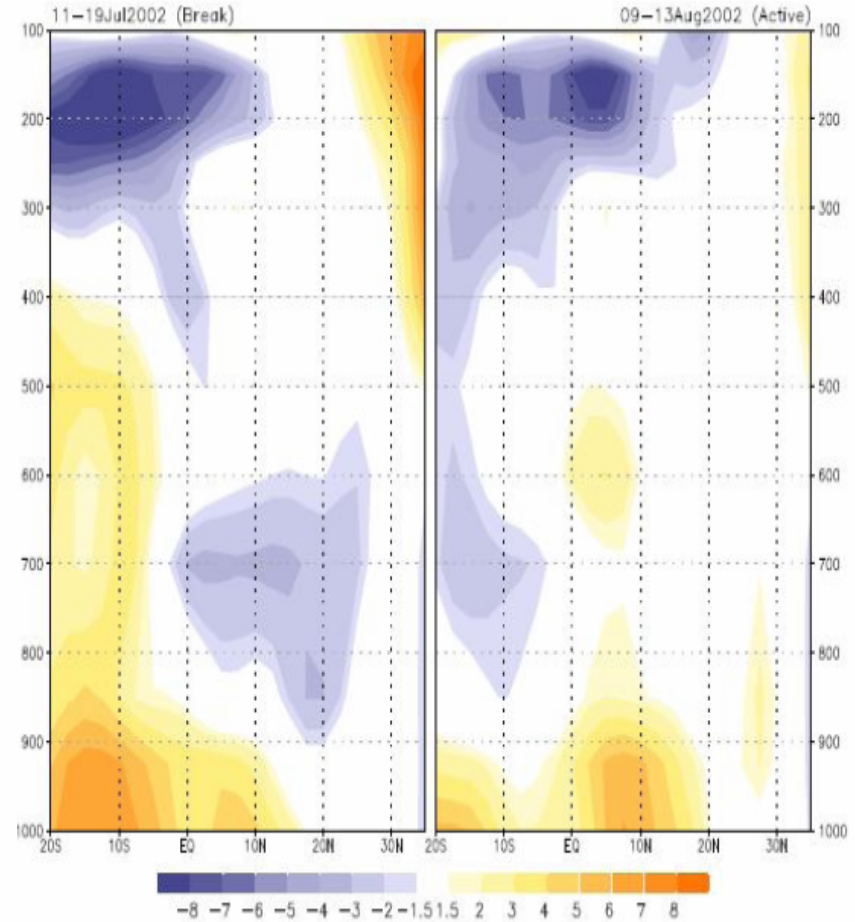


g.4b : The daily MJO indices plotted using markers during the entire duration of each of the 47 break events occurred during the period 1974-2008 (excluding 1978). The encircled numbers inside 8 sectors of the diagram represent 8 phases of the MJO in the diagram. The circle of unit radius with centre at the origin of the diagram delineates the strong and weak MJO categories. Break events of duration < 6days, 6-9days and  $\geq 10$  days are shown using distinct markers. Markers corresponding to each of the break events of duration <6 days & 6-9 days are connected with solid lines separately and that of duration  $\geq 10$  days are connected with dotted lines

Latitude-Height Section of Meridional Wind Climatology (Jul)



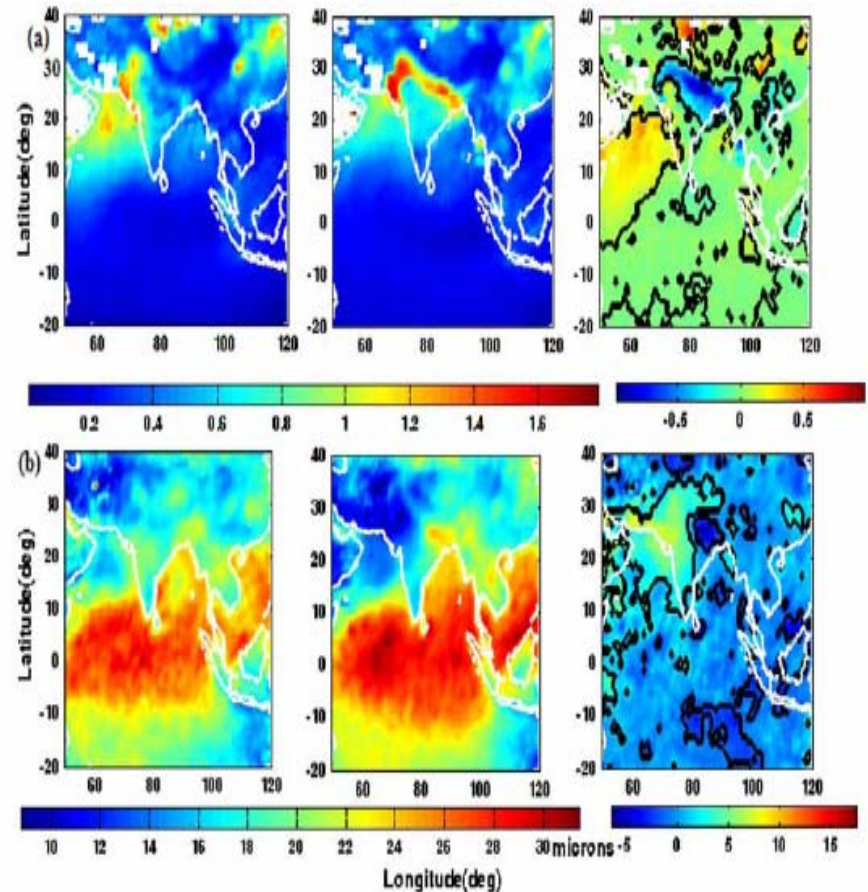
Latitude-Height Section of Meridional Wind Averaged over 78-88°E



During intense breaks, a heat type circulation (limited to about 700 hPa) is observed over the monsoon core region.



During the monsoon breaks, large scale advection of aerosol is observed over central plains of India with associated changes in cloud properties also.



**What is the role of absorbing aerosols in active-break cycle of Indian monsoon?**

Ravi Kiran, M. Rajeevan, 2009 Geophys. Res. Letters



**Cloud Aerosol Interaction and  
Precipitation Enhancement Experiment**

*Indian Institute of Tropical Meteorology,  
Dr. Homi Bhabha Marg, Pashan, PUNE -  
411008*



**CDP Cloud Droplet Probe (CDP)**

**CIP Cloud Imaging Probe (CIP)**  
measures the size and shape  
of particles



**Condensation Nuclei (CCN)  
counter**



**Passive Cavity Aerosol  
Spectrometer Probe (PCASP)**  
measures aerosol particles

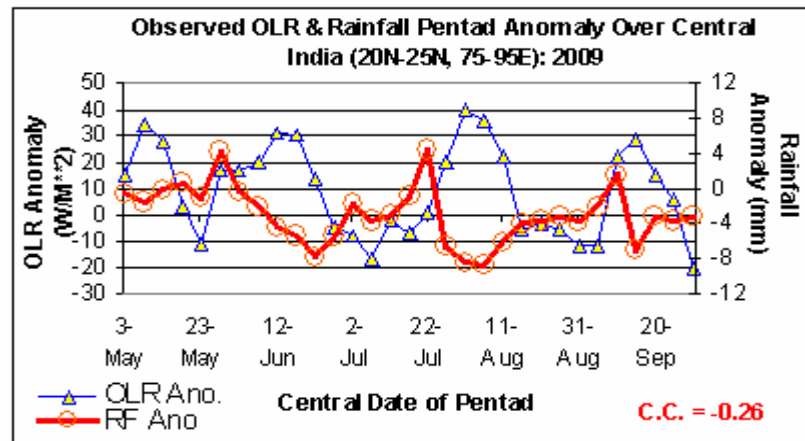
**Other instruments:**

- GPS Sonde
- Black Carbon
- Ice Nuclei

# Efforts in empirical extended range forecasts

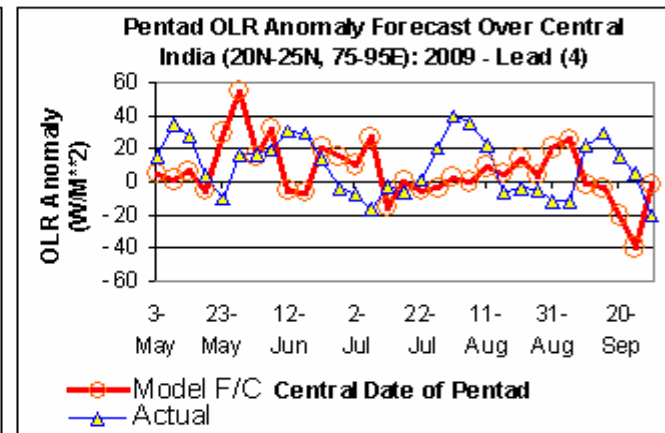
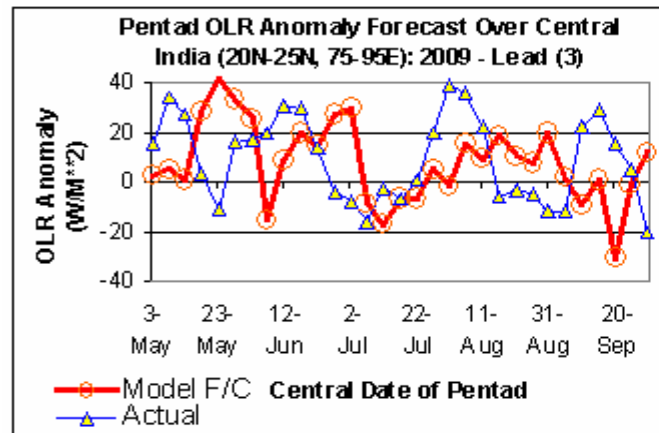
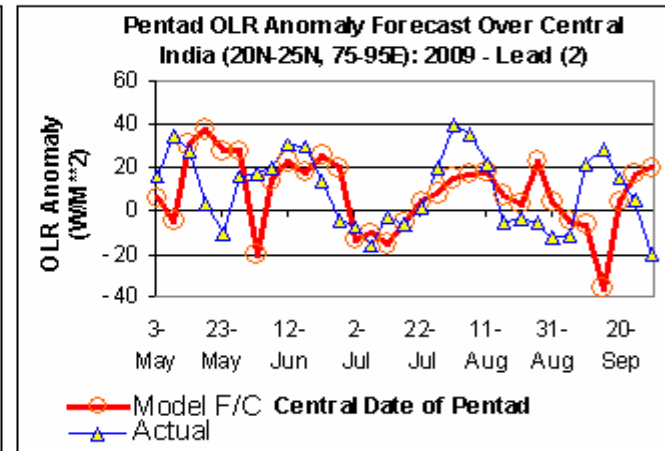
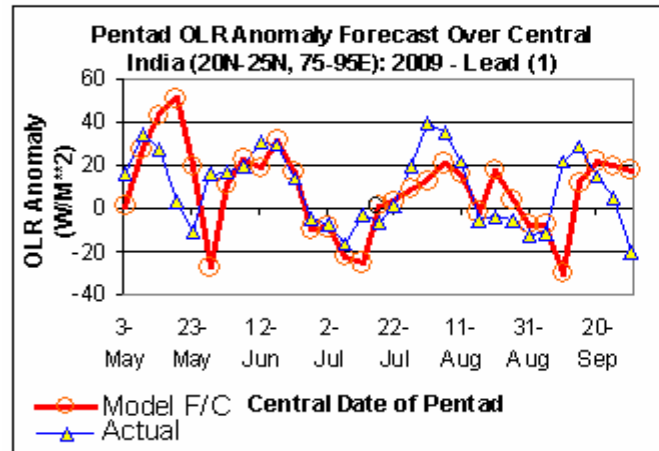
- **Von Storch and Xu (1990), Clim. Dyn**
- **Waliser et al., 1999. J. Clim.**
- **Lo and Hendon, 2000, MWR**
- **Jones et al., 2004**
- **Webster and Hoyos, 2004 (BAMS).**
- **Based on EOF and Analog techniques: Xavier and Goswami., 2007, MWR**
- **Based on Self-Organizing Map and Analogues: Chattopadhyay, Sahai and Goswami., 2008, JAS.**

# 2009 predictions



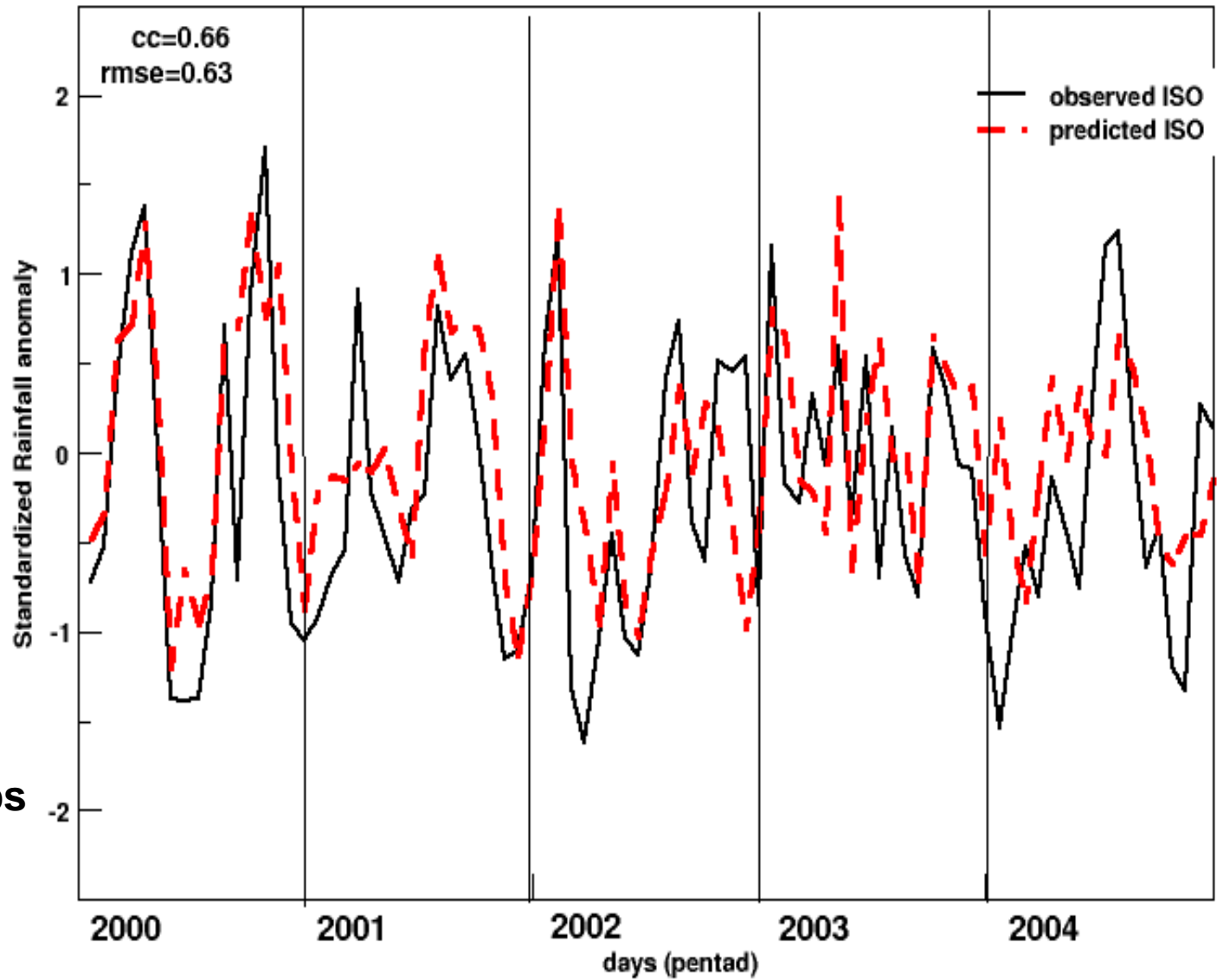
o The C.Cs between the actual and forecast OLR anomaly series of central India with one pentad lead is 0.37.

o For the forecast with lead periods of 2 pentads, 3 pentads and 4 pentads, the C.Cs are 0.08, -0.16 and -0.19 respectively.



**Xavier and Goswami 2007**

### 4th pentad forecast Central India



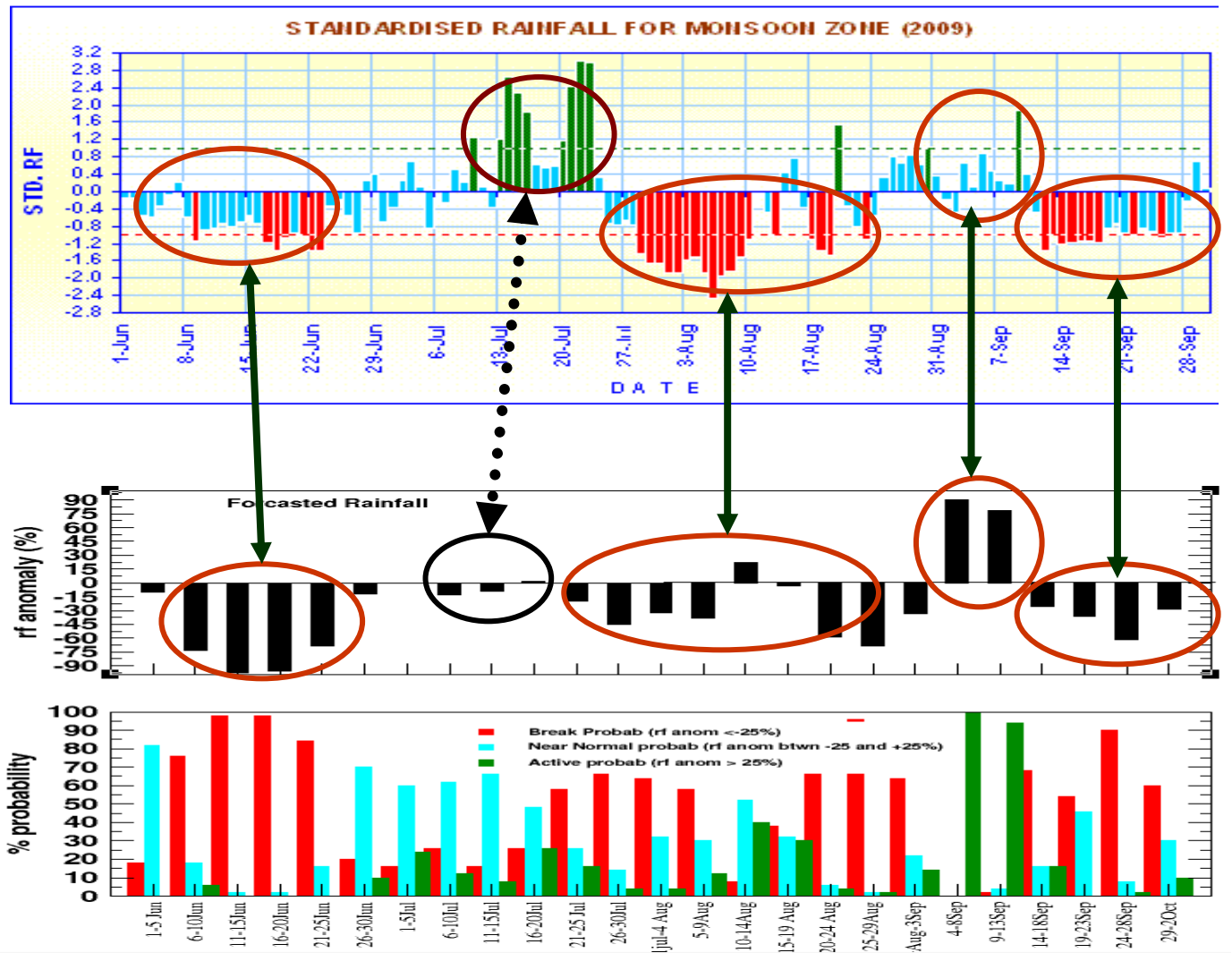
**Self Organizing Maps  
(SOM) Method**

**Chattopadhyay, et al, JAS, 2008**

# Experimental Probabilistic Prediction of Active/break: 2009

→  
Well predicted spells

⋯→  
Partially predicted spells



Chattopadhyay,  
Sahai, Goswami  
JAS, 2008

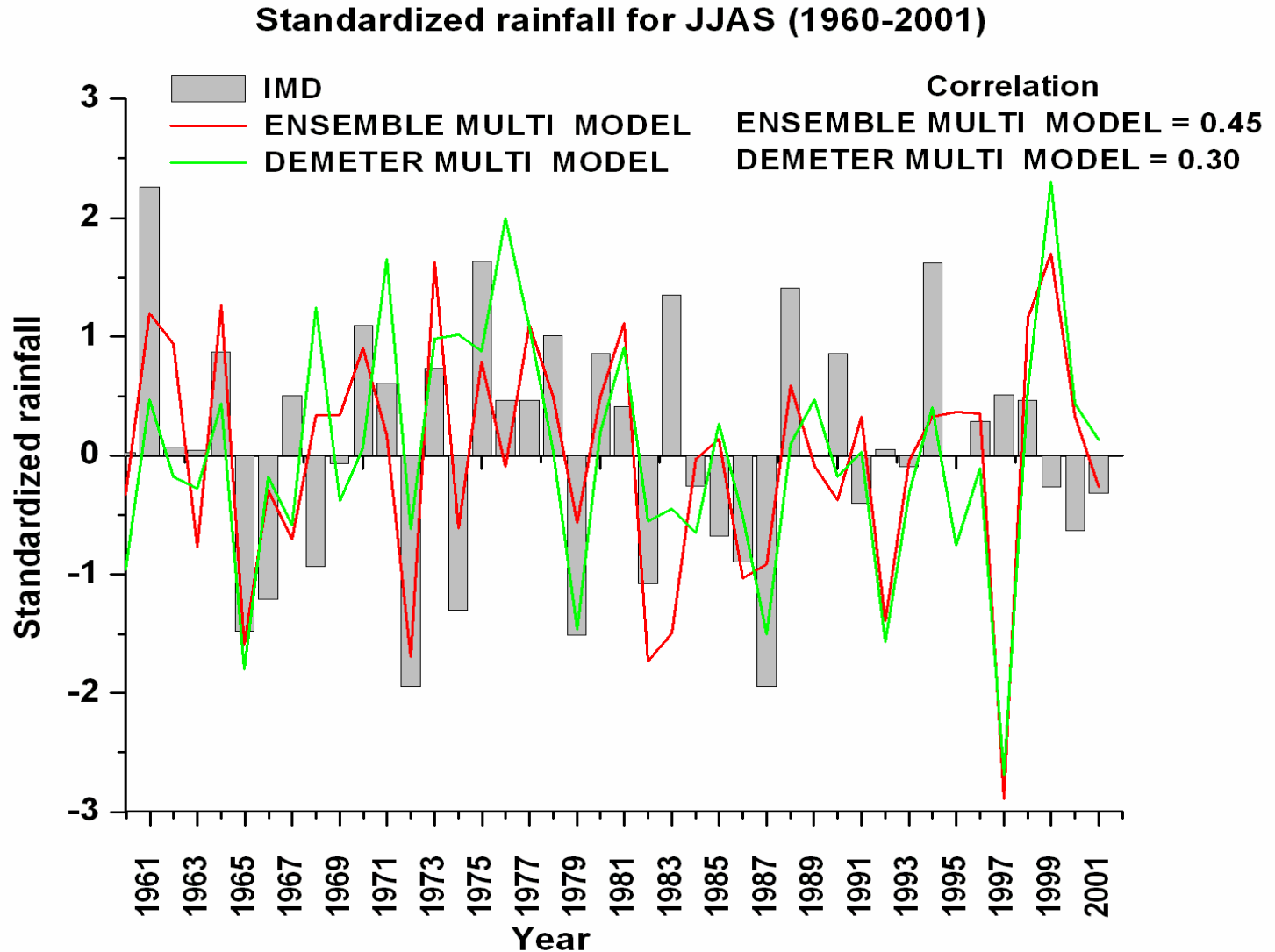
# Seasonal Forecasts



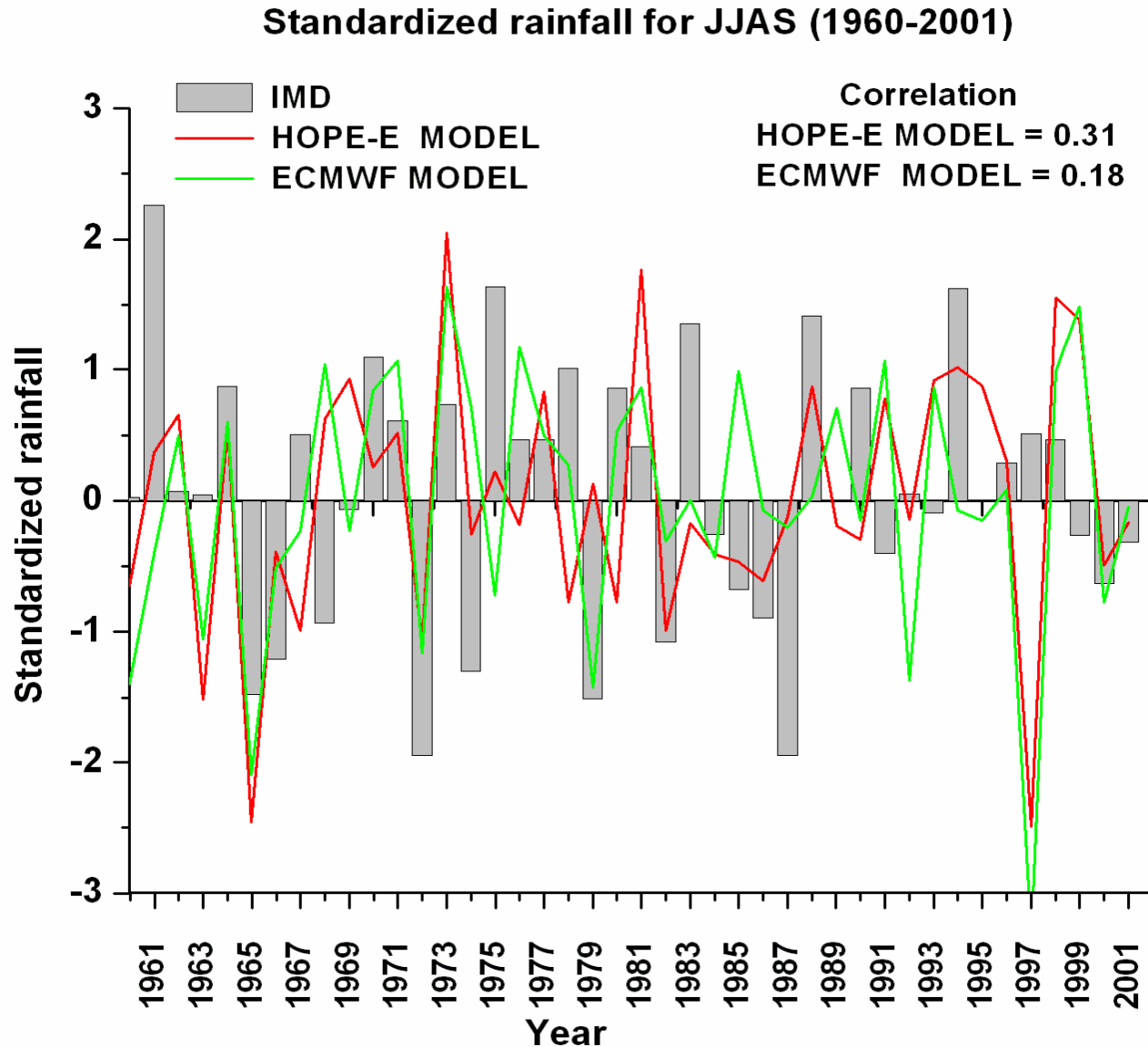
# Shifting focus towards dynamical models

- India Meteorological Department (IMD) has been using statistical methods for preparing operational seasonal forecasts with limited success.
- More emphasis is now given in using dynamical models for preparing seasonal forecasts.
- IMD and other institutes are now using different dynamical models for preparing experimental seasonal forecasts.
- IITM developed capability of running the NCEP CFS model for preparing seasonal forecasts.

# EU ENSEMBLES MODELS BETTER THAN DEMETER MODELS

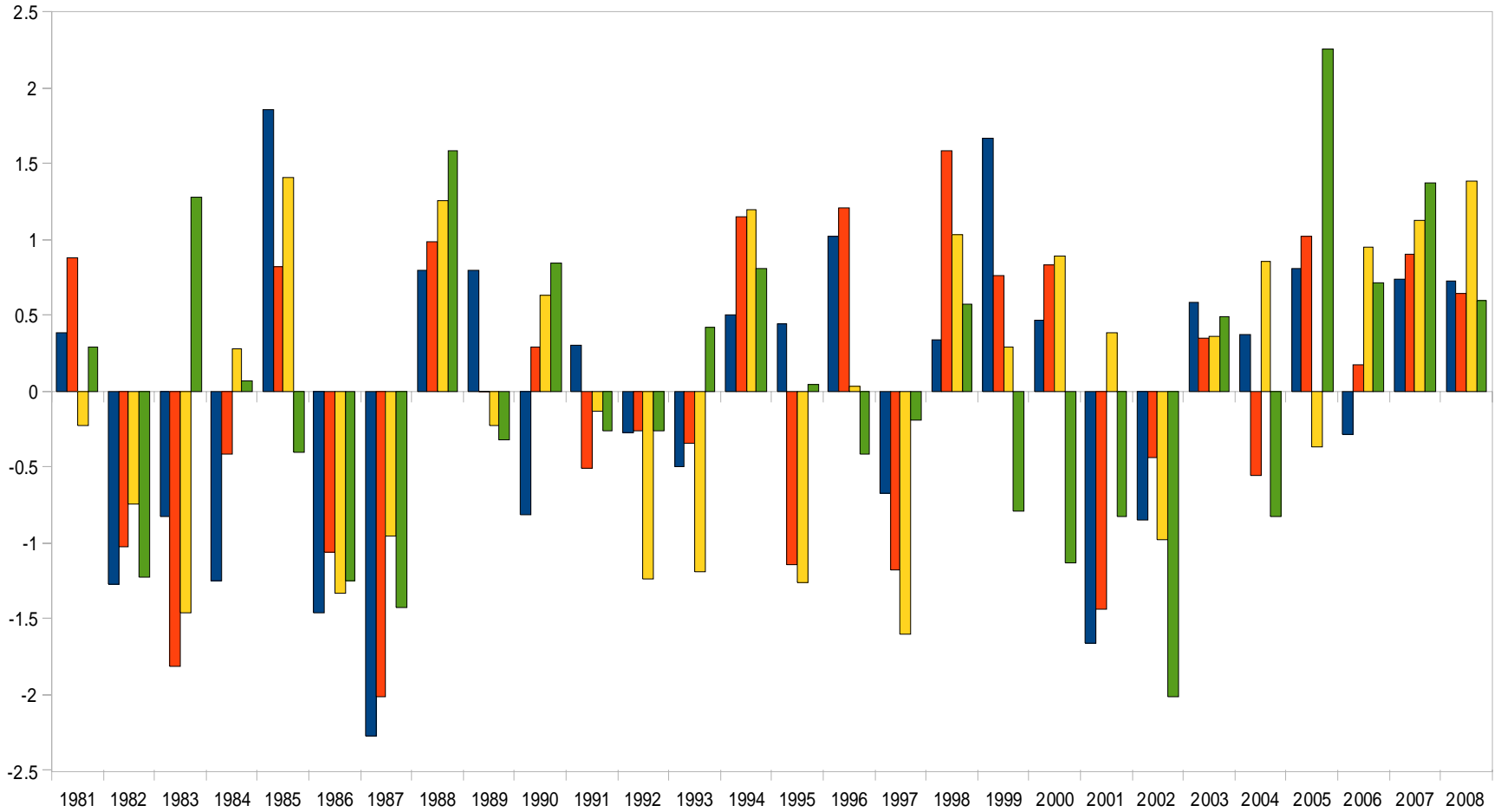


# ECMWF seasonal model also doing better



# Hindcast comparison of T62L64 ISMR with IMD RAINFALL DATA

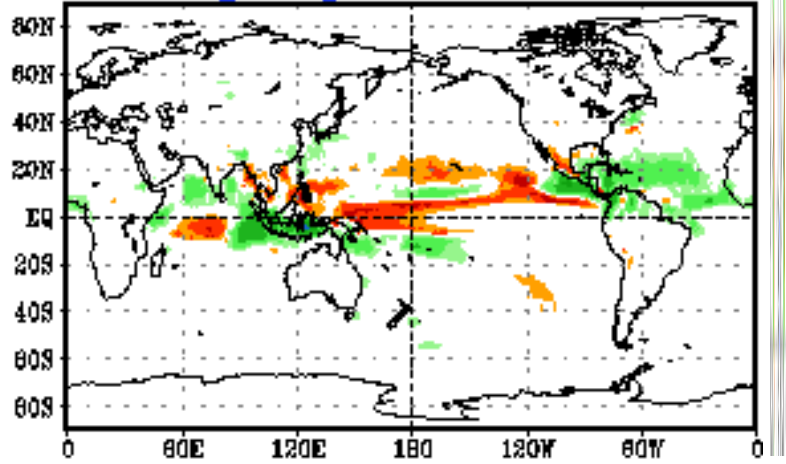
■ March\_IC\_anom ■ Apr\_IC\_anom ■ May\_IC\_anom ■ imd\_jjas\_mean\_anom



**NCEP GFS HINDCAST RESULTS**

# 2010 Monsoon Forecast (May IC)

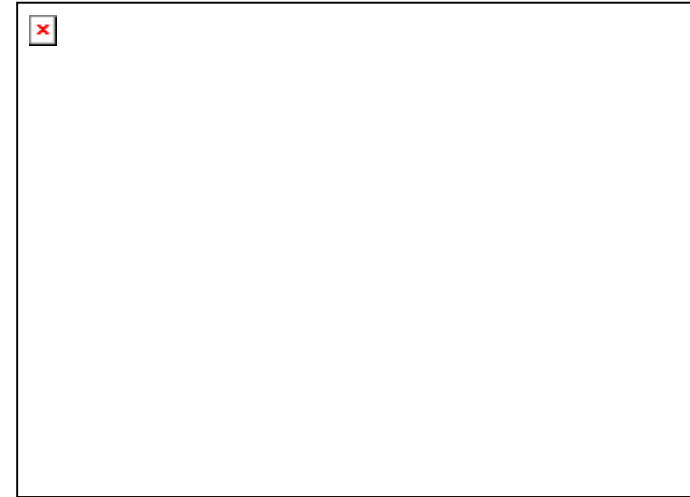
Jul-Aug-Sep 2010



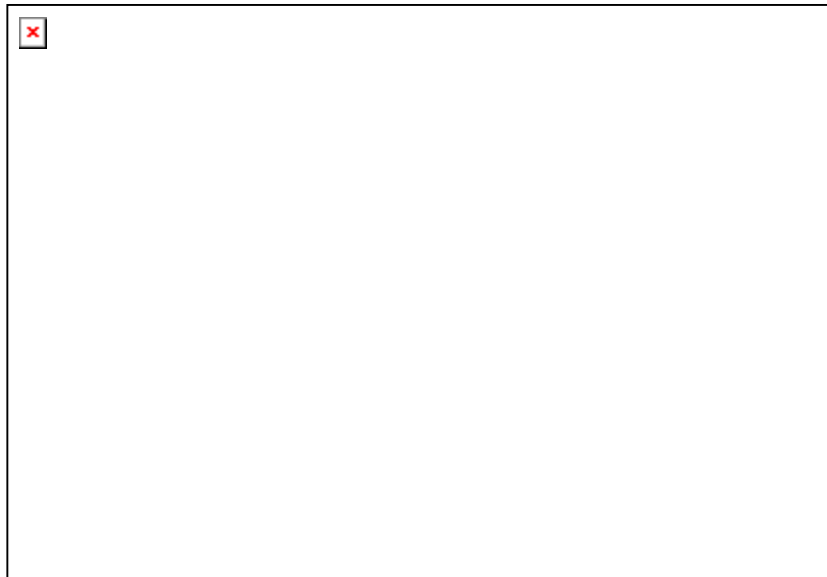
NCEP

Departure of JJA rain

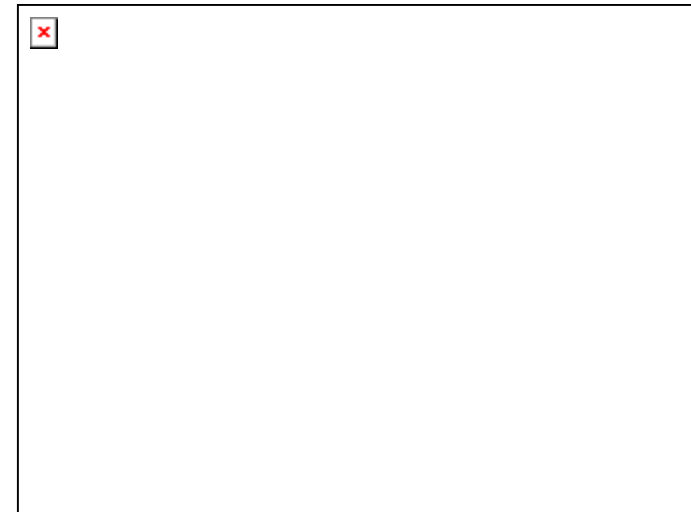
Departure of JJAS rain



IITM



% Dep of JJAS rain

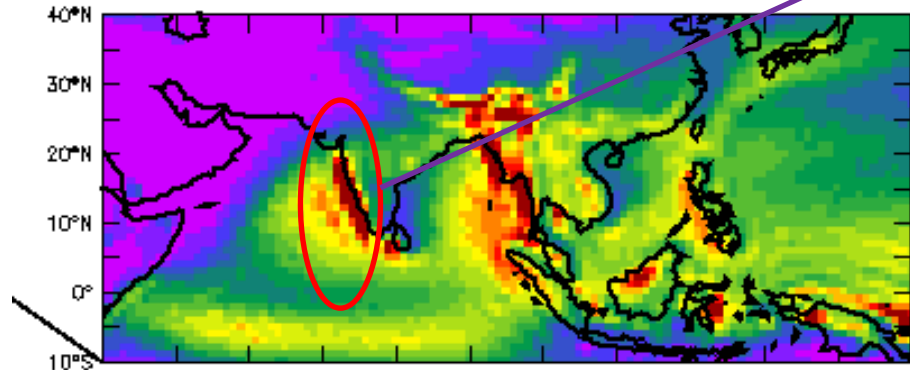
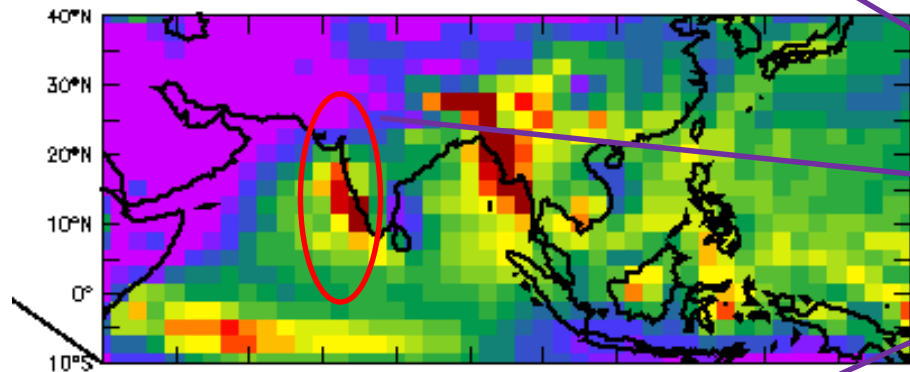
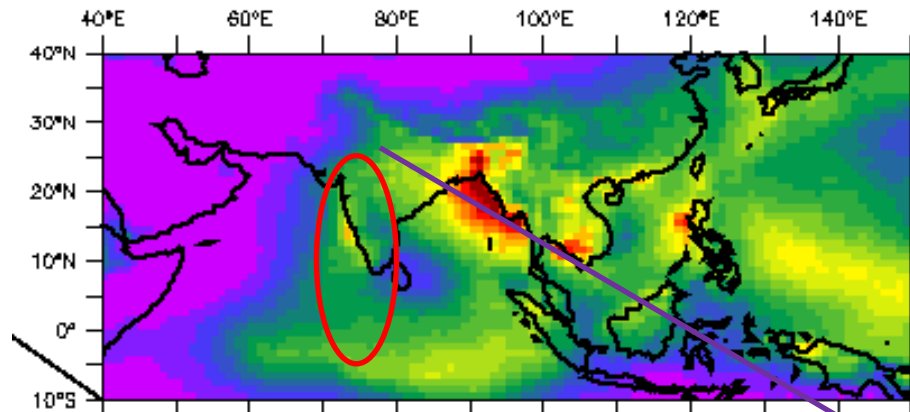


Courtesy: Suryachandra Rao, IITM

## Model comparison with GPCP 1Deg. Rainfall dataset

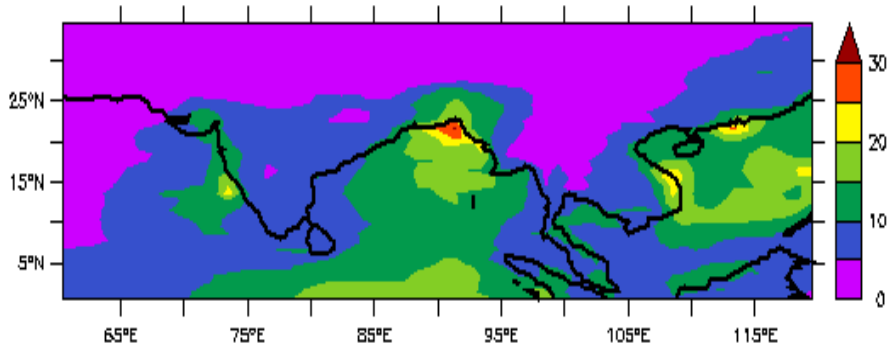
In T126 run simulation of rainfall over Indian subcontinent is improved and OTCZ bias is reduced

Overestimation of Rainfall over western Ghats/Eastern Arabian Sea



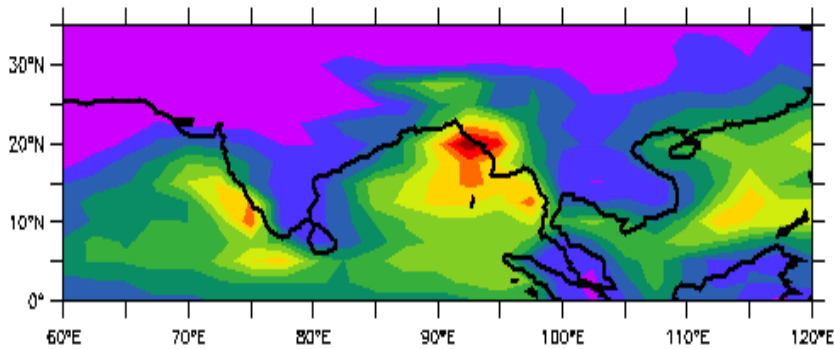
Courtesy: Suryachandra Rao, IITM

GPCP ISO variance



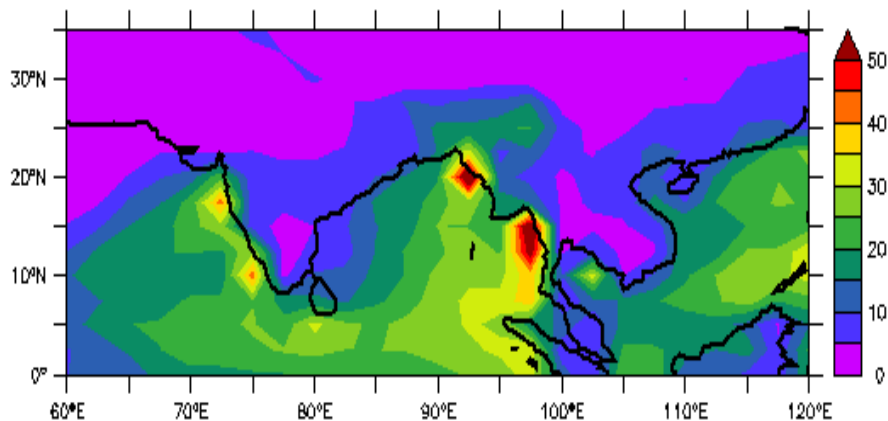
**Model comparison with  
GPCP 1 deg. Rainfall  
dataset**

CFS T62 ISO variance



**ISO Variance in the  
model is reasonably  
well simulated, however,  
its strength is almost  
double in the model**

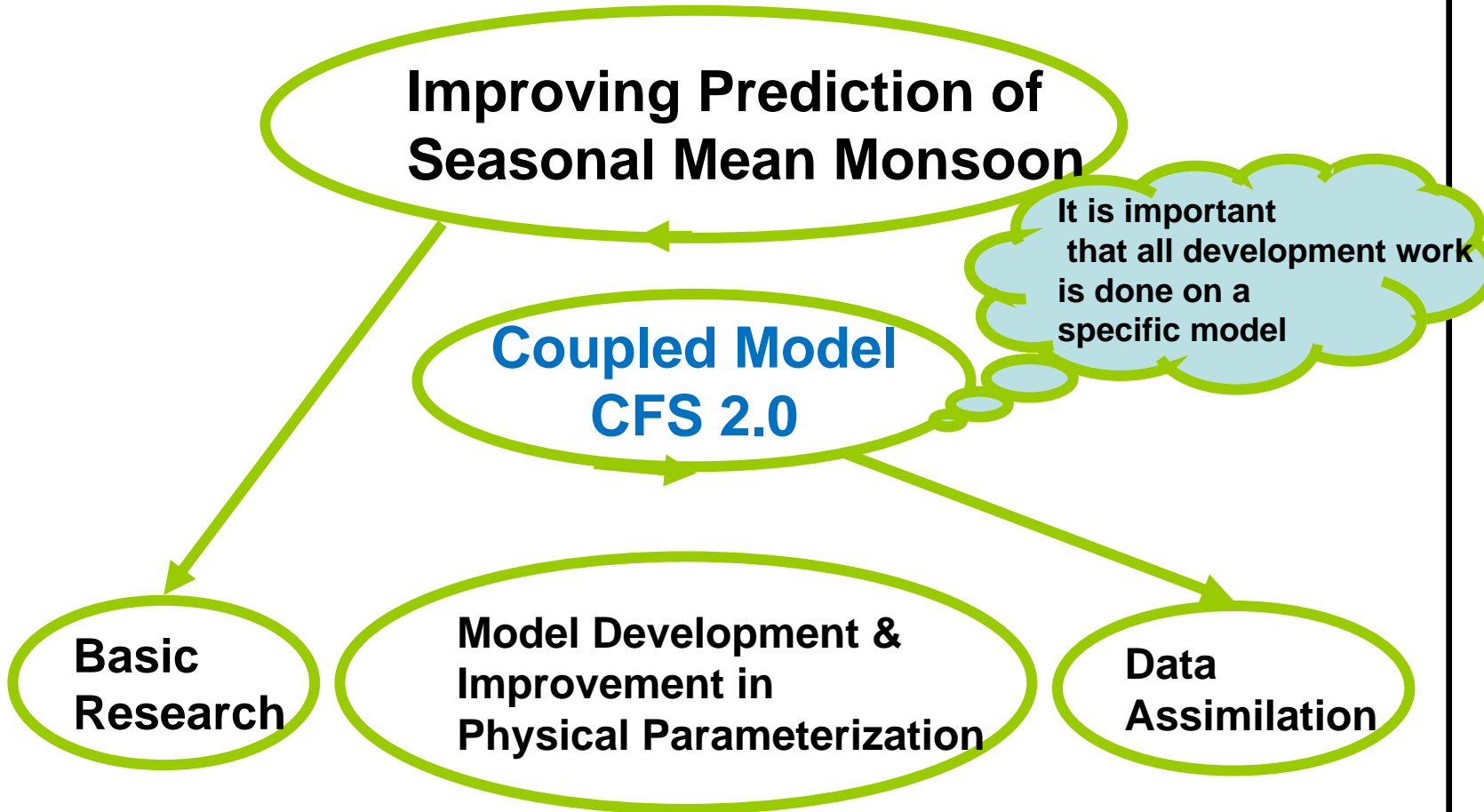
CFS T126 GPCP ISO variance



**Courtesy: Suryachandra Rao,  
IITM**

# National Monsoon Mission

## Coordination of National Mission of Monsoon





Thank you