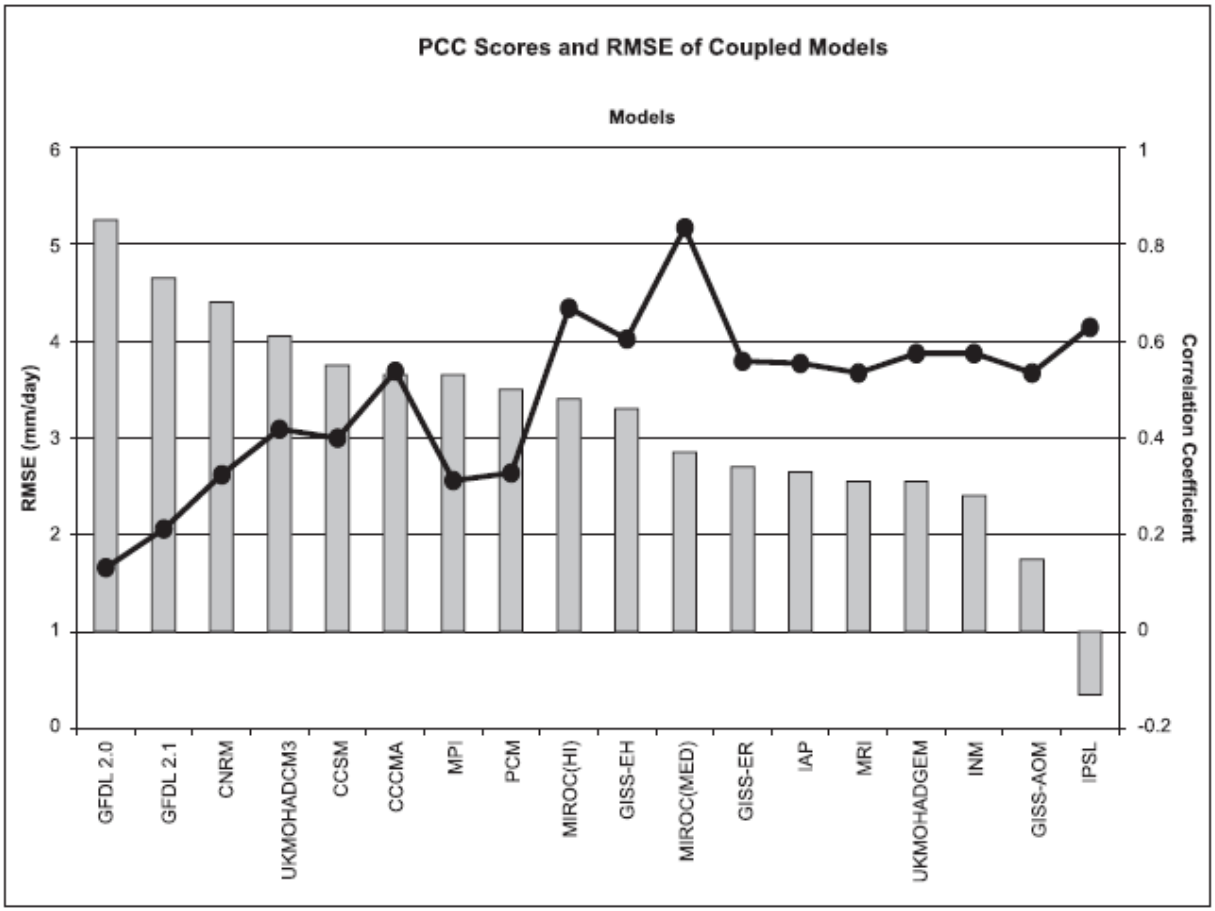
CURRENT TRENDS
IN SCIENCE

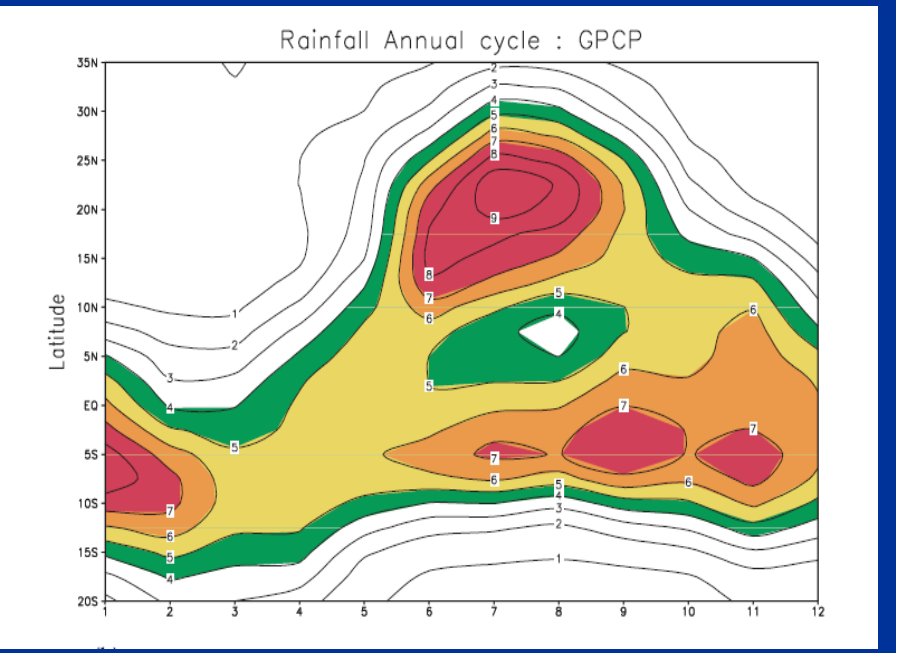
PLATINUM JUBILEE SPECIAL

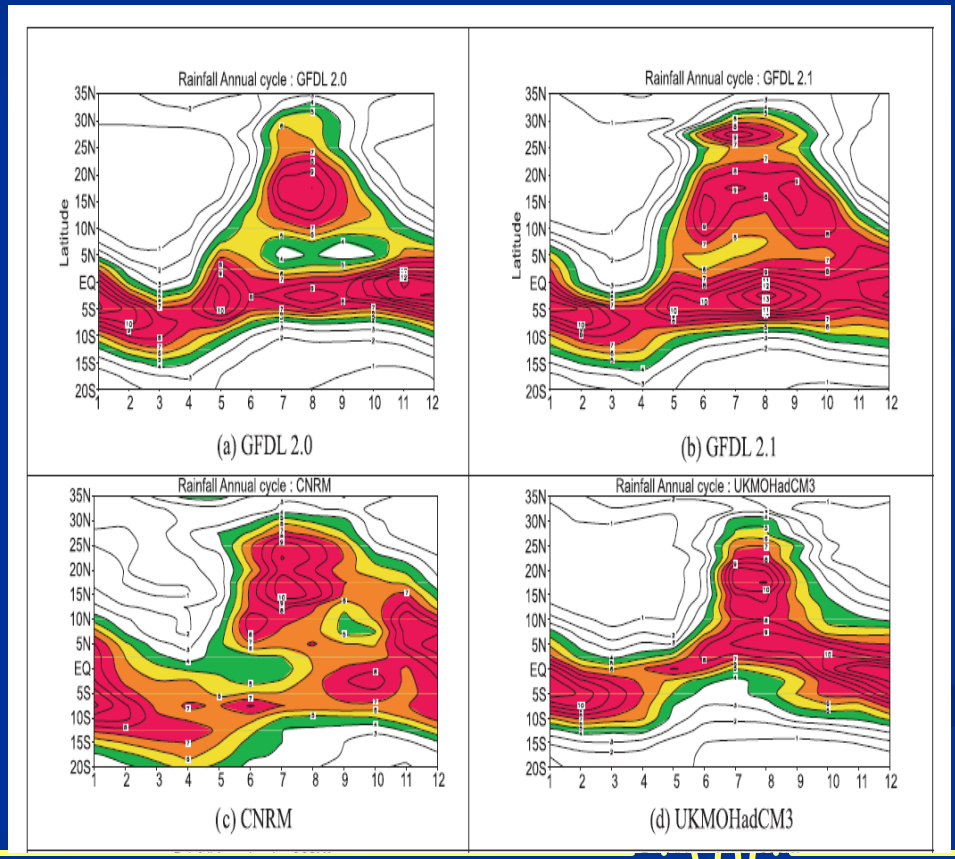
Coupled model simulations of twentieth century climate of the Indian summer monsoon

M RAJEEVAN[1] and RAVI S NANJUNDIAH[2]


PCC Scores and RMSE of Coupled Models
Models
RMSE (mm/day)
Correlation Coefficient
6
5
4
3
2
1
0
1
0.8
0.6
0.4
0.2
0
-0.2
GFDL 2.0
GFDL 2.1
CNRM
UKMOHADCM3
CCSM
CCCMA
MPI
PCM
MIROC(HI)
GISS-EH
MIROC(MED)
GISS-ER
IAP
MRI
UKMOHADGEM
INM
GISS-AOM
IPSL

Annual Cycle





Improving Dynamical Prediction of Seasonal Mean Monsoon & Extended Range Prediction of Active-Break Spells

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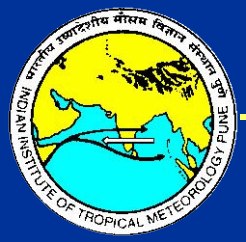
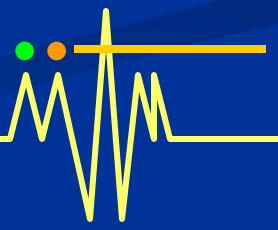
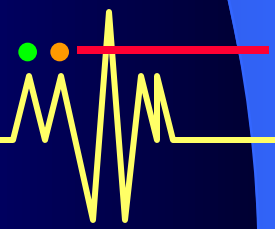
Inputs: Dr Suryachandra Rao, Prof. B.N.Goswami, IITM



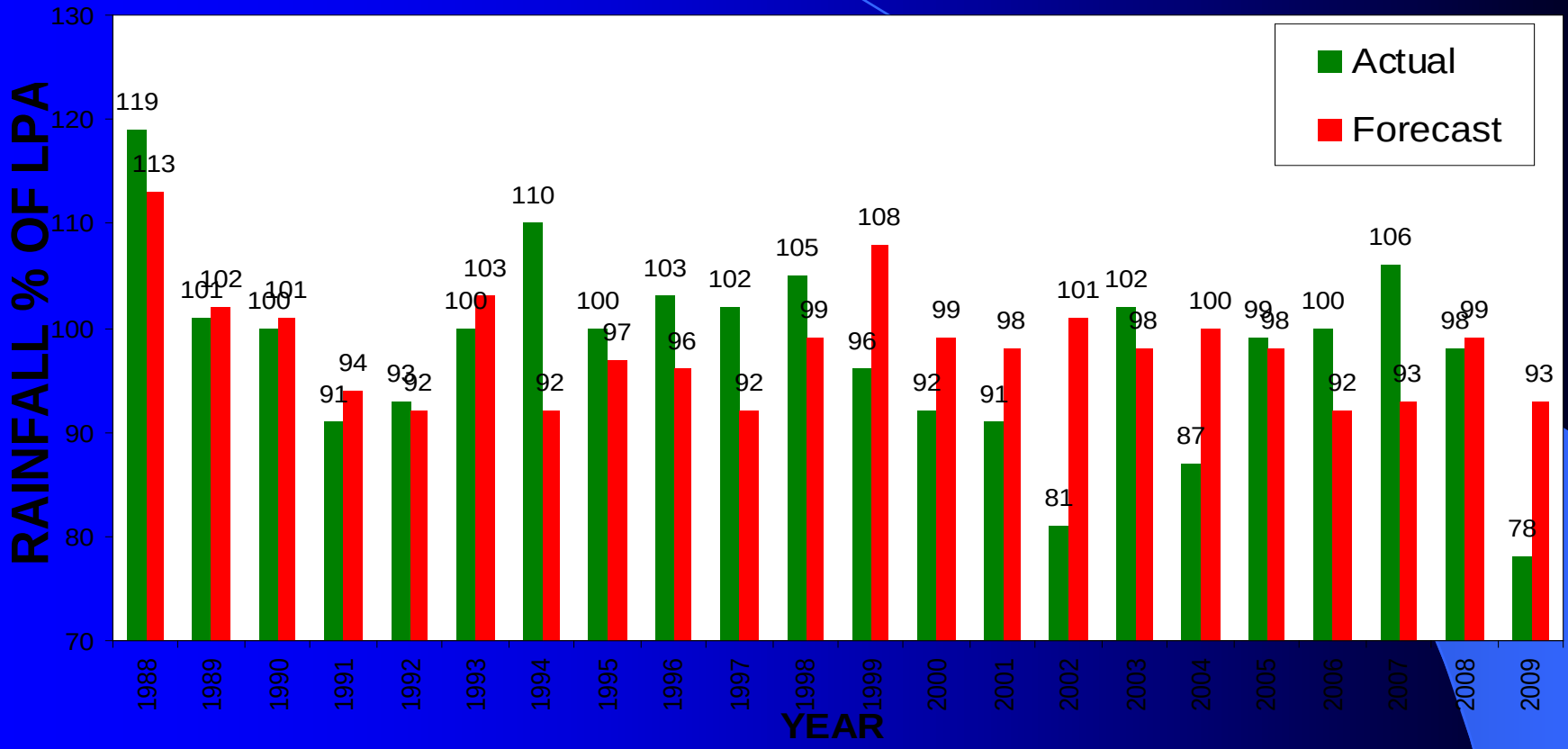


The Mission

- The Mission's goal is to build a working partnership between the Academic R & D Organizations and the Operational Agency to improve monsoon forecast skill.
- This would require all to work on A Modeling Framework!



Performance of Operational Forecast for All India Summer Rainfall (1988-2009)



- During 7 years (including 2009) error is ≥ 10% with highest during 2002 (20%) and 1994 (18%). Error during 2009 was 15%.

Average Abs Error of Op. forecasts (1988-2009) = 7.5%

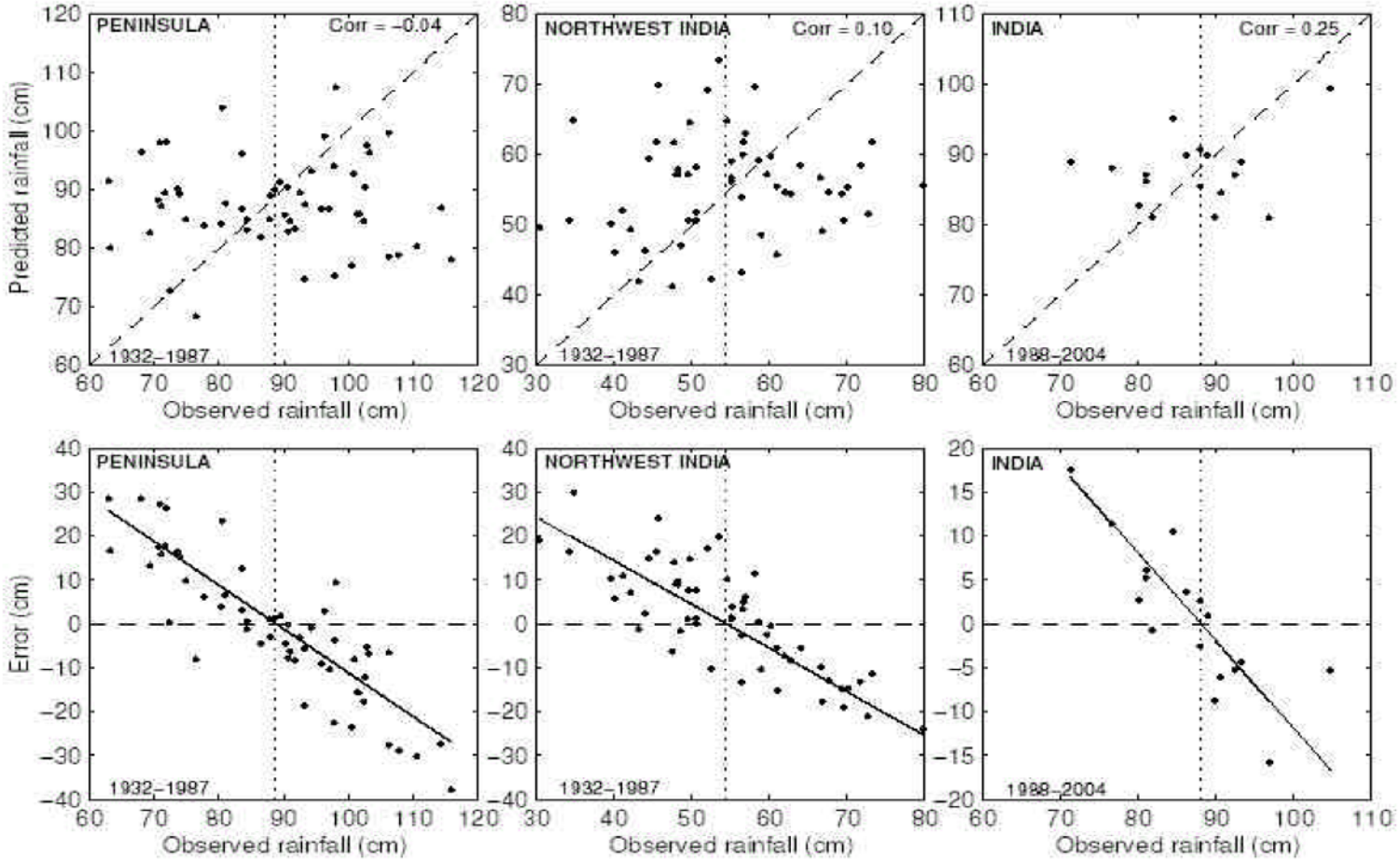


Figure 8. Predicted versus observed (top) and error versus observed rainfall. The line represents a perfect prediction (top) and the negative of the observed anomaly (mean-observed) versus observed (bottom). If the prediction was always given as the mean, the error would fall on this line. As it is, the points are scattered around the line.

- **Tends to predict 'normal'. Can not predict extremes**
- **No improvement of skill in 30 years**

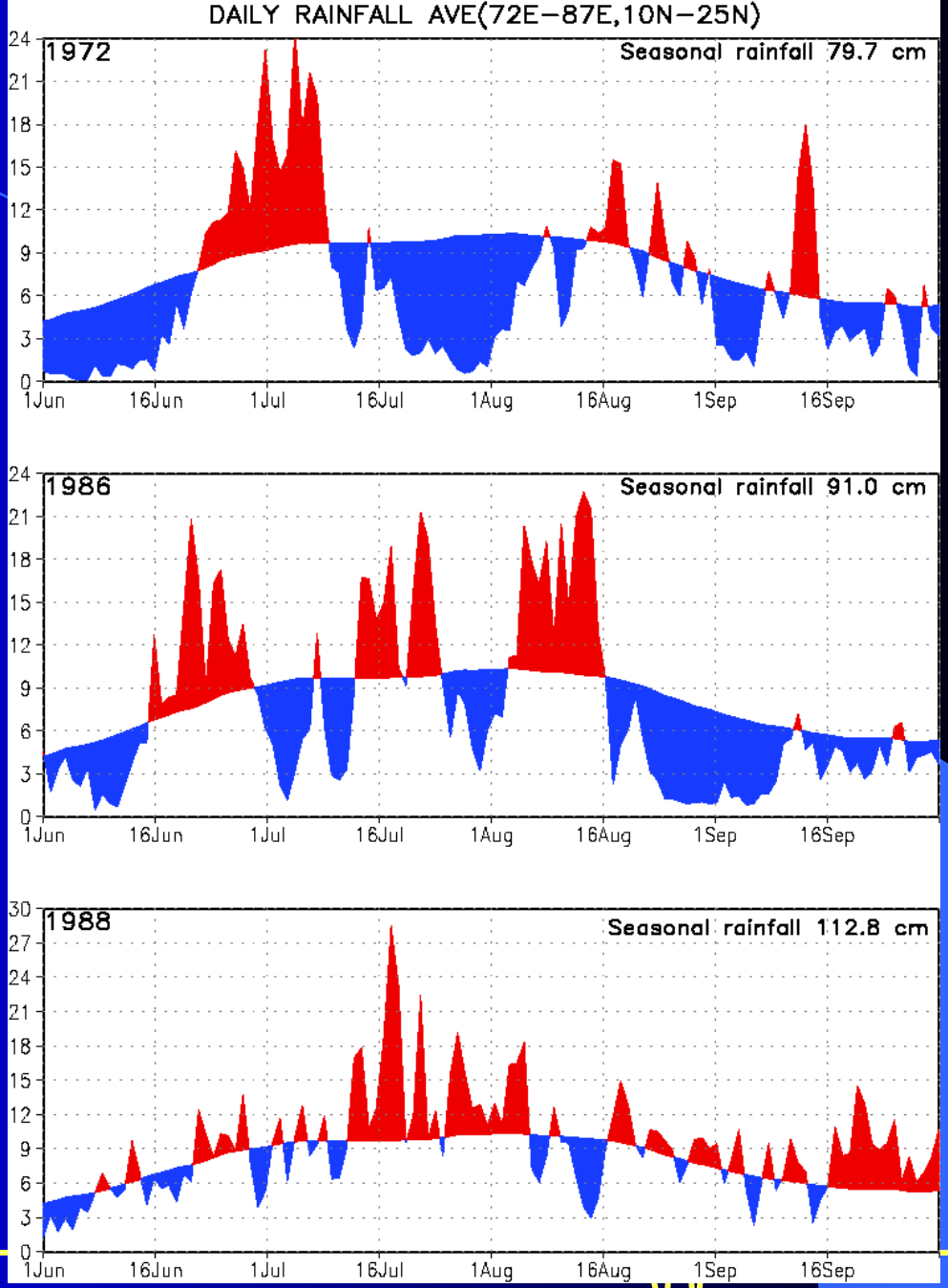
Gadgil et al, 2005, Curr. Sci

Active-break spells (cycles)

Daily rainfall (mm/day) over central India for three years, 1972, 1986 and 1988

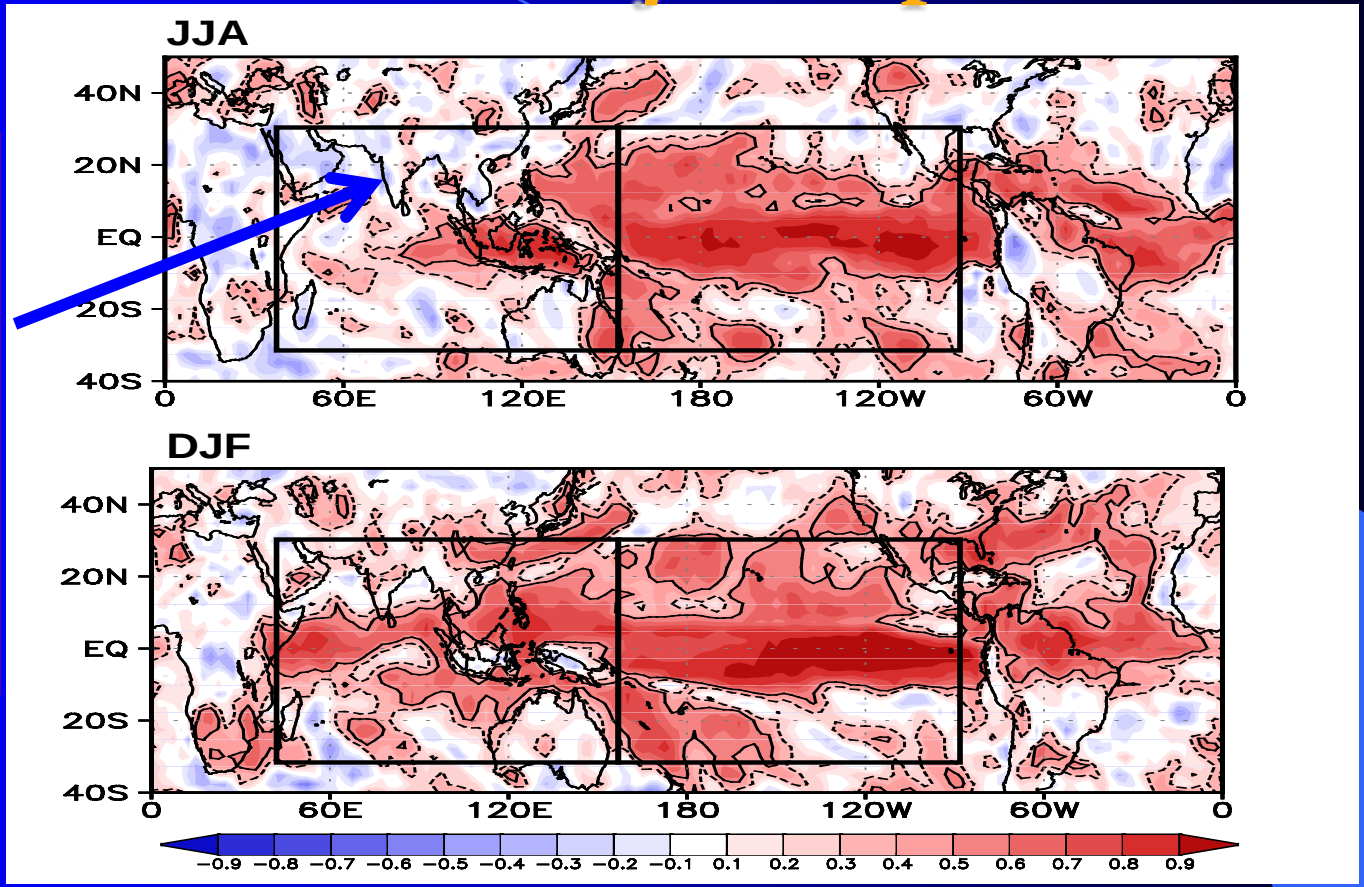
The smooth curve shows long term mean.

Red shows above normal or wet spells while blue shows below normal or dry spells



Correlation bet. Prediction and observation of Precipitation

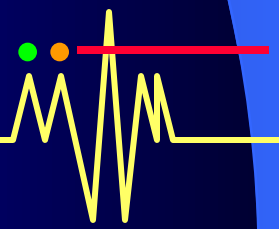
Current Dynamical models have little skill in predicting Indian monsoon



There is a great need to improve this!!

Why CFS Model System?

- Through the NOAA-MoES MoU Institutional support from NCEP will be available.
- However, amongst the existing model systems, skill of CFS seems to be on the better side. It also has a reasonable monsoon climatology
- Appears to be a system upon which future developments could be built.



CFS T126L64

The NCEP CFS Components

T126/64-layer version of the CFS

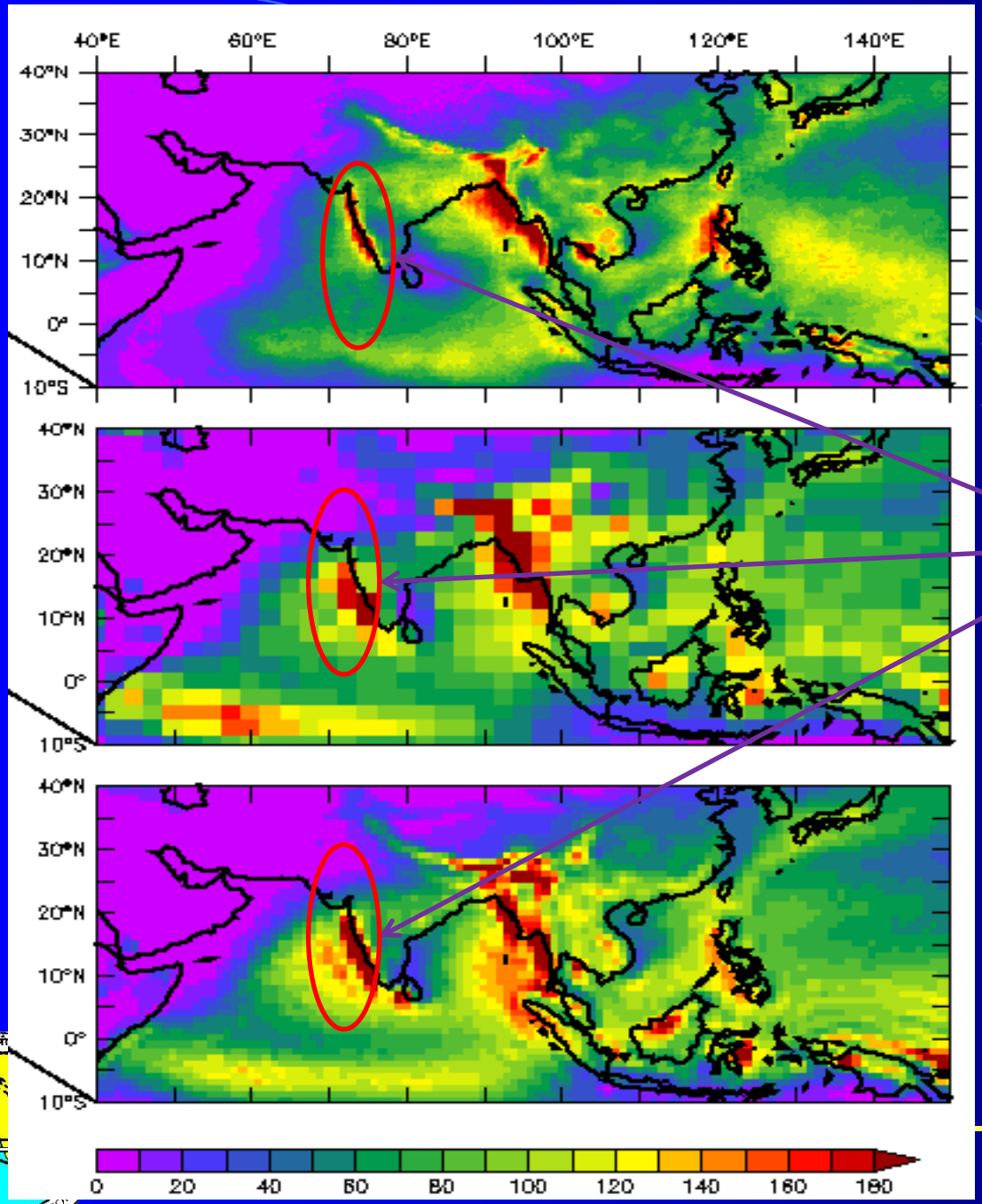
Atmospheric **GFS (Global Forecast System) model**

- Model top 0.2 mb
- Simplified Arakawa-Schubert convection (Pan)
- Non-local PBL (Pan & Hong)
- SW radiation (Chou, modifications by Y. Hou)
- Prognostic cloud water (Moorthi, Hou & Zhao)
- LW radiation (GFDL, AER in operational model)

GFDL **MOM-3 (Modular Ocean Model, version 3)**

- 40 levels
- 1 degree resolution, 1/3 degree on equator

Model comparison with TRMM 0.25 deg. Rainfall dataset

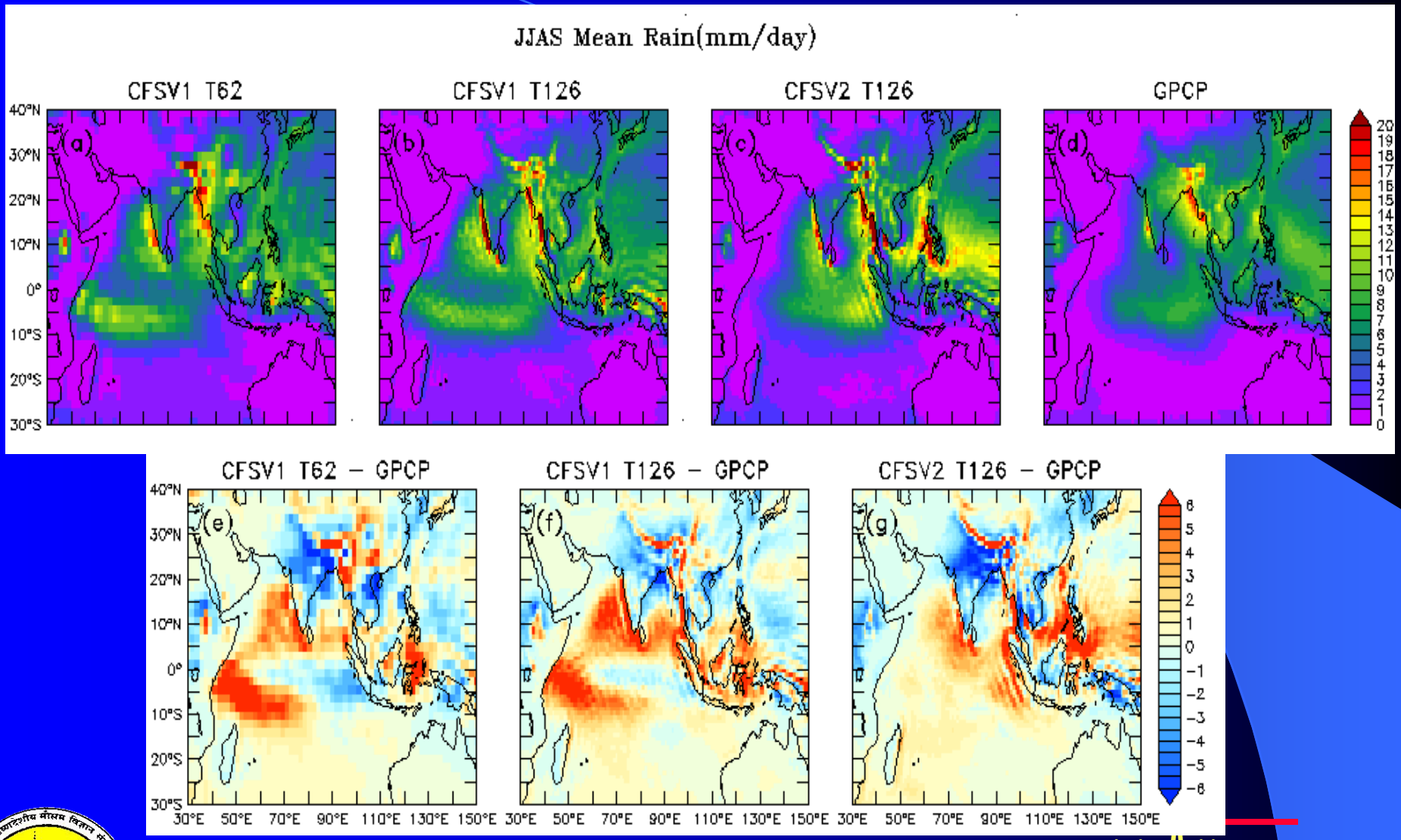


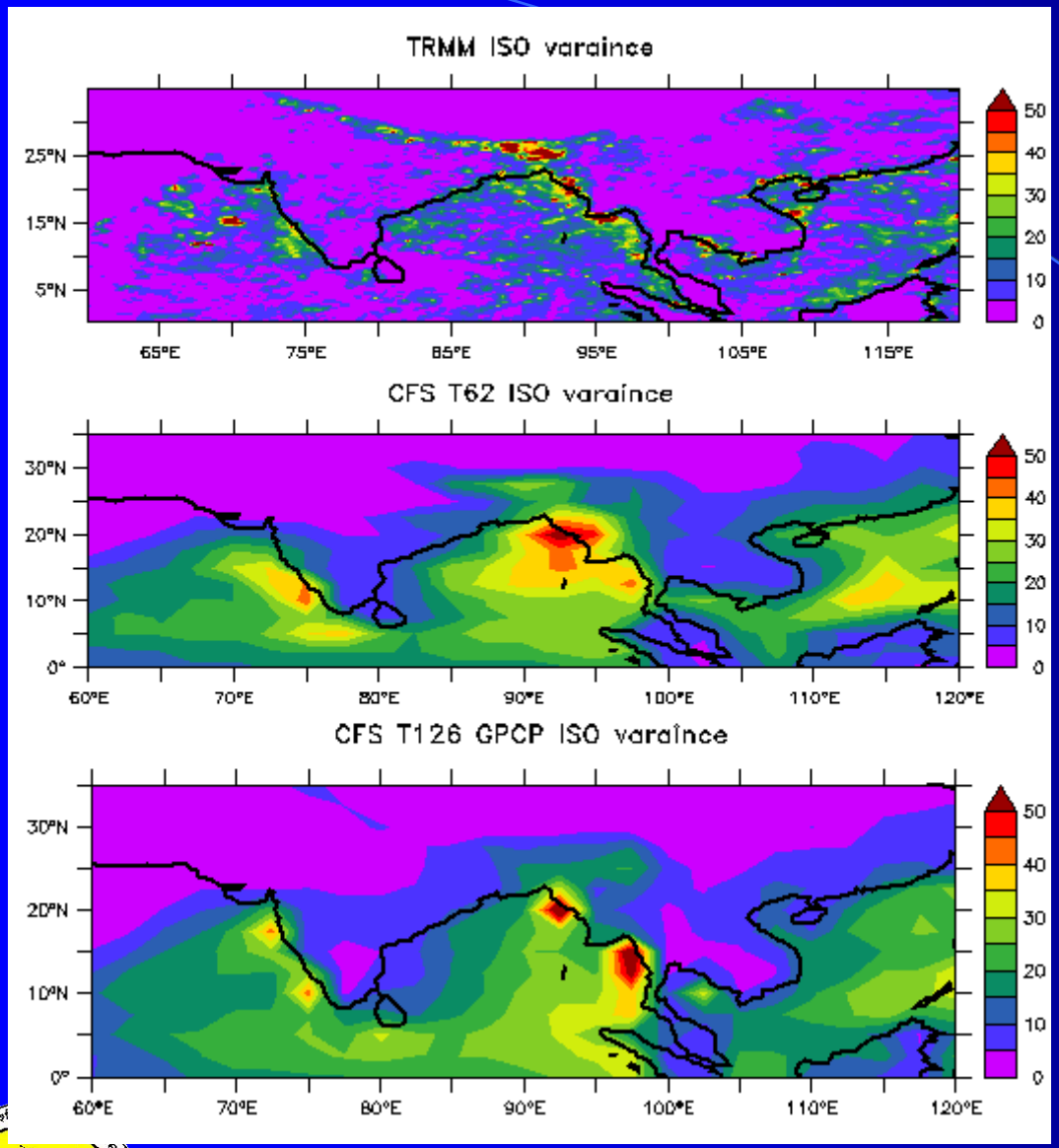
TRMM rainfall (cm)

NCEP-CFS rainfall (cm)

Realistic simulation of rainfall over Western Ghats.

Spreading of rainfall Into eastern Arabian Sea still remains in T126

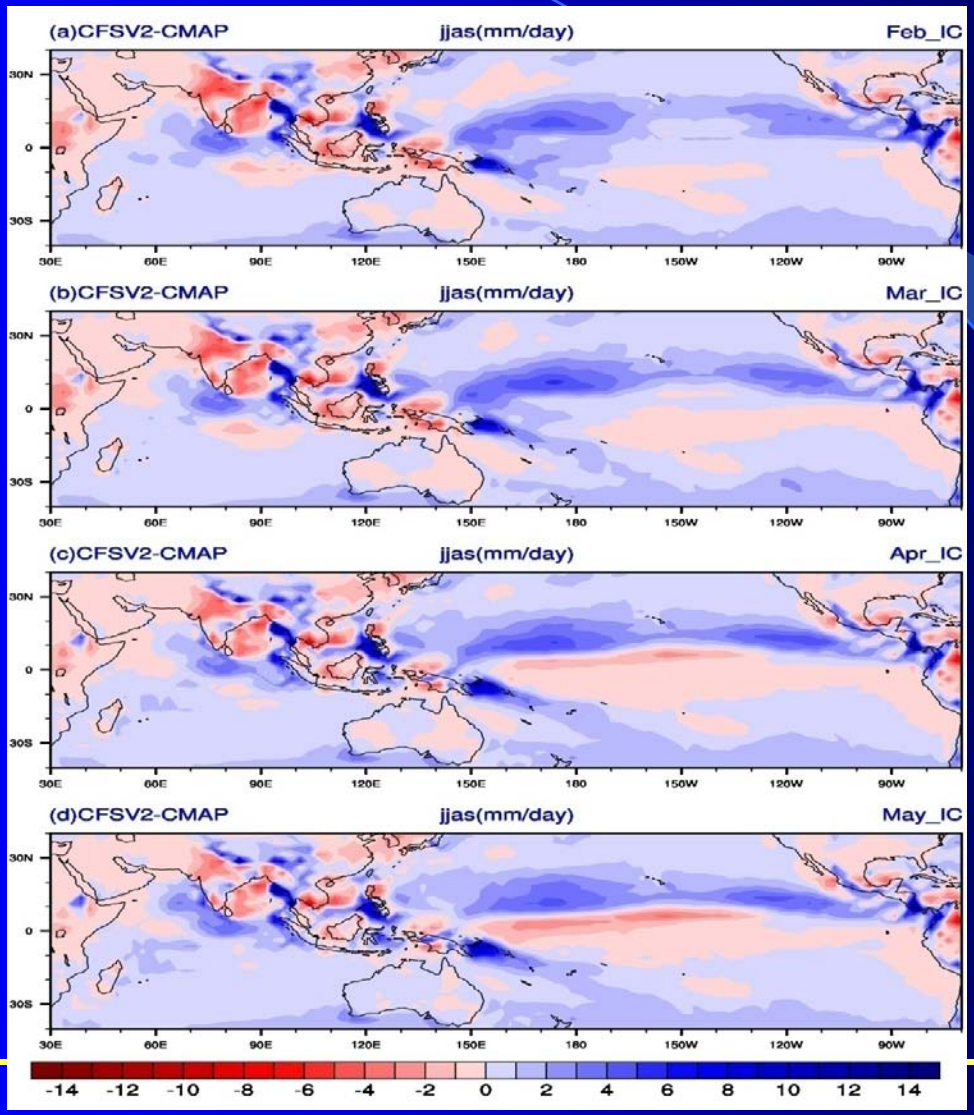

JJAS Mean Rain(mm/day)
CFSV1 T62
CFSV1 T126
CFSV2 T126
GPCP
(a)
(b)
(c)
(d)
40°N
30°N
20°N
10°N
0°
10°S
20°S
30°S
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
CFSV1 T62 – GPCP
CFSV1 T126 – GPCP
CFSV2 T126 – GPCP
(e)
(f)
(g)
30°E
50°E
70°E
90°E
110°E
130°E
150°E
6
5
4
3
2
1
0
−1
−2
−3
−4
−5
−6



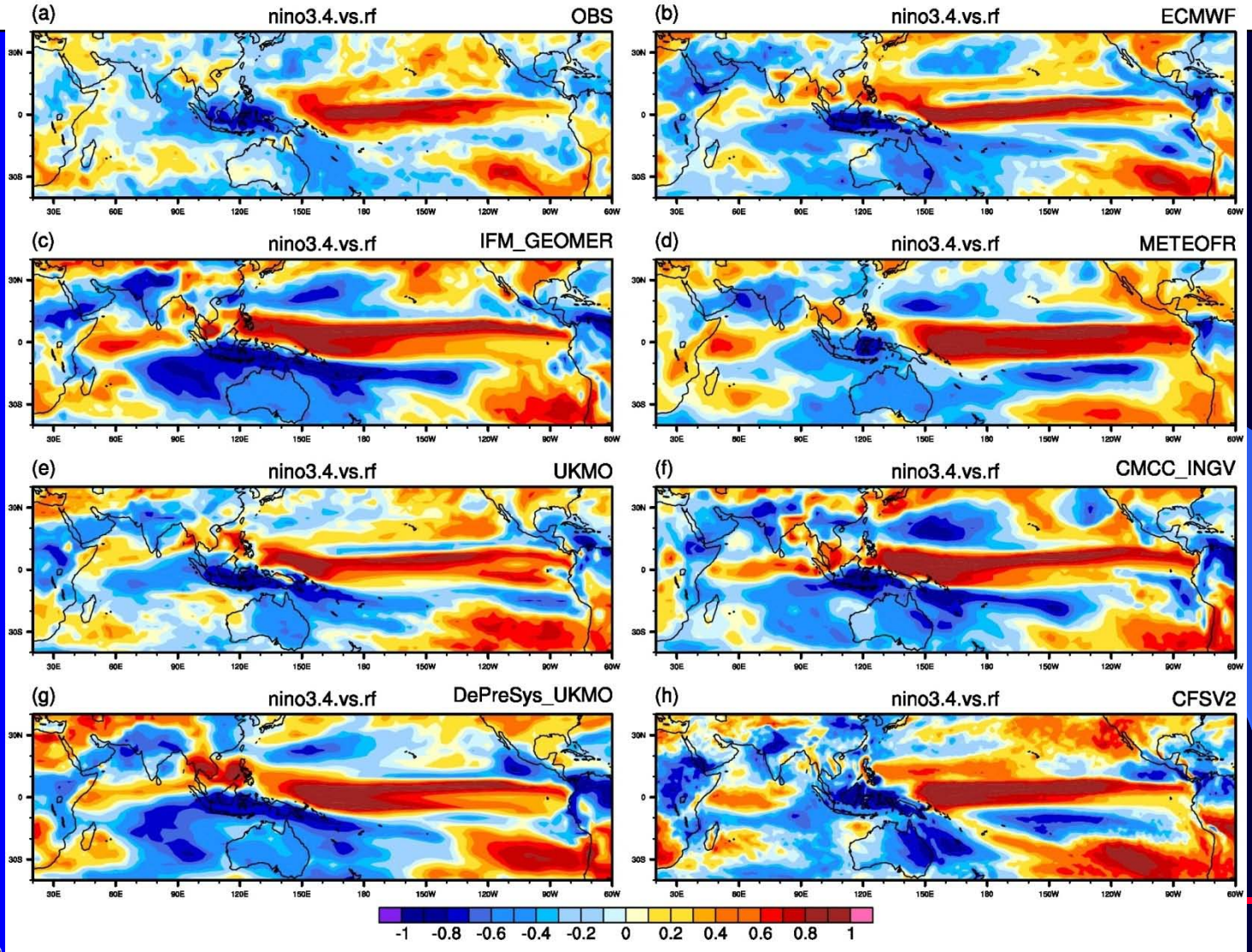
Model comparison with TRMM 0.25 deg. Rainfall dataset

ISO Variance in the model is reasonably well simulated.

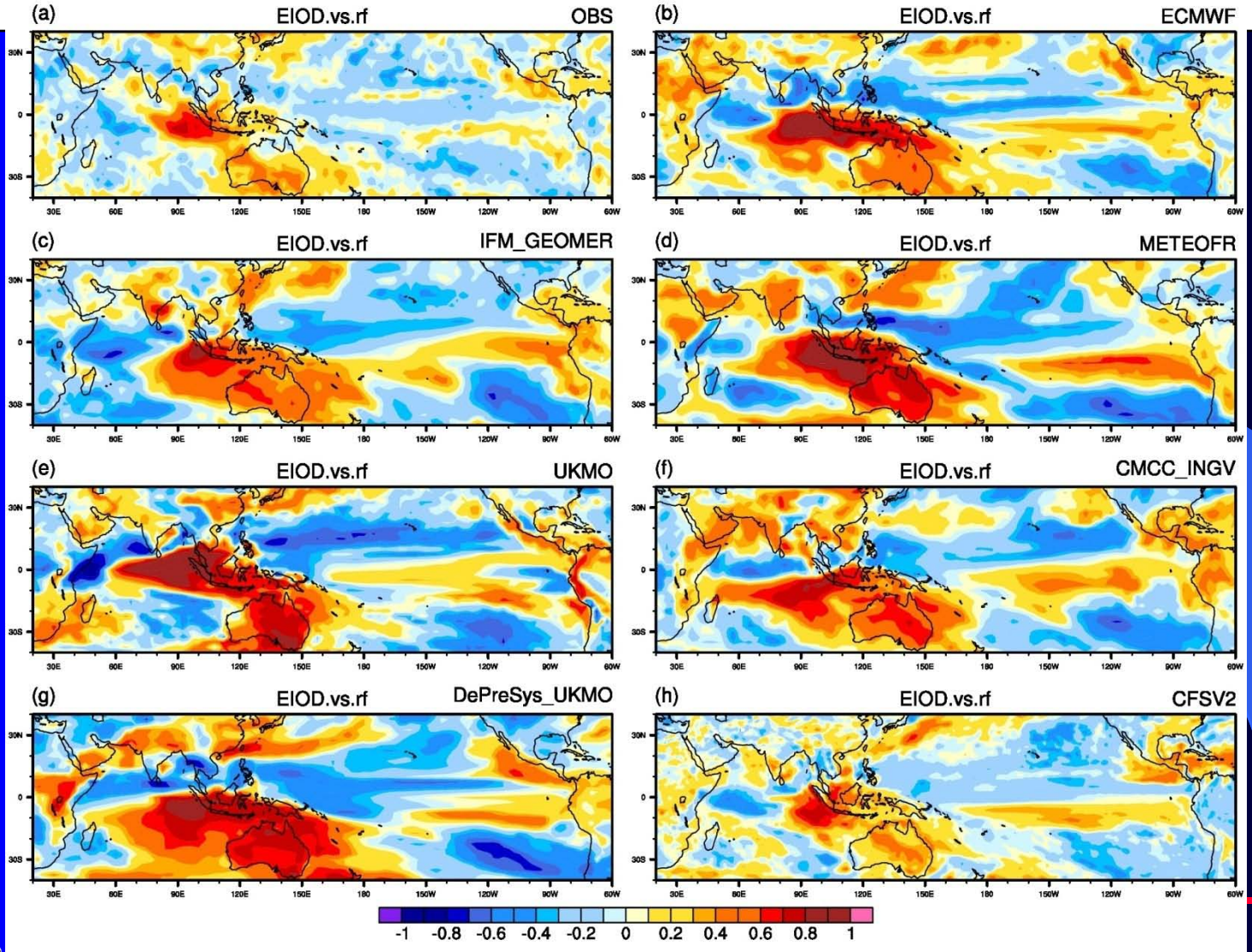
JJAS mean rainfall difference (CFSv2-CMAP)



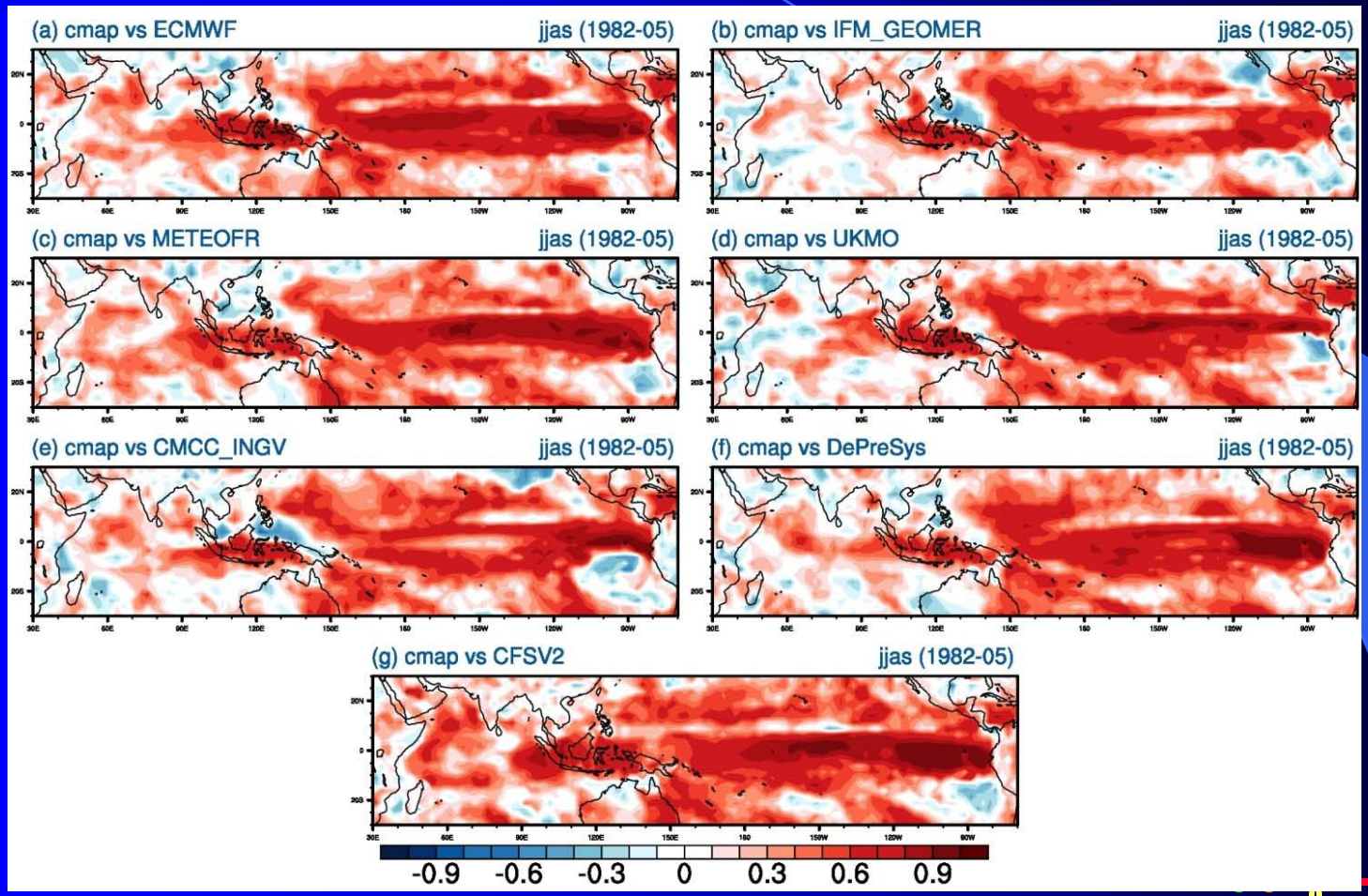
Nino 3.4 SSTA correlated with JJAS Rain Fall

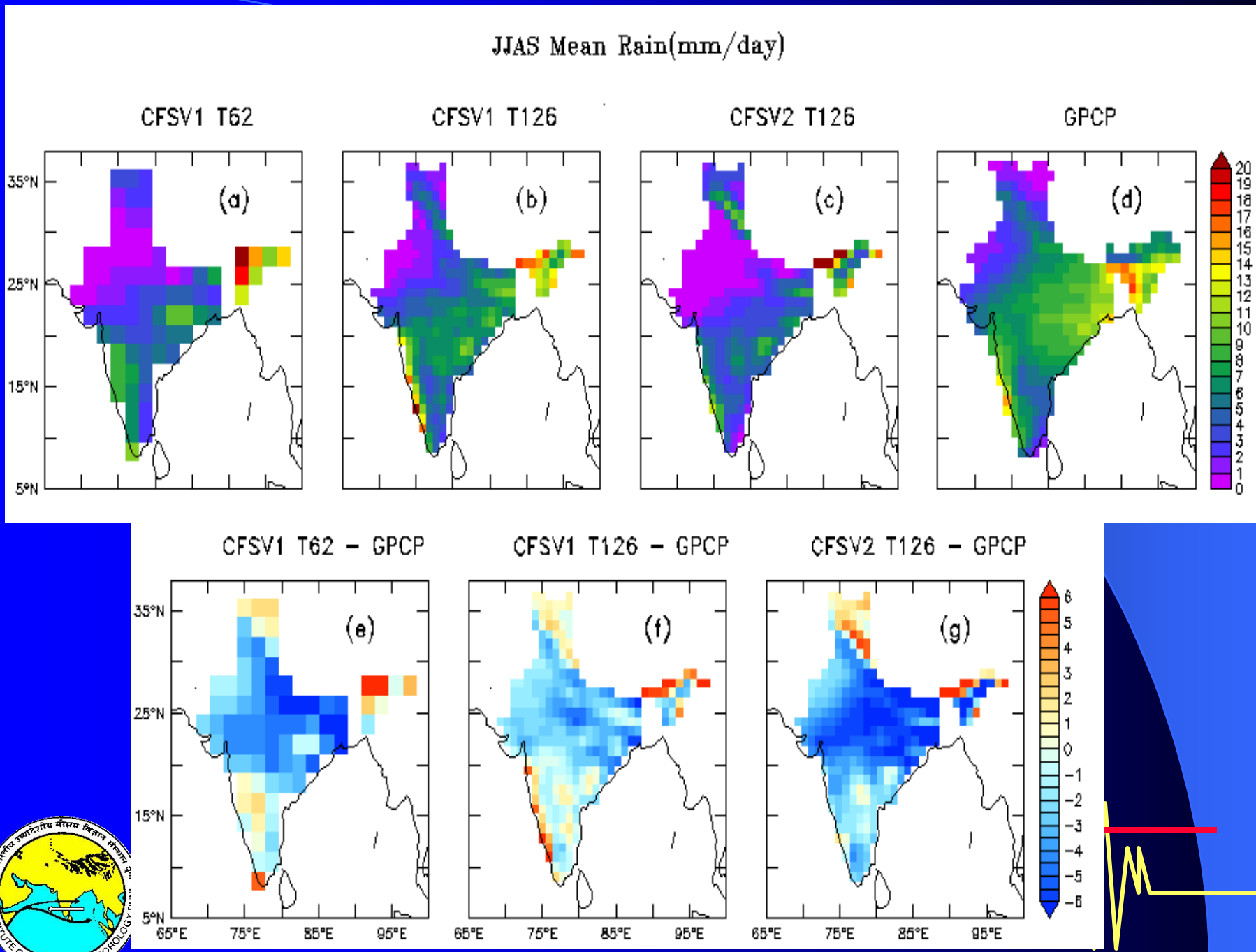


EIOD SSTA correlated with JJAS Rain Fall



Correlation between CMAP rainfall and rainfall from latest models (JJAS rainfall anomaly)




JJAS Mean Rain(mm/day)
CFSV1 T62
CFSV1 T126
CFSV2 T126
GPCP
(a)
(b)
(c)
(d)
35°N
25°N
15°N
5°N
20
19
18
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9
8
7
6
5
4
3
2
1
0
CFSV1 T62 – GPCP
CFSV1 T126 – GPCP
CFSV2 T126 – GPCP
(e)
(f)
(g)
35°N
25°N
15°N
5°N
65°E
75°E
85°E
95°E
6
5
4
3
2
1
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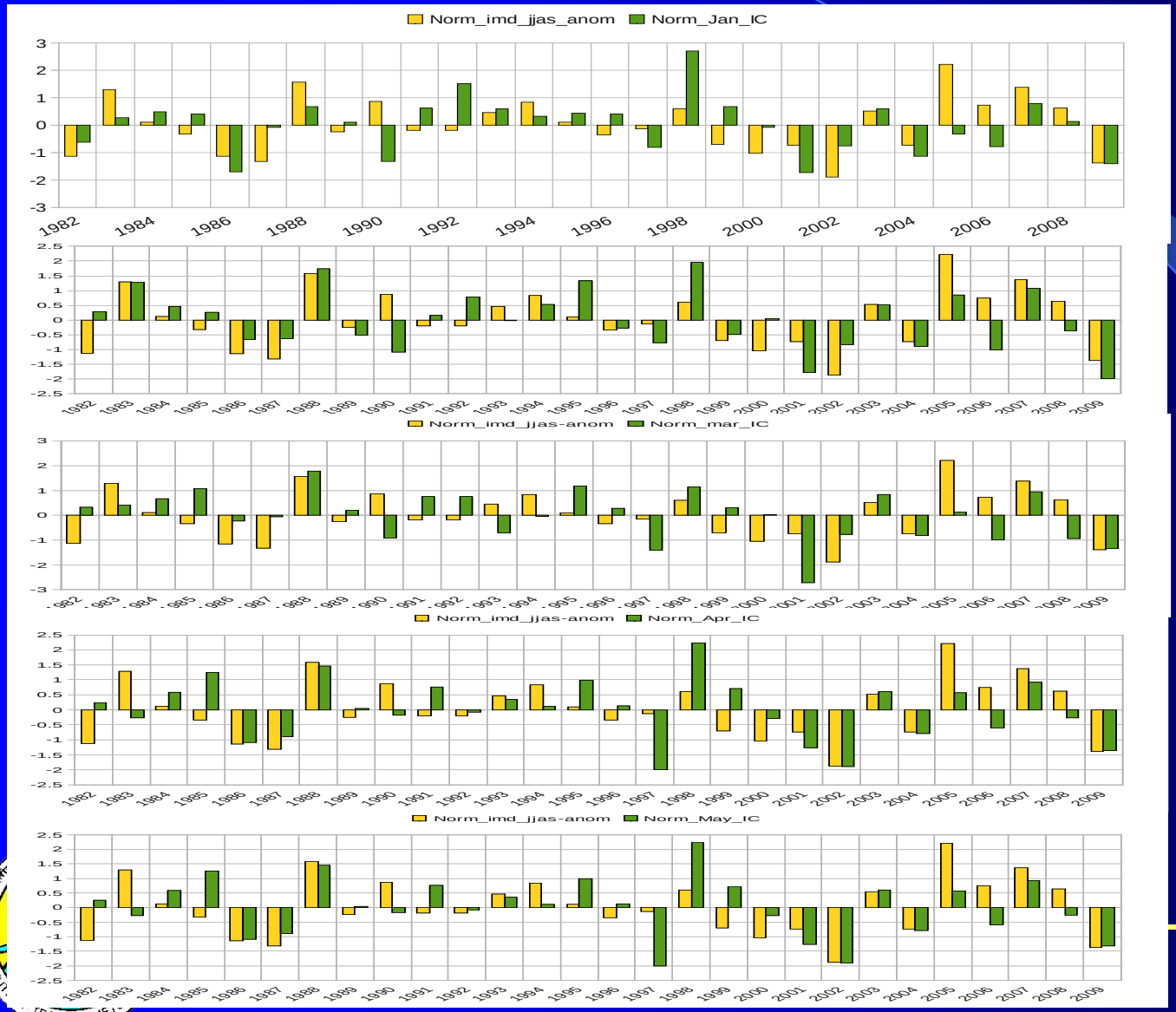
−1
−2
−3
−4
−5
−6

Prediction Skill of ISMR in CFS V2.0



CFS v2 Jan IC Correlation = 0.37

CFS v2 Feb IC Correlation = 0.59

CFS v2 Mar IC correlation = 0.33

CFS v2 Apr IC Correlation = 0.53

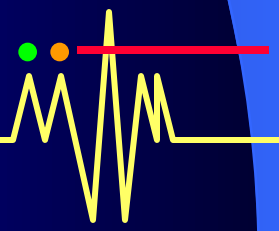
CFS v2 May IC correlation = 0.36

Improving Prediction of Seasonal Mean Monsoon

It is important that all development work should be done on a specified model

Coupled Model CFS V 2.0

- Basic Research
- Model Development & Improvement in Physical Parameterization
- Data Assimilation



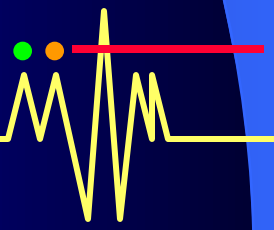
Basic Research

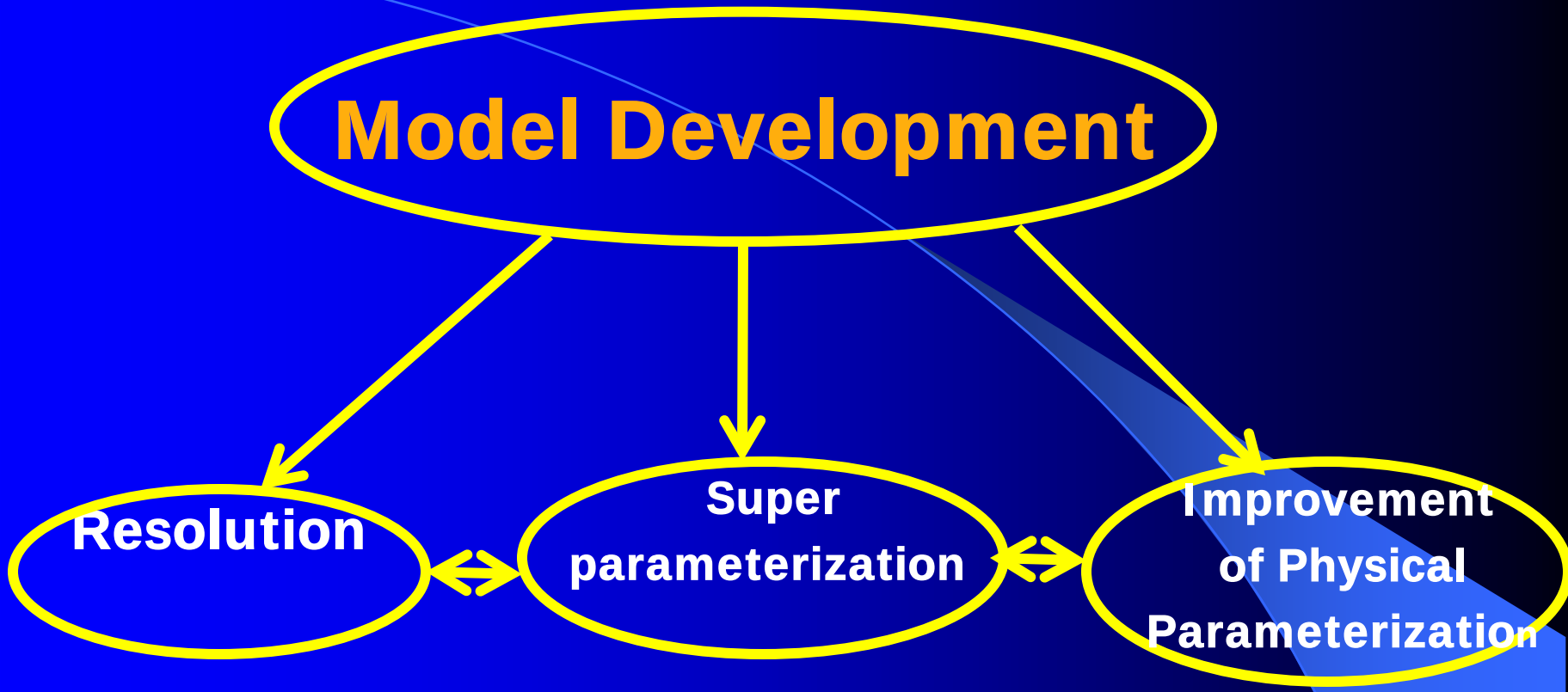
Dynamics of Monsoon IAV, Why each year monsoon different?

What combination of driving forces?

Tropical clouds, Organization, Parametrization, Diurnal cycle

Scale Interactions Diurnal-ISO-sesaonal





National: IISc, IITM, IMD, NCMRWF

International: COLA, NCEP, IPRC, INGV, APCC, GFDL ,JAMSTEC

Data Assimilation

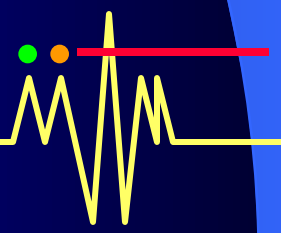
Atmospheric Data Assimilation

Ocean Data Assimilation

Coupled Data Assimilation

National: NCMRWF, INCOIS, IITM, IISc, IITD, IMD

International: NCEP/NCAR, ECMWF, GFDL



Proposed modalities to achieve mission objectives

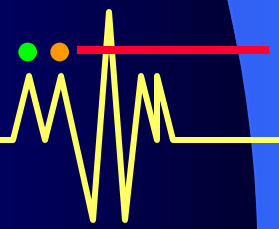
- **IITM to coordinate the effort.**
- **Proposals to be invited from National as well as international Institutes on very specific projects and deliverables through which improvement of the CFS model are expected.**
- **Provisions for funding the National partners as well as the international partners will be year marked.**
- **The Proposal partners will be allowed to use the HPC facility at IITM which will be suitably enhanced for this purpose.**
- **Funding for students, post docs and some scientists time (consultancy) and some minor equipments may be provided.**

HPC Facilities at IITM

IBM Power 6		Nimbus Sun Cluster
7.2 TF	Peak Performance	2.3 TF
P6-575	Processors	AMD Opteron
192/384	No. of CPU/cores	64/256
1.5 TB	Total Memory	512 GB
20 TB	Online Storage	4 TB
80 TB	Near Online Storage	48 TB

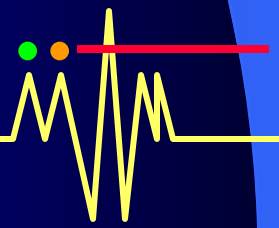
Up gradation Plan for Computing Facility at IITM

- Existing HPC System is being upgraded with additional 101 IBM P575 nodes with 60.2 TF peak power to achieve more than 70TF peak performance. Additionally 4 high end servers, 10 workstations, 144 ports IB switch!
- Internet bandwidth is proposed to be upgraded to 100 Mbps!



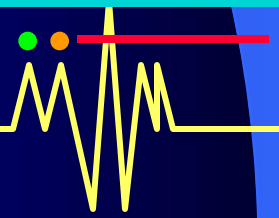
Probable Partners

- International Partners
  - USA: NCEP, COLA, GFDL,IPRC
  - Brazil: INPE
  - Europe: INGV
  - Asia: JAMSTEC, APCC, CCSR
- National Partners
  - IISC, IITs, MOES institutes, Universities



Time lines of the national Mission

2010-2011	**Setting up nodal point at IITM** **Setup CFS V 2.0 model at IITM**
2011-2012	**Identify the strengths and weakness of the model and define the problems for further investigation. Invite the project Proposals and distribute the work**
2011-2015	**Carryout research on identified problems together with national/ international partners and review the progress made by external experts committee**
2011-2015	**Implement the experts suggestions in the proposal and carryout the model development activities and test the model's skill**
2015-2016	**Expected to have an intermediate model, whose skill will be slightly better than model adopted at the initial stages**
2016	**Review the progress made by the national mission (seasonal/ Extended range prediction)**



Thank You