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

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

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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!
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
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.
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
Realistic simulation of rainfall over Western Ghats.
Spreading of rainfall into eastern Arabian Sea still remains in T126 Model comparison with TRMM 0.25 deg. Rainfall dataset.
ISO Variance in the model is reasonably well simulated. Model comparison with TRMM 0.25 deg. Rainfall dataset.
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)
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

Coupled Model
CFS V 2.0

Basic Research
Model Development & Improvement in Physical Parameterization
Data Assimilation

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

Dynamics of Monsoon IAV, Why each year monsoon different?

Tropical clouds, Organization, Parametrization, Diurnal cycle

Scale Interactions Diurnal-I SO-sesasonal

What combination of driving forces?
Model Development

Resolution
Super parameterization
Improvement of Physical Parameterization

National: IISc, IITM, IMD, NCMRWF
International: COLA, NCEP, IPRC, INGV, APCC, GFDL, JAMSTEC
Data Assimilation

Atmospheric Data Assimilation
National: NCMRWF, INCOIS, IITM, IISc, IITD, IMD

Ocean Data Assimilation
International: NCEP/ NCAR, ECMWF, GFDL

Coupled Data Assimilation
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

<table>
<thead>
<tr>
<th>IBM Power 6</th>
<th>Nimbus Sun Cluster</th>
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<tbody>
<tr>
<td>7.2 TF Peak Performance</td>
<td>2.3 TF</td>
</tr>
<tr>
<td>P6-575 Processors</td>
<td>AMD Opteron</td>
</tr>
<tr>
<td>192/384 No. of CPU/cores</td>
<td>64/256</td>
</tr>
<tr>
<td>1.5 TB Total Memory</td>
<td>512 GB</td>
</tr>
<tr>
<td>20 TB Online Storage</td>
<td>4 TB</td>
</tr>
<tr>
<td>80 TB Near Online Storage</td>
<td>48 TB</td>
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Upgradation 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
- Carry out 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 carry out 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)