Model Biases in CFS V2 in Summer Monsoon Climate: Some sensitivity Experiments

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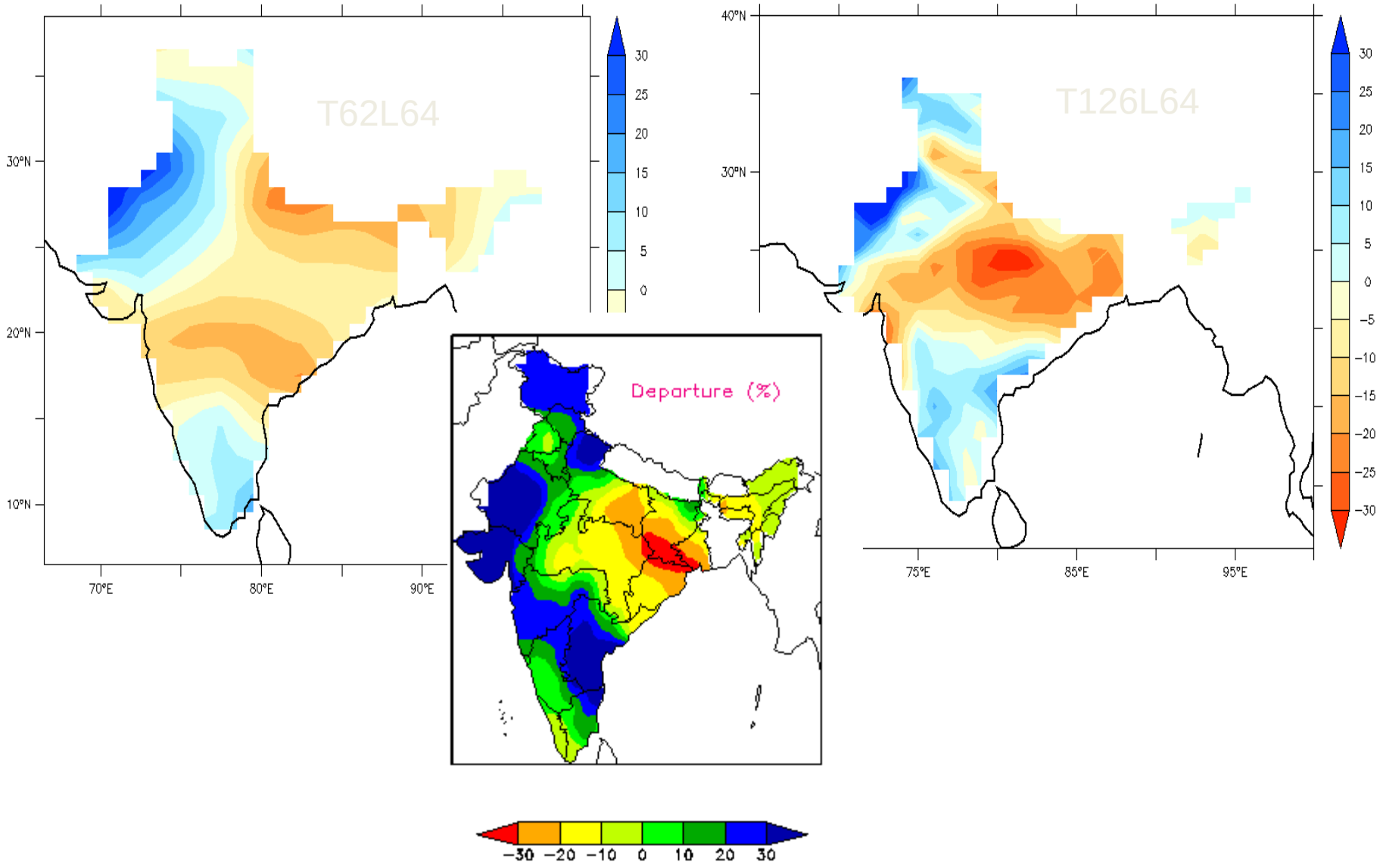
CFSv2 Evaluation Workshop
April 30 - May 1, 2012
College Park, MD

Outline of the Presentation

- **CFSv2 skills – Indian Monsoon**
- **Model Biases identified in CFS v2**
- **Sensitivity experiments**
  - **With model physics**
  - **High resolution model results**
- **Future Directions and 2012 monsoon**

Dynamical Seasonal Prediction of Indian Monsoon Rainfall – 2010 (March IC)



Design of Ensemble Experiments: Monsoon 2011 (CFS V2.0)

Atmospheric Initial States : GFS/GSI from NCMRWF

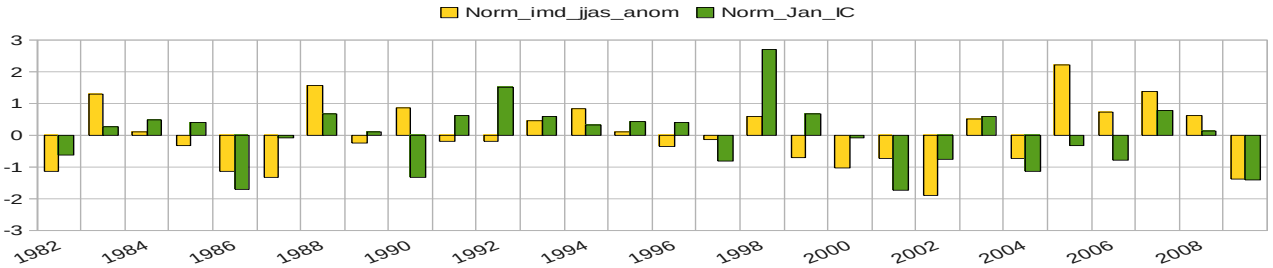
- 15-member forecast ensemble per month
- Forecasts for summer monsoon months alone
- 3-month lead forecasts
- Initial states 00/06/12/18 GMT Atmospheric ICs of 5^{th} ,10^{th} ,15^{th} , 20^{th} for each month

Ocean Initial States : NCEP Global Ocean Data Assimilation (GODAS) forced by R-2 fluxes from INCOIS

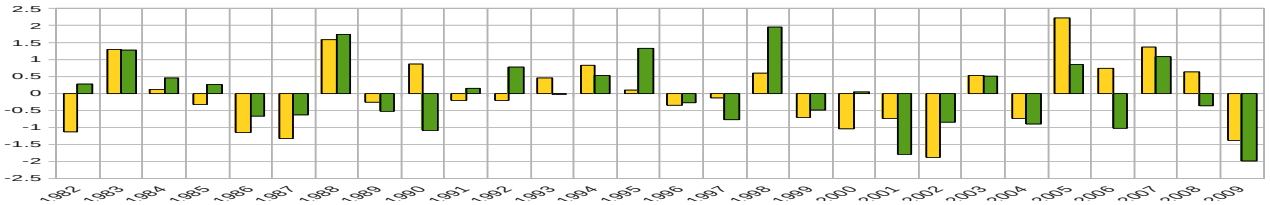
- NCEP Global Ocean Data Assimilation System (GODAS)
- Initial states 0000 GMT for 5^{th}, 10^{th}, 15^{th} and 20^{th} of each month

Fully coupled atmosphere-ocean (no flux correction)

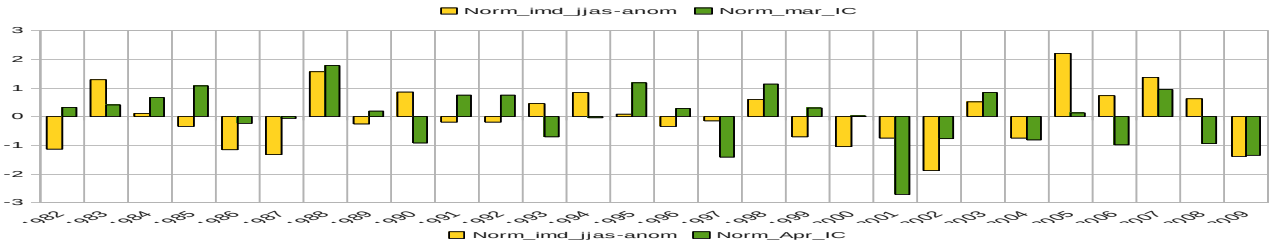
Prediction Skill of ISMR in CFS V2.0



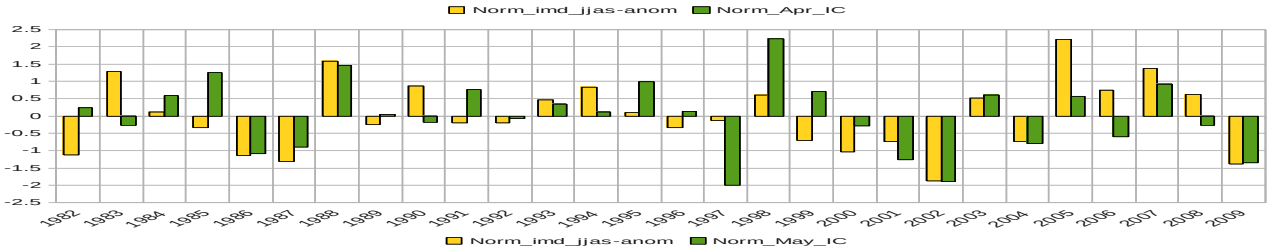
CFS v2 Jan IC
Correlation=0.37



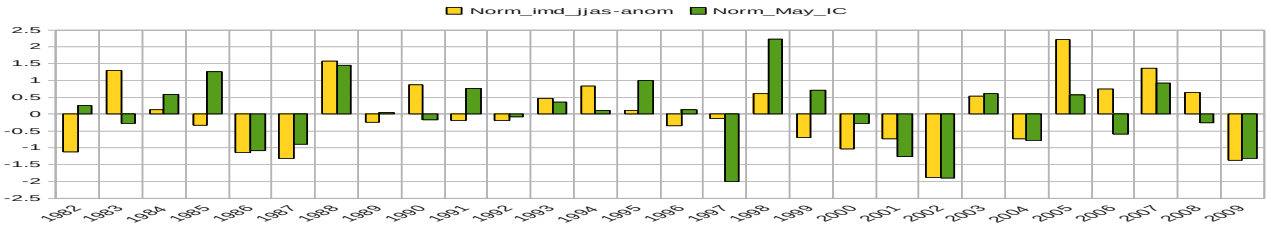
CFS v2 Feb IC
Correlation=0.59



CFS v2 Mar IC
correlation=0.33

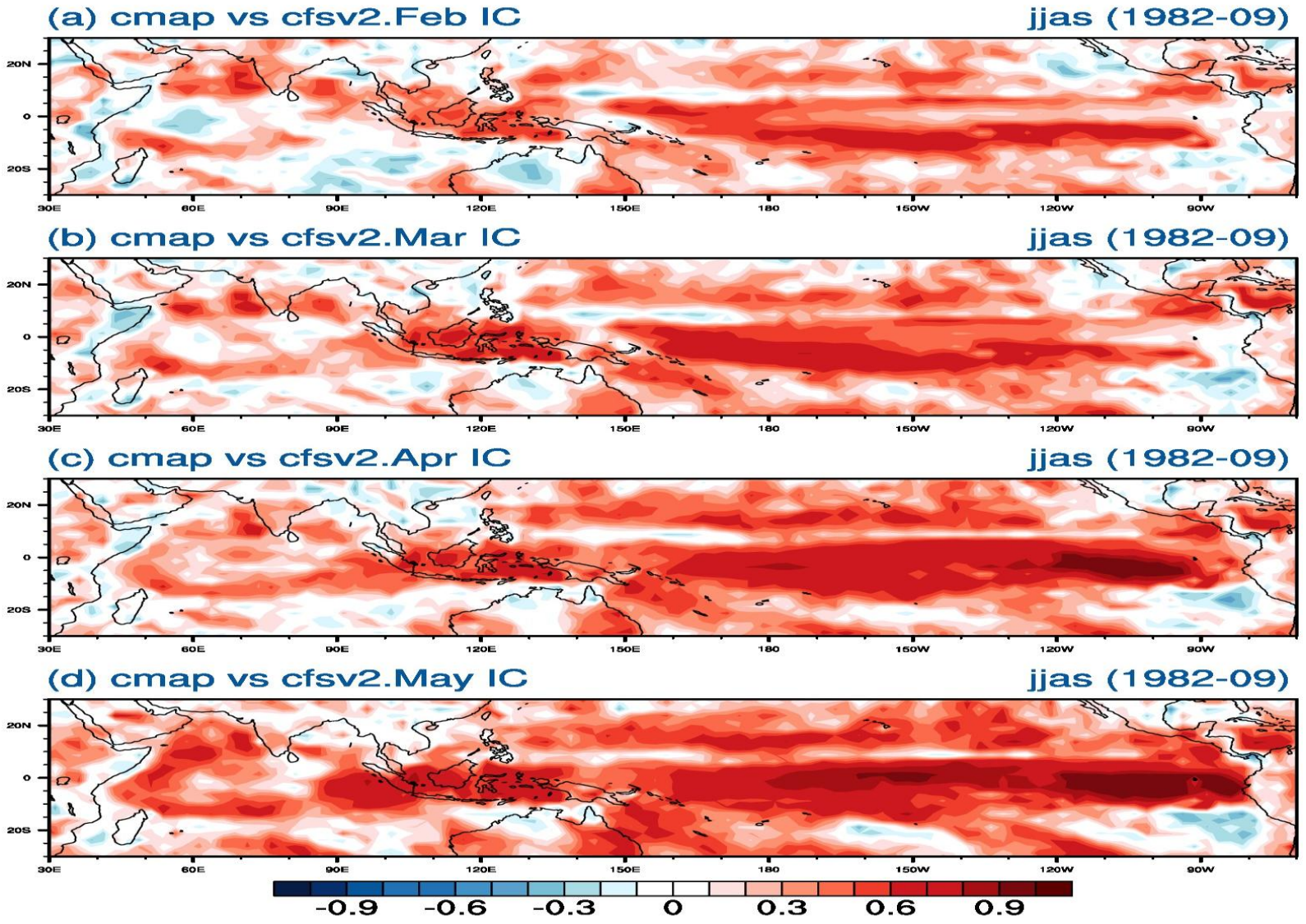


CFS v2 Apr IC
Correlation=0.53

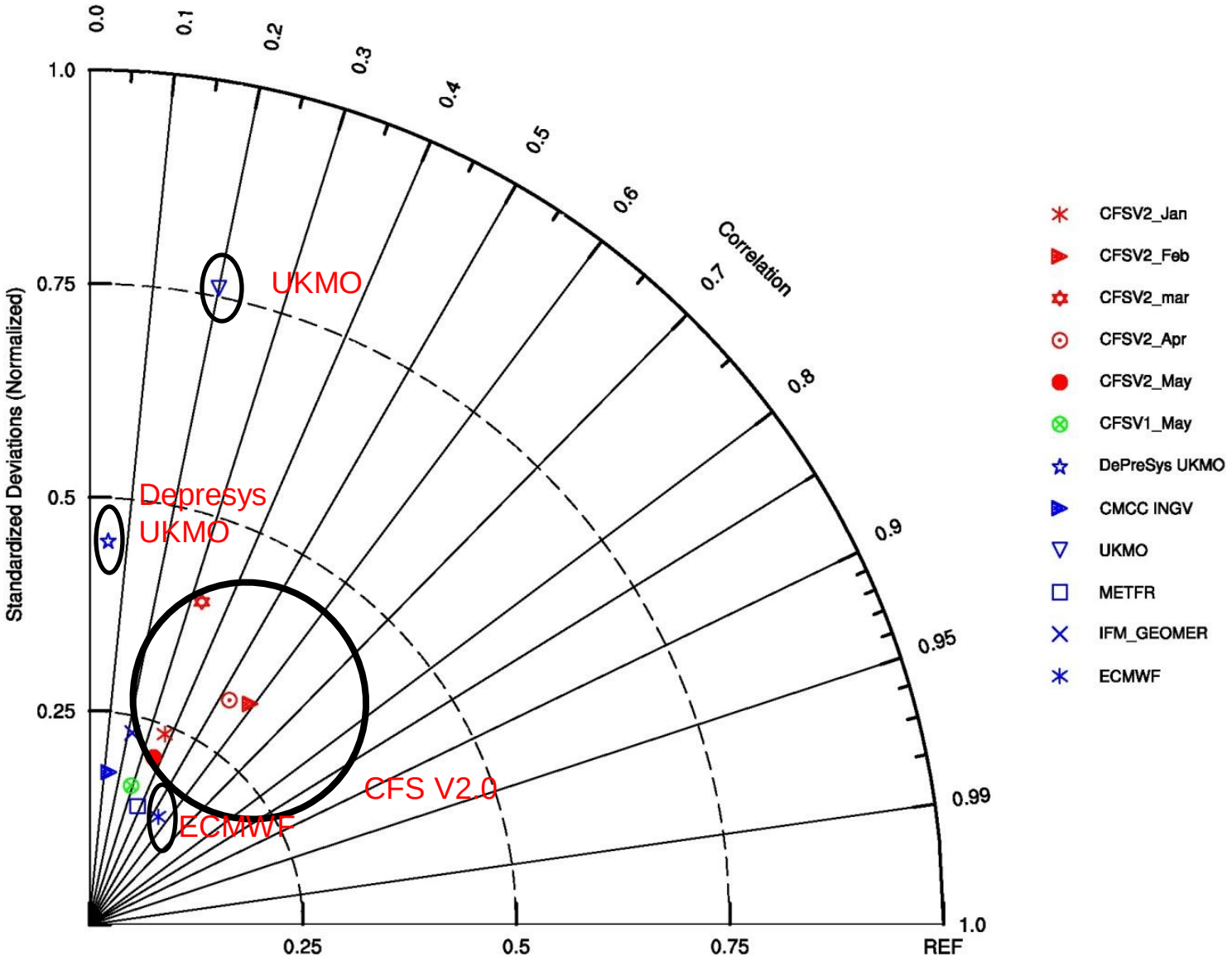


CFS v2 May IC
correlation=0.36

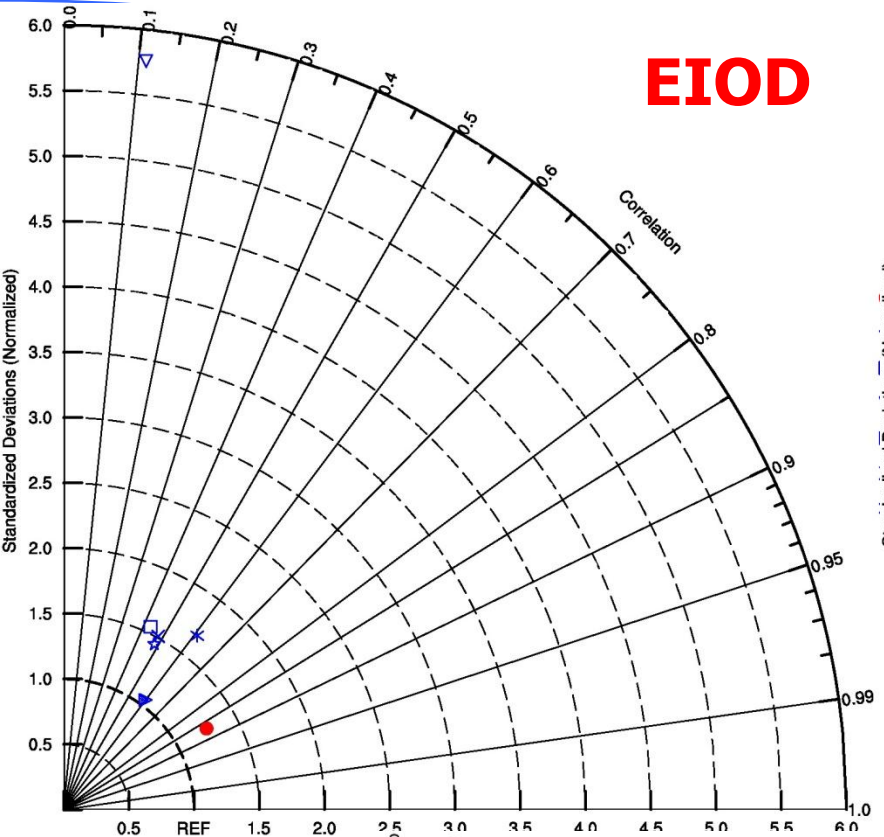
Correlation between observed and predicted rainfall CFS v2



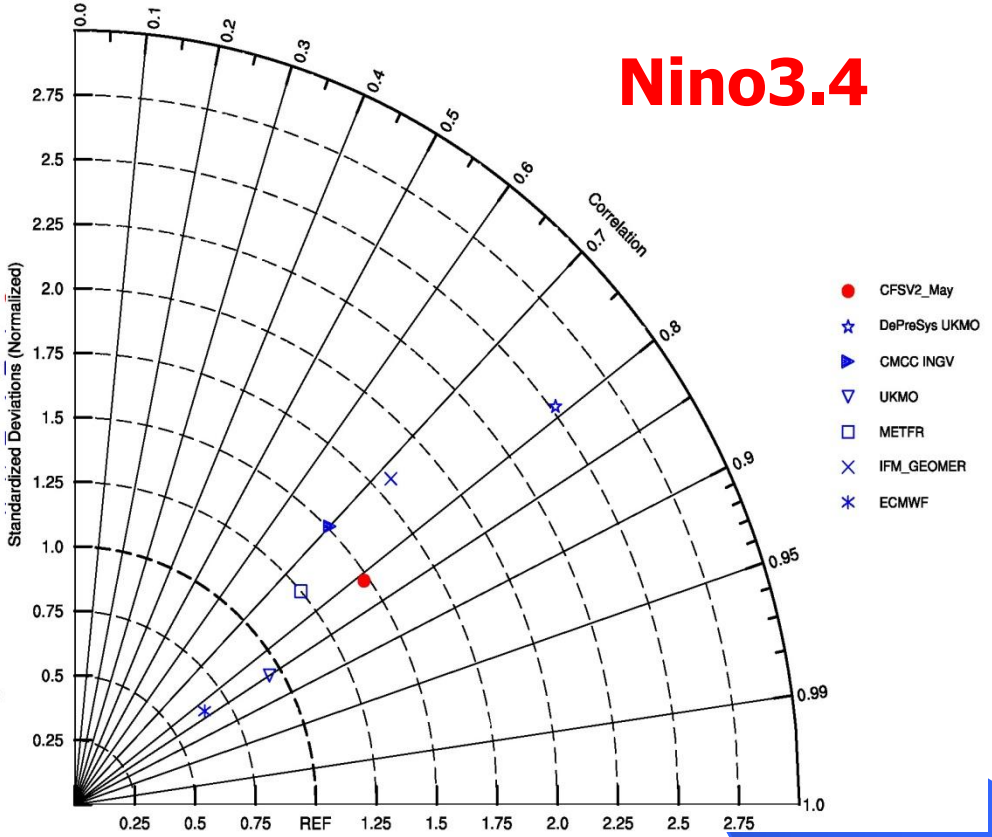
Rainfall skill Land points



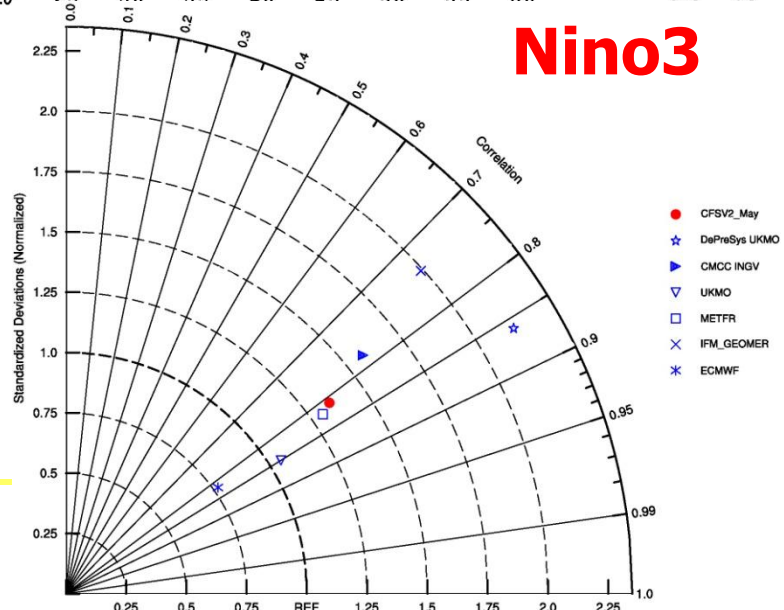
EIOD



Nino3.4



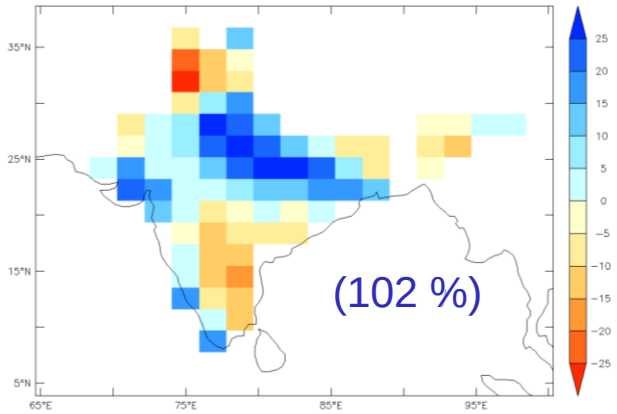
Nino3



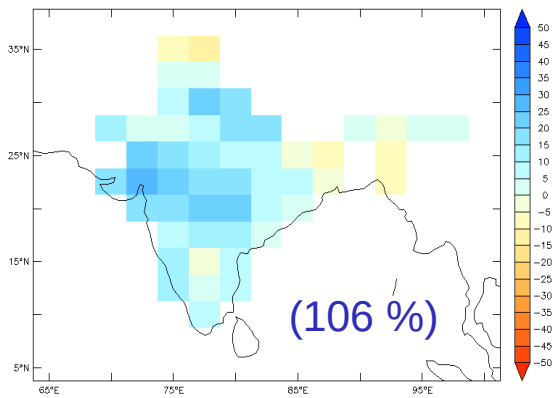
Skill of various SST Inter-annual indices

Dynamical Seasonal Prediction of Indian Monsoon Rainfall – 2011(CFS V1T62 / V2 T126)

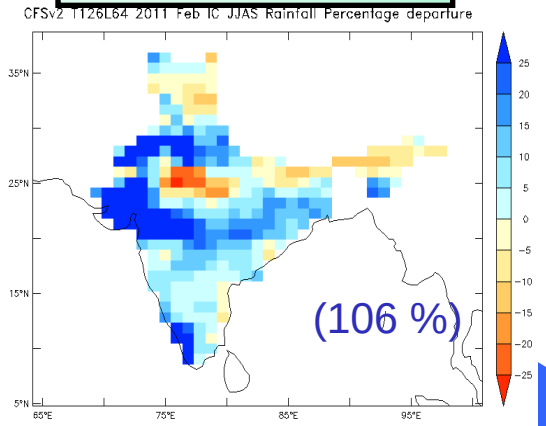
CFSv1 (March IC)



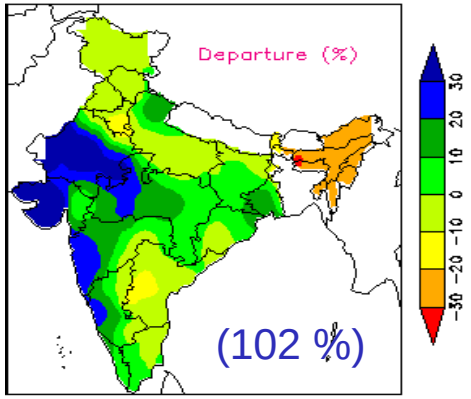
CFSv1 (May IC)



CFSv2 (Feb IC)

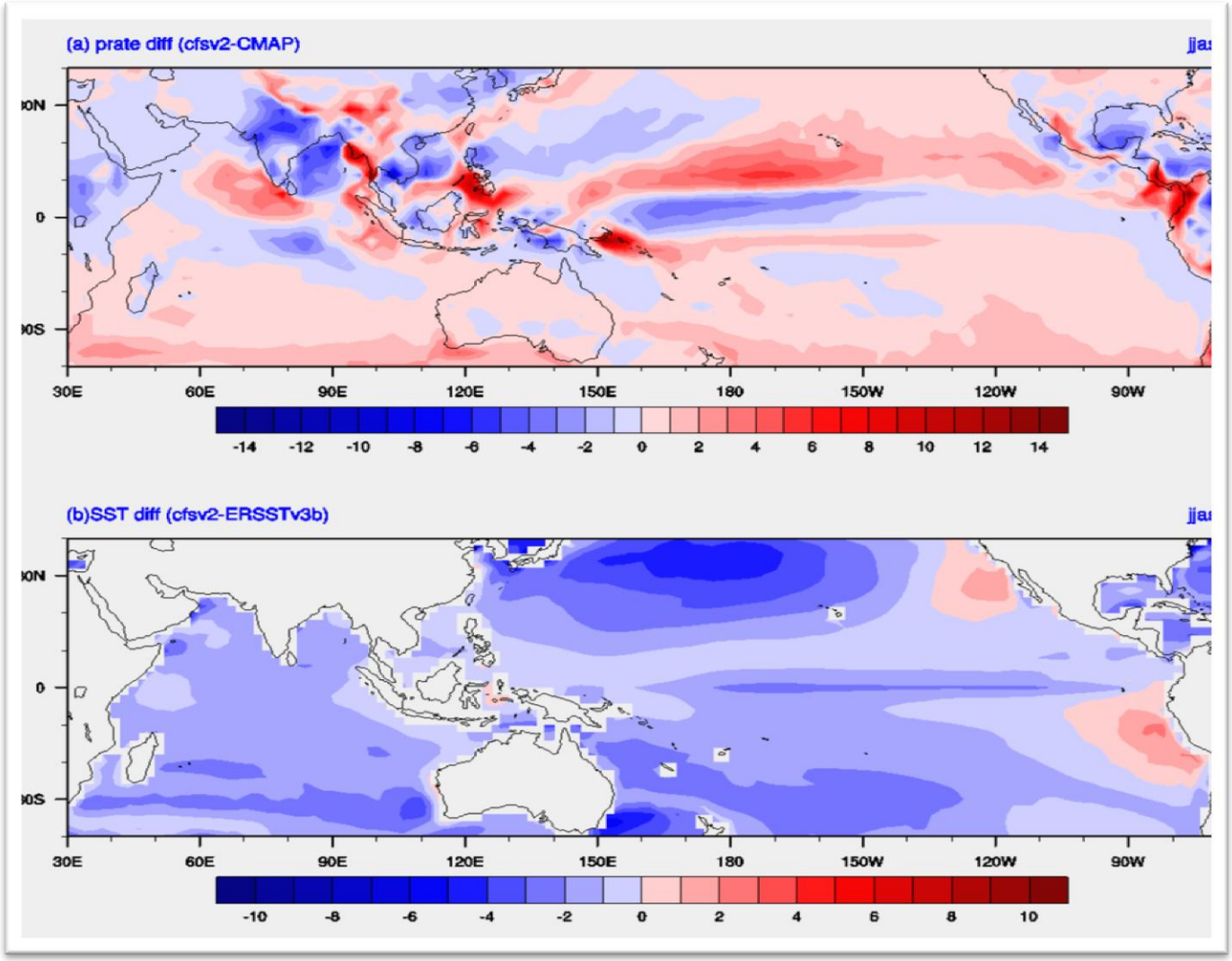


Observed

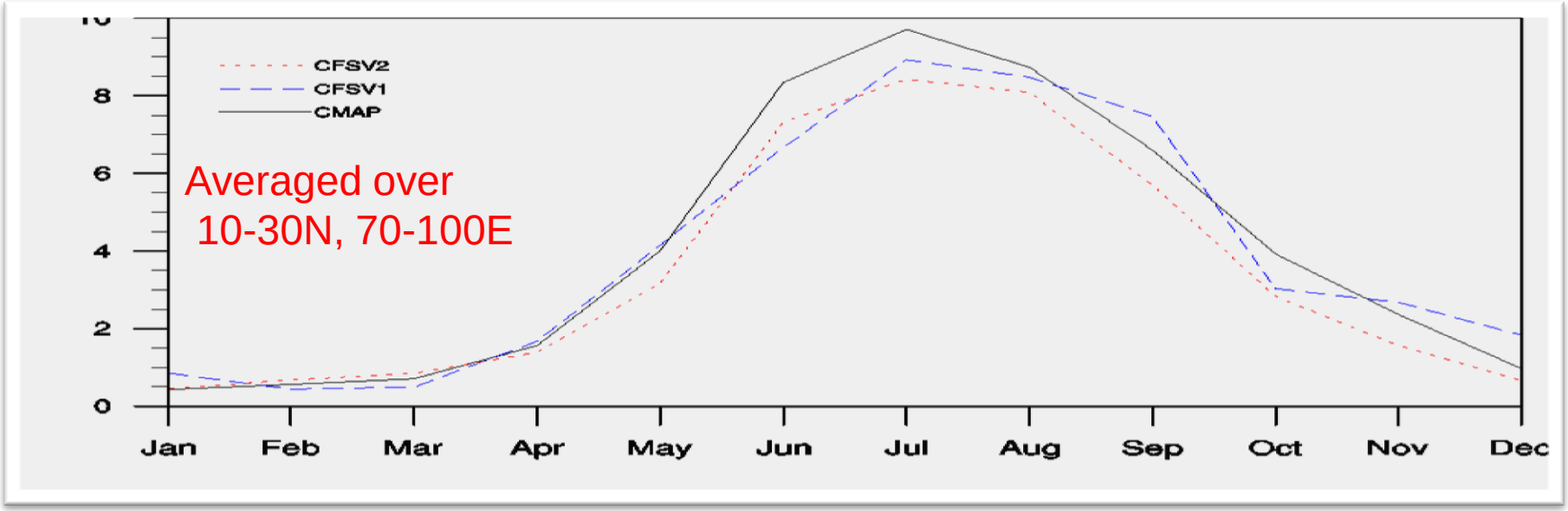


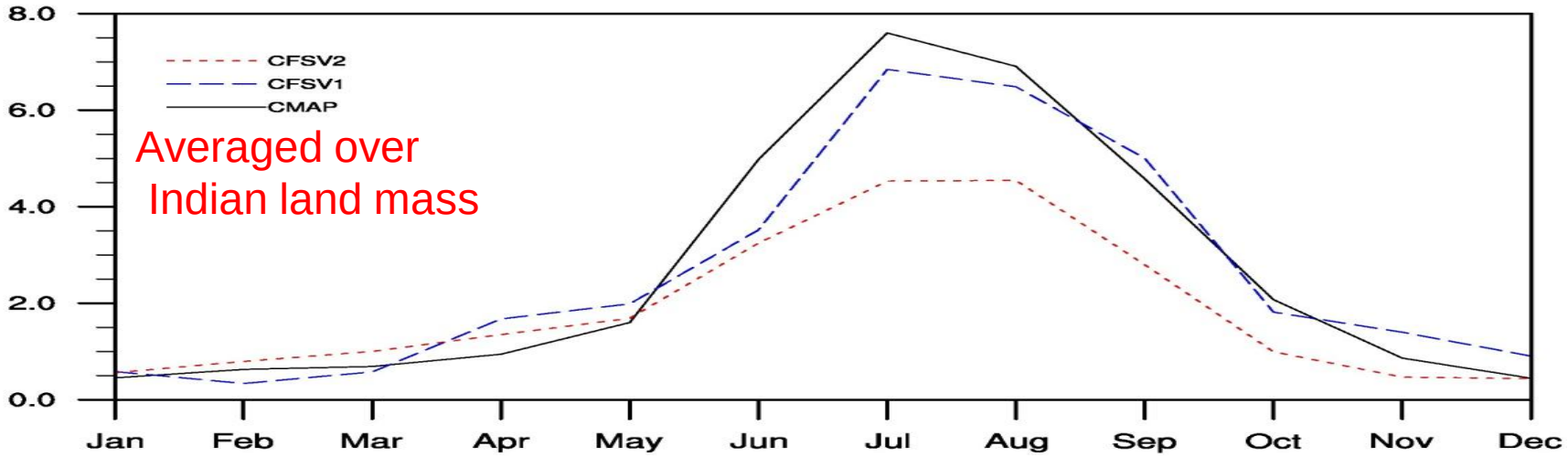
CFSv2 30 Years Free Run Model Biases and Corrections

SST and Rainfall Bias in CFS V2 (JJAS)



Rainfall Seasonal cycle

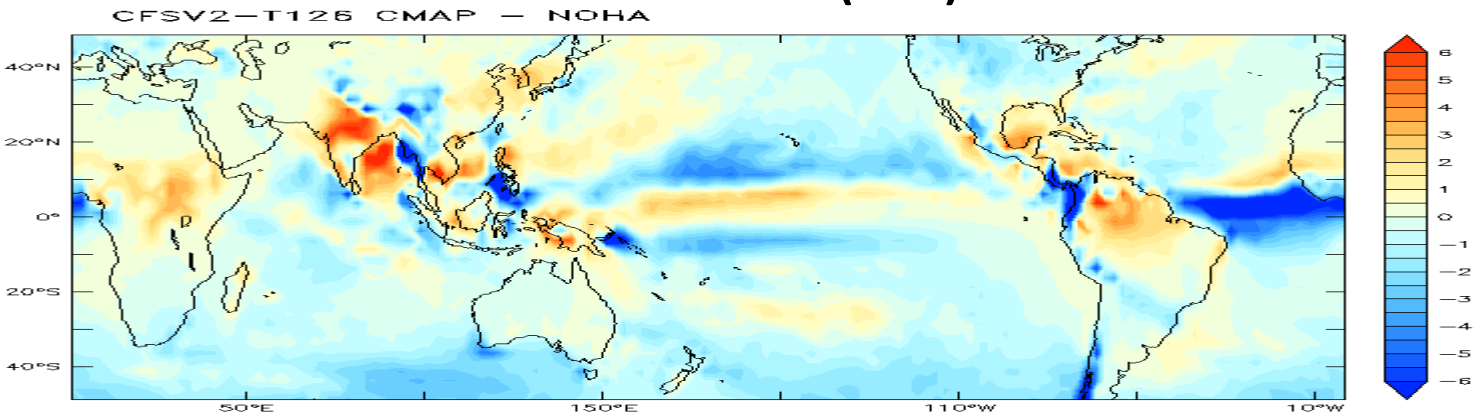




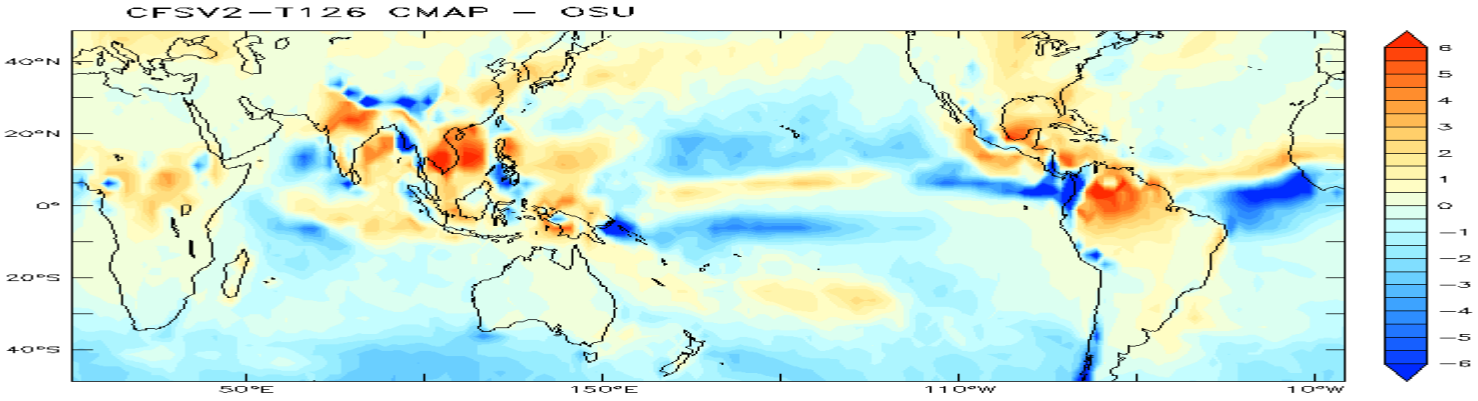
Source: Subodh, Samir, Hemant, Rao

Rainfall Difference (JJAS)

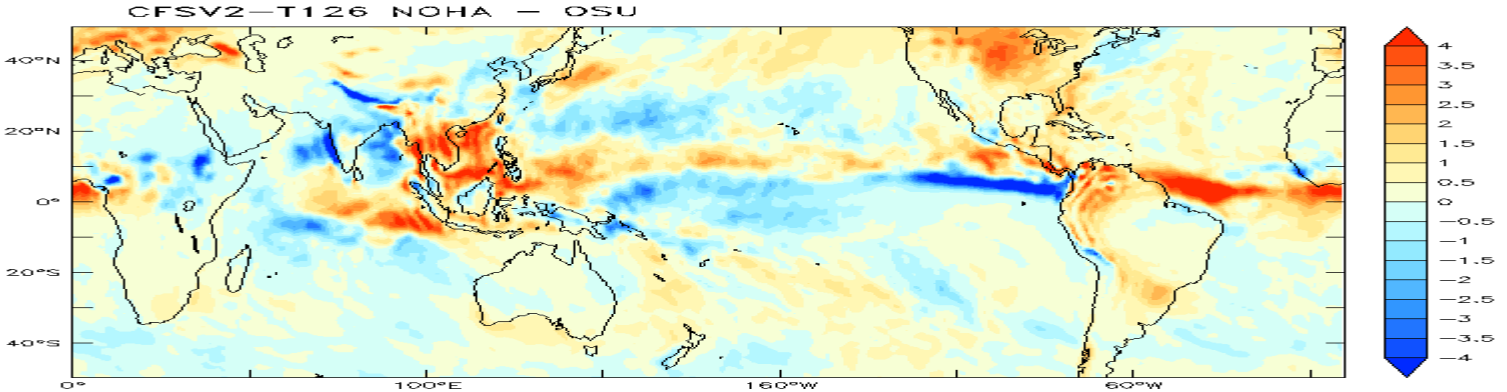
CMAP - Noah



CMAP - OSU

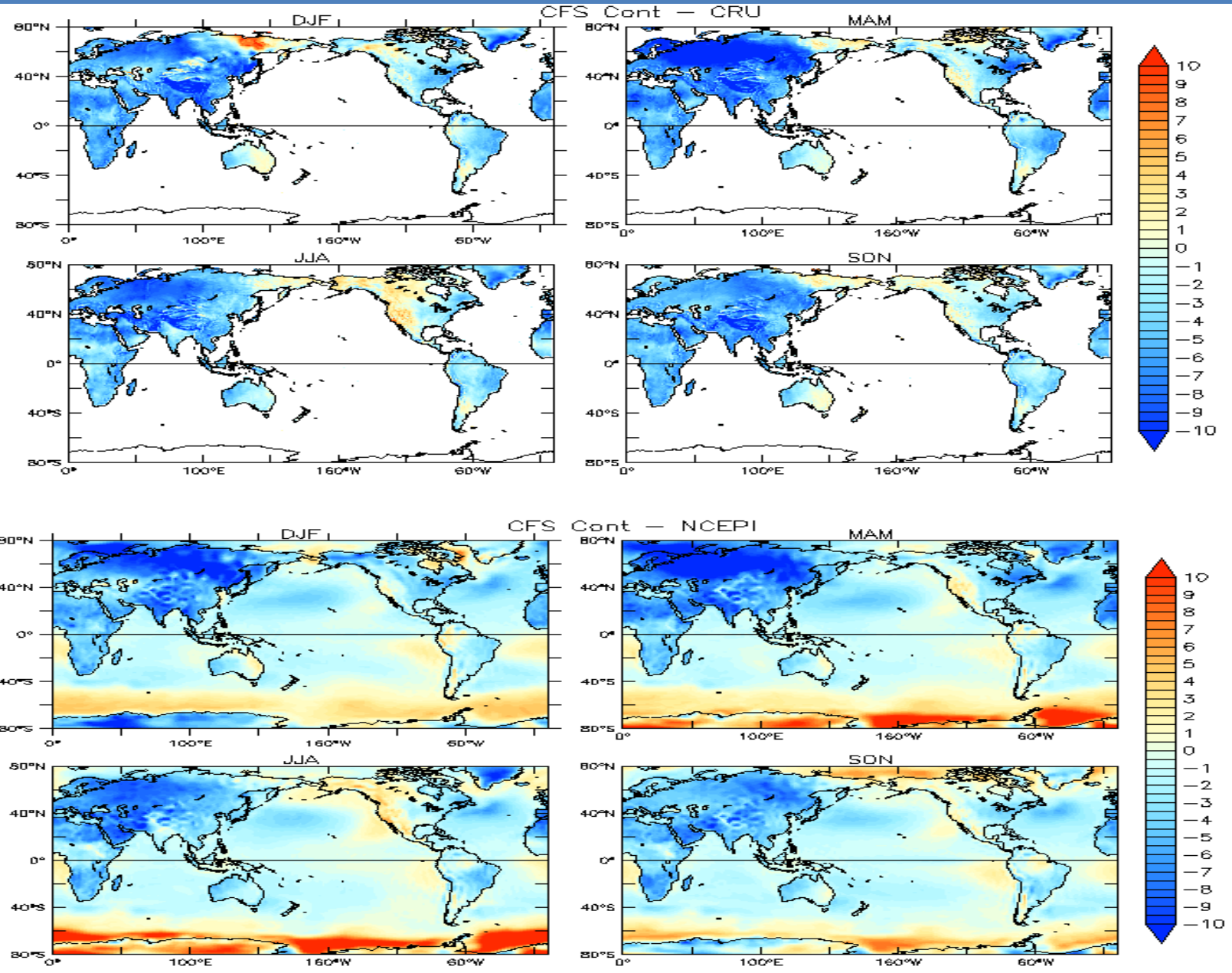


Noah - OSU



Noah model under estimates the rainfall over Indian land mass. OSU model reduces this underestimation. However, equatorial dry bias increases with OSU model.

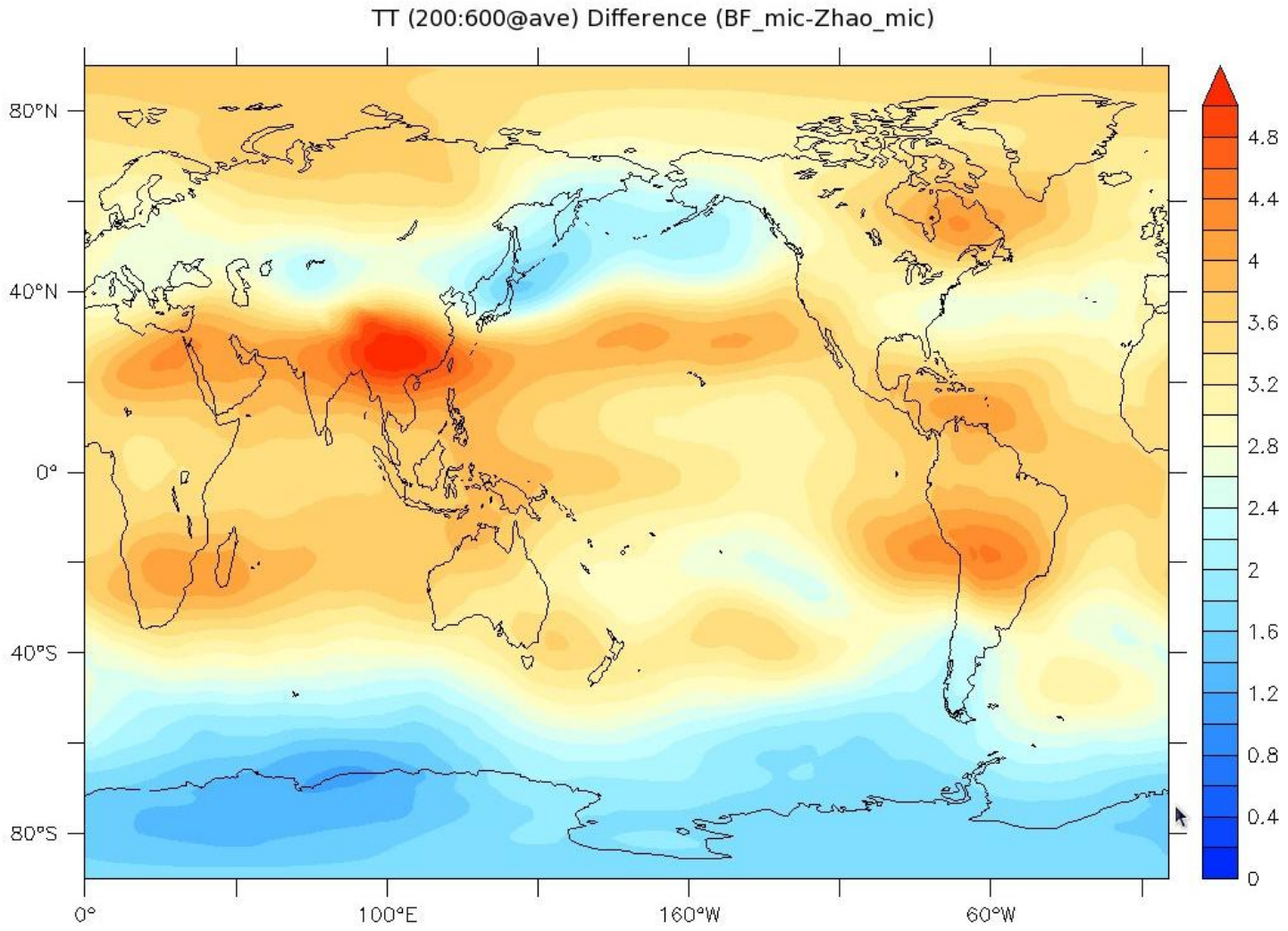
Difference in 2m Air Temperature



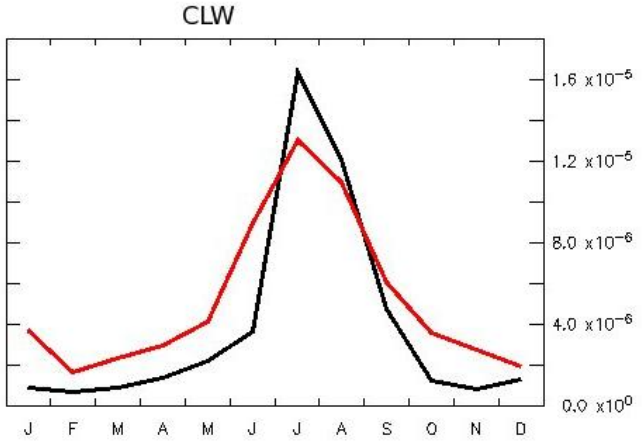
Comparing grid-scale microphysics schemes

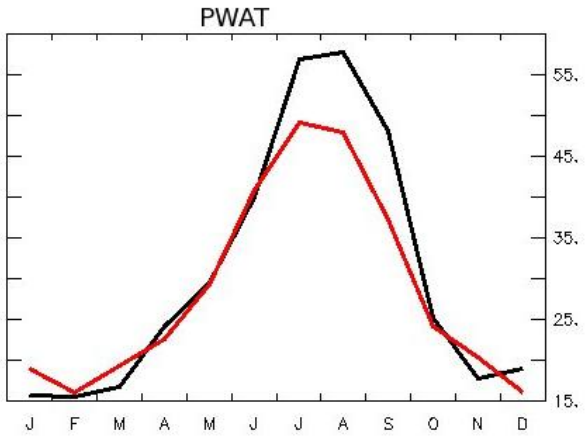
FEATURE	Zhao & Carr (1997) [Modified version in GFS]	Ferrier et al. (2002) [In Eta, WRF option]
Prognostic variables	Water vapor, cloud condensate (water or ice)	Water vapor, total condensate (cloud water, rain, cloud ice, snow/graupel/sleet)
Condensation algorithm	Sundqvist et al. (1989)	Asai (1965) [used in high res models]
Precip fluxes and storage	Top-down integration of precip, no storage, & instantaneous fallout.	Precip partitioned between storage in grid box & fall out through bottom of box
Precip type	Rain, freezing rain, snow	Rain, freezing rain, snow/graupel/sleet (variable rime density for precip ice)
Mixed-phase conditions	No coexistence of supercooled cloud water & ice, simple melting eqn.	Mixed-phase at >-10C, includes riming, more sophisticated melting/freezing

from Ferrier (2005)

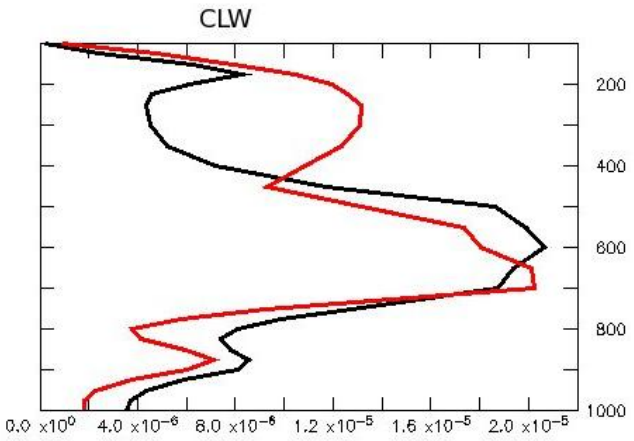


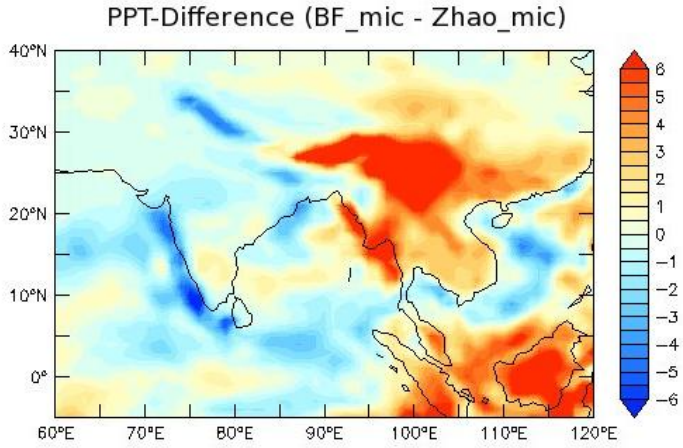
Source: Anupam, Hemant, Ashish, Subodh, Samir and Rao





Black=BF_mic; Red=Zhao_mic





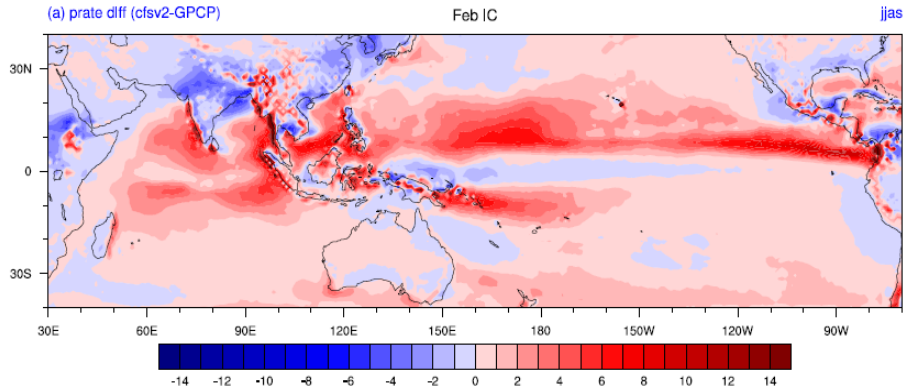
Source: Anupam, Hemant, Ashish, Subodh, Samir, and Rao

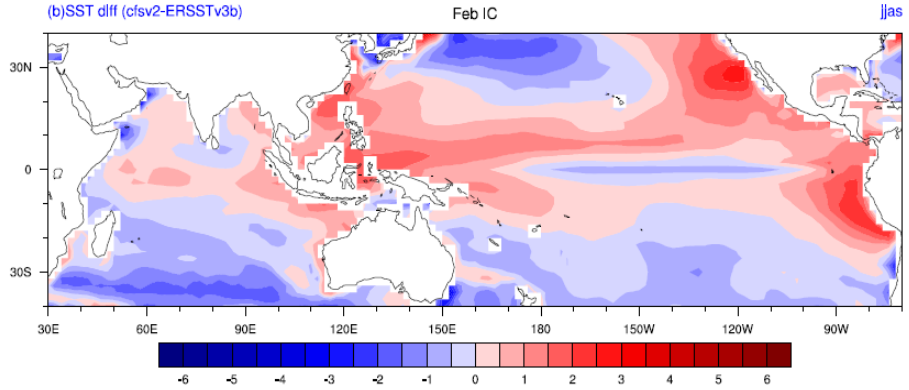
High resolution Seasonal Prediction Experiments

CFSV1	CFSV2	CFSV2/IITM
T62 horizontal resolution (~200 Km)	T126 horizontal resolution (~100 Km)	T382 horizontal resolution (~38Km)
Sigma vertical coordinate with 28 levels with top pressure ~3 hPa	Sigma-pressure hybrid vertical coordinate with 64 levels with top pressure ~0.266 hPa	
Simplified Arakawa-Schubert convection	Simplified Arakawa-Schubert convection with momentum mixing	
Tiedtke (1983) shallow convection	Tiedtke (1983) shallow convection modified to have zero diffusion above the low level inversions	
Orographic gravity wave drag based on GLAS/GFDL approach	Orographic gravity wave drag based on Kim and Arakawa(1995) approach and sub-grid scale mountain blocking following Lott and Miller (1997)	

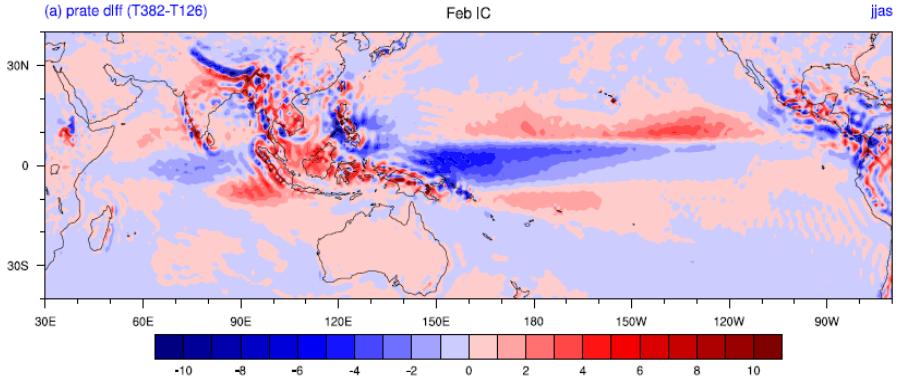
High resolution Seasonal Prediction Experiments

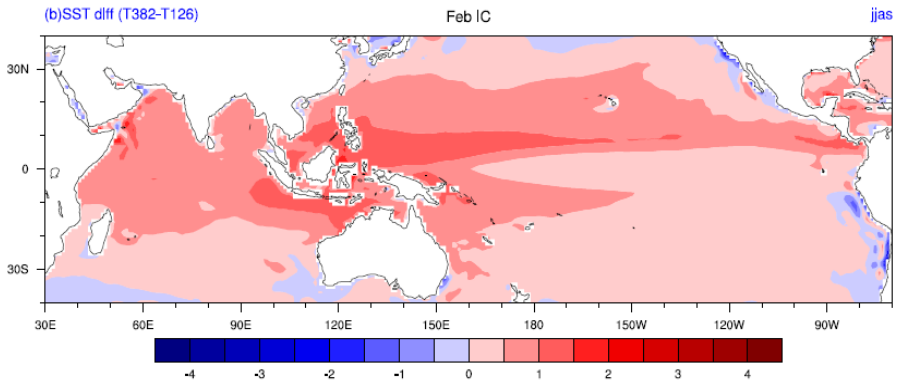
T382 model bias



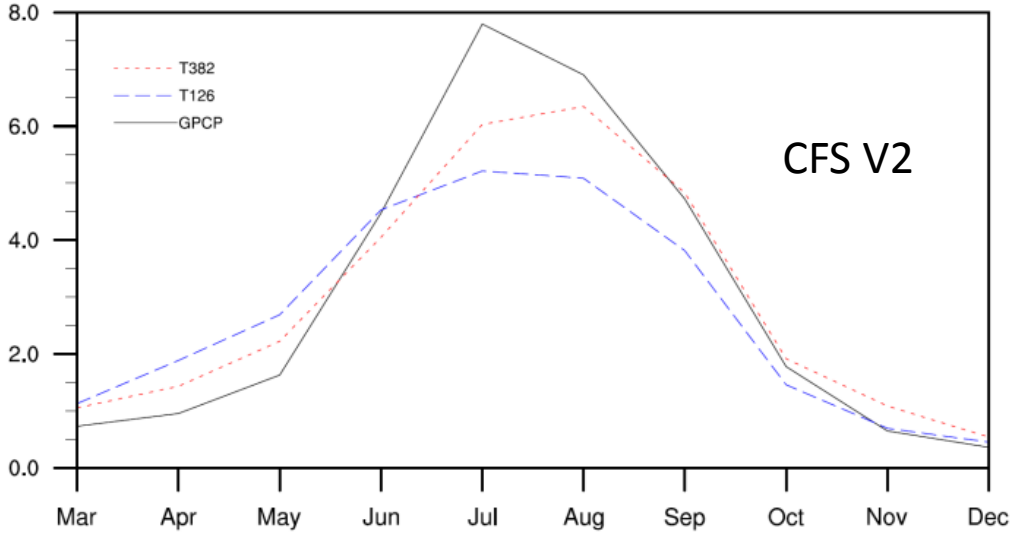


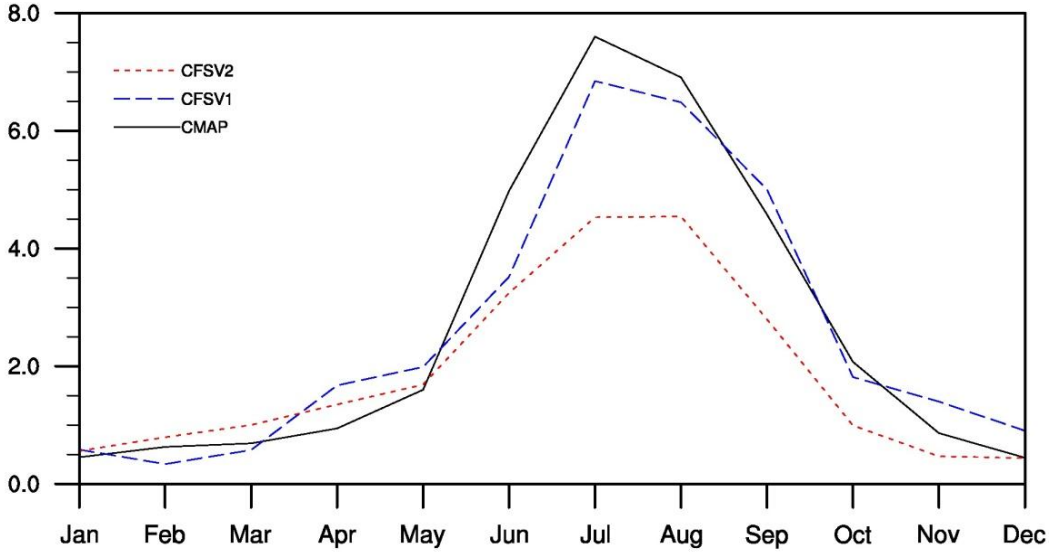
T382 vs. T126



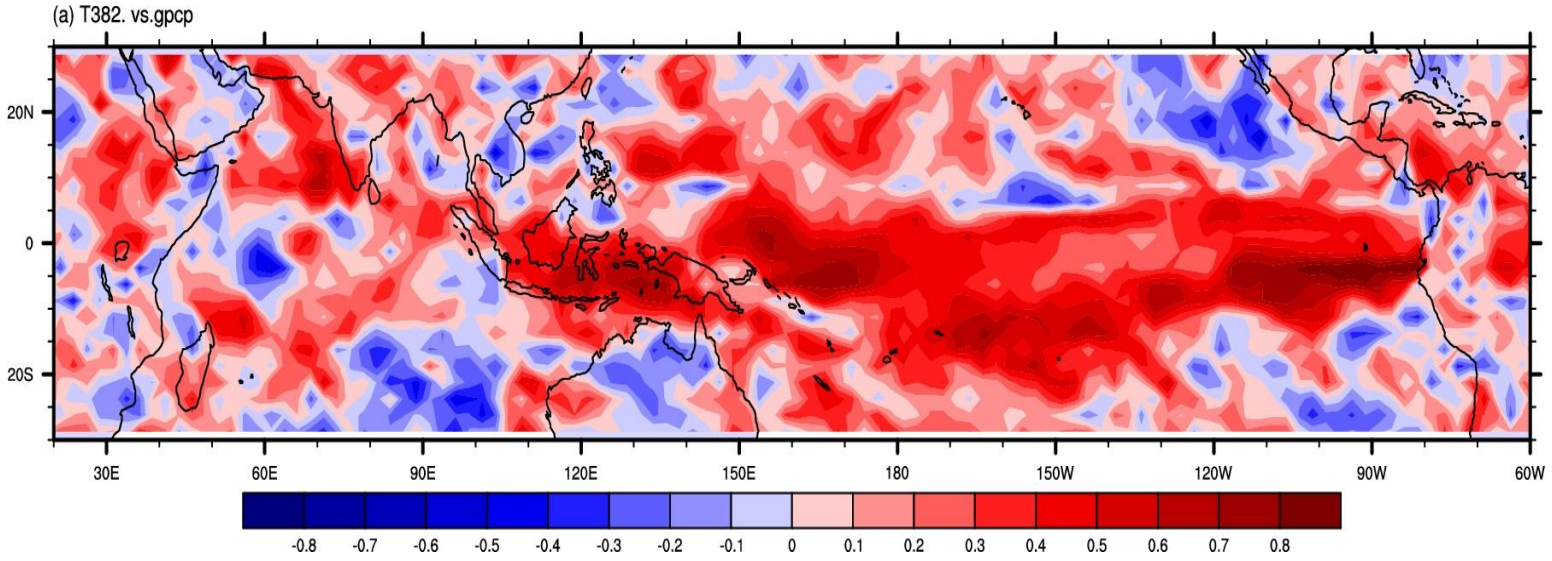


Annual Cycle of ISMR

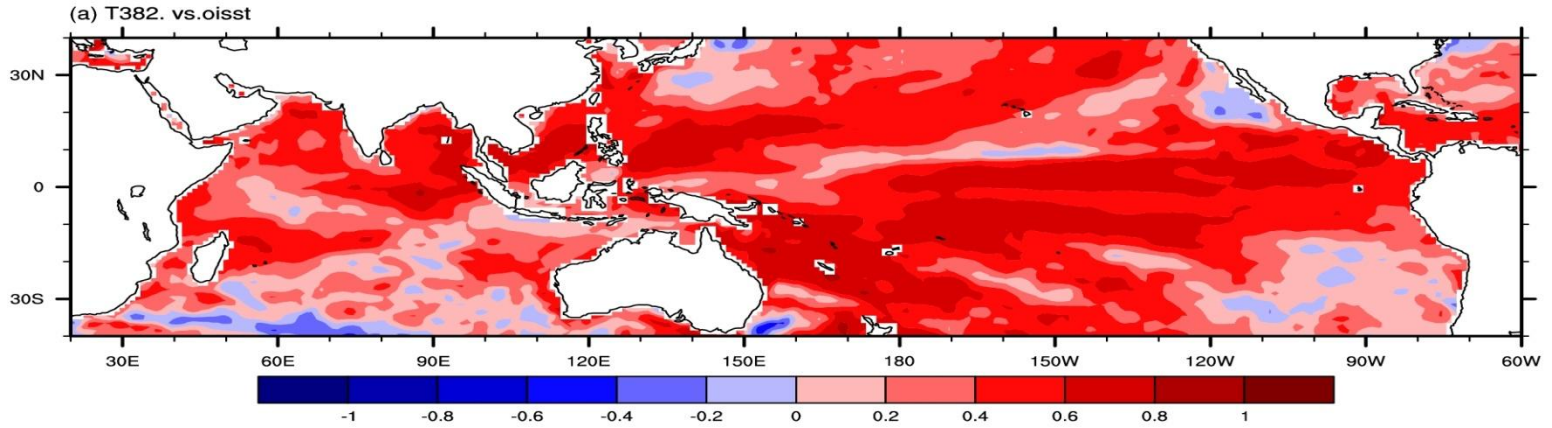




Improved skill in SST and Rainfall (JJAS)



GPCP VS T382

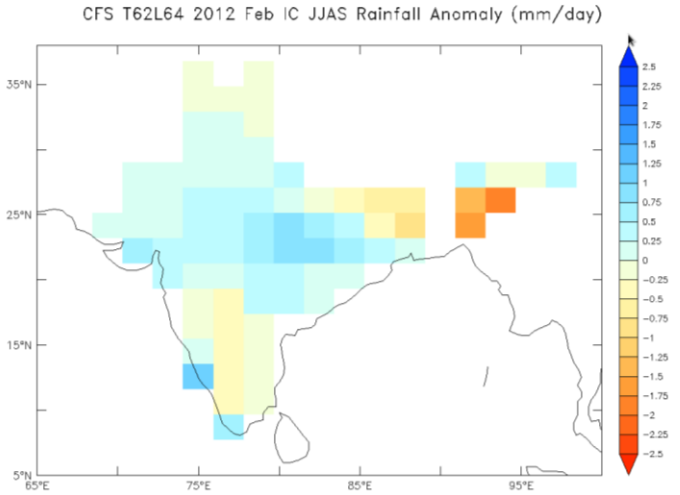


ERSST VS T382

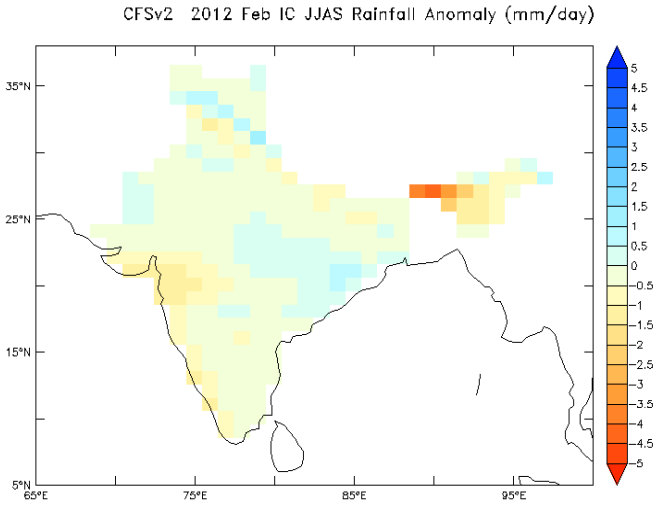
Summary and Conclusions

- Change in cloud microphysics from Zhao to Ferrier physics has considerably reduced cold bias over troposphere and improved rainfall simulation over larger Asian monsoon region.
- Changing land surface from Noah to OSU has not resulted in improved simulations over Indian land mass
- High resolution (in atmosphere model) has resulted in reducing the dry bias over land and also resulted in improvement of skill
- Future experiments will focus on improving cloud microphysics and cloud parametrization schemes.

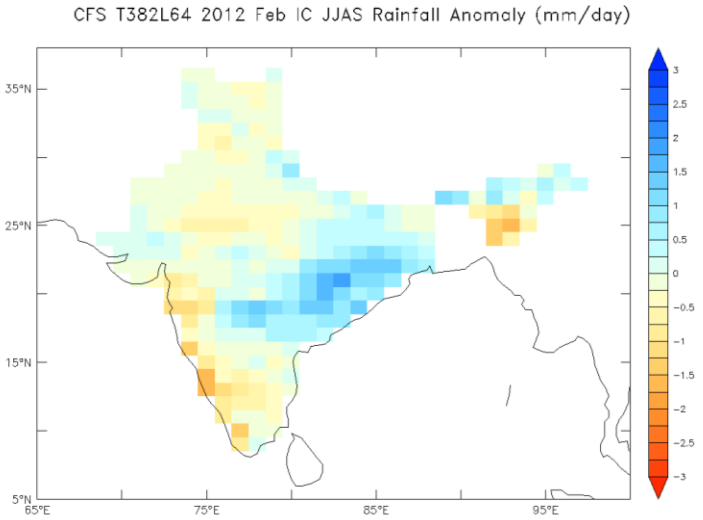
Predictions for 2012



Monsoon Performance = 102 %



Monsoon Performance = 99 %



Monsoon Performance = 100 %

Thank you