

# Possible Improvements of Multiscale Indian Summer Monsoon through Embedded Regional Modelling

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**WCRP-JNU Training School on Monsoon Variability in Changing Climate**

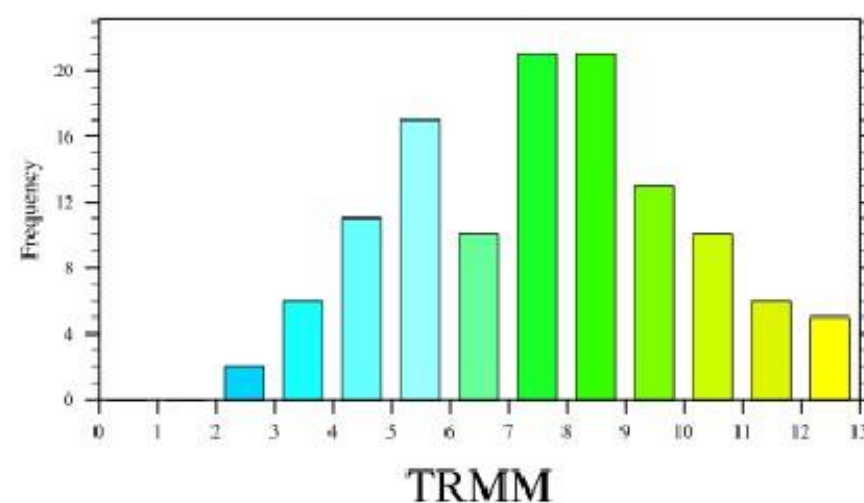
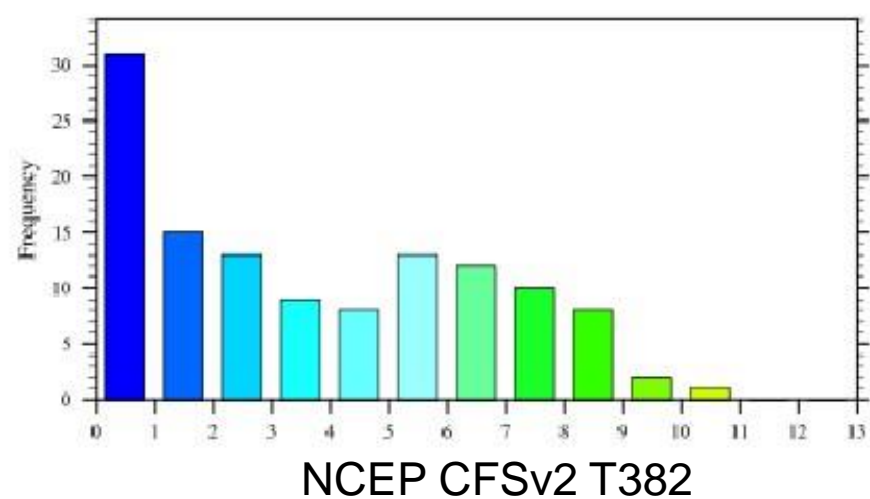
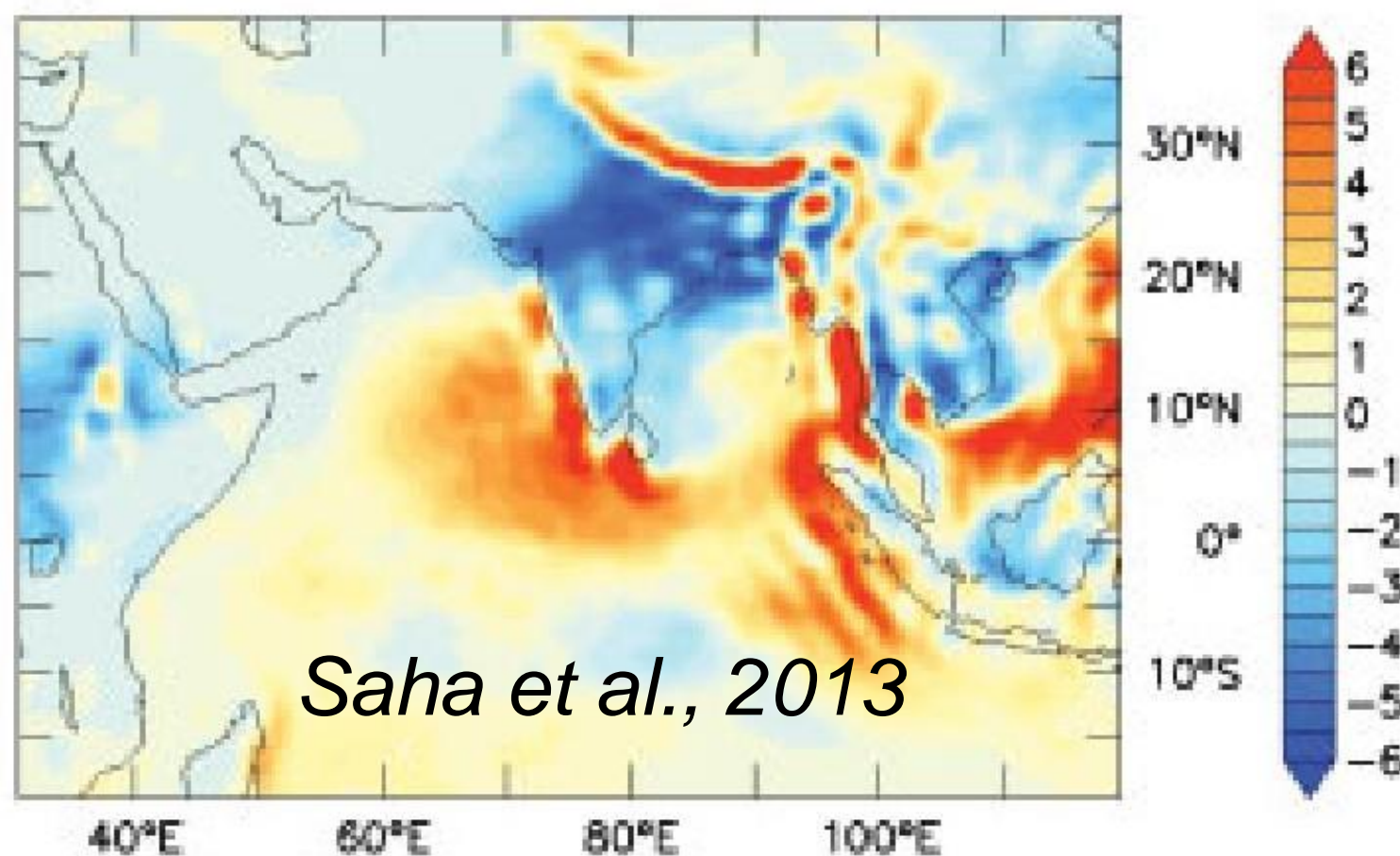
# Background

- Growing recognition of monsoon as a complex systems (*Sikka and Gadgil, 1980; Suhas et al., 2011*)
- A framework for understanding monsoon interannual variation as an multiscale system has been developed (*Goswami et al., 2006*)

## Objectives

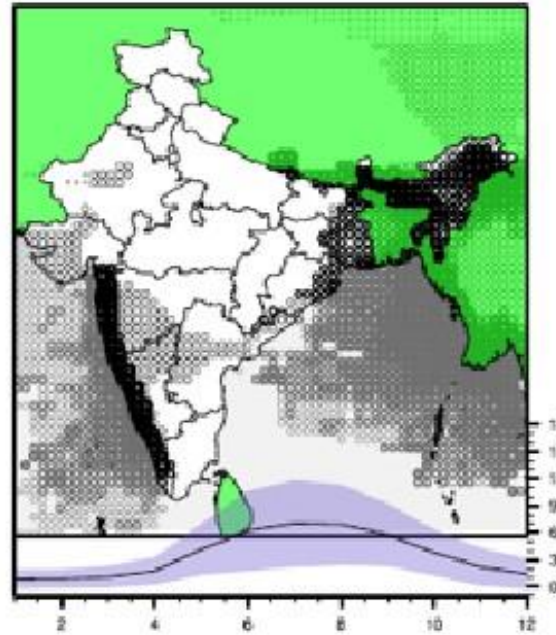
- Objective identification of multiple scales and their validation in simulations
- Evaluate whether NCEP CFSv2 captures important scales of monsoon variability correctly
- Using WRF as an intermediate tool to explore factors relevant to scales of ISMR variations of interest to this project

## ■ Candidate model of Monsoon Mission: NCEP CFSv2



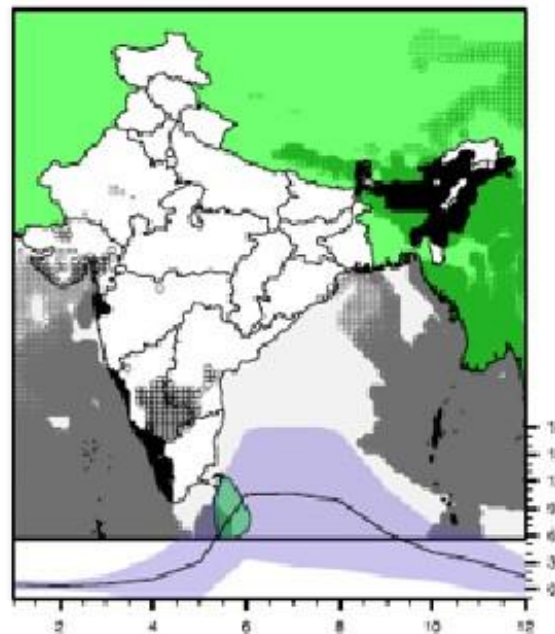
# Annual cycle of rainfall

SW monsoon

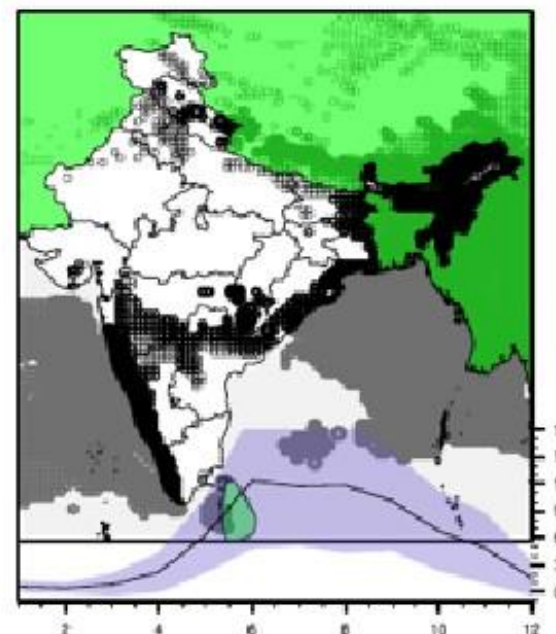


Aphrodite + TMI

NCEP CFSv2

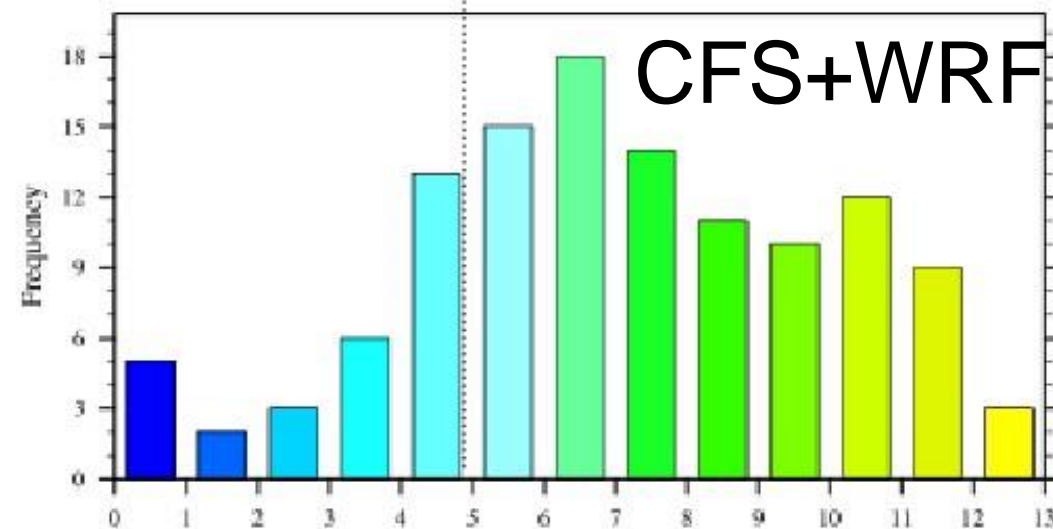
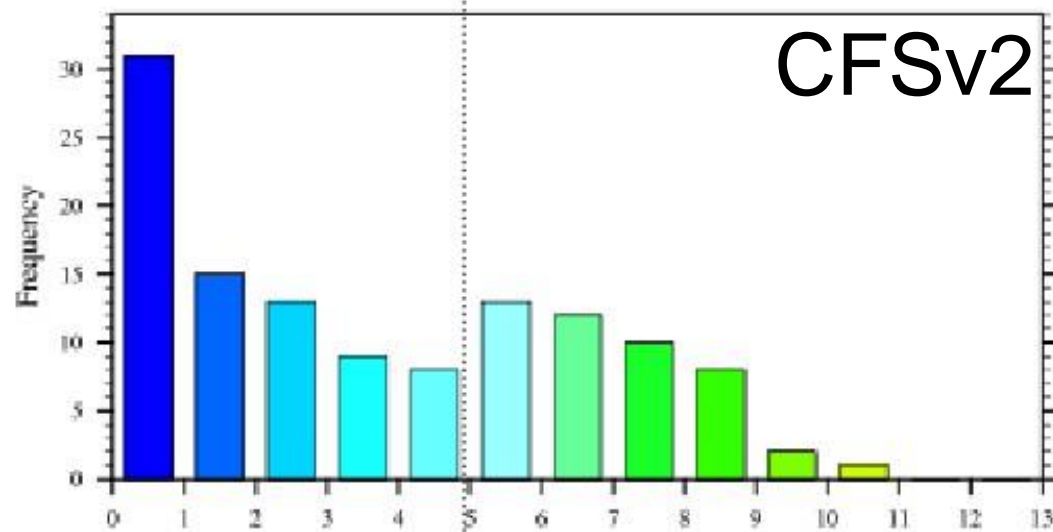
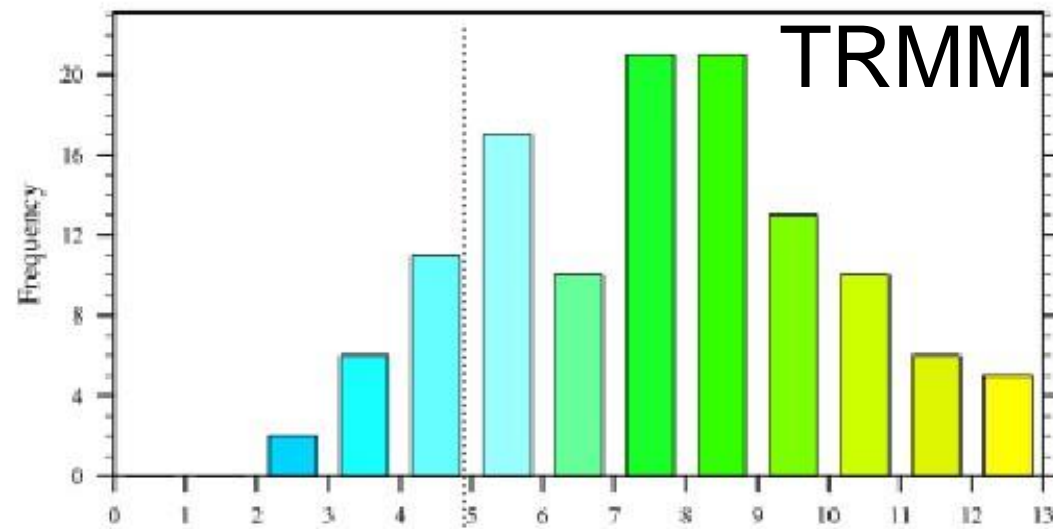


CFS + WRF



**Similar improvements  
in Central India rainfall**

# Comparison over CI region



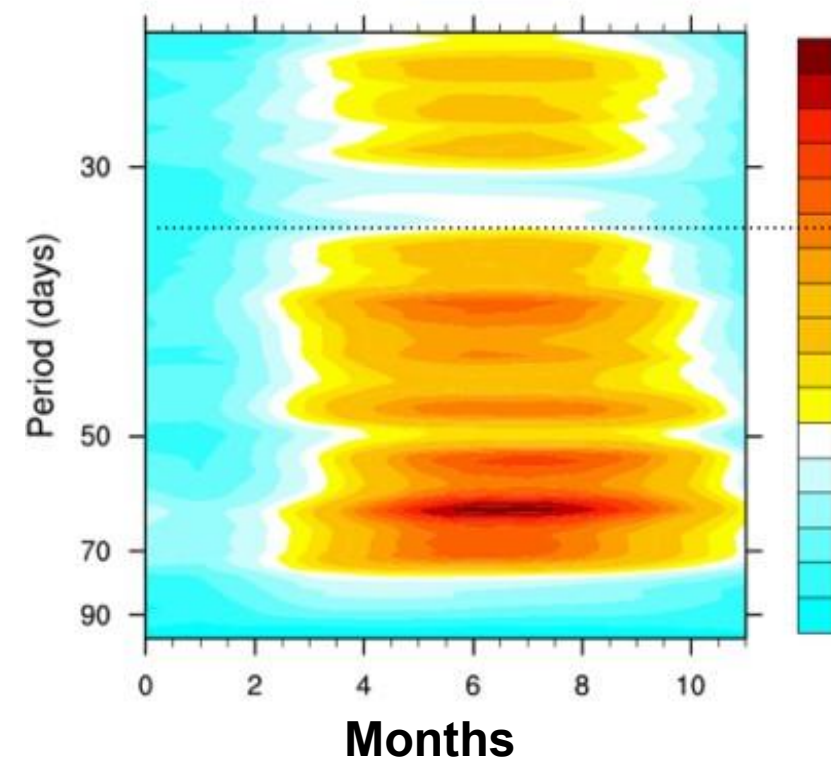
PDF of daily rainfall  
intensity is shown



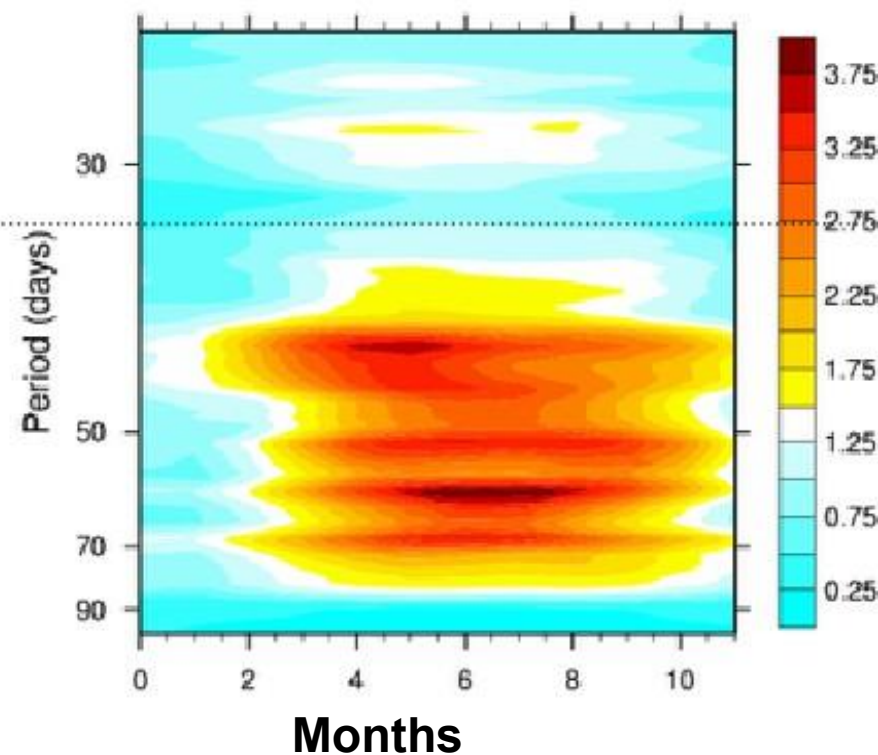
# Multiscale ISMR rain regimes

subseasonal scale

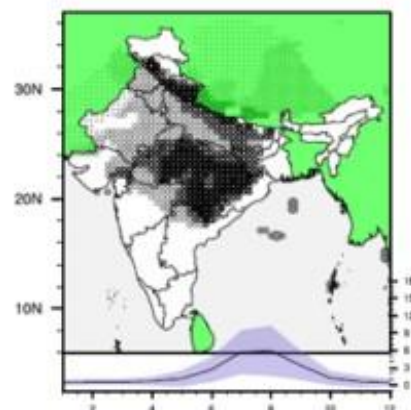
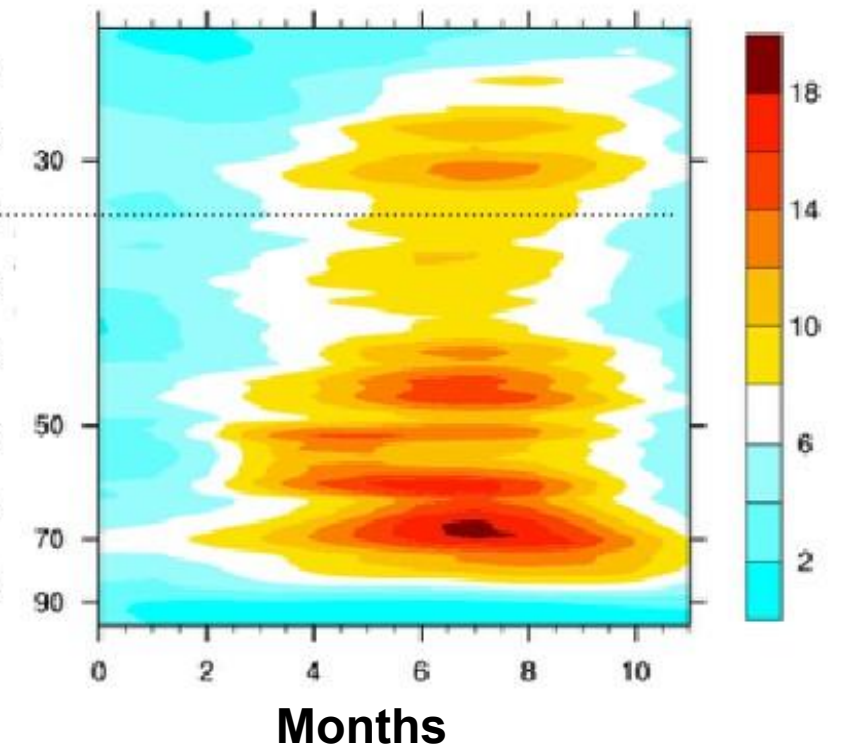
Aphrodite



NCEP CFSv2

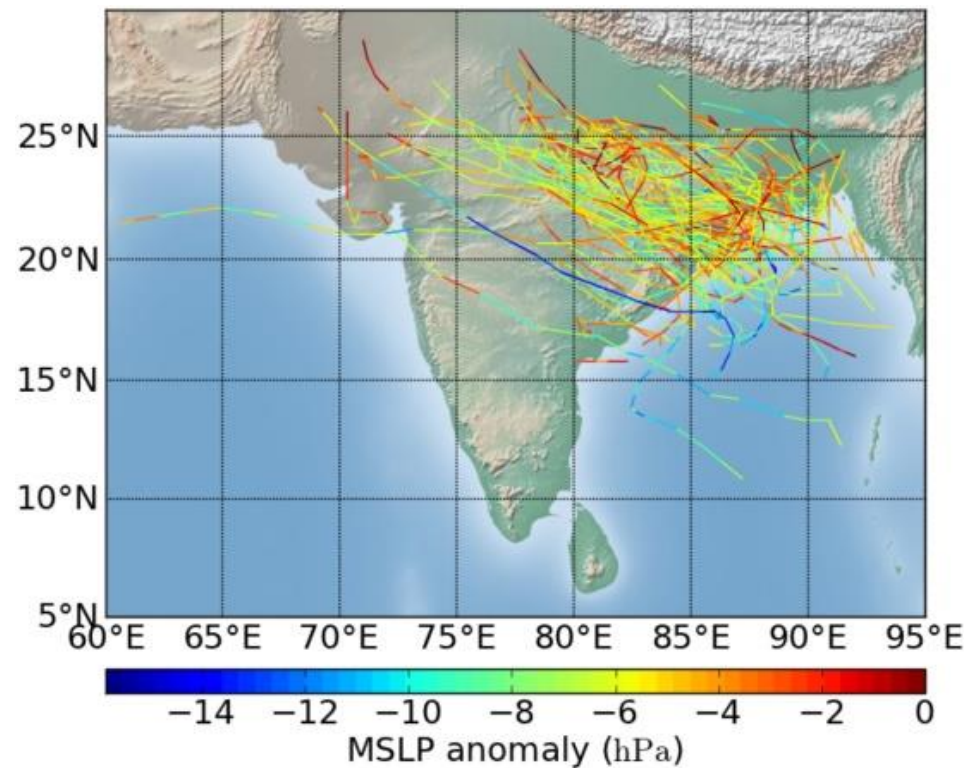


CFS + WRF

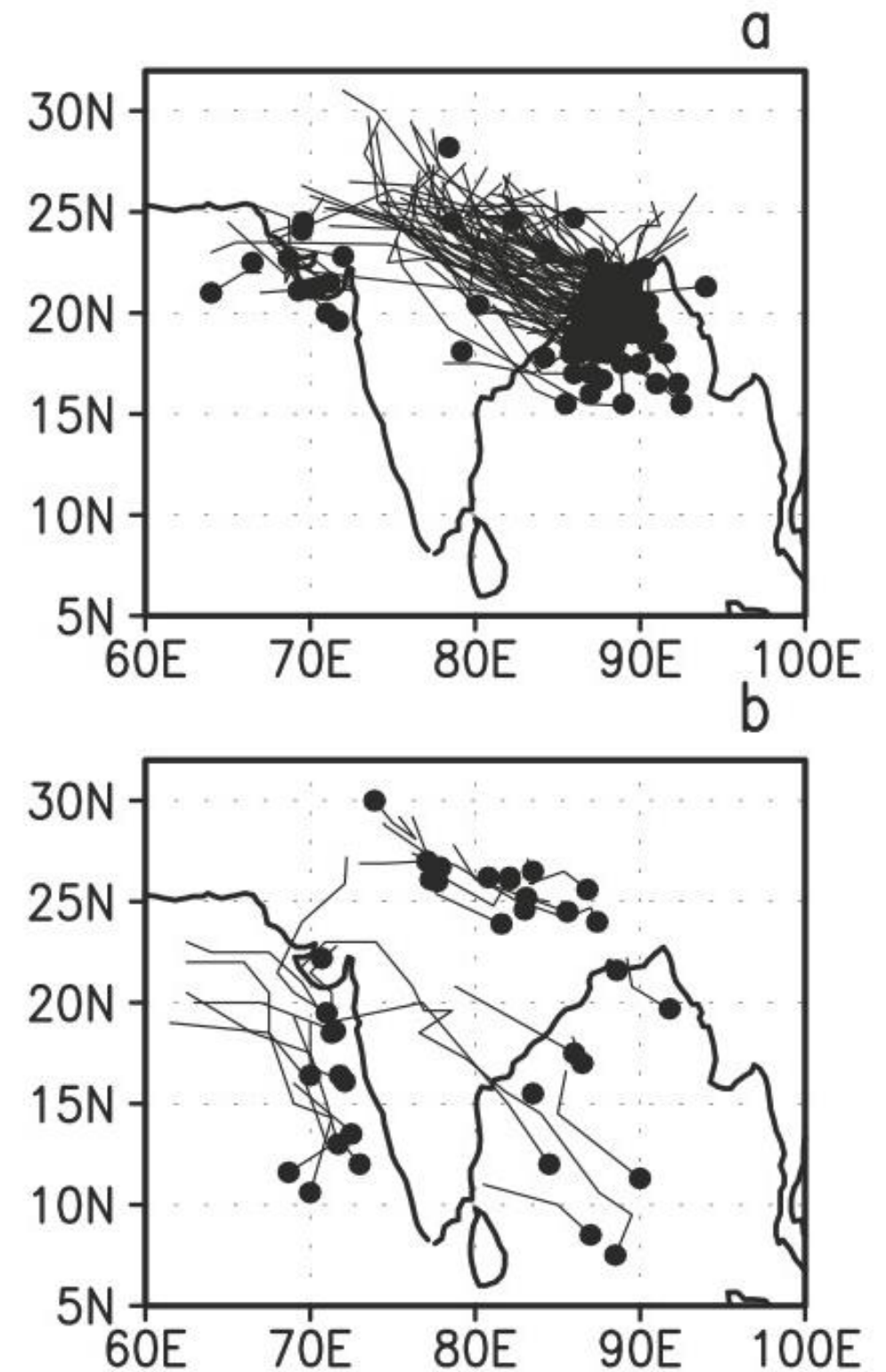


# Modulation of synoptic activity by Monsoon ISO

- Collectively account for 50% of the total ISMR rainfall (Sikka 1977, 2006)



*Hunt et al., 2016*

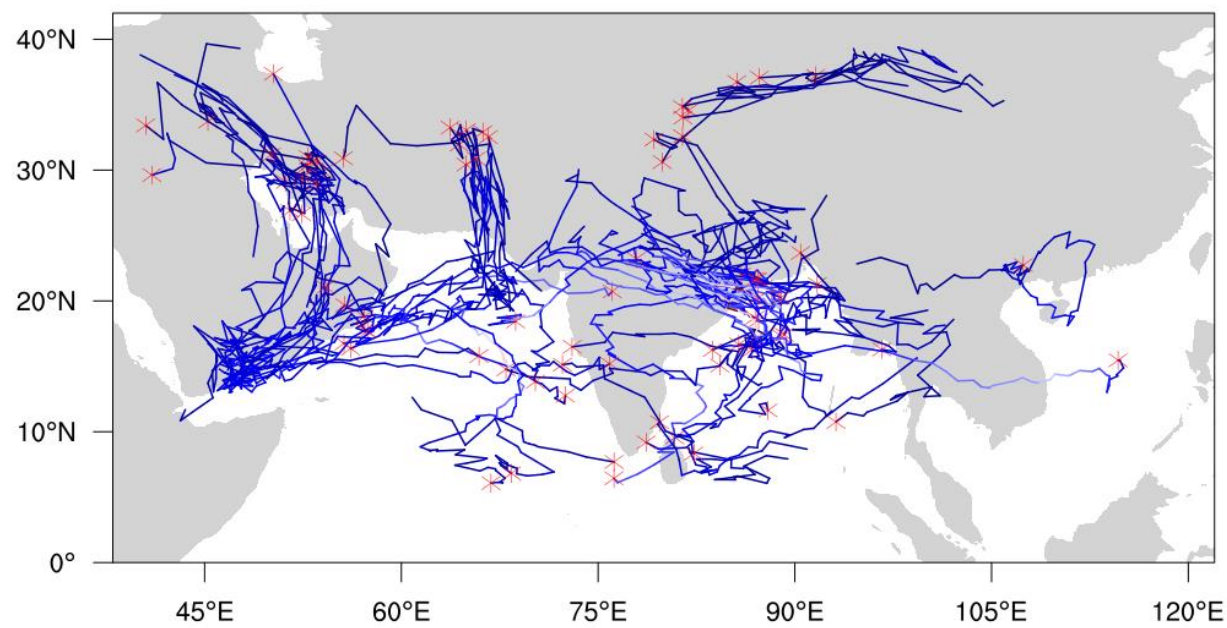


*Goswami et al., 2003*

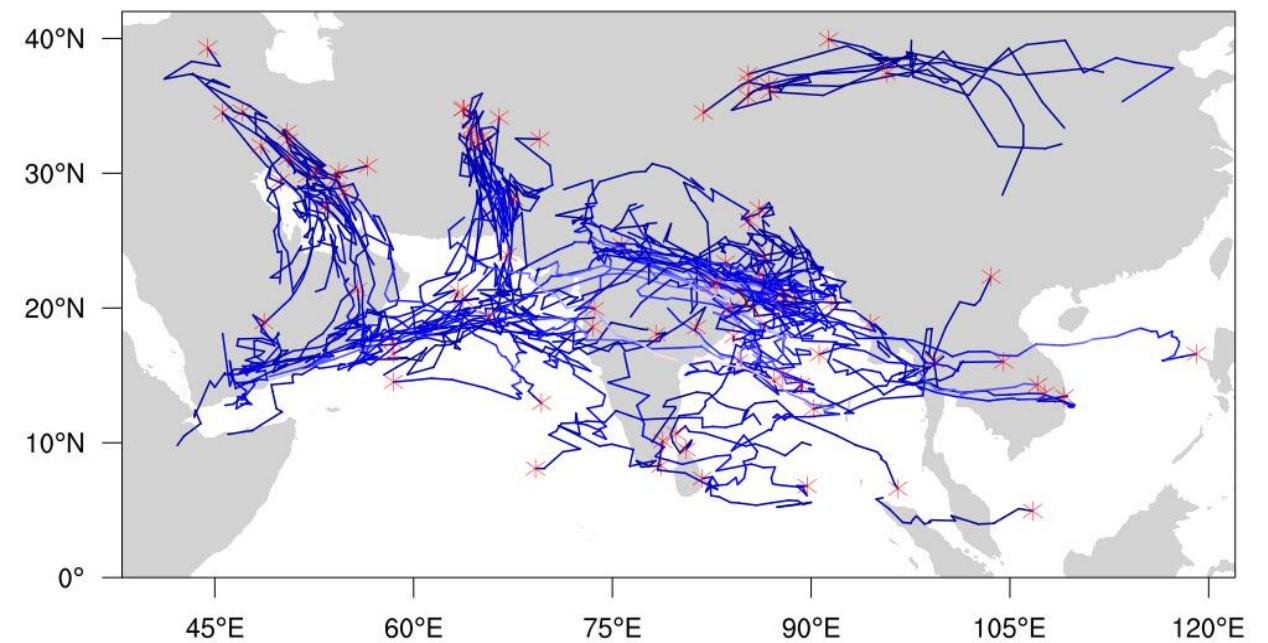


# How ENSO induced large scale circulation affects low pressure systems during Indian summer monsoon period?

JJAS ELNINO COMPOSITE 79-15



JJAS LANINA COMPOSITE 79-15



- Tracks identified based on ERA Interim 6 hrly 850 hPa rel vorticity data
- IOD years excluded



# Summary

- **A new SOM based framework for identifying and assessing ISM features in better way**
- **A series of 7 year-long embedded regional simulations using NCEP CFSv2 T382 free run as LBCs has been carried out**
- **A set of experiments with Linear Baroclinic Model (LBM) for understanding ENSO-monsoon teleconnection**
- **Studied effect of ENSO circulation in monsoon low pressure systems**



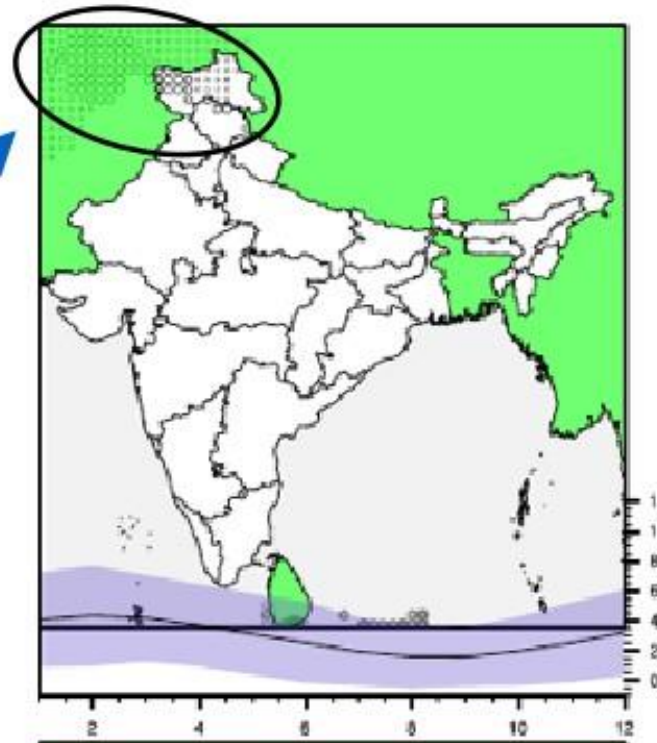
**Extra slides**



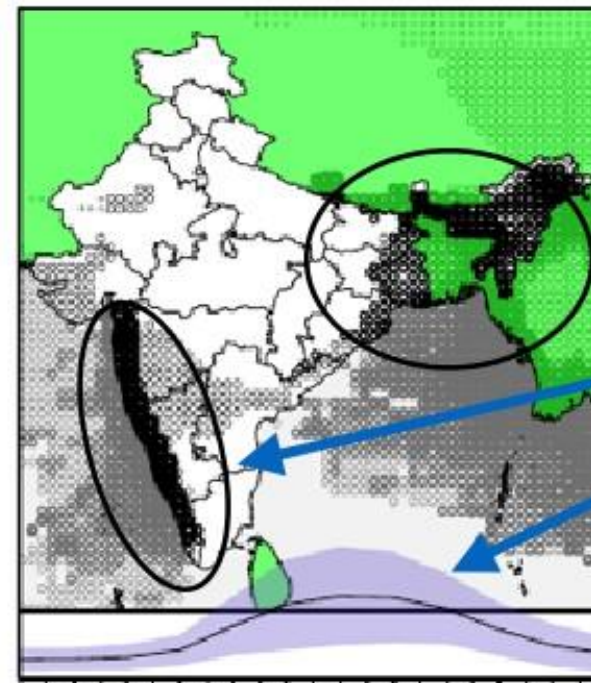
# Multiscale IMR regimes

annual scale

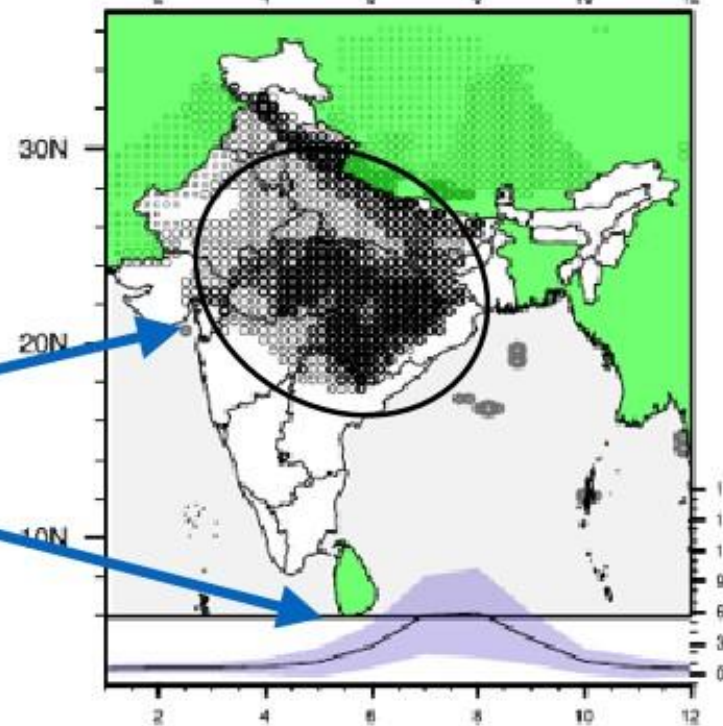
Late winter/  
Early spring  
NW



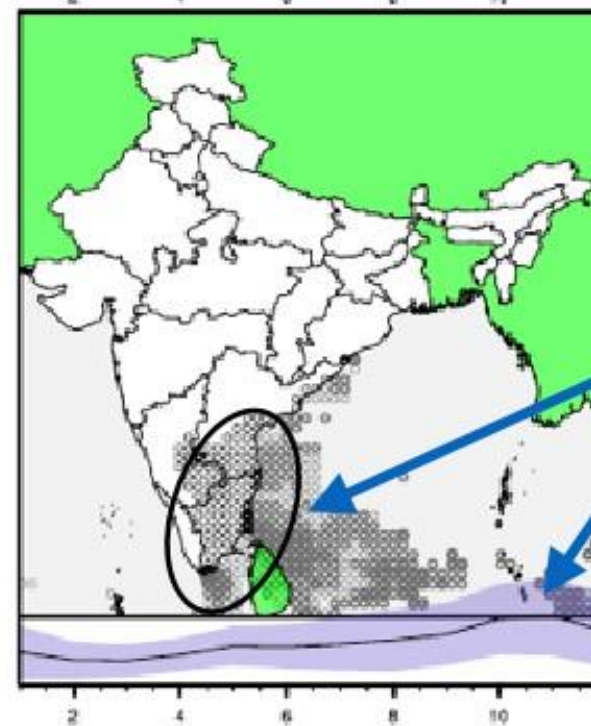
Follows evolution of  
SW Monsoon



Rapid evolution  
over Central India  
Jul-Aug



Follows evolution  
of NE Monsoon



Data source:  
Aphrodite

# Multiscale IMR rain regimes

- Monsoon rain rich in scales of variability
- Central Indian rain has several unique features
  - sharp evolution during the middle of the summer monsoon
  - intense rainfall events associated with monsoon lows and depressions
  - dominantly interannual
- Western ghat rain
  - Evolution of rain closely related to SW monsoon
  - intense rainfall events
  - dominantly decadal
  - dominantly quasi-biweekly

# Multiscale ISM variations in the NCEP CFSv2 T382 runs and embedded simulations



# Model Data and Embedded experiments

- NCEP CFS v2 T382
  - Coupled (free) runs spanning 20 years
- Embedded WRF simulations (CFS+WRF) with above as LBC
  - 5 Experiments, each for a 7-year period corresponding to model years 1999-2005
    1. No SST
    2. Daily updated NCEP CFS SST
    3. Coupled to 1D mixed layer Pollard, Rhines and Thompson (1972) - spatially uniform, time-invariant depth of 50m
    4. Same as above, but MLD from observations and varies on monthly scale

# Physical Schemes for the embedded simulations

- Cumulus: Betts-Miller-Janjic scheme
- Longwave Radiation: RRTMG scheme
- Shortwave Radiation: RRTMG shortwave
- Land surface: unified Noah land-surface model
- Surface Layer: Monin-Obukhov (Janjic Eta) scheme
- Boundary layer: Mellor-Yamada-Janjic (Eta) TKE scheme
- Microphysics: WSM 3-class simple ice scheme