Probabilistic Real Time Prediction of Monsoon Intraseasonal Oscillation

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Introduction

The monsoon ISOs are broad spectrum 20-80 day non-linear convectively coupled oscillation with large horizontal structure, distinct baroclinic vertical structure associated with complex (superposed) modes of diabatic heating and clear northward phase propagation during the monsoon season.

The prediction of monsoon ISO in the extended range (3/4 pentad in advance) is operationally important and pose a challenging problem to the meteorological community.

This poster illustrates the latest effort of monsoon ISO prediction in the extended range by IITM through a novel methodology: Self Organizing Map (SOM)

The Aim of This Study

The poster demonstrates the comprehensive use of SOM technique in the diagnosis and prediction of monsoon ISO. The prediction of ISO is attempted using a deterministic approach & then modifying it into a probabilistic approach.

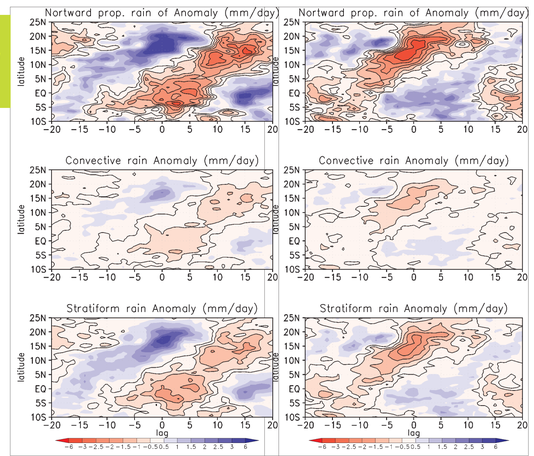
Why ISO is revisited using non-conventional technique?

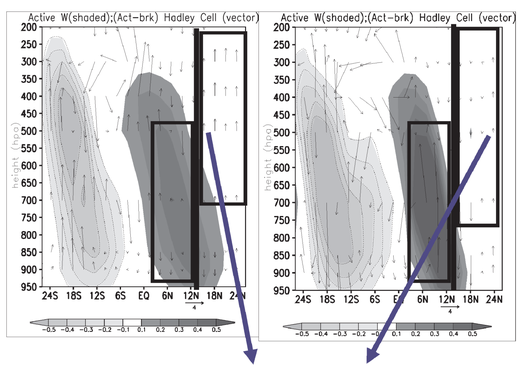
Complexity in ISO scale Organization

e.g. different for convective and stratiform rain rate

Role of large scale dynamics & diabatic heating in northward propagation of ISO

A diagnostic framework missing keeping in mind of prediction





A numerical simulation showing the inclusion of stratiform rain rate favor the northward propagation

Vertical Motion enhanced to the north For S70 profile than C100 profile

What is a SOM approach?

The SOM is a non-linear clustering analysis that identify the dominant mode of variability (or the most significant principal component) existing in a data (times series) or a large group of data through an iterative approach based on some closeness criteria (associated with an iterative training algorithm, Kohenen, 1990).

The identified dominant mode is characterized by the presence of large number of phases (which is pre determined) called nodes in a time sequenced manner (similar to a lag/lead phase composite plot).

Advantage:

- A non-linear filter to extract dominant mode of variability from a data without a priori knowledge of spectrum.
- Implicit time –sequencing of phases which are important (or iteratively evolve as important).
- No end point effect: perfect for prediction.
- Can be used to identify various 'shades' or 'clones' of the same variability that has a broad spectrum like monsoon ISO.

Acknowledgements

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Some References

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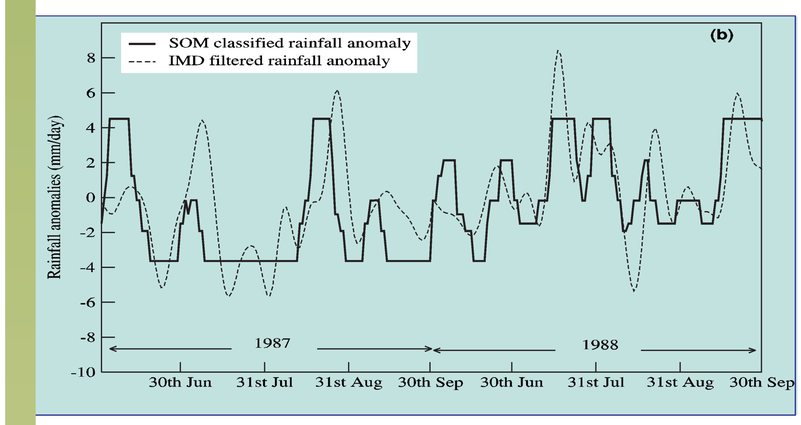
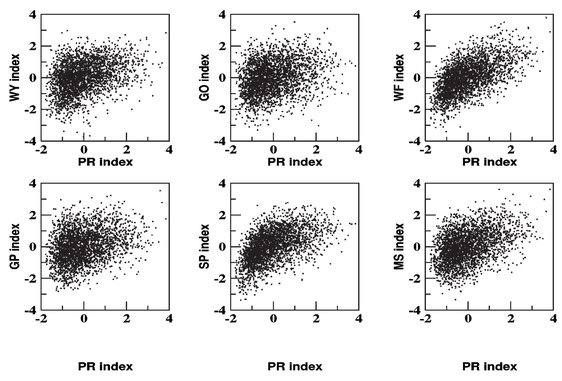
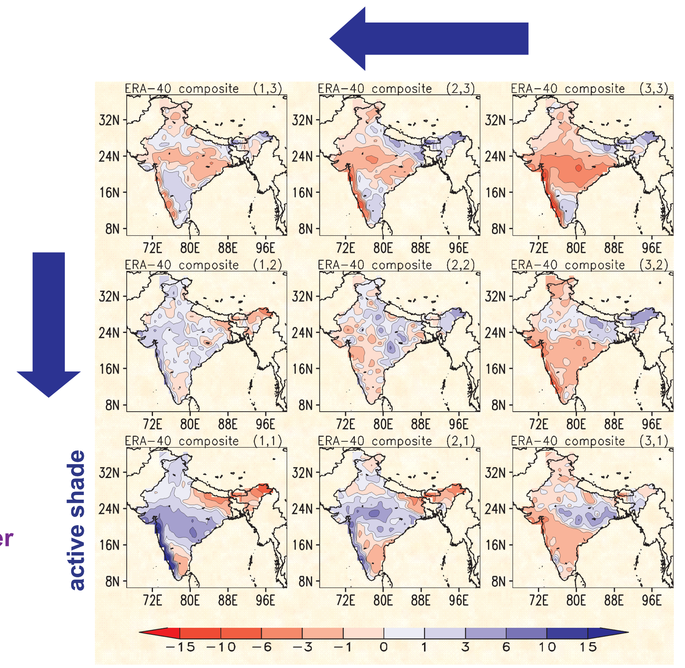
Application of SOM: 1. Capture the dominant mode of monsoon rainfall ISO from a group of large scale dynamical parameters: SOM used as a Non-linear Filter





The apparently non related indices (very high scatter) can be used to filter Rainfall data. This feature of extracting commonality among apparently uncorrelated parameters is a powerful Feature of SOM



The SOM technique also captures the spatial evolution of temporally filtered pattern as shown in the plot above

Application of SOM : 2. ISO prediction in the extended range

Basically this is an analog method of prediction

Here we present a scheme for prediction of rainfall over central India (15N-25N, 70E-85E) 4 pentads in advance.
The SOM classification on the training period extracts 15X15 patterns and their evolutionary history and stores them in the 'reference' vectors. Time histories of the patterns are saved in the dates clustered at each node. For prediction from a given date, a 'forecast' vector is created with current and past data for 9 days for all the large scale variables. This essentially contains the pattern and its evolutionary history at the initial time. If we could find an analogue of this pattern and its evolution in the past from the 'reference' vectors corresponding to different nodes, we could make a 4 pentad prediction from the evolutionary history of the analogue.

1. Create Reference Vector through SOM training

SOM Nodes=3X3=9
9 shades of ISO

3,1	3,2	3,3
2,1	2,2	2,3
1,1	1,2	1,3

$R^{i,j}_{k=1,N}$

N is the no. of Index

Each node is identified with a unique and distinct reference vector R. Thus for most active node (1,1) or break node (3,3) R represents opposite phases. Similarly other states also has different R.

2. Create a forecast vector *F* equal in dimension* with *R*.

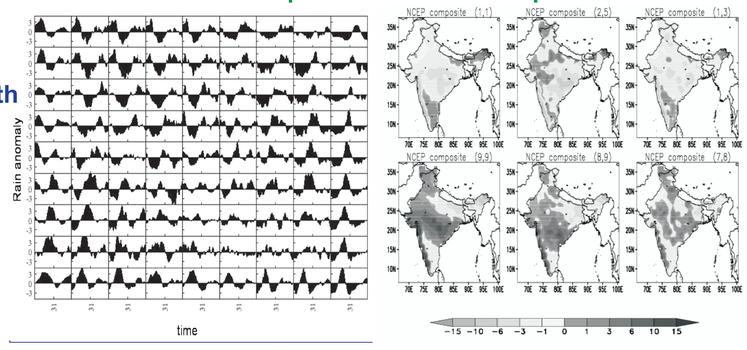
F is constructed from the data length up to today.

$F^{i,j}_{k=1,N}$ *dimension=N X no. of Past day

3. Calculate | R-F| $_{min}$ and identify the node which points to this min value

4. 4th pentad evolution of the identified node is the 4th pentad forecast

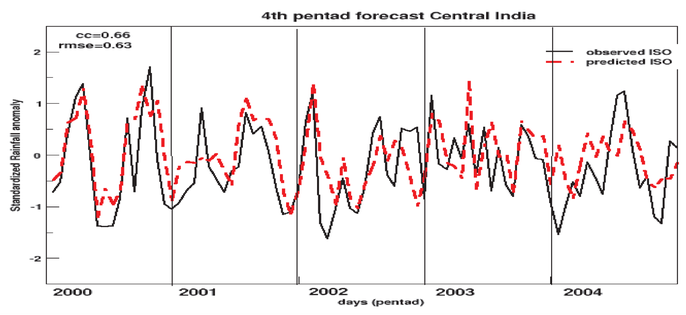
Examples of analogues: A 9x9 SOM classification
Almost similar temporal evolution and spatial structure



Temporal Shades# Spatial Shades#

Shade : Almost similar spatial structure or temporal evolution

4 pentad forecast over Central India



Probabilistic Prediction

Prediction scheme is analogue in nature

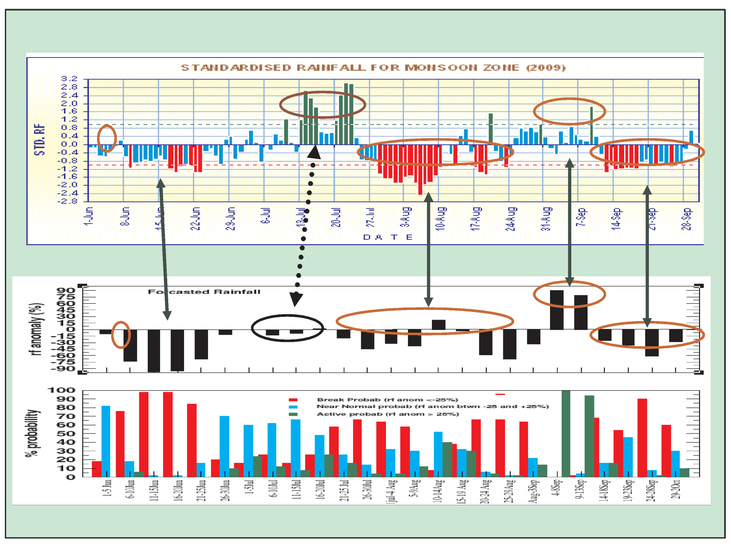
Constructed an ensemble of 50 members.

Each member is chosen randomly from a large pool of past data

Each member predicts the ISO in the present based on past history patterns they stored in the training period.

The history patterns for each member are different from each other and are created based on randomly selected years for that member (similar to that of seasonal prediction scheme)

Experimental Probabilistic prediction: 2009



Certain spells are better predicted than others

Drought spells are better predicted than active spells

Prediction skill shows strong seasonality/year to year variability (not shown)

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