Evaluating a New Calibration Method for Seasonal Probabilistic Prediction for Indian Summer Monsoon

Nachiketa Acharya

Andrew Robertson, Nicolas Vigaud, Michael K Tippett
and
Lisa Goddard

International Research Institute
for Climate and Society
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Motivations

- A single deterministic rainfall forecast is not sufficient for predicting seasonal Indian summer monsoon rainfall (ISMR) which is characterized by large variability. The user community should be given probabilistic forecasts that convey the inherent uncertainty within the prediction.

Deterministic Model

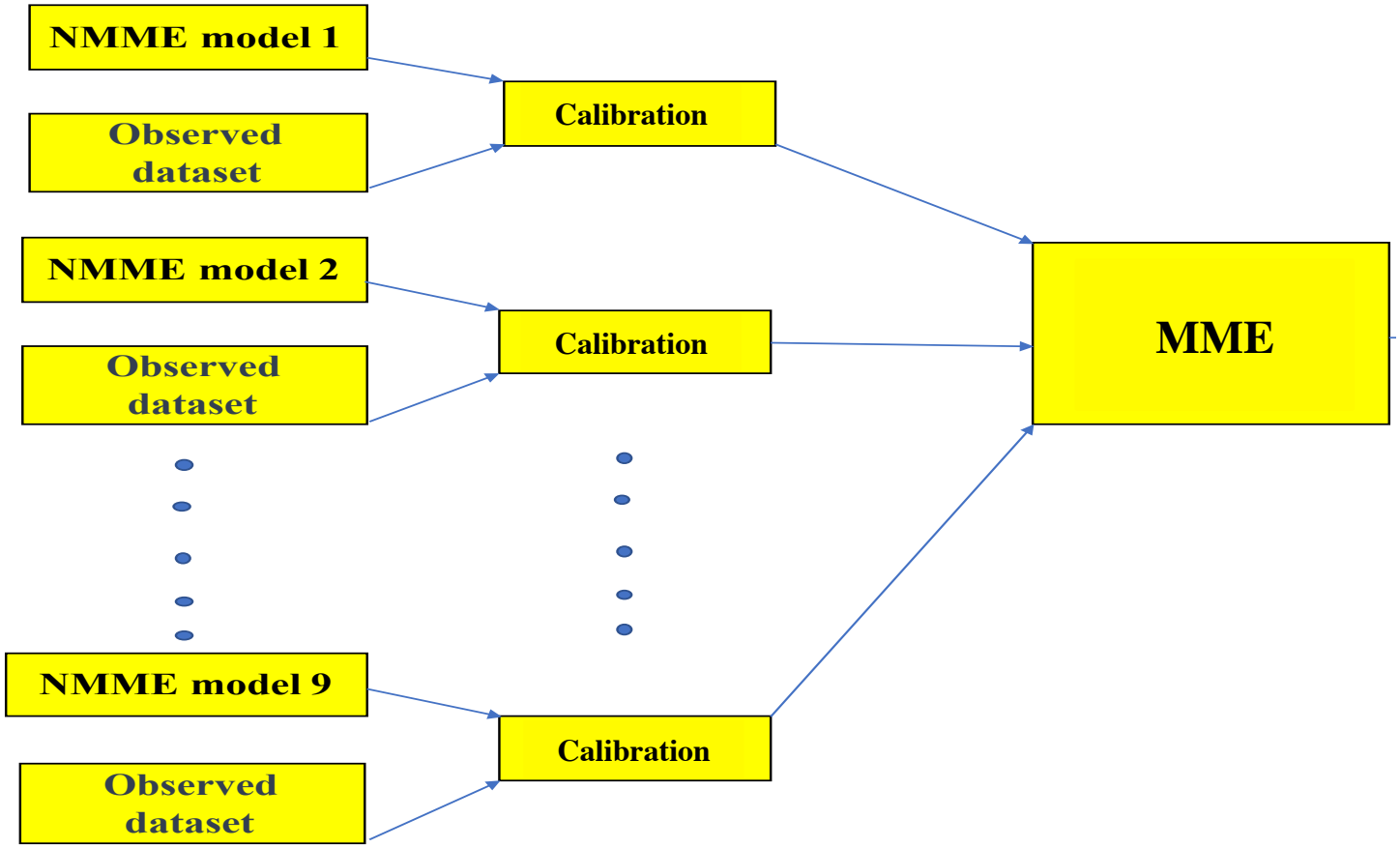
Probabilistic Model

- Though a plethora of study exists to make a deterministic model for predicting ISMR, only a few studies have described the probabilistic prediction system.

- Common approach to make such probabilistic forecast
  1) Counting ensemble members of GCMs (Uncalibrated).
  2) Combine (average, multiple linear regression) multiple GCMs (Uncalibrated) and convert in to probabilistic space using Gaussian distribution.

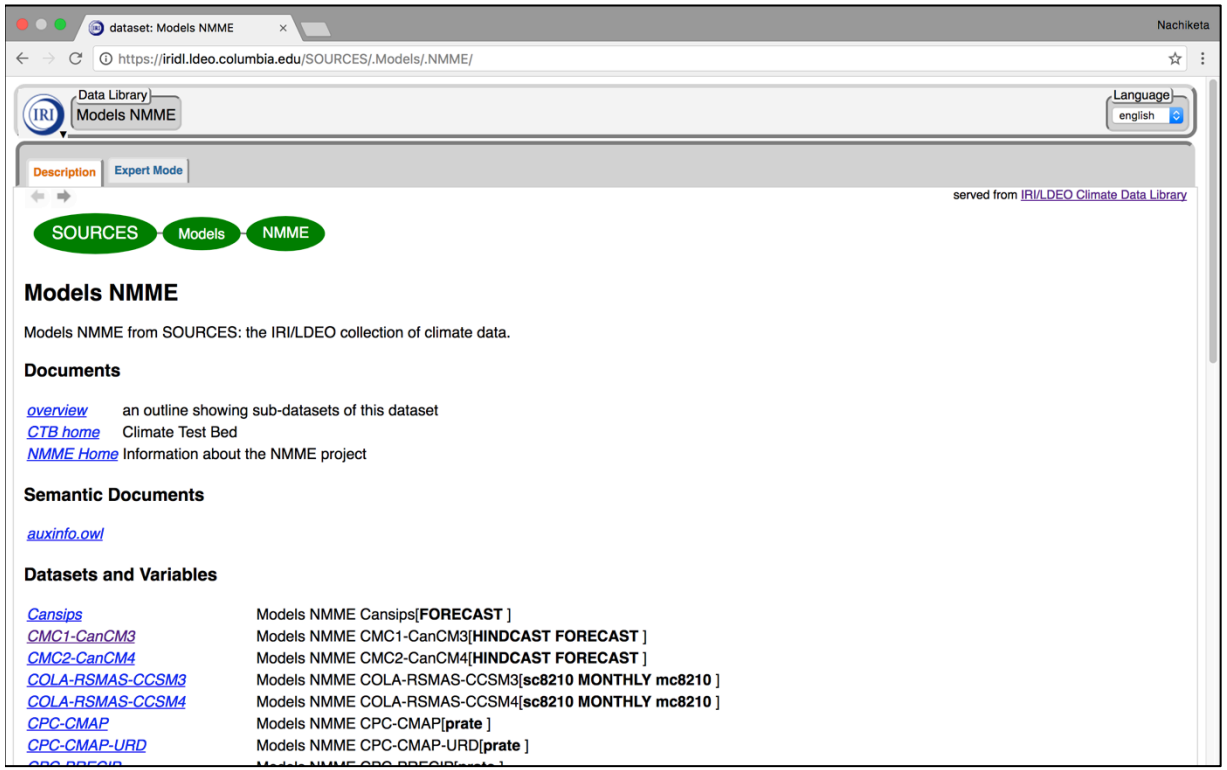
Objective

Evaluation of a calibrated probabilistic forecast system using NMME models in a non-Gaussian framework for ISMR.



NMME datasets in IRI DL

https://iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/



Model lists

- CMC1-CanCM3
- CMC2-CanCM4
- NCEP-CFSv2
- NCAR-CESM1
- COLA-RSMAS-CCSM4
- NASA-GMAO-062012
- GFDL-CM2p1-aer04
- GFDL-CM2p5-FLOR-A06
- GFDL-CM2p5-FLOR-B01

Observations

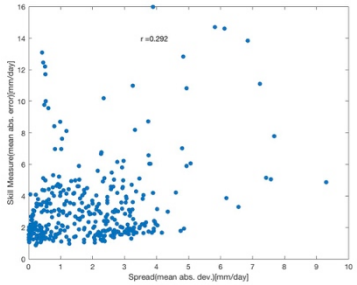
- IMD's gridded data

The lead-1 (using initial conditions of May) hindcast runs for mean rainfall of JJAS spanning over 1982-2010 is used.

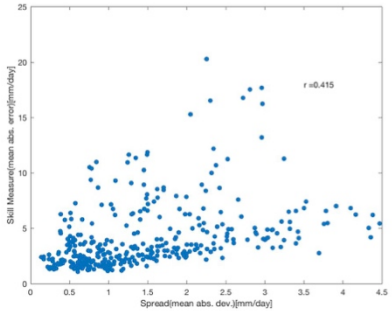
Representation of Uncertainty in GCMs

Spread-Error relationship

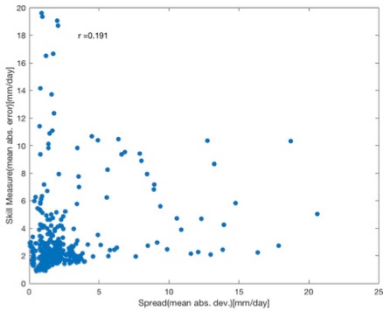
CFSv2



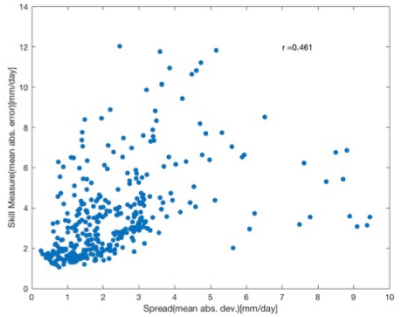
CNCM1



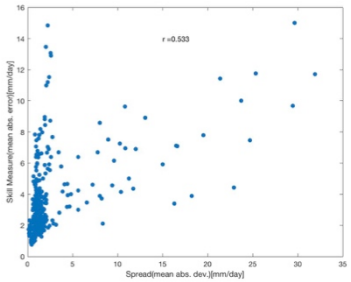
CNCM2



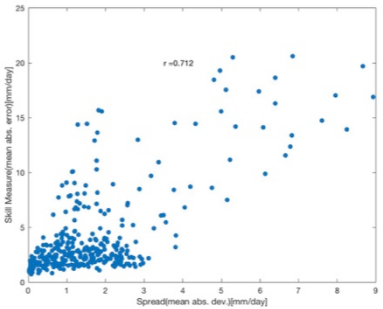
CCSM4



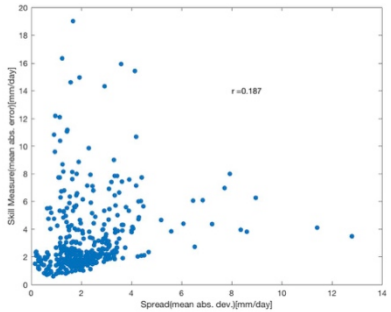
CESM1



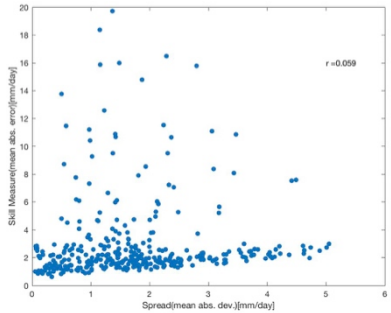
NASA



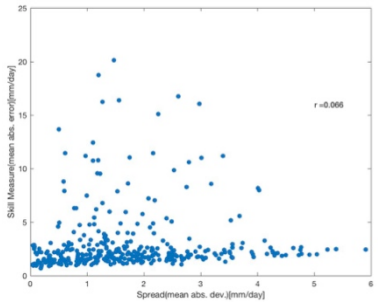
GFDL1



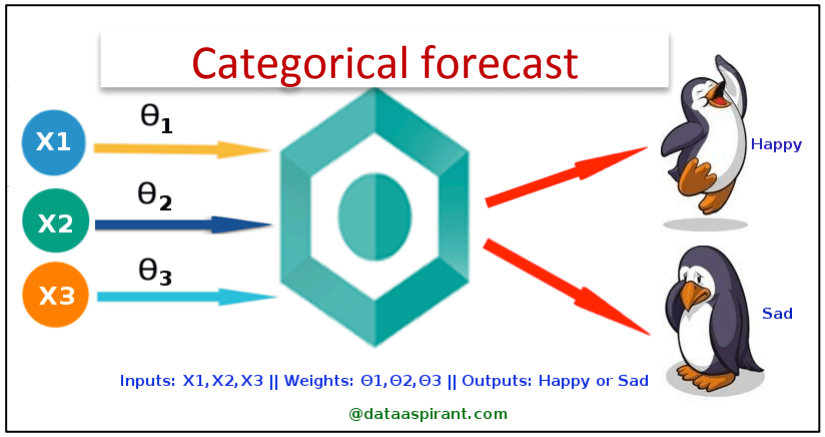
GFDL2

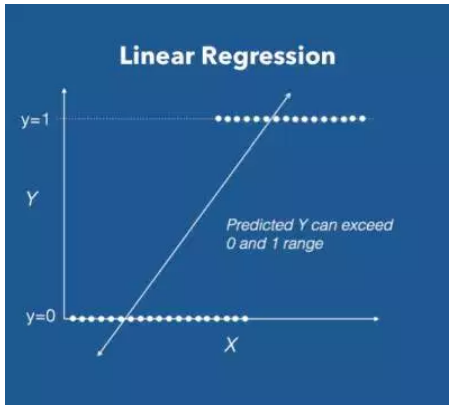


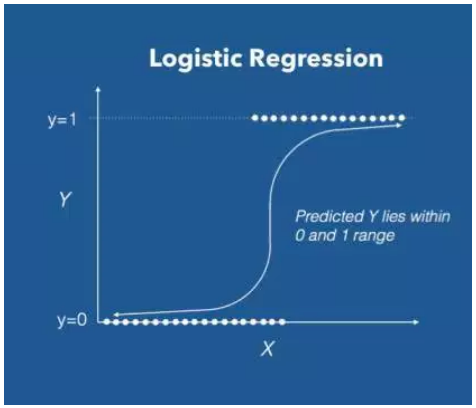
GFDL3



Calibration Method







Logistic Regression

Logistic regression is well famous method to make probability forecast

Where *p* is the (cumulative) probability of not exceeding the quantile *q*

Logistic regression (LR), a nonlinear regression method where probability itself can be considered as the predictand rather than a measurable physical quantity, is an alternative model for Gaussian approach.

Calibration Method

$$\ln\left[\frac{p}{1-p}\right] = f(x) + g(q)$$ Where

Limitations:

- Probabilities of different categories estimated by fitting separate equations for selected predictand quantile thresholds (q), yielding a collection of threshold probabilities rather than full forecast probability distributions.
- However, the most problematic consequence of separate equations for different predictand thresholds is that forecasts derived from the different equations are not constrained to be mutually consistent.

Wilks (200

Extending Logistic Regression:

- Extending LR (ELR) by including the predictand threshold as an additional predictor (link function g itself function of the quantile q), allows the derivation of full predictive distributions to avoid the problem of potentially incoherent forecast probabilities (Wilks,2009).

Wilks (20C

- Cumulative probability for a smaller predictand threshold cannot be larger than the probability for a larger threshold.

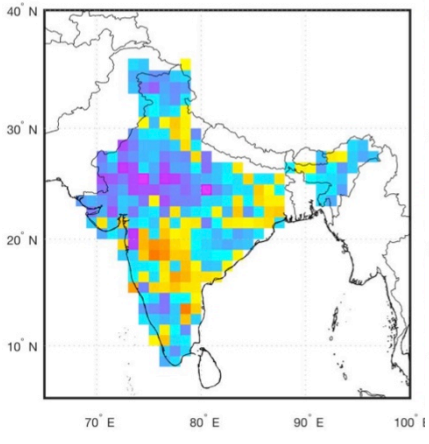
Wilks, D., 2009: Extending logistic regression to provide full-probability-distribution MOS fore- casts. *Meteor. Appl.*, 16, 361–368.

Skill Assessment: Counting Ensemble vs ELR

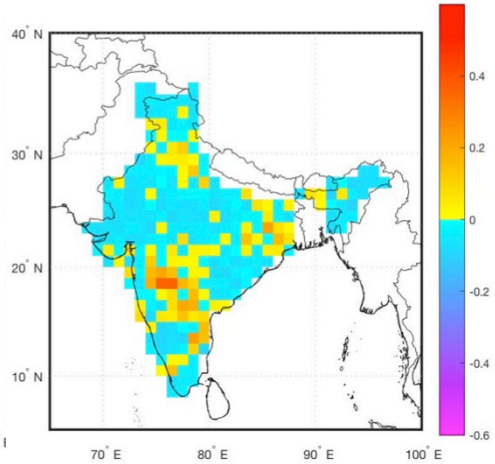
For a single GCM (GFDL3)

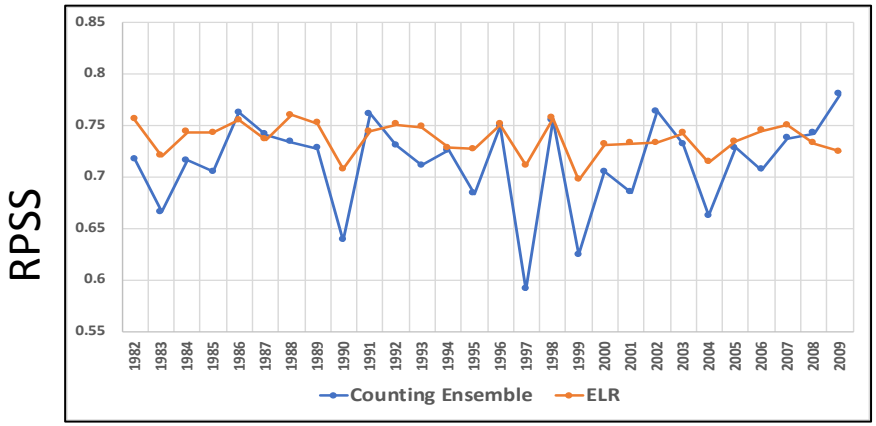
Rank Probability Skill Score (RPSS)

Counting Ensemble



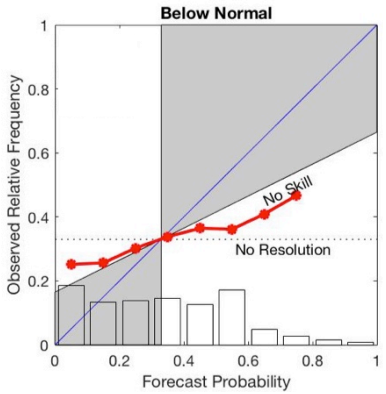
ELR



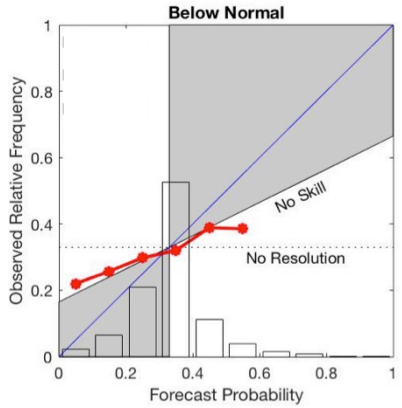


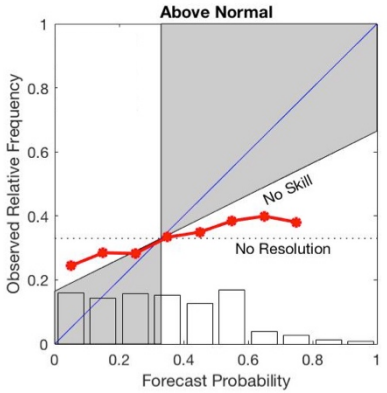
Reliability Diagram

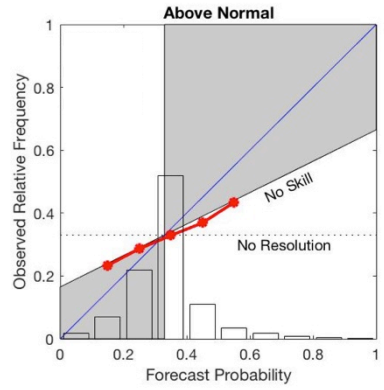
Counting Ensemble



ELR

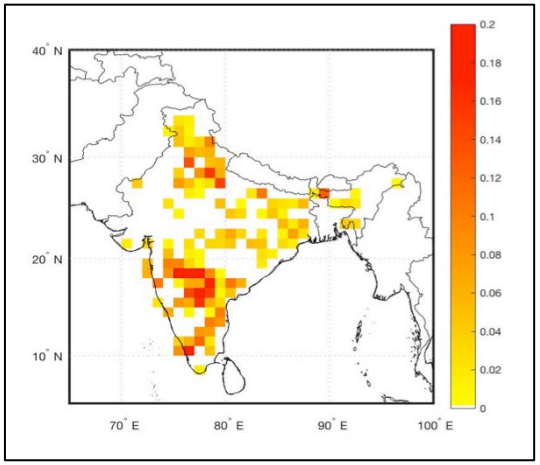


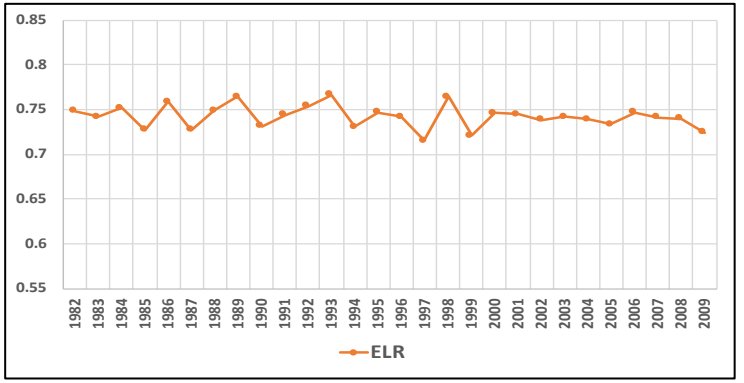




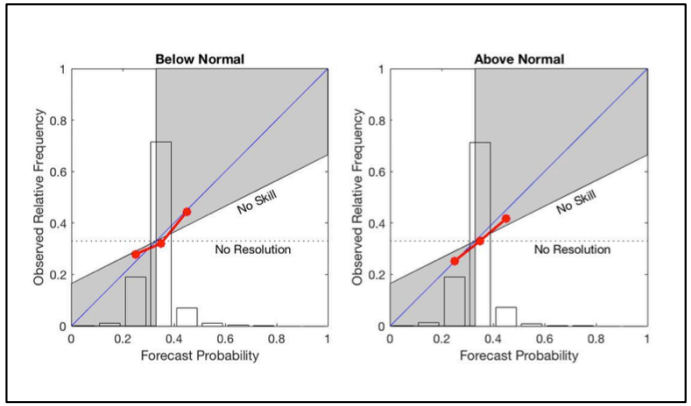
Skill Assessment: ELR based MME

Rank Probability Skill Score (RPSS)

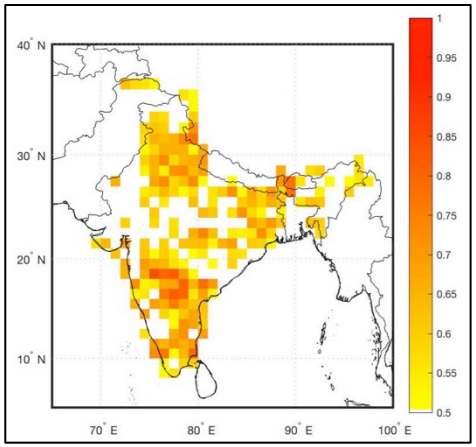




Reliability Diagram



Generalized ROC Score (GROC)

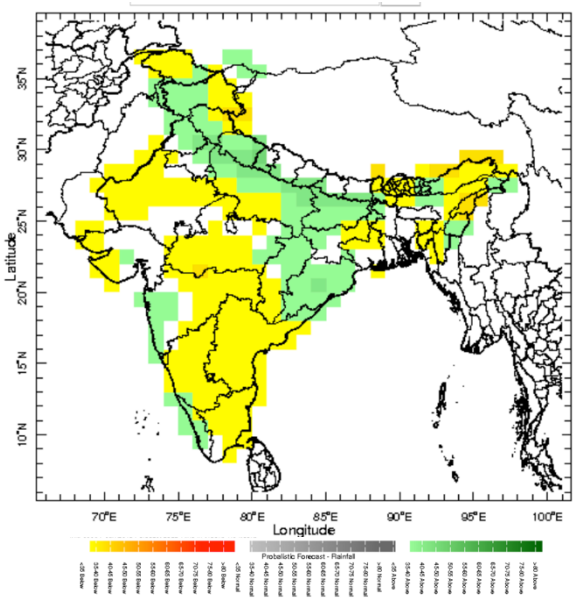


Courtesy: Simon Masson and Ángel Muñoz

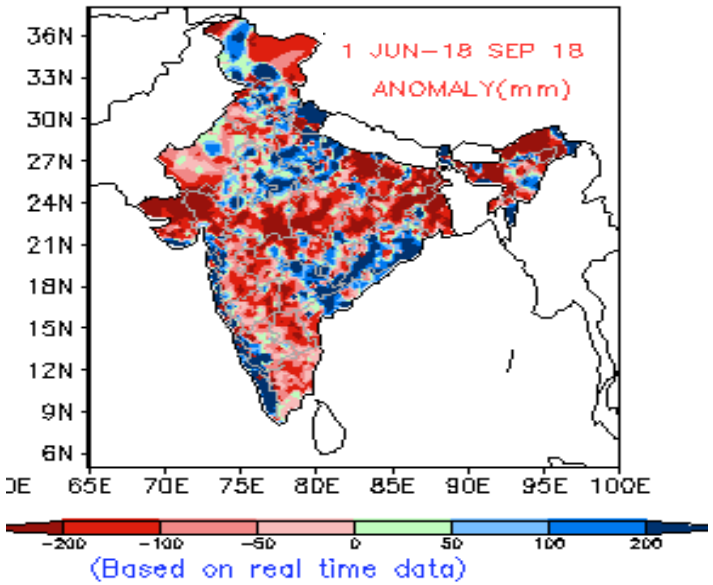
Real time Forecast (tercile) and Verification

- Real-time experimental probability forecast generated by above stated calibration method for monsoon 2018.

Forecast for JJAS generated in June,2018



Real time Anomaly for JJAS,2018



Source: http://imdpune.gov.in/Seasons/Pre_Monsoon/premonsoon.html

- The spatial pattern of deficit and excess rainfall well capture by Forecast.

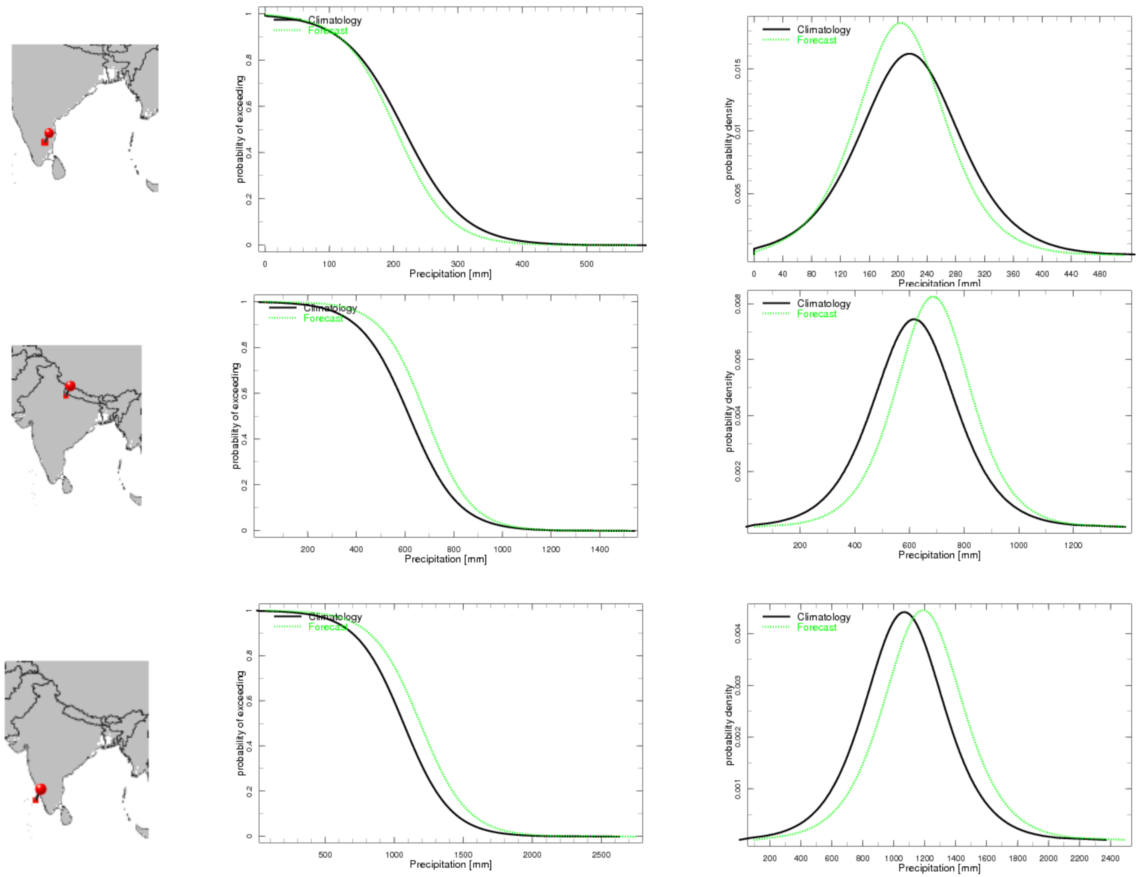
Real time Forecast (full distribution) and Verification

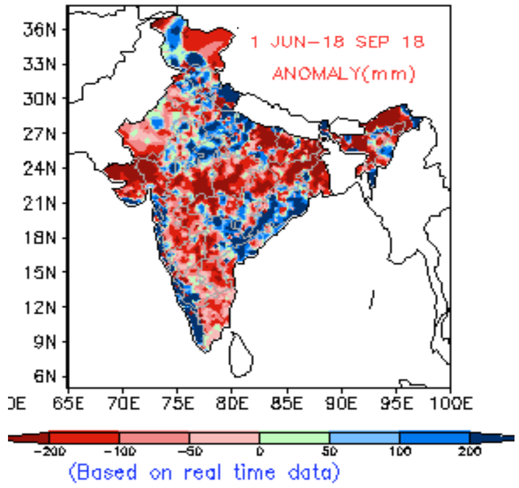
Forecast for JJAS generated in June,2018

Real time Anomaly for JJAS,2018

CDF

PDF





Remarks

- ELR based forecast show some good hope for making reliable probability forecast.

- The proposed calibration method also make a flexible forecast format (full distribution rather tercile) that allows users to glean information from those part of forecast distribution what matters most to them such as the probability of extremely dry/wet conditions.

- Room for Improvement: ELR based forecast is less sharp.

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Thanks!

nachiketa@iri.columbia.edu

web: iri.columbia.edu/cpt/

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