Improving short to medium range GEFS precipitation forecasts in India using post-processing techniques

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Abstract

This study aims to enhance the accuracy and reliability of the Global Ensemble Forecast System's (GEFS) precipitation forecasts over the Indian subcontinent using two post-processing techniques, namely the Analog method (AN) and Logistic Regression method (LR). The post-processing techniques and GEFS Numerical Weather Prediction Model (NWP) outputs were evaluated against the observed dataset using probabilistic and deterministic evaluation metrics. Results found that both the methods considerably improves short range to medium range (1-15 day) precipitation forecasts over India. Overall results showed that both the methods perform poorly during the monsoon seasons compared to other seasons. Basin analysis showed that both the methods underperform in the Western Ghats, while the performance is comparable and decent in other parts of India. Analysis of precipitation at different terciles showed that both the AN and LR methods underperforms at higher terciles compared to the lower ones. This is because the GEFS model itself was performing poorly in detecting the heavy precipitation events. The comparison of logistic regression and analog methods shows that the LR method outperforms the AN method in almost all the locations and lead times.

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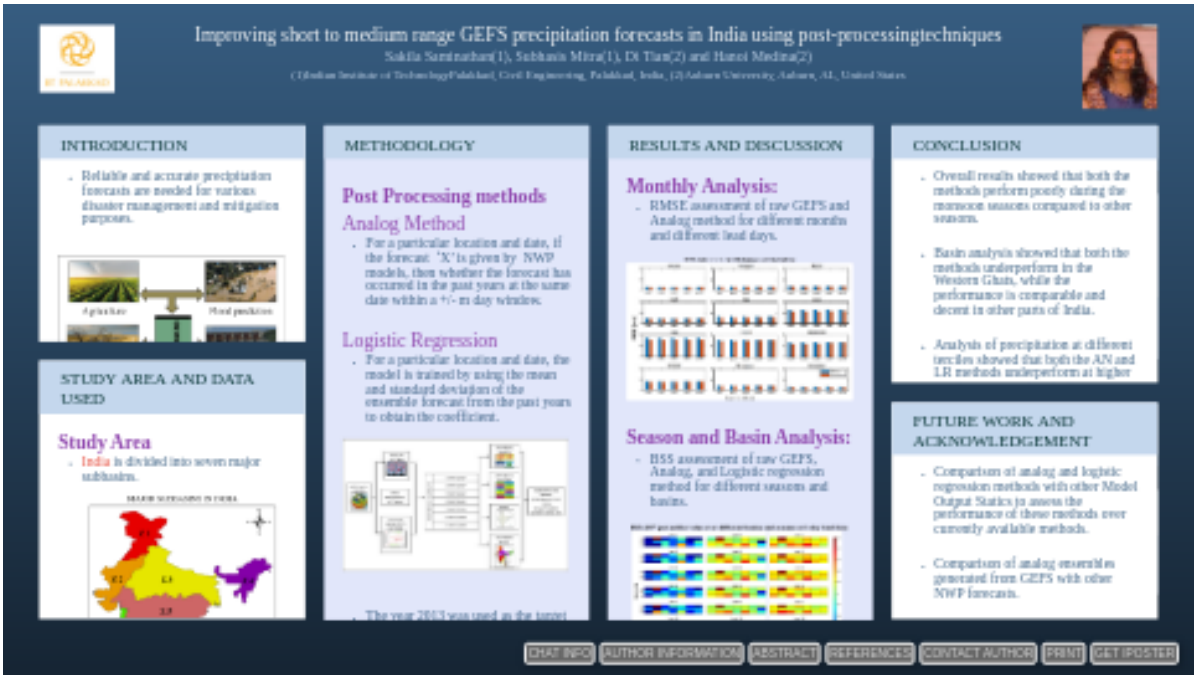

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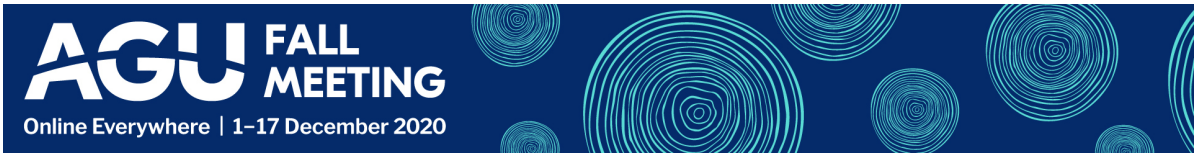
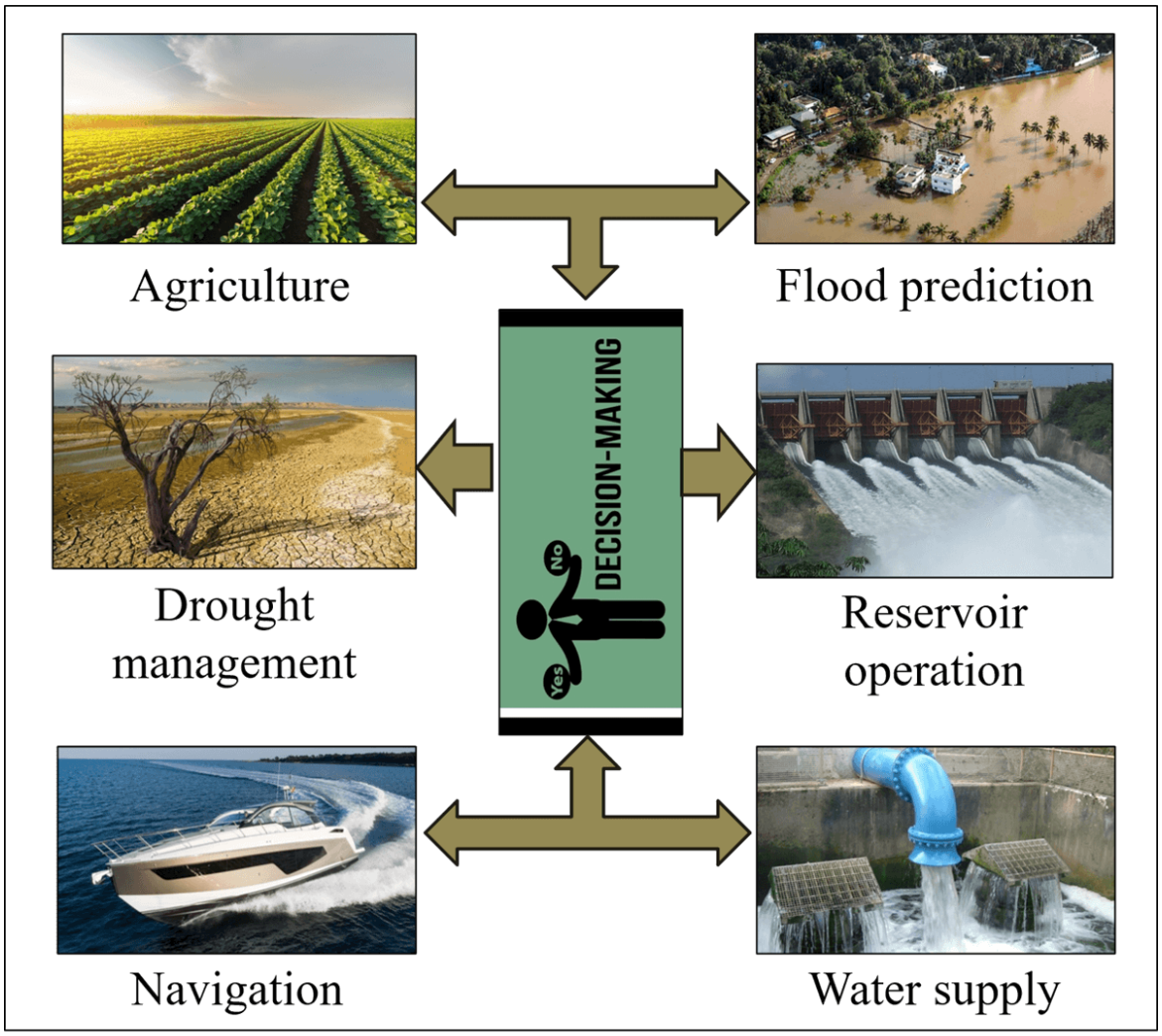


INTRODUCTION

- Reliable and accurate precipitation forecasts are needed for various disaster management and mitigation purposes.



- Precipitation forecasts from numerical weather prediction models (NWP) exhibit systematic biases and hence needs to be post-processed before being used for further applications.
- In this study, a simple analog method and logistic regression are implemented to post-process short to medium range precipitation forecasts from the Global Ensemble Forecast System (GEFS) forecasts for the entire Indian sub-continent.

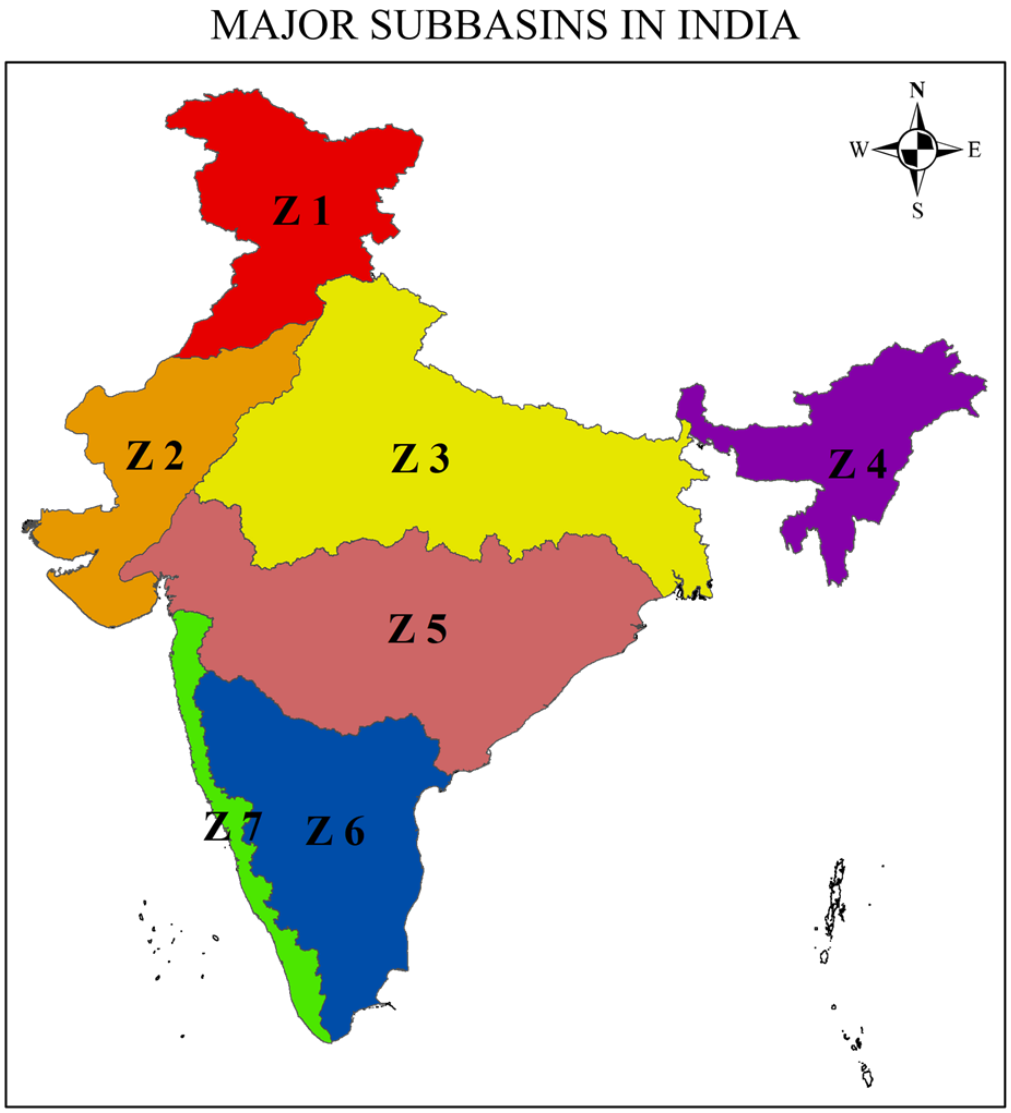
- The analog method (AN) uses the current forecast information and searches for closely related forecasts within a specified search window in the hindcast data to produce an ensemble of precipitation forecasts.

- Logistic regression (LR) is a postprocessing technique that yields a probabilistic forecast. The LR model is trained at a specific location and date using different predictors to obtain the predictand.

STUDY AREA AND DATA USED

Study Area

- India is divided into seven major subbasins.



- Northern basin: Z 1;

  Northwestern basin: Z 2;

  Indo Gangetic plain: Z 3;

  Northeastern basin: Z 4;

  Central basin: Z 5;

  Southern basin: Z 6;

  Western Ghats: Z 7;

- Season:

    1. Classification according to India Meteorological Department
    2. Winter, Summer, Monsoon, Postmonsoon

Data Used:

- Daily Precipitation data.
- Duration: 1985-2013.

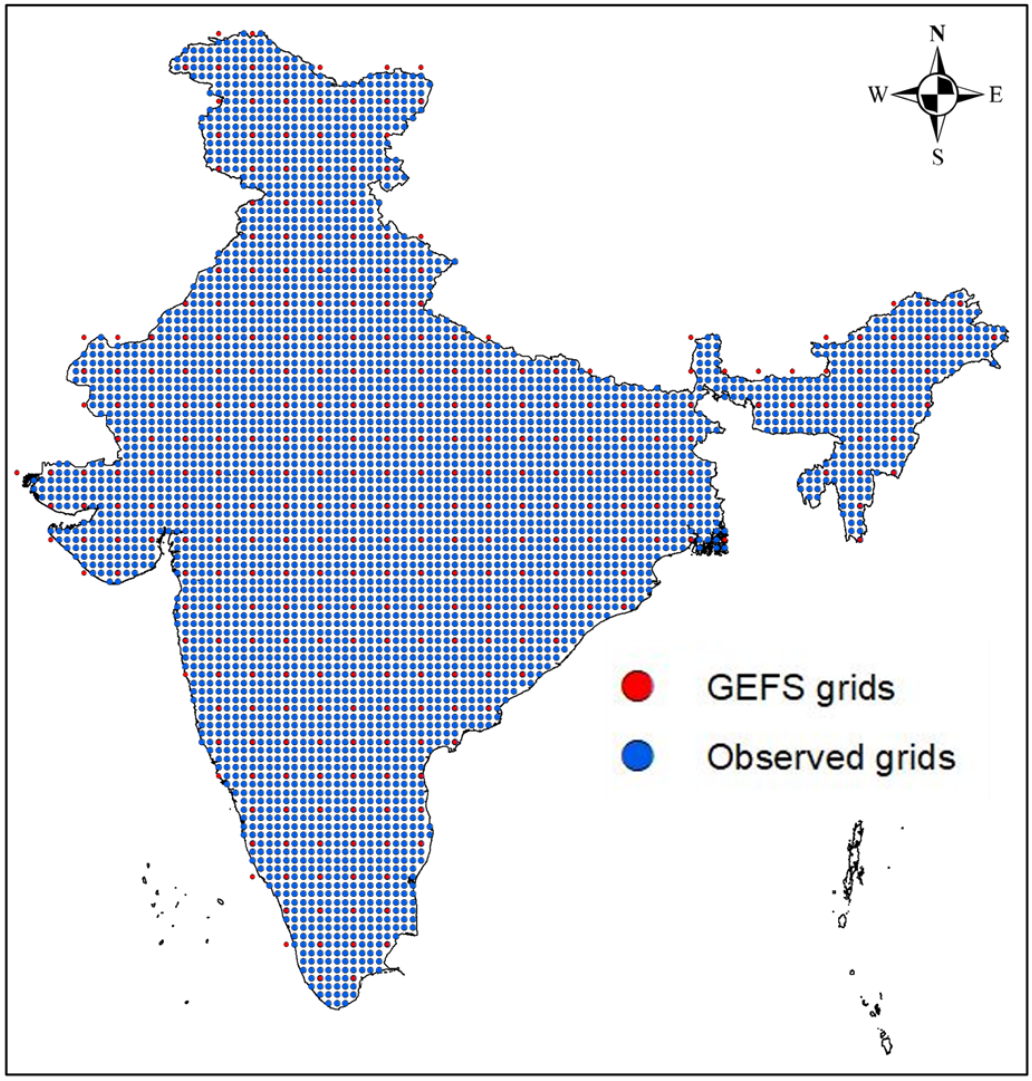
- Observed Data:

    1. India Meteorological Department [IMD]
    2. IMD data for validation.
    3. Spatial resolution: 0.25˚ X 0.25 ˚

- Forecast Data :

    1. Global Ensemble Forecast System [GEFS]
    2. Forecast lead time: 1 – 16 days.
    3. Ensemble members: 11 [1 control + 10 perturbed].
    4. Temporal resolution: 3 hours forecast data for 1st 3days and 6 hours for all 1-15 days.
    5. Spatial resolution: 1 ˚ X 1˚.

GEFS AND IMD OBSERVED GRID POINTS



METHODOLOGY

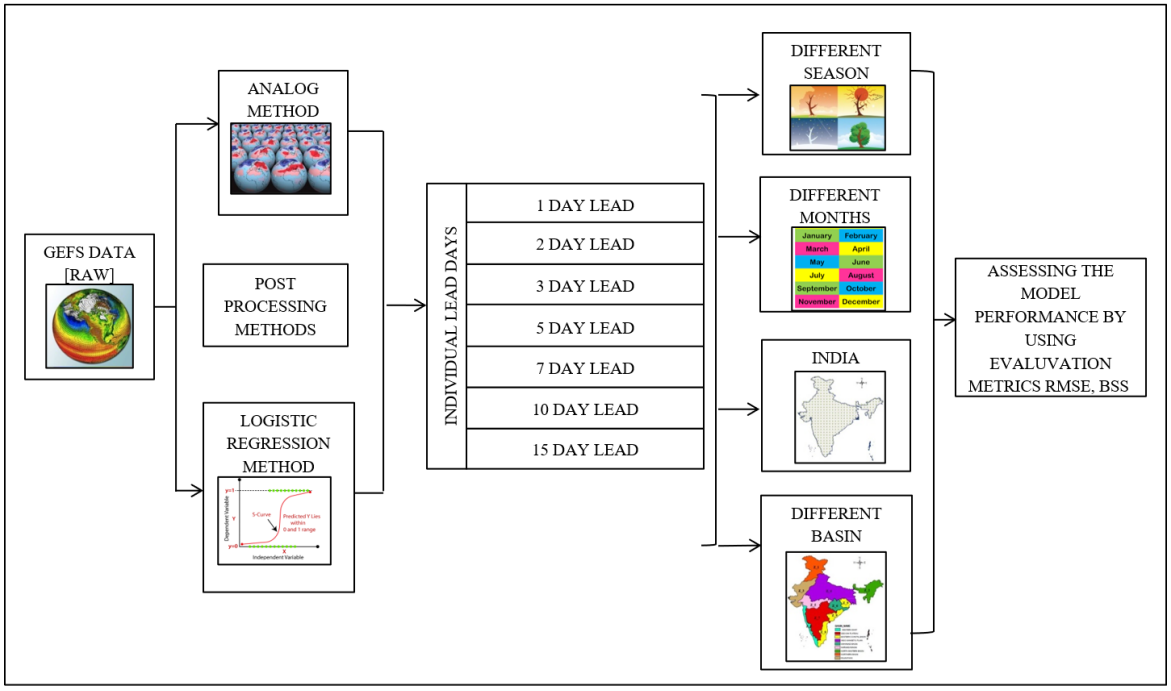
Post Processing methods

Analog Method

- For a particular location and date, if the forecast 'X' is given by NWP models, then whether the forecast has occurred in the past years at the same date within a +/- m day window.

Logistic Regression

- For a particular location and date, the model is trained by using the mean and standard deviation of the ensemble forecast from the past years to obtain the coefficient.



- The year 2013 was used as the target year to estimate the post-processed Precipitation forecast the GEFS forecast using the AN and LR method.

- For each day in the year 2013, logistic regression and analog ensemble forecasts were generated at 1, 2, 3, 5, 7, 10, 15 lead days.

- The analogs were estimated for 4964 grids points in the Indian region for the year 2013.

Evaluation Metrics:

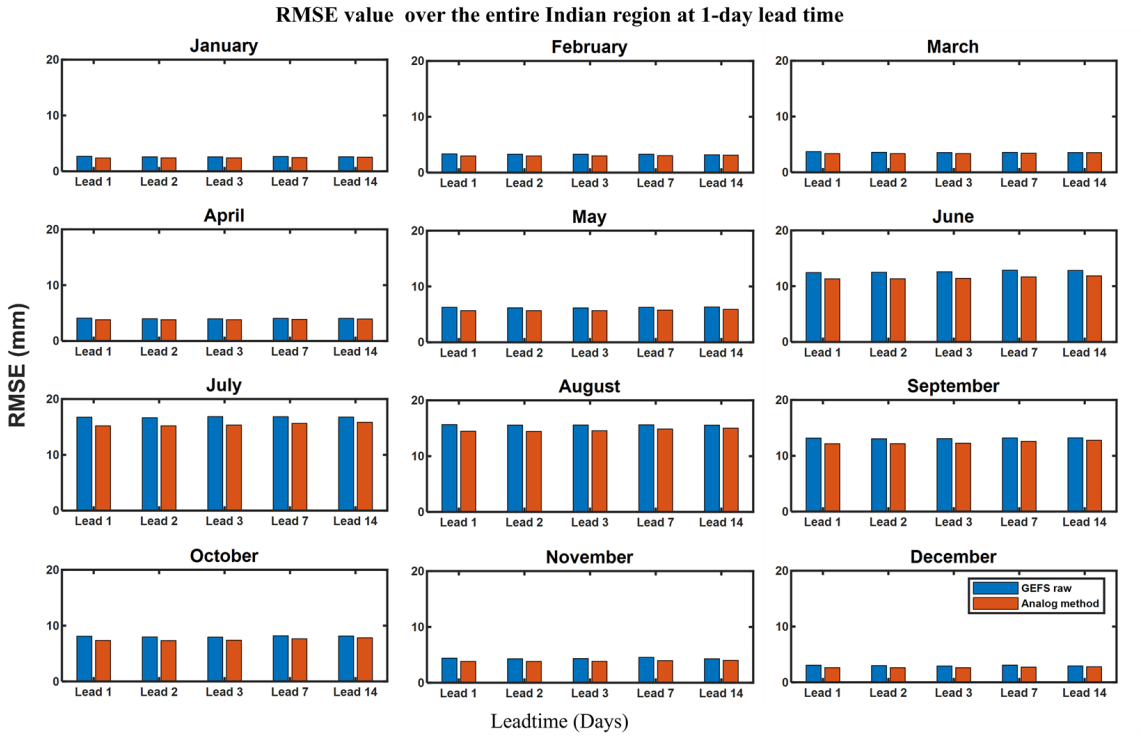
- Brier Skill Score $BSS = 1 - \frac{BS_{forecast}}{BS_{climatology}}$

- Root Mean Square Error $RMSE = \sqrt{\frac{\sum_{i=1}^{n} [F_i - O_i]^2}{n}}$

RESULTS AND DISCUSSION

Monthly Analysis:

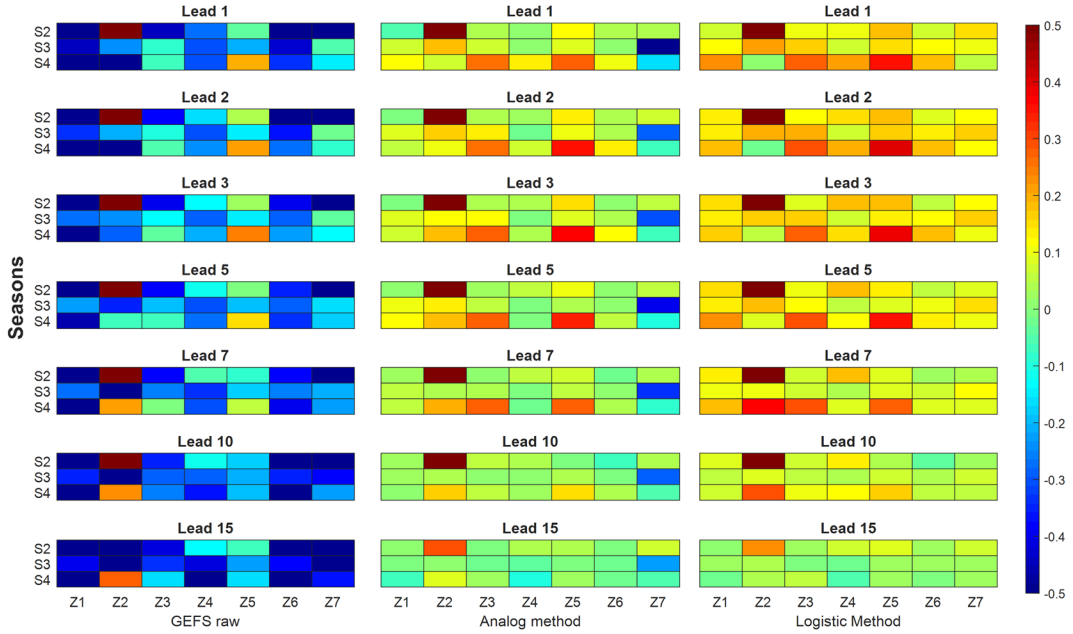
- RMSE assessment of raw GEFS and Analog method for different months and different lead days.



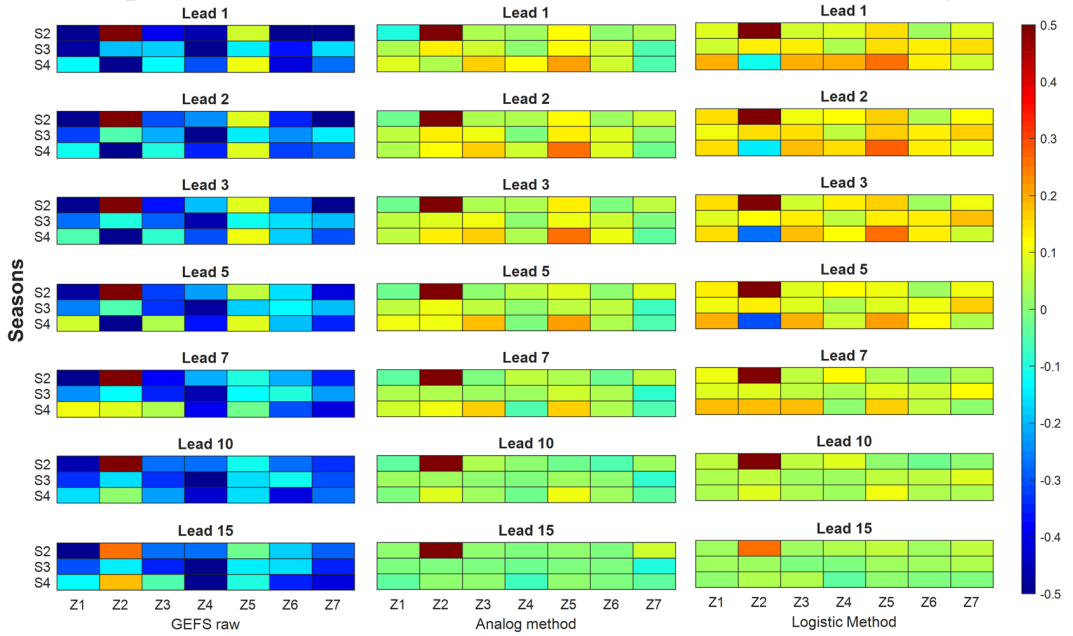
Season and Basin Analysis:

- BSS assessment of raw GEFS, Analog, and Logistic regression method for different seasons and basins.

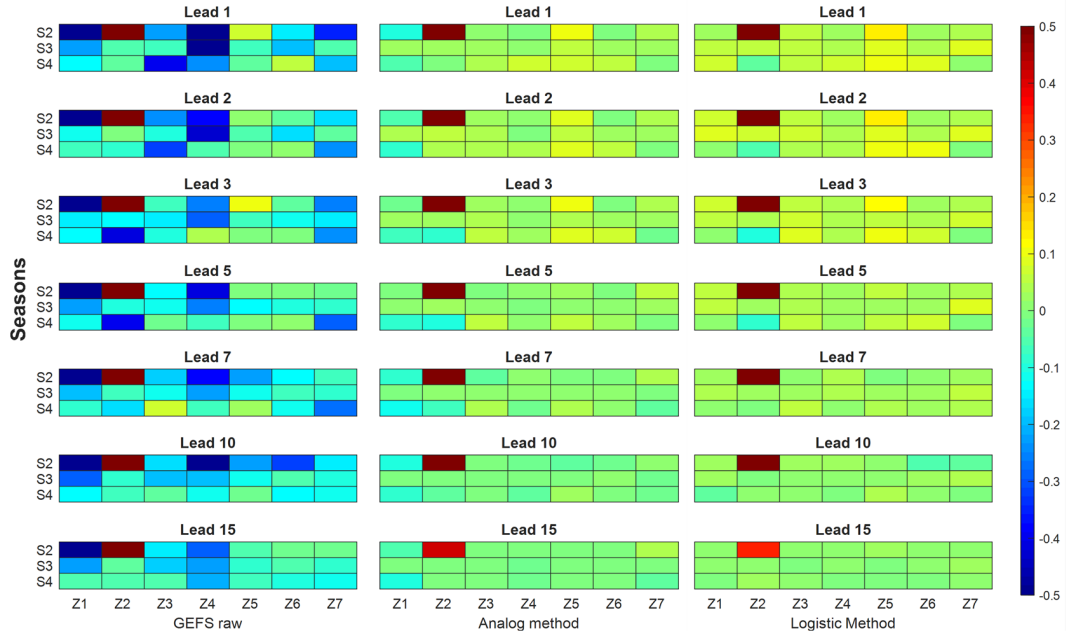
BSS (10th percentile) value over different basins and seasons at 1-day lead time



BSS (50th percentile) value over different basins and seasons at 1-day lead time

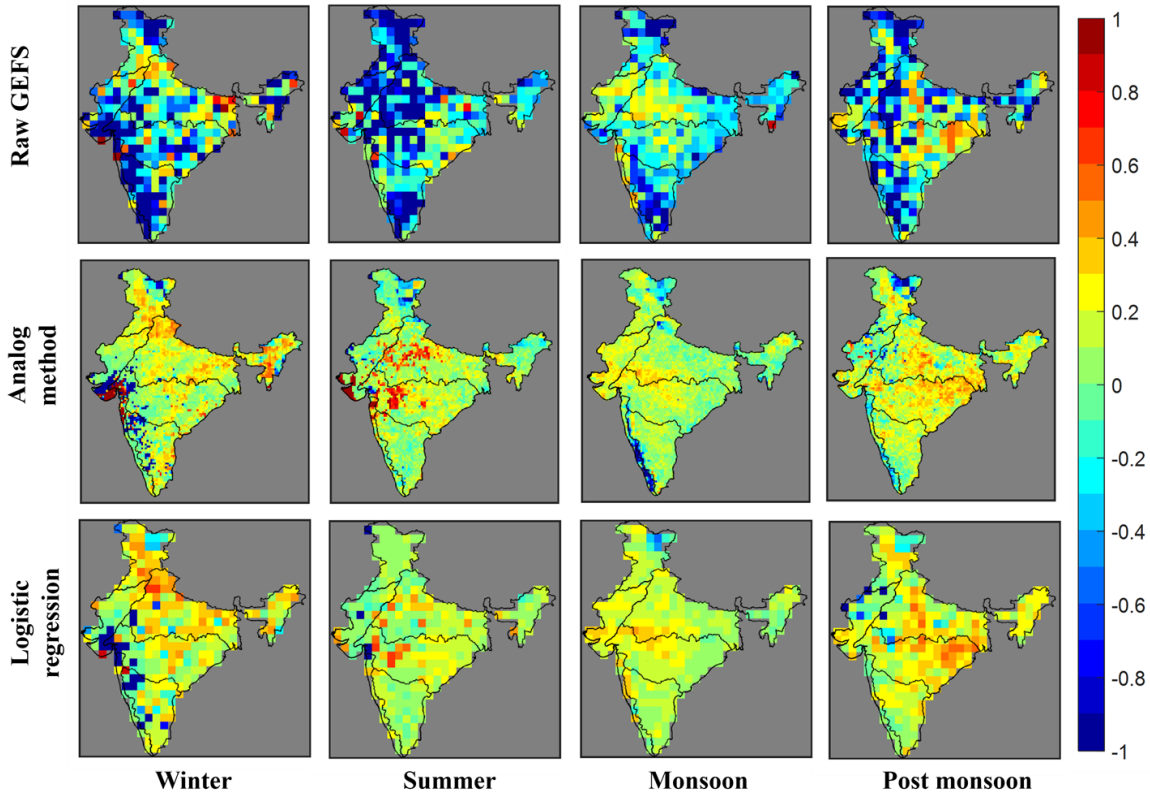


BSS (90th percentile) value over different basins and seasons at 1-day lead time



- BSS (1mm threshold) assessment of raw GEFS, Analog and Logistic regression method over the Indian region at 1-day lead time

BSS (1mm threshold) over the Indian region at 1-day lead time



CONCLUSION

- Overall results showed that both the methods perform poorly during the monsoon seasons compared to other seasons.

- Basin analysis showed that both the methods underperform in the Western Ghats, while the performance is comparable and decent in other parts of India.

- Analysis of precipitation at different terciles showed that both the AN and LR methods underperform at higher terciles compared to the lower ones.

- The comparison of logistic regression and analog methods shows that the LR method outperforms the AN method in almost all the locations and lead times.

FUTURE WORK AND ACKNOWLEDGEMENT

- Comparison of analog and logistic regression methods with other Model Output Statics to assess the performance of these methods over currently available methods.

- Comparison of analog ensembles generated from GEFS with other NWP forecasts.

- Forcing analog ensembles into a Hydrological model for forecasting of Streamflow.

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