EGU Poster Number HS2.3.4

Monitoring and forecasting of reservoir storage in India

Amar Deep Tiwari and Vimal Mishra
Indian Institute of Technology (IIT) Gandhinagar, India

1 Introduction

- Reservoirs work to reduce the effect of interannual and interseasonal streamflow fluctuations so that there is smooth functioning of water supply to control flood and drought and hydroelectric power generation also.
- Reservoir storage forecast information at a high temporal resolution is important to mitigate the effect of extreme events like floods and droughts.
- There is a lack of timely information of reservoir storage for decision making, which causes the economic losses due to flood and drought events.
- South Asia experiences one of the highest fatality rates in the world due to floods. Therefore a near real-time reservoir storage and forecast data for the proper monitoring of the reservoir storage is needed to avoid these extreme conditions and ensure effective water supply.
- 1-7 days lead streamflow forecast for reservoir storage will help water managers and decision makers.

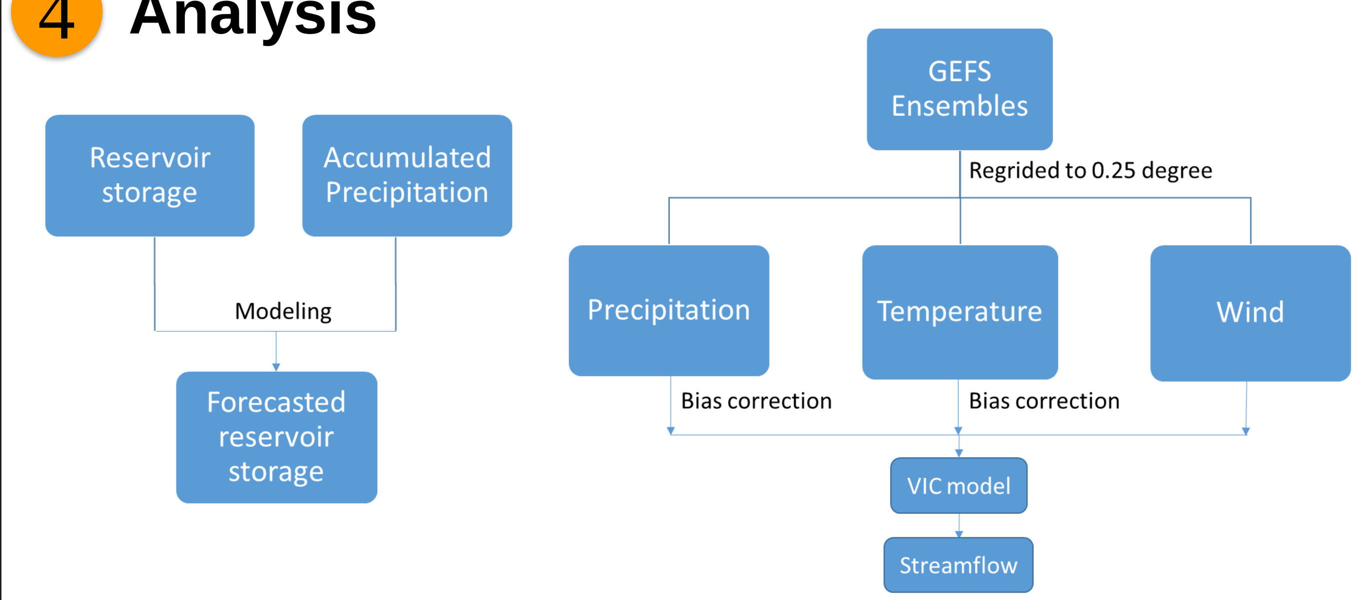
2 Objectives

- To predict the reservoir storage for 1-3 month lead time using precipitation data to monitor the reservoir operations smoothly.
- To forecast the streamflow to the reservoir for 1-7 days lead time using forecasted precipitation, temperature and wind data.

3 Data

Data	Sources	Spatio-temporal resolution	Availability
GEFS Precipitation	https://esrl.noaa.gov/psd/forecasts/reforecast2/	1 degree, sub-daily forecast	1985-present
GEFS Temperature	https://esrl.noaa.gov/psd/forecasts/reforecast2/	1 degree, sub-daily forecast	1985-present
GEFS Wind	https://esrl.noaa.gov/psd/forecasts/reforecast2/	1 degree, sub-daily forecast	1985-present
Gauge observations	http://india-wris.nrsc.gov.in/wris.html/	Daily	2002- present
CHIRPS-Precipitation	http://chg.geog.ucsb.edu/	0.05° and 0.25°, Daily and Pentad	1981-present

4 Analysis



- Compared reservoir storage with precipitation and forecasted the storage data for 1-3 months lead time using precipitation and reservoir storage data.
- Regrided 11 GEFS ensemble model data to 0.25 degree from 1 degree data and bias corrected precipitation and temperature GEFS data.
- Evaluated the forecast skill of GEFS data, before and after bias correction.

5 Results

RSI and SPI comparison

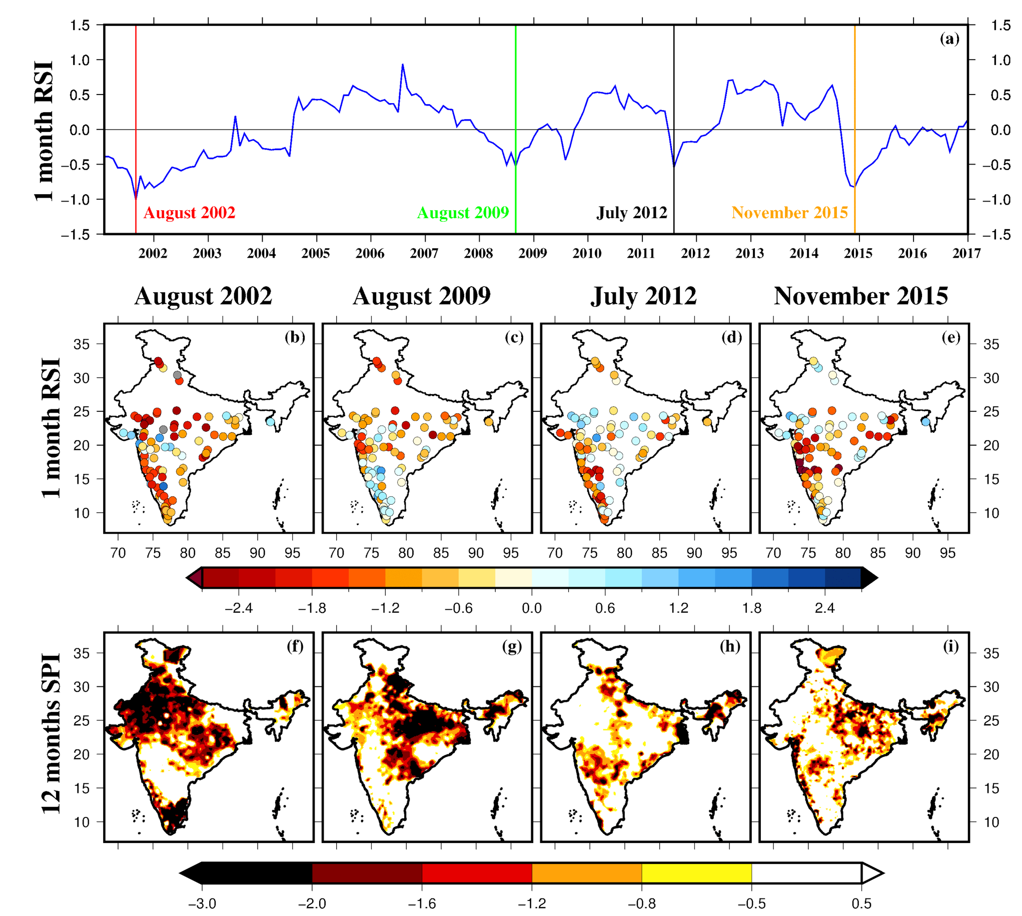


Figure 1. (a) 1-month Reservoir Storage Index (RSI) of all the reservoirs from the year 2002 to the year 2017. (b-e) 1-month RSI for August 2002, August 2009, July 2012, and (e) November 2015 for all the reservoirs. 12-month Standardized Precipitation Index (SPI) for (f) August 2002, (g) August 2009, (h) July 2012, and (i) November 2015.

Correlation of accumulated precipitation with observed storage

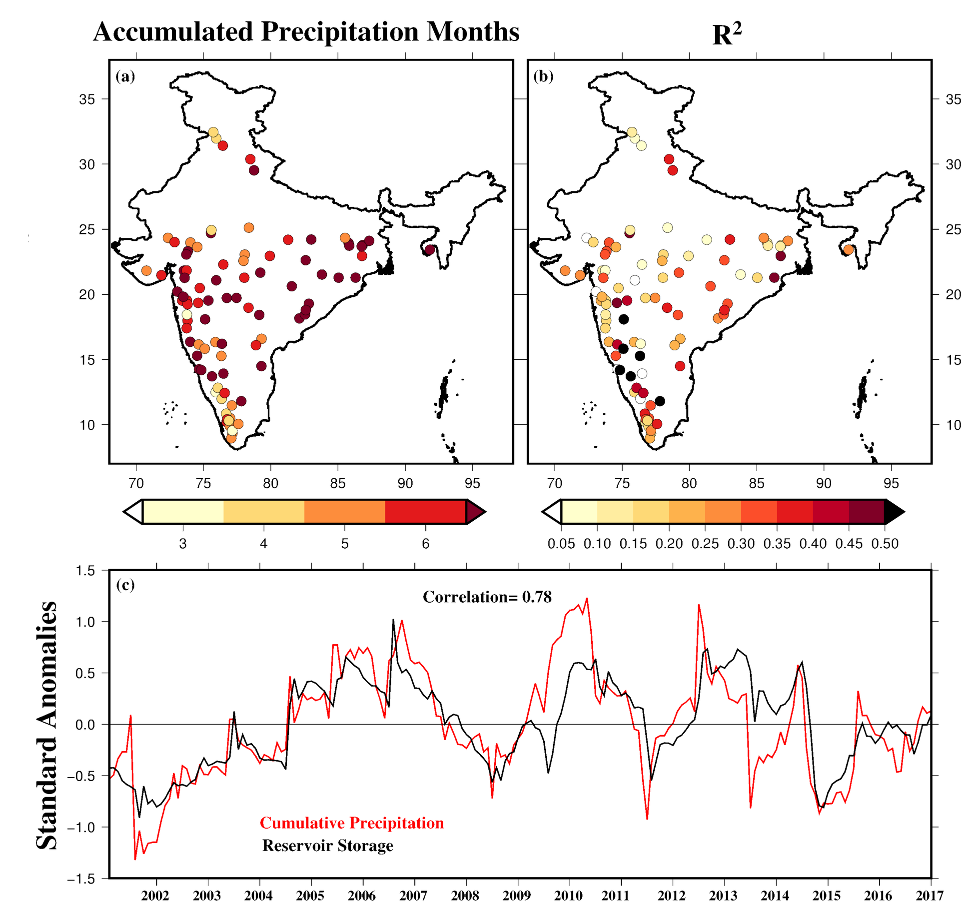


Figure 2. (a) Number of months of cumulative precipitation that showed the best correlation with the current month of the reservoir storage for each reservoir, (b) coefficient of determination (R^2) for accumulated precipitation anomaly and reservoir storage anomaly for each reservoir, and (c) Comparison between all-India averaged standard anomalies of cumulative precipitation and reservoir storage for the period of 2002 to 2017.

Forecast skill of reservoir storage

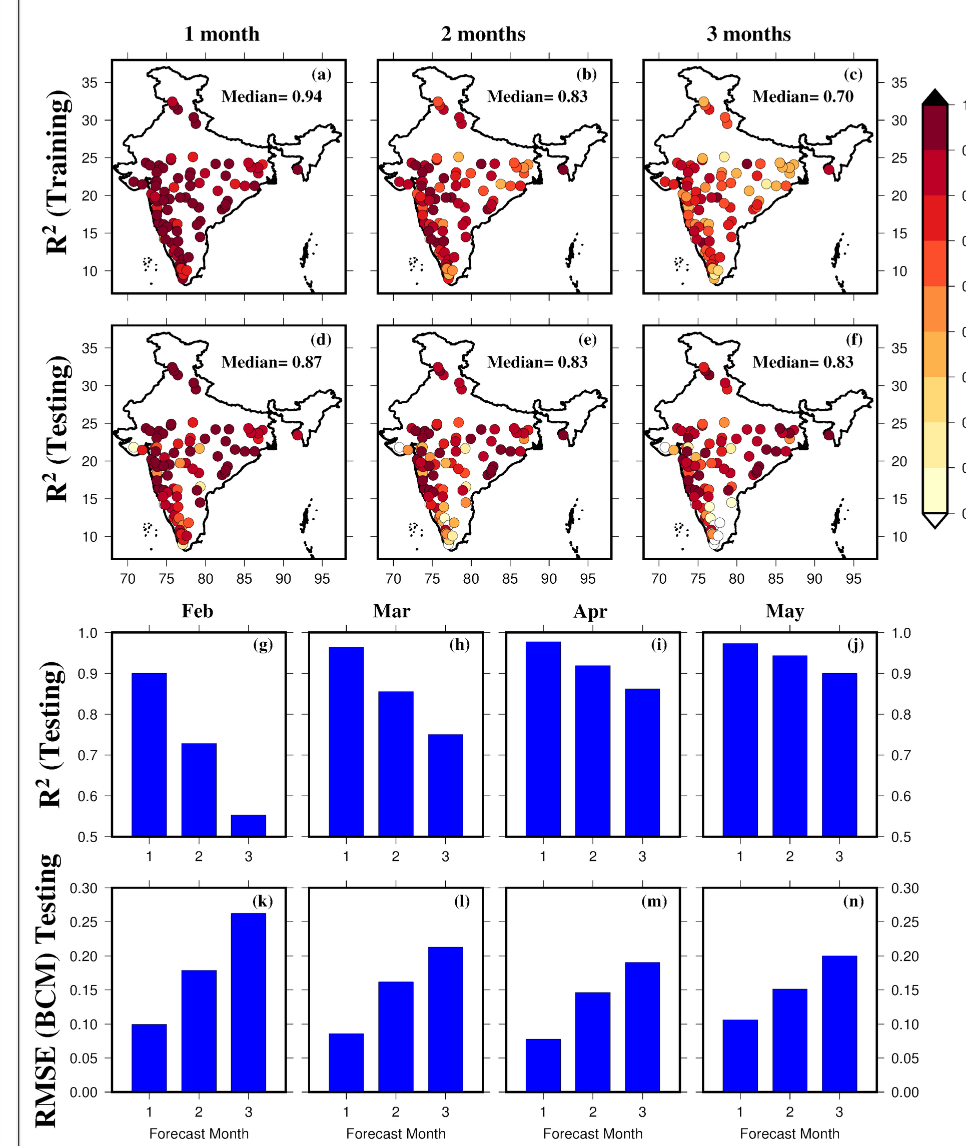


Figure 3. (a-c) Skill of forecast of the reservoir storage estimated using coefficient of determination for the training period (2002-2015) and for the (d-f) test period of 2016 for 1-3 months lead time, (g-j) R^2 for 1-3 month lead time, and (k-n) Root Mean Squared Error (RMSE) for the 1-3 month lead time for the months of February, March, April, and May for the year 2016 where R^2 and RMSE is calculated using anomaly of observed and forecasted reservoir storage for testing period.

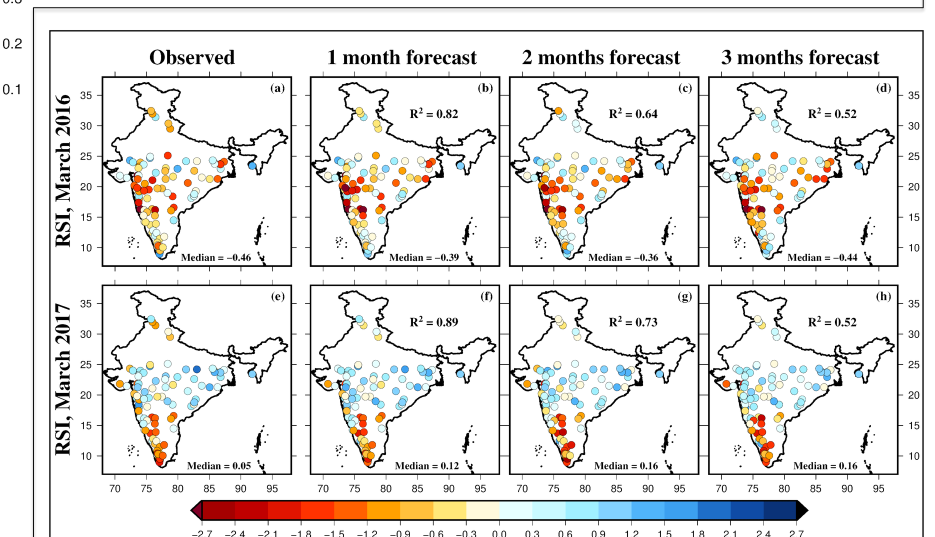


Figure 4. 1 month observed reservoir storage index for (a) March 2016 and (e) March 2017 for all reservoirs. Forecasted reservoir storage index for (b) 1 month forecast, (c) 2 months forecast, and (d) 3 months forecast for March 2016 and (f) 1 month forecast, (g) 2 months forecast, and (h) 3 months forecast for March 2017 for all reservoirs

Bias correction of precipitation forecast

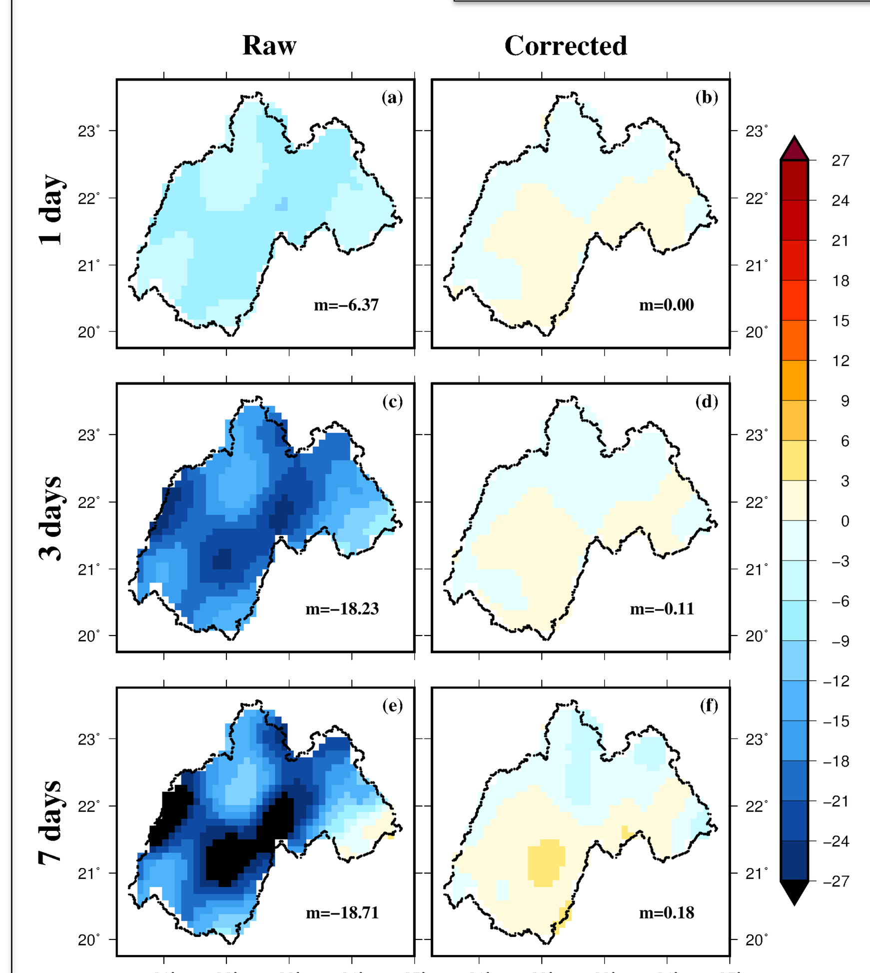


Figure 5. (a-b) Comparison of monsoon precipitation bias for before and after bias correction for 1 day forecast, (c-d) same as (a-b) but for 3 days cumulative forecast, (e-f) same as (a-b) but for 7 days cumulative forecast for the Hirakud basin

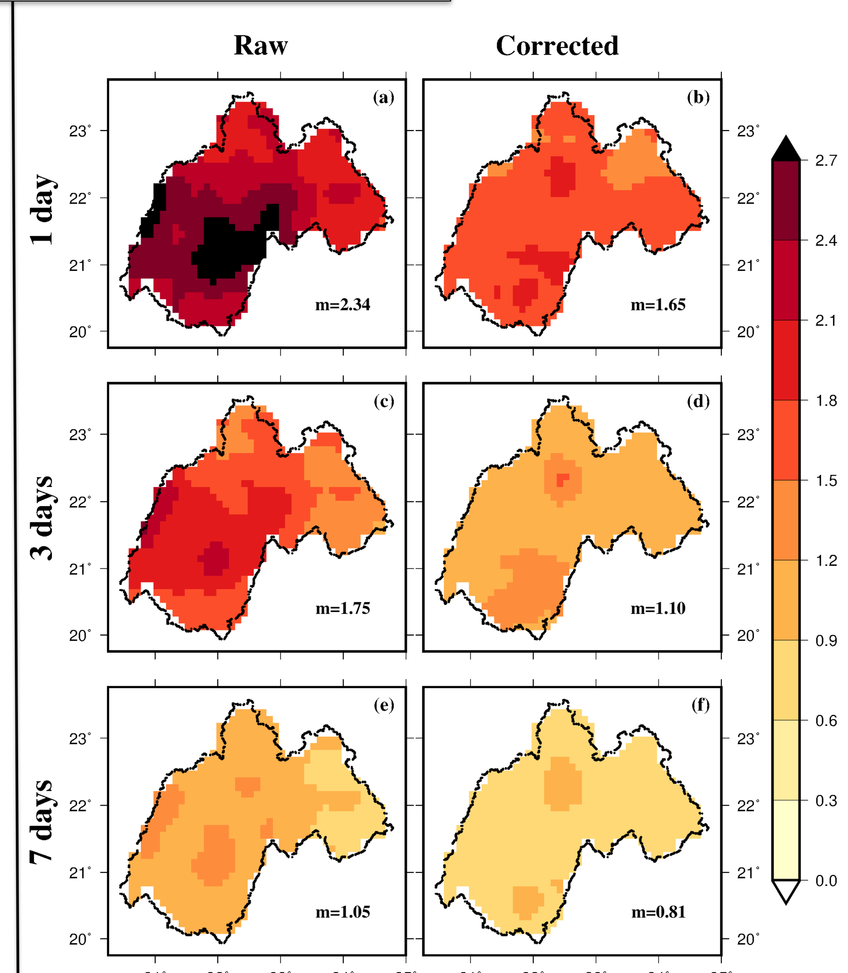


Figure 6. (a-b) Comparison of monsoon precipitation normalized root mean square error (nrmse) for before and after bias correction for 1 day forecast, (c-d) same as (a-b) but for 3 days cumulative forecast, (e-f) same as (a-b) but for 7 days cumulative forecast for the Hirakud basin

Bias correction of temperature forecast

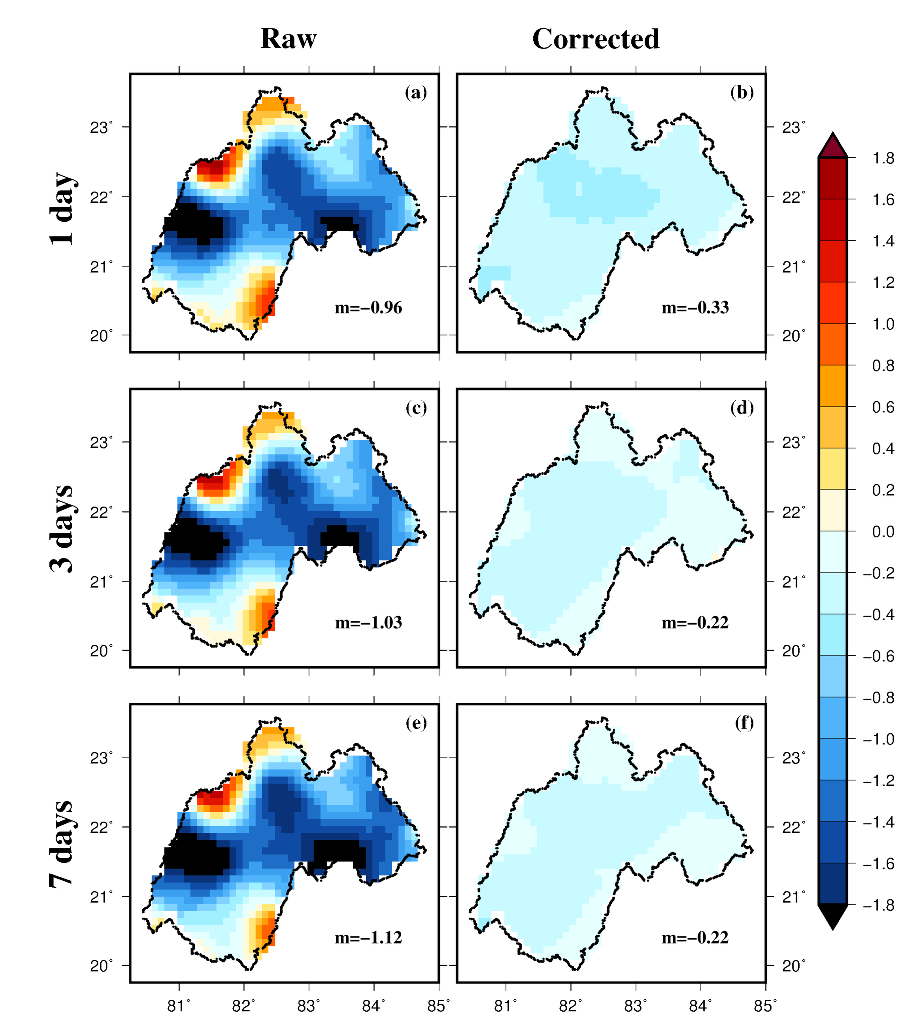


Figure 7. (a-b) Comparison of monsoon temperature bias for before and after bias correction for 1 day forecast, (c-d) same as (a-b) but for 3 days forecast, (e-f) same as (a-b) but for 7 days forecast for the Hirakud basin for the testing period only (2011-2017)

6 Conclusions

- Severe droughts that occurred in 2002, 2009, 2012, and 2015 substantially affected reservoir storage in the major reservoirs in India. Among all these four droughts, the reservoir storage was predominantly declined in 2015, which can be attributed to deficit in the monsoon season precipitation for the two (2014-15) consecutive years [*Mishra et al.*, 2016].
- Accumulated precipitation for 3-6 months is strongly linked with monthly reservoir storage for individual reservoirs (R^2 >0.6) and for all-India RSI (R^2 =0.79). Moreover, accumulated precipitation is strongly associated with the reservoir storage at 1-3 month lag. Accumulated precipitation and reservoir storage as predictive variables provide good forecast skills (R^2 >0.7) at 1-3 month lead for October-April period.
- 1-7 days forecasted streamflow to the reservoir will help for the smooth monitoring of the reservoir operations.

Acknowledgement

The first author appreciates financial assistance from the Indian Ministry of Human Resource Development (MHRD).

https://orcid.org/0000-0003-1649-8889

- Contact information: amar.tiwari@iitgn.ac.in, vmishra@iitgn.ac.in