

**Interactive comment on “Short-to-medium range hydrologic forecast to manage water and agricultural resources in India” by Reepal Shah et al.**

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The manuscript entitled “Short-to-medium range hydrologic forecast to manage water and agricultural resources in India” by R. Shah, A. K. Sahai, and V. Mishra evaluates precipitation and air temperature reforecasts/forecasts from CFSv2, GEFSv2 and IITM models over India for the period of 2001 to 2009. The evaluation is performed at lead times ranging from 7 to 45 days for the southwest monsoon season. The focus of this study is to assess the performance of operational numerical model forecasts for water resources and agricultural practices in India. The topic of research is of broader interest and vital in Indian perspective. The authors have also used bias correction method to precipitation and air temperature forecasts and integrated them in VIC model to assess total runoff and soil moisture. Before getting to my specific comments, I hope that my inputs are not taken as criticisms, but as constructive suggestions.

Thanks. We appreciate your constructive comments and suggestions.

Specific comments: 1. The improvement after bias-correction should be explicitly mentioned quantitatively in “Abstract” and “Conclusion” sections.

Thank you. We have added following text in the Abstract:

*“Bias corrected precipitation forecast showed an improvement of 2.1 mm (on all-India median MAE) while bias corrected temperature forecast was improved by 2.1°C for 45 days lead time” on page # 1 in lines#16-18.*

The following text has been added in the Conclusions:

*“Bias correction of precipitation and air temperatures resulted an improvement of about 2.1 mm and 2.1°C, respectively in all-India median mean absolute error. Total runoff and root-zone soil moisture forecasts obtained using the corrected IITM-ensemble showed higher skill as compared to the CFSv2 and raw IITM-ensemble for lead time up to 45 days. We found that all-India median CSI for runoff forecast was improved from 0.63 to 0.71 after bias correction while CSI of soil moisture forecast was improved from 0.6 to 0.67 for 45 days lead time” on page# 13 in lines #24-27.*

2. Please mention the spatial resolutions of the IITM forecast products as well.

We have included “Forecast ensemble members from IITM are available at 1° resolution” on page# 4 in line # 11

3. The spatial resolution of IMD gridded air temperature is 0.5° and also all the model products are available at coarser spatial resolution. But, the assessment is performed at finer spatial resolution of 0.25°. It is suggested to discuss about the propagation of errors due to resampling from coarser to finer spatial resolution with at least one example.

Thanks. we added the following text (page #4, Lines #29-30):

*“We, however, carefully evaluated all the products at their original spatial resolution and at  $0.25^\circ$  to make sure that datasets are consistent at both resolutions for spatial and temporal variability. We considered a common period of 2001-2009 for comparison and evaluation of different forecast products against the observed gridded data from IMD. Moreover, the influence of regridding was evaluated by comparing area averaged bias in the products at coarser and higher spatial resolutions after regridding. We found that the bias in the forecast products at coarser and higher resolution was consistent.”*

4. The use of mean absolute error (MAE) alone for error quantification might be misleading eventually (Ref: Chai and Draxler, 2014, Geosci. Model Dev., 7, 1247-1250). The use of any normalized error metric would be more appropriate to better understand the error characteristics.

We compared Normalized RMSE and MAE for lead-7 & 15 days to find errors in different products as shown in figure below. Spatial patterns and overall results obtained from both the matrices were similar. Therefore, we kept MAE in the revised manuscript for further discussion.

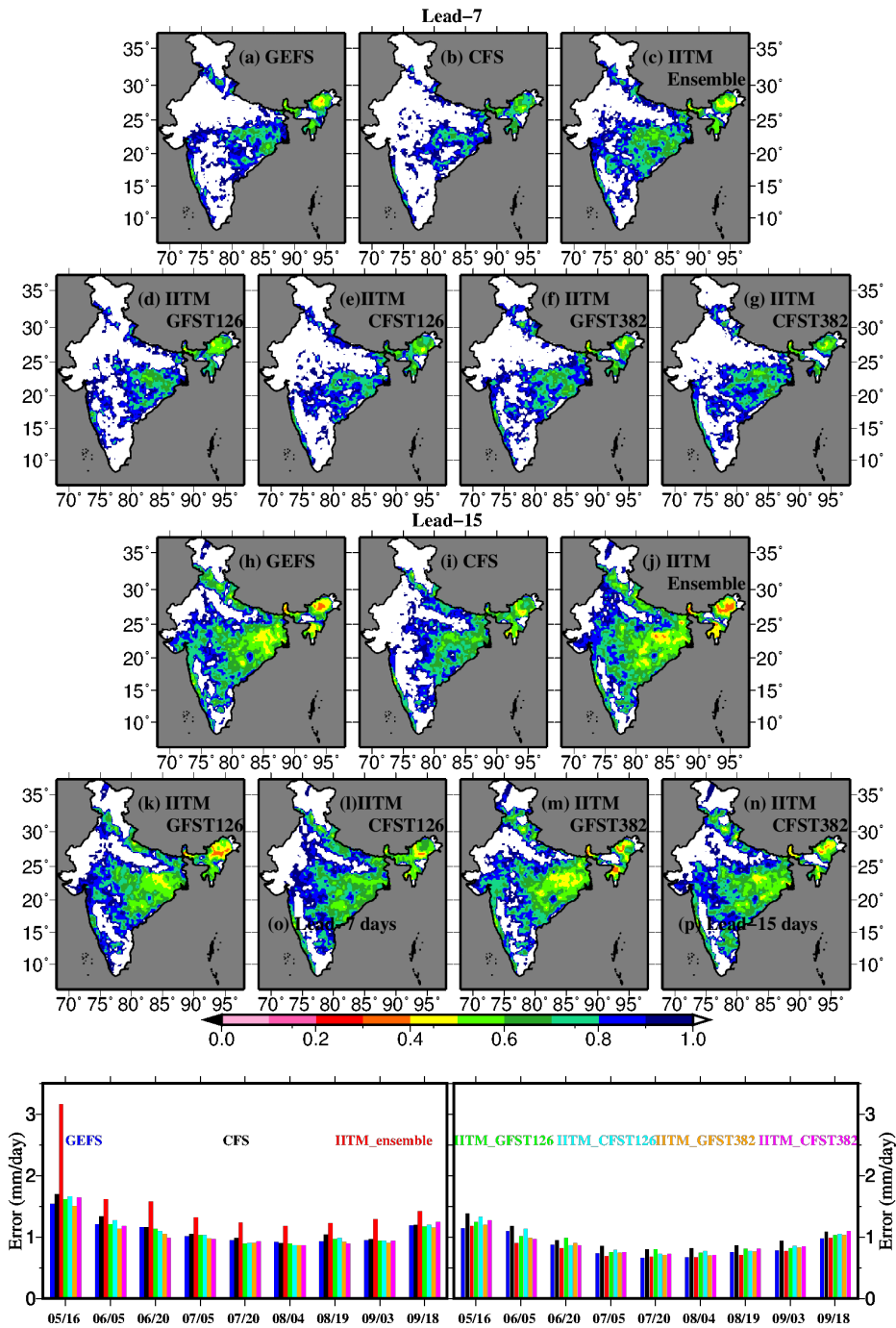


Figure 1: Normalized RMSE in precipitation forecast as compared to observed (OBS) precipitation. (a) Error in precipitation forecast accumulated up to 7-days from GEFSv2 as compared to OBS, (b) same as (a) but with CFSv2 (c) same as (a) but with IITM (multimodel, multiresolution) ensemble (d) same as (a) but with IITM GFST126, (e) same as (a) but with IITM CFST126, (f) same as (a) but with IITM CFST382, (g) same as (a) but with IITM GFST382. (h-n) same as (a-g) but for lead 15 days. (o) area-weighted error in different forecast accumulated up to 7-days as compared to OBS for forecast initiated on different monsoon season dates (p) same as (o) but for lead 15 days. (Period: 2001-2009).

5. Again, CSI is not an equitable categorical metric to evaluate the performance of any numerical model. It is surprising why authors selected CSI alone for this study, even though several better skill metrics are now well-documented.

Thanks. We used Equitable Threat score (ETS) as given below where  $a_r$  represents number of forecast events captured by chance.

$$ETS = (hit - a_r) / (hit + miss + false - a_r)$$

Where  $a_r = (hit + miss) * (hit + false) / n$ ,  $n$  is sample size.

ETS estimated for CFSv2, IITM ensemble, and bias-corrected IITM ensemble mean's performance in capturing dry anomalies is shown in Figure below.

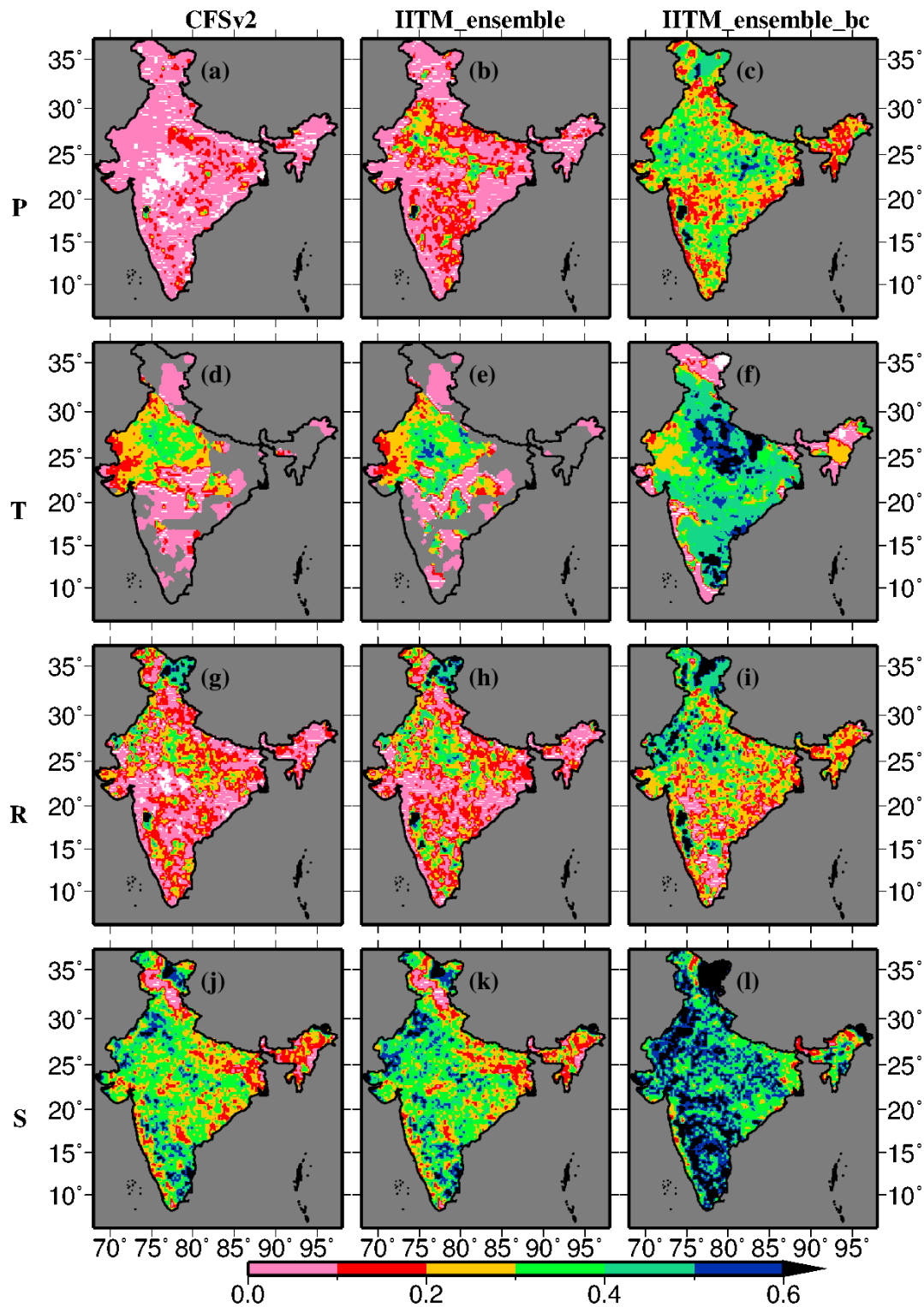


Figure 2 Equitable Threat Score (ETS, averaged for forecast dates) of predicting precipitation (a-c), temperature (d-f), runoff (g-i), and soil moisture (j-l) anomalies with respect to the observed anomalies for CFSv2, IITM-ensemble, and bias corrected IITM-ensemble (IITM-ensemble\_bc).

The spatial pattern shown by ETS is similar to that of CSI (Figure 4). This supports our finding that bias-corrected IITM ensemble performs better in capturing dry anomalies. Hence, we used CSI for our analysis.

6. It is suggested to discuss about the impact of sample size at significance of the evaluation in the “Conclusion” section.

We have discussed the influence of sample size in the revised manuscript and added the following text:

*“One of the limitations of evaluation of the products in this study is small sample size. The evaluation of all the forecast products was based on 10 common years and 9 forecast dates during the monsoon season. Increasing the sample size in future based on the availability of forecasts for longer period may further improve evaluation and the bias correction.”* on page#13 lines# 9-12

7. The authors have appreciably used VIC model here to assess one of the droughts in India. Better prediction of floods is also equally important during the monsoon in India. It would be great if authors demonstrate the same for one flood case too.

The focus of the present study was to evaluate hydrologic prediction for drought assessment (page #2, line#20), which has been mentioned in the last paragraph of Introduction. Assessment of floods is an important topic, which requires significant work related to observed data collection and development of robust routing models. Therefore, that will be considered in a separate manuscript.

8. A careful language check is recommended. For instance, first sentence of page 2 needs to be re-written. Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-504, 2016

The manuscript has been carefully checked for possible errors related to grammar.