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Application of bias correction to NCMRWF models for improved MAM heatwave forecast

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Introduction

In spite of many significant improvements in NWP models including major improvements in the model physics and resolution, these models still suffer from systematic biases. There are several methods available to remove these systematic errors from a model, for example by applying statistical post processing algorithms. In the current study we have made an attempt to correct the bias in the maximum temperature (*Tmax) forecasts obtained from the NCMRWF's Ensemble Prediction System (NEPS).*

Bias Estimation and Correction of Probabilistic forecasts

Bias Estimation and Correction of NEPS's probabilistic *Tmax* forecasts–

- Used Decaying Average Bias Correction (BCDA) method for the current study.
- BCDA is a statistical post-processing method applies an adaptive [Kalman filter type (KF)] algorithm to accumulate the decaying averaging bias.
- Initially BCDA applied to the ensemble mean (1st Moment) *Tmax* for all lead time, and this does not lead any bias-correction in the spread of the EPS.
- The method of Variation Inflation is used to correct the spread (2nd moment) of NEPS.

The BCDA significantly improves the probabilistic Tmax forecasts in the application of heat wave forecasting.

Verification of Tmax raw, 1st Moment and 2nd Moment

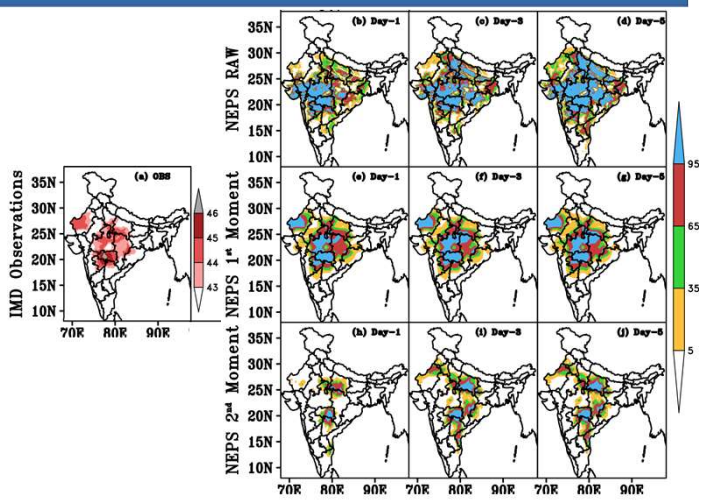

Figure 1. The probabilistic verification of NEPS Tmax with (a) IMD observations Tmax 43°C, upper-panel day1, day3 and day5 lead time (b, c & d) are from model raw forecast and middle panel (e, f & g) are the 1st Moment and the lower panel (h,I,&j) are the 2nd Moment bias corrected forecast valid for 30 May 2019.

It is seen that high Tmax (≥ 43°C) observed in Rajasthan, most of the central India Uttar Pradesh, Madhya Pradesh, Jharkhand, and Maharashtra regions. For the raw forecast it is seen that there is a large area which shows a more than 95% probabilities having Tmax ≥ 43°C. This implies that in the raw forecast, false alarms are seen over most parts of the Gujarat, Haryana, Uttar Pradesh, Bihar west Bengal and Odisha. After bias correction (1st Moment) false alarms removed form the Gujarat, Haryana, Uttar Pradesh west Bengal, Odisha and Bihar and the high probabilities (95%) are confined to the Rajasthan and most of central India for all lead times.

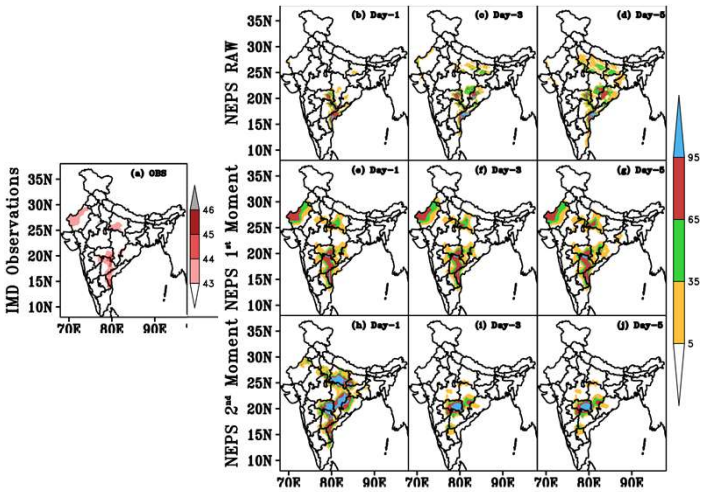

Figure 2. The probabilistic verification of NEPS with (a) IMD observations Tmax 46°C, upper-panel day1, day3 and day5 lead time (b, c & d) are from model raw forecast and lower panel (e, f & g) are bias corrected forecast valid for 06 May 2019.

It can be seen from the figure there are three main areas which shows high temperatures over, northwest Rajasthan, southwest Uttar Pradesh and Vidarbha region of Maharashtra, Telangana and Andhra Pradesh. In the raw forecast these regions were missed by the model except Telangana regions. After bias correction (1st Moment), al the three regions were predicted with high probabilities varying from 65-69%.

Verification scores for Tmax (raw and bias corrected)

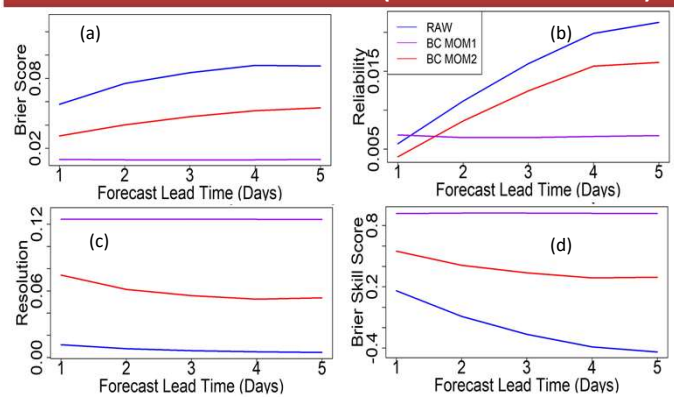

Fig. 3 (a) Brier Score (b) Reliability (c) Resolution and (d) Brier Skill score for MAM 2019.

For a perfect forecast Brier Score (BS) should be '0' i.e., a smaller BS indicates a better forecast. The reliability is lower in the case of both bias corrected forecasts as compared to the raw forecast indicating an improved reliability (forecasting capability) after bias correction. It is seen that the resolution values of the raw forecast are much lower than the both the bias corrected forecasts. This shows that the bias correction leads to better resolution indicating an improved ability to discriminate. It is seen from the figure that the BSS for the raw forecast is negative after Day-3 which indicates a poor ability of the model in forecasting Tmax above 40°C. For the 1st Moment forecasts, with just the correction in the mean, it is seen that the BSS values are very close to 1 (perfect BSS) which indicates a very good skill in forecasting the event.

Conclusions

The bias correction was useful in removing these false alarms in the forecasts to a large extent. The reduction in the false alarms is higher for correction of mean but however correcting the spread, forecasts show slightly higher false alarms and lower hits rates. These false alarms are still lower than the raw forecasts. BSS shows higher values after bias correction hence proving that bias correction has improved the skill of the forecast. Similarly reliability as component of BS shows lower values and resolution shows higher values after bias correction.