Ministry of Earth Sciences पृथ्वी विज्ञान मंत्रालय
Earth System Science Organisation पृथ्वी विज्ञान प्रणाली संगठन
National Centre for Medium Range Weather Forecasting
राष्ट्रीय मध्यम अवधि मौसम पूर्वानुमान केंद्र

Evaluation of regional ensemble model bias and spread

Ashu Mamgain and Abhijit Sarkar
Email:ashu.mamgain@gov.in

Introduction

A Short-range (0-75h) ensemble prediction system (EPS) running operationally in the NCMRWF, India at convective scale (~4km) with 11 perturbed ensemble members (Prasad et al., 2019; Bowler et al., 2008). It is evaluated with respect to the global model also running operationally at 12 km resolution (Mamgain et al. 2020). We have considered Day 1 to Day 3 Forecast with 11 perturbed members at 00 UTC from both the models. Standard verification matrices have been used to assess the EPSs performance.

- **Study Period**: August and September 2019 (Monsoon months)
- **Domain:** 62° E-106° E; 6° S 41° N (Centering over India)

Main characteristics of the NEPS-R and NEPS-G

	NEPS-R (Regional EPS)	NEPS-G (Global EPS)
Resolution	4km	12km
Ensemble Size	11 members+1control	11 members+1control
Vertical levels	80 (Top:38.5km)	70 (Top: 80 km)
Grid points	1200x1200	2048x1536
Domain	62° E-106° E; 6° S 41° N	Global
Forecast length	75hrs	10 days
Model time step	2 minutes	5 minutes
Long forecast /day	1(00 UTC)	2 (00 and 12 UTC)

Results

RMSE and ensemble spread

Zonal wind 850 (m/s) or U850

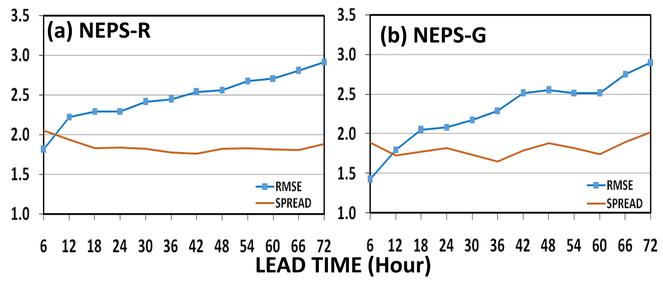

Fig.1 NEPS-R spread in U850 is slightly higher than that in NEPS-G during starting hours only and after that it is nearly constant. U850 ensemble spread of NEPS-G is varying between 1.6 and 2 (m/s) and not increasing with forecast lead time.

Precipitation (mm/day)

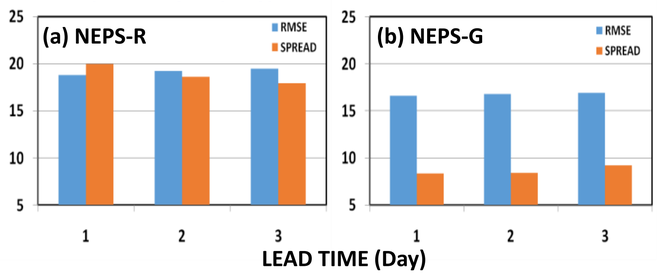

Fig.2 RMSE and spread in precipitation are much closer to each other in NEPS-R as compared to NEPS-G. RMSE is slightly better in case of NEPS-G. A larger spread is noticed in NEPS-R. Whereas in NEPS-G, precipitation values are more under-dispersed.

Verification skill scores

Zonal wind 850 (m/s) or U850 > 1Standerd Deviation from the sample climatology

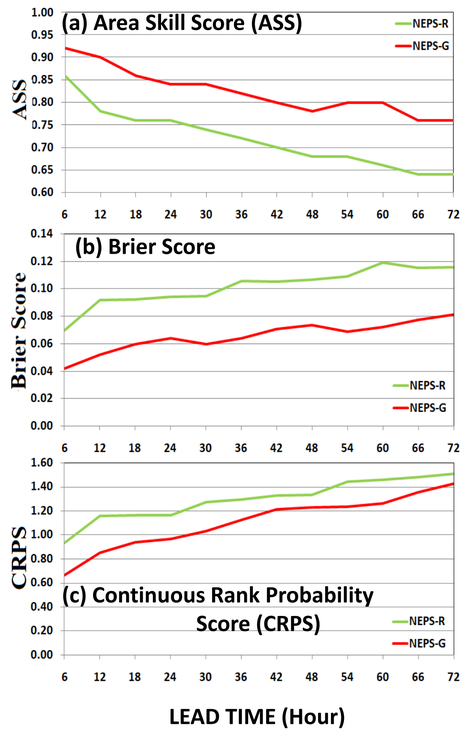

Fig. 3. Discrimination property (ASS) of the both the models have skill above 0.6 till 72 hours of the forecast. Overall, the NEPS-G in case of U850 has shown better skill score as compared to the NEPS-R

Precipitation (mm/day)

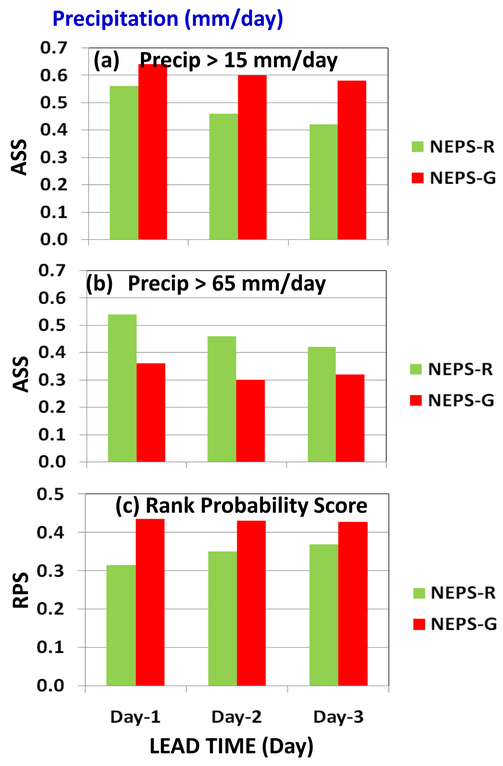

Fig. 4 NEPS-G which performs better for light and moderate rainfall intensity events is not better than NEPS-R for heavy rainfall cases. RPS indicates that overall performance of NEPS-R in simulation of rainfall is better than NEPS-G at all forecast lead times

Rank Histograms

Zonal wind 850 (m/s) or U850

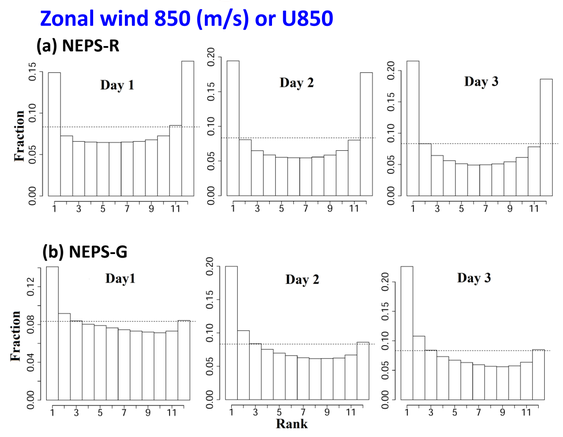

Fig. 5. Both the EPSs are under-dispersive or over-confident forecasting systems in all forecast lead days. NEPS-G larger populations at the lower ranks means forecast have wet bias or over forecasting. NEPS-R shows that the ensemble has little spread.

Precipitation (mm/day)

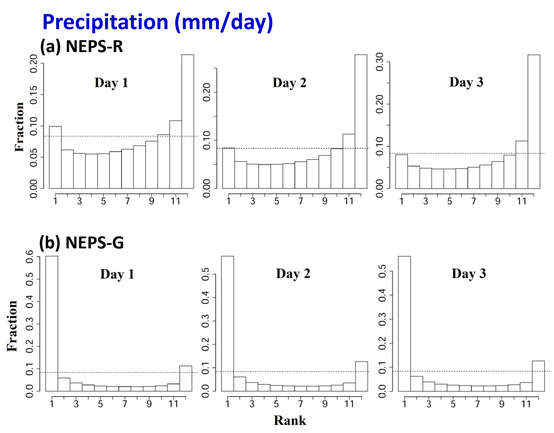

Fig. 6. NEPS-R shows dry bias while NEPS-G exhibits tendency of over-estimating precipitation. The positive bias in NEPS-G may be overestimation of light precipitation due to parameterized convection. NEPS-R underestimates statistics of light rainfall events.

Extremely Severe Tropical Cyclonic Storm FANI

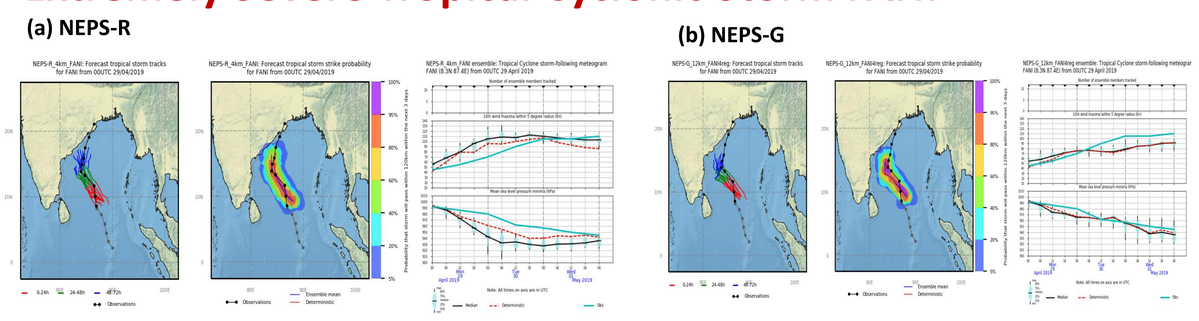

Fig. 7. FANI intensified into an extremely severe cyclonic storm and reached its peak intensity on 2 May. The rapid intensification in wind speed has been nicely captured by NEPS-R as compared to NEPS-G as shown in storm following meteograms.

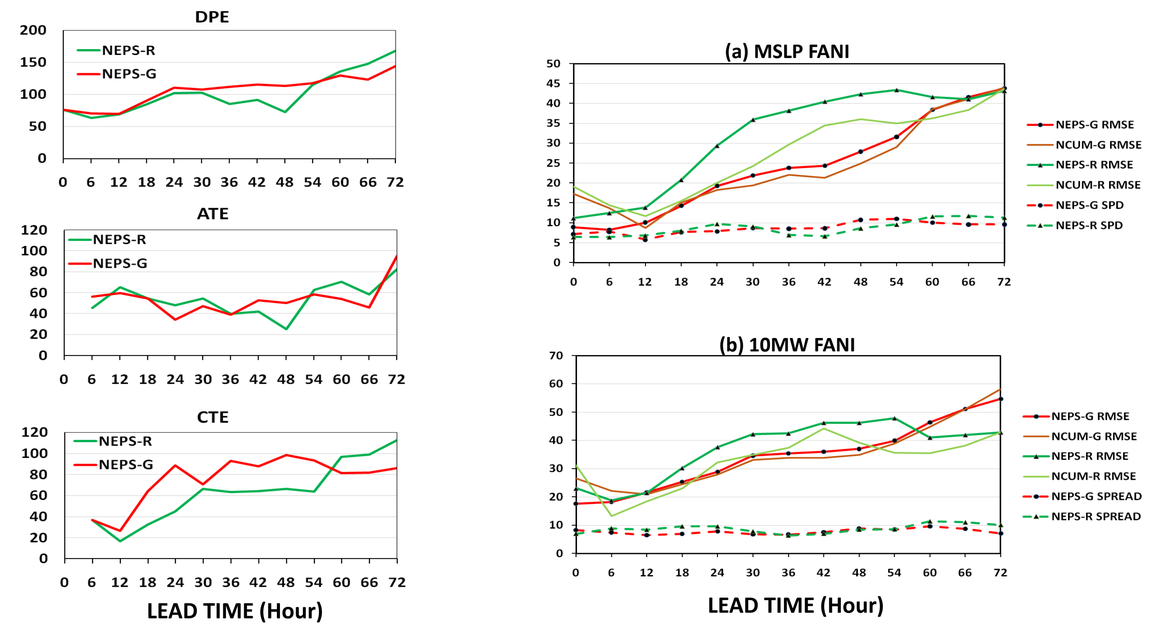

Fig. 8. Variation of (a) DPE, (b) ATE and (c) CTE of NEPS-G and NEPS-R forecast track errors with time for Fani averaged over 29th April to 2nd May 2019. DPE and CTE are less in NEPS-R till 54 hours of forecast

Fig. 9. RMSE and Spread in (a) MSLP, and (b) 10m wind speed indicates that RMSE of both the variables are higher in case of NEPS-R whereas spread in both the models are comparable

Conclusion

- NEPS-R has shown improvement in ensemble spread for precipitation. It can add more value to the NEPS-G forecasts products specifically for heavy rainfall cases.
- Cyclone Intensity prediction is challenging. NEPS-R can provide more information in case of cyclone prediction. However, intensity prediction would be challenging.
- A major issue in case verification and identifying systematic biases of surface variable is non availability of high-resolution observation

References:

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