# Probabilistic forecasting of extreme weather events by NCMRWF ensemble prediction systems

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**Abstract**

An Ensemble Prediction System (EPS) provides a way in quantifying the uncertainty associated with numerical weather prediction model. The quantification of uncertainty in forecast helps the users in decision making. An EPS predicts the probability of forecast states given a probability distribution of random analysis error and the model uncertainties. It generally includes a control member which starts from the best estimated initial condition or analysis and a number of perturbed members running from slightly different initial states. The NCMRWF Global and Regional Ensemble Prediction Systems are based on Met Office Global and Regional Ensemble Prediction System (MOGREPS). The Global Ensemble Prediction System of NCMRWF (NEPS-G) of 12 km horizontal resolution has been operational since June 2018. NEPS-G provides 10-day probabilistic forecasts using 23 ensemble members (1 control and 22 perturbed). The initial condition perturbations are generated by Ensemble Transform Kalman Filter (ETKF) method. The model uncertainties are taken care by the Stochastic Kinetic Energy Backscatter (SKEB) and Random Parameters (RP) schemes. Perturbations of surface parameters such as sea-surface temperature, soil moisture content and soil temperature are also included.

The NCMRWF Regional Ensemble Prediction System (NEPS-R) is operational since 20 July, 2019 and runs with 12 members (1 control + 11 perturbed). The model domain extends from $67^0$ E to $98^0$ E and from $7^0$ N to $38^0$ N with 4km resolution covering the whole Indian region with 80 vertical levels. The initial and boundary conditions of NEPS-R are provided by the NCMRWF Global Ensemble Prediction System (NEPS-G) and provides probabilistic forecasts up to 3 days. The Random Parameters (RP) scheme takes care of the model uncertainties.

The extreme weather event of TC-FANI and the heavy rainfall event of 5 September, 2019 over the west coast of India have been chosen to assess the performance of NEPS-G and NEPS-R in predicting these events. TC-FANI is the most intense TC crossing Odisha coast in pre-monsoon season in satellite era with a recurving track length was about 3030 km. NEPS-R could capture the rapid intensification of TC-FANI between 29 and 30 April 2019, whereas NEPS-G was unable to capture the rapid intensification. NEPS-R predicted MSW and minimum MSLP comparable with observation. Direct position error and cross-track error of NEPS-R mean track is more during first 24-30 hours and less

during next 36-48 hours than that of NEPS-G. The heavy rain event of 5 September, 2019 over the west coast of India was very well predicted by NEPS-R compared to NEPS-G. NEPS-R is successful in predicting very heavy and extremely heavy precipitations with higher probability in case of the extreme heavy rain event over the west coast.

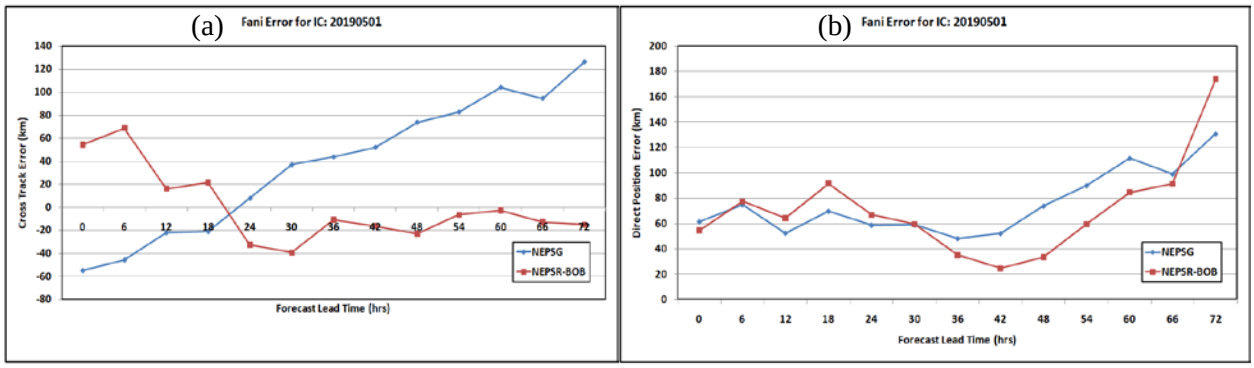


Figure 1: (a) Cross Track error (b) Direct position error of TC-FANI up to 72hrs.

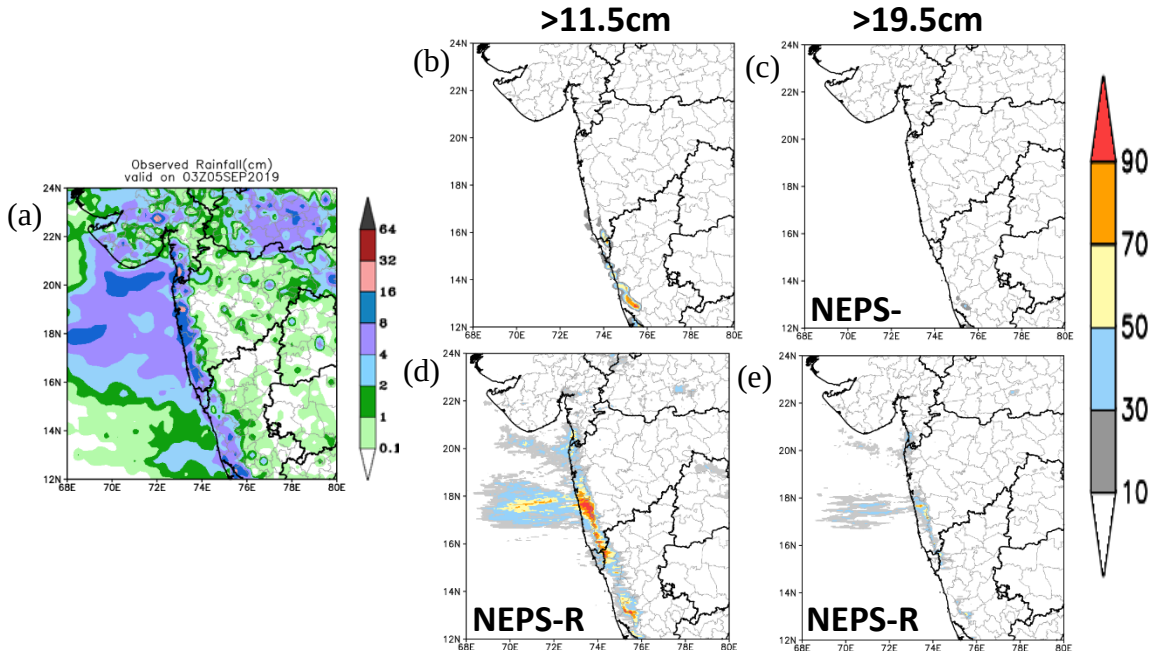


Figure 2: (a) Observed precipitation and day 1 probabilistic precipitation forecasts of NEPS-G (b-c) and NEPS-R (d-e) exceeding the threshold values of 11.5 and 19.5 cm/day valid on 5th September, 2019

## References

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Prasad, S. K., Sarkar, A., Mamgain, A and Rajagopal,E. N. 2019: Implementation of NCMRWF Regional Ensemble Prediction System (NEPS-R), NMRF/TR/09/2019.