Verification of Experimental Quantitative Precipitation Forecast over Koyna Dam Catchment using WRF

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1. Introduction

The amount and pattern of precipitation over a given region is influenced by the orography, mesoscale precipitation processes occurring in the local atmosphere and large scale processes governing the local weather. The modeling of Quantitative Precipitation Forecast (QPF) over a mesoscale region is a very challenging task, however critical it may be. Koyna Dam is one of the largest dams in Maharashtra, India and a major hydro-electric power generation station. The complexity of the terrain of western ghats modulates the precipitation occurring over its catchment. The forecast of quantitative precipitation over Koyna dam region is crucial for controlling the water discharge efficiency. Therefore, in collaboration with Koyna Dam Authority, Irrigation Department, Govt. of Maharashtra we have issued an experiment QPF over Koyna Dam region during the period of 3rd August - 3rd October 2007 using Weather Research and Forecasting modeling system (WRF/ARW). The QPF were issued twice daily based on 00 (Evening Forecast) and 12 (Morning Forecast) UTC initial conditions. The results obtained from this experiments are discussed in this paper.

2. Model Configuration

WRF/ARW is a state of art modeling system developed by National Centre for Atmospheric Research (NCAR), Bolder, USA and described by Skamarock, 2005. WRF (ARW) version 2.2 is used in real time (www.rtws.cdac.in) to issue the QPF. Three two way nested computation domains of 277 X 184 X 27, 184 X 202 X 27 and 166 X 334 X 27 computational grid points with the resolution of 36 Km, 12 Km and 4 Km have been configured for the experiment. The model top is set at 10 hPa. The first domain covers most of South Asia and Indian subcontinent and is ranging approximately from 30^0 E to 130^0 E in longitude and 10^0 S to 45^0 N in latitudes. This domain captures the synoptic scale forcing responsible for the cumulus convection occurring over the Arabian Sea and the Bay of Bengal and majority of weather disturbances influence the weather over the Indian region for the period of 3 – 5 days. Other details of model configuration and initialization are presented in Table 1. The numerical output data processed to obtain the average amount of precipitation over Koyna catchment region and is compared with averaged observed precipitation of five rain gauge stations of the Irrigation Department in the catchment viz. Koyna, Navaja, Mahabaleshwar, Bamnoli and Pratapgad. The results are described in next section.

3. Results and Conclusions

Fig. 1 (a) and (b) show the quantitative precipitation forecast issued in morning and updated at evening based on 12 UTC initial conditions of previous day and 00 UTC initial conditions of same day respectively. As seen from this figure WRF is successful in simulating the average precipitation over Koyna dam region fairly well. However it is also seen that the point QPF for station needs higher resolution as well as improvement in representation of mesoscale processes in the model. It was observed that the 24 hour QPF issued in evening has less departure from observed than the QPF issued at morning hours. The scatter plot of observed 24 hour accumulated precipitation measured from 03 UTC of the day to 03 UTC of next day and 24 hour forecast are shown in Fig. 2 (a) and (b) for morning and evening forecast. These plots also show trend line of the precipitation and lines of 100 % more or less precipitation on both sides. It can be observed that by and large we can divide precipitation into three different categories viz. 0 – 20, 20 - 50 and more than 50 mm. The multi category validation of morning and evening forecast based on these categories are presented in Table 2. It can be seen that even though there are some "false alarms" none of the heavy precipitation event is missed by model. It can be seen that the number of false alarms are lesser in the evening forecast as compared to the morning one. This can be use to avoid the losses due to false alarm. The study shows further refinement of the QPF using statistico-dynamical techniques is required to increase value of the forecast.

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Table 1: WRF Model Configuration and Initialization

WRF Model Settings	Model Specifications
Domain	Indian Subcontinent, 30 E – 120 E / 10 S – 45 N
Resolution	36, 12, 4 km grid length, 27 vertical levels, 90 sec time step
Initialization and lateral boundary conditions	3 hourly boundary conditions using NCEP GFS system forecast (00 and 12 UTC analysis)
Physics Options	Microphysics: Thompson Scheme (Thompson et al, 2004) Cumulus Parameterization: Betts Miller Janjic (Janjic, 2000) Surface Layer: MM5 similarity (Paulson 1970; Dyer and Hicks 1970; Webb 1970) Land Surface Model: Noah LSM (Chen and Dudhia, 2001) Planetary Boundary Layer: Yonsei University (Hong et al, 2006; Hong and Dudhia 2003) Radiation: long wave: RRTM (Mlawer et al., 1997) Radiation: short wave: Dudhia (1989)
Objective Analysis & Data Assimilation	*3D Var (initial 3 hours, Nudging 00 / 12 UTC)* *GTS data (World Space + IAF)*
Forecast Duration Forecast Cycle	99 hours, output at each 15 minutes 00 and 12 UTC

Table 2: Verification of QPF issued with NCEP GFS initial conditions of 12 UTC of previous day (Morning Forecast and that of 12 UTC of same day.

Forecast \ Observed	0-20	20-50	>50	0-20	20-50	>50
	Morning Forecast			Evening Forecast		
0-20	16 (100%)	0	0	21 (96%)	1(4%)	0
20-50	6 (67%)	3 (33%)	0	8 (67%)	3 (25%)	1(8%)
>50	10 (26%)	10 (26%)	18 (48%)	5 (16%)	9 (29%)	17 (55%)

Red : Hit , Blue : Missed, Brown : False Alarm

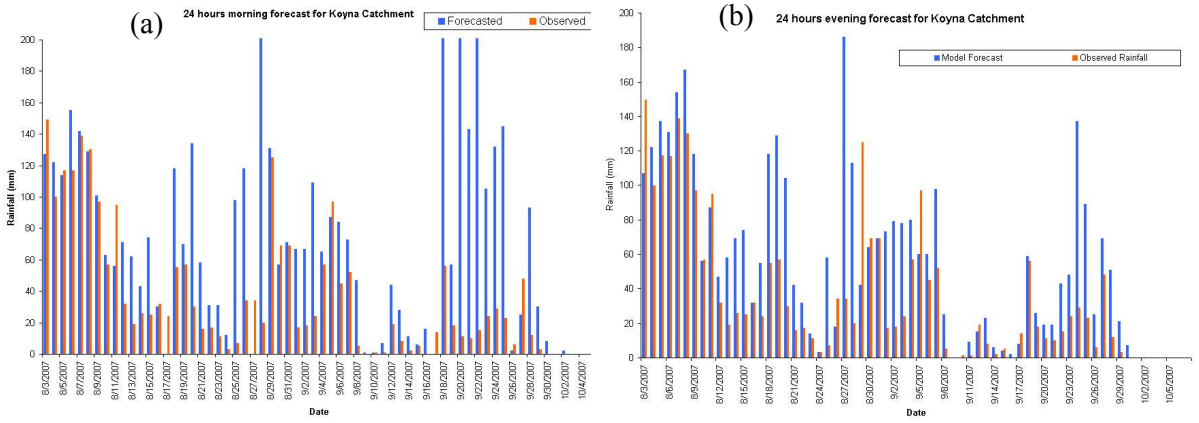

Fig. 1: Time Series of QPF and its comparison with averaged precipitation over Koyna Basin (a) Morning Time (b) Evening Time

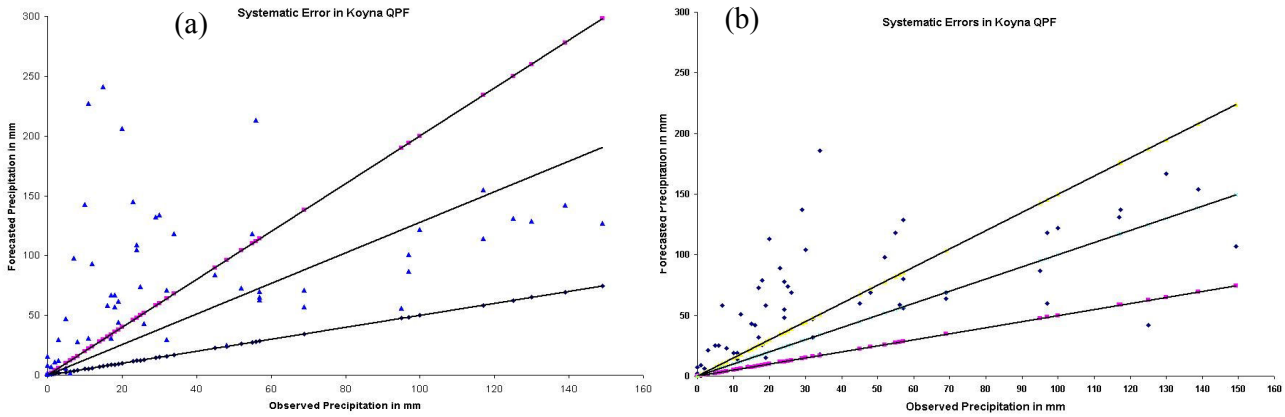

Fig. 2:Scattered plots of averaged observed precipitation over Koyna Dam region and QPF (a) Morning Time (b) Evening Time