Simulation of Tropical Cyclones Over Bay of Bengal: Impact of Dwr Data

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Tropical cyclones (TCs) are one of the most hazardous events that affect the lives as well as the economy. This loss can be significantly reduced by reasonably accurate TC forecast. The improved weather forecast depends heavily upon improved specification of the initial conditions (ICs). Hence, it is very much required to improve the initial vortex position and structure of TCs for better track, intensity and precipitation forecast. In recent years, the TCs (when close to coast) are well monitored by Doppler weather radar (DWR) network. So, it is necessary to assess the impact of high resolution (spatial and temporal) DWR data (reflectivity and radial velocity) in improving the model forecast by assimilating the data into model IC.

Three numerical experiments are performed using WRF-ARW modeling system with a single domain of 9 km horizontal resolution and 51 vertical levels. The first experiment is the control simulation (CNTL) in which only NCEP FNL analyses (of 1^0 x 1^0 resolution) are used as initial and boundary conditions. In the second experiment, known as GTS, all the GTS observations are utilized and the third, DWR experiment uses the radial velocity and reflectivity of Kolkata DWR along with GTS observations to improve the coarser resolution (FNL) analyses. These high resolution analyses (with GTS and DWR data) are prepared using WRF-3DVAR (WRF 3-dimensional variational data assimilation) system. Two recent very severe cyclonic storms "SIDR" (during 11-16 November 2007) and "Aila" (during 23-26 May 2009) over BoB are chosen for this study. Both the TCs are simulated using 5 different initial times. SIDR is simulated from 00UTC of 13 to 15 November 2007 and TC Aila is simulated from 00UTC of 23 to 25 April 2009.

To examine the GTS and DWR data impact, model simulated TC track, intensity and rainfall are studied and validated with India Meteorological Department (IMD) observations. The mean initial vortex position improves by 11% in GTS (position error of 54 km) as well as 31% in DWR (41 km) with respect to CNTL experiment (62 km). The CNTL experiment fails to simulate the realistic track, intensity and hence the rainfall distribution. In the DWR experiment, the track and intensity is well simulated compared to GTS experiment. However, the GTS experiment is also better compared to CNTL. The mean improvement in track errors of GTS and DWR (24hr, 48hr, 72hr forecast) compared to CNTL experiment are (41%, 30%, 25%) and (58%, 55%, 77%) respectively. Intensity is also well predicted with DWR experiment. As the track and intensity are improved in DWR experiment, the rainfall prediction also improved well. Some dynamic and kinematic diagnostics also studied for better understanding of individual data performance on intensity and structure prediction. With this study, it is evident that the inaccurate global analysis may be responsible for the relatively poor performance of the CNTL forecasts and

the assimilation of DWR reflectivity and radial velocity along with the GTS observations substantially improved the accuracy of the initial condition and hence the forecast.
Key words: Tropical cyclone, DWR and GTS observations, 3DVAR data assimilation