Simulation of Track and Intensity of Tropical Cyclones with WRF Modeling Systems

U.C. Mohanty*, Krishna K. Osuri and Sujata Pattanayak
CAS, IIT Delhi, Hauz Khas, New Delhi – 110016
**correspondance: ucmohanty@gmail.com*

As all know, tropical cyclones (TCs) are the most dangerous hydro-meteorological disaster that affects the lives as well as the economy. In this paper, we made an attempt to study the capability of two different dynamical cores ARW and NMM of Weather Research Forecasting (WRF) modeling system to simulate realistic TCs. Two recent cyclones "GONU" (super cyclone over Arabian Sea) and "NARGIS" (very severe cyclonic storms over BoB) are chosen for this study. Both the TCs are simulated using different initial times. Gonu is simulated from 00UTC of 02 to 04 June 2007 and Nargis is simulated from 00UTC of 28 to 30 April 2008. The forecast lengths for all the simulations vary from 120 hours to 72 hours with aim of predicting the realistic TC in advance of 3 days at least.

Two sets of numerical experiments are performed with initial time. 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, known as GTS experiment, all the GTS observations are utilized to improve the coarser resolution (FNL) analyses. These high resolution analyses (with GTS and DWR data) are prepared using ARW-3DVAR (WRF 3-dimensional variational data assimilation) system. The ARW-3DVAR system is linked to WRF-NMM core and the above mentioned experiments are repeated with NMM core. Both the model cores (ARW and NMM) use a single domain of 9 km horizontal resolution. Before this study, both the model cores are well customized to Indian sea's cyclones and the best combination of physical parameterization schemes are used for this study. All the remaining aspects regarding the configuration of domain, additional GTS data are same for all the experiments.

Out of 9 cases (using different initial times as mentioned above) of ARW model simulations, the initial position of vortex improve in 7 cases by about 35%. The 24-, 48-, 72- and 96-hr mean track forecast improves by 22%, 31%, 41% and 47% respectively. The landfall prediction is significantly improved in 8 cases and by 40%. The intensity prediction in terms of mean sea level pressure (MSLP) and 10-m maximum wind improves by (10-20) %.

With NMM core, the mean initial vortex position error is reduced in 3DVAR experiment (54 km) compared to (61 km) with an improvement of 14%. The VDEs of 24-hr track forecast from CNTL and 3DVAR are 149 km and 117 km which show the improvement of 27% with 3DVAR. Similarly, in 48-hr forecast also, there is an improvement of 49% with 3DVAR experiment.

Key words: Tropical cyclone, DWR and GTS observations, 3DVAR data assimilation