# 3DVAR Assimilation of Doppler Weather Radar (DWR) Data for Simulating a Monsoon Depression over Indian Region using the WRF model

P. K. Sinha[1,*], A. Chandrasekar[1,2] and D. Pradhan[3]
[1] *Department of Physics & Meteorology, Indian Institute of Technology Kharagpur, Kharagpur, 721302*
[2]*Indian Institute of Space Science and Technology, Dept. of Space, Government of India, Thiruvananthapuram,695022*
[3]*Cyclone Detection Radar, Regional Meteorological Centre, India Meteorological Department, Kolkata*
** pankaj@phy.iitkgp.ernet.in, +919800808816*

Monsoon depressions, which form in the Bay of Bengal and the Arabian Sea and also over adjacent land points in eastern and central India, contribute significantly to the seasonal monsoon rainfall over India. They need to be better understood and simulated; however, simulating realistically these low pressure systems and depressions and their associated spatial and temporal distribution of rainfall using the available mesoscale models [1] is a challenging task. Since sea is a region of conventional data scarcity, satellite and Doppler weather data (DWR) provide the only source of atmospheric information of these systems. For the short-range prediction, accurate initial conditions for better model performance is very much necessary since all the mesoscale models are sensitive to the small perturbations in the initial fields and the errors in model-predicted parameters can be due to errors in the initial conditions [2]. Data assimilation plays a vital role in obtaining the accurate initial state of the atmosphere in the atmospheric numerical models [2].

In this study, the effect of 3DVAR assimilation of the DWR's reflectivity and radial wind data are used in the simulation of a monsoon depression which formed during 19-22 September 2006 using the Weather Research and Forecast (WRF) modeling system. The depression was observed over Head Bay (22˚ N, 88˚ E) on 21 September 2006, which subsequently intensified into a deep depression. The depression's central pressure low was 996 hPa and the maximum sustained wind speed was 10-15 ms-1 (~ 19-30 knots).

The NCEP GFS (global forecast) data fields available at a horizontal grid spacing of 1ox1o and a time resolution 03 hours were used for the initial and lateral boundary conditions. Two model runs were employed in this study; first a control (CTRL) or a base run without any data assimilation and another three dimensional variational (3DVAR) run in which the DWR reflectivity and radial wind data were assimilated

using the 3DVAR assimilation. The model results from both the runs were compared with one another as well as with Tropical Rainfall Measurement Mission (TRMM) observations and GFS-ANL (analysis) fields. For the 3DVAR run, the 3DVAR assimilation of DWR data was performed at 00 UTC on 19 September 2006.

A clear and marked positive impact of ingesting the DWR's reflectivity and radial wind data in terms of the simulated precipitation (for both intensity and spatial distribution) and mean sea level pressure (mslp) have been obtained for the depression that formed during 19-22 September 2006. The profiles of air temperature difference and the relative vorticity provide good evidence of the improved results due to assimilation of DWR data. The 3DVAR run results reproduce a very active depression while the center of low pressure and its movement were also well captured. Furthermore, there is a clear improvement in the quantitative measures of the skill scores as the 3DVAR run consistently shows lower BIAS (higher underestimation here), lower false alarm ratio (FAR), higher probability of detection (POD) and higher equitable threat score (ETS) for all rainfall thresholds as compared to the CTRL run.

Keywords: Data assimilation; 3DVAR; WRF; DWR data; Monsoon Depression.

References

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