ABSTRACT

Mesoscale simulation of monsoon depressions (MDs) and tropical cyclones (TCs) are challenging since the errors in the model-predicted parameters are due to the errors in the initial conditions and deficiencies in the model physics. Data assimilation plays a vital role in obtaining the accurate initial state of the atmosphere in the atmospheric models for better model performance. This thesis investigates the impact of assimilation of ocean surface wind data from various satellites – Quick Scatterometer (QuikSCAT) and Oceansat-2 – and Doppler Weather Radar (DWR)'s reflectivity and radial velocity into the Advanced Research Weather Research and Forecast (ARW-WRF)-V.2.2 and V3.2 models using the three dimensional variational (3DVAR) data assimilation technique for the simulation of MDs and TCs over India. Results of simulations performed with and without data assimilation are compared with the Tropical Rainfall Measurement Mission (TRMM) observations, Joint Typhoon Warning Center (JTWC) observations, and GFS analysis (GFS-ANL) fields for the validation of the forecast. The results of the assimilation of QuikSCAT wind data show a clear impact in the simulations of mean sea level pressure (mslp) fields, 950 hPa wind vectors, thermal structure of the meteorological systems, relative vorticity profile, and the intensity and spatial distribution of the precipitation. The investigation of impact of 3DVAR assimilation of DWR data has indicated noticeable improvements in the simulation of above parameters. Track simulation results obtained due to assimilation of QuikSCAT and DWR data for the cyclone cases show good agreement with the best track of the JTWC while time series of minimum slp and maximum wind speed indicate the observed trend of intensification/weakening of the cyclone. Assimilating Oceansat-2 data for cyclone Bandu reveals improved simulation of an active cyclone, however, results of 3DVAR simulation of cyclones Phyan and Ward do not compare favorably with observations. The month long assimilation of the QuikSCAT wind on the short-range prediction shows improvements in the simulation of precipitation due to data assimilation while the results for the forecast impact (FI) on 850 hPa U- and V- components, FI on 850 hPa and 500 hPa temperature and relative humidity, reveal large positive improvements.

Keywords: Data assimilation, 3DVAR assimilation technique, WRF, Monsoon Depressions, Tropical Cyclones, QuikSCAT, Oceansat-2, DWR, NWP, Mesoscale modeling, TRMM, JTWC, GFS.