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Data Assimilation of Mesoscale Convective Systems of pre-monsoon season associated with squalls and tornado

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In the pre-monsoon season (March through May), the thunderstorms are mesoscale convective systems (MCSs) and are popularly known as Nor'westers and Kalbaishakhis. This MCSs create squalls, tornado, thunder, torrential rain, hail storms, downburst, lightning, flash flood. An attempt has been taken to study the pre-monsoon MCSs, which occurred over the Bangladesh. Every year there is a significant loss of lives and properties due to the Nor'westers in Bangladesh, east and north-eastern Indian regions. Nowadays, the Nor'westers death tolls are significantly more compared to the vulnerability of tropical cyclones in Bangladesh and Indian region. Time and location specific forecasting of Nor'westers/thunderstorms are the great challenges to the atmospheric researchers. It is found in pre-monsoon season during 2006-2014 that there are three hundred fifty-one squall events recorded by 35 observatories of Bangladesh Meteorological Department. The vulnerability documented in print and electronic media are more than the meteorological records. Unavailability of precise data for those events is the great obstacle to understanding. Numerical weather prediction (NWP) models are one of the solutions to better understand the phenomena which are not available from the observational sources. Understanding of the MCSs through numerical simulation is an important aspect of this study. It is well-established that the performance of mesoscale numerical simulations is erogenous to the selection of initial conditions. In the study, Weather Research and Forecasting (WRF) model Advanced Research WRF (ARW) dynamical core along with Three-Dimensional Variational (3DVAR) Data Assimilation (DA) techniques are used to improve the simulation of these intense events. In the DA system, Doppler Weather Radar products of radial wind and reflectivity are used with the conventional and non-conventional data. Pre-monsoon squalls and tornado are studied by employing observations from the surface and upper air with Tropical Rainfall Measuring Mission (TRMM) and ground-based radar. Subsequently, an attempt is also made to simulate the storms using WRF model at 4 km single, nested 3 km and 1 km horizontal resolution. The Brahmanbaria tornado event of 22 March 2013 has been simulated by using the WRF model. The maximum amount of vorticity transferred by directional shear in the storm updraft (helicity) simulated by the model is found to be 1774 m2 s-2. The highest vertical velocity simulated by the model is about -28 to 58 m s-1 and reaching up to 300 hPa. After DWR data assimilation of squalls, the time series of sea level pressure and surface wind show better intensity and structure of the MCSs. The assimilation experiments are able to capture the location and amount of rainfall over Bangladesh reasonably well compared to without data assimilation.

Keywords. Pre-monsoon, MCS, WRF, 3DVAR, DWR