Simulation of Thunderstorms: Impact of Assimilation of Data Collected During STORM Pilot Phase 2009

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Thunderstorm (TS) is a severe weather phenomenon, the impact of which is increasingly felt by all the sectors of society. During April and May, the eastern and northeastern parts of the country, i.e. Gangetic West Bengal, Jharkhand, Orissa, Bihar, Assam and parts of other northeastern states are affected by higher frequency of severe TSs, locally named as 'Kal-baishakhi' or 'Nor'westers'. Realizing the importance of better understanding and prediction of these severe local storms and their socio-economic impact, the Department of Science and Technology, India initiated a national coordinated programme on 'Severe Thunderstorm Observation and Regional Modeling (STORM)'. Under this programme special observations were taken from various platforms during the pilot phases of 2006, 2007 & 2009. It is well known that the improved weather forecast depends heavily upon improved specification of the initial conditions. Hence, in the present study an attempt has been made to evaluate the impact of improved initial condition by assimilating observational data, on genesis and development of TS.

Three numerical experiments are performed using WRF-ARW modeling system with a single domain of 4 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 SAT, all the available satellite derived winds (sea surface winds and upper air winds) are utilized. The third experiment referred as GTS uses all the GTS observations (collected during pilot phase of STORM) along with satellite derived winds to improve the coarser resolution (FNL) analyses. These high resolution analyses (in SAT and GTS experiments) are prepared using WRF 3-dimensional variational data assimilation system. Two cases of severe TS on 3rd May and 11th May 2009 during the STORM pilot phase were taken up for the present study.

To assess the impact of satellite derived winds and GTS observations on model simulation, a number parameters are analyzed and validated with IMD observations. The GTS experiment improved the time of occurrence of TS compared to that of CNTL and SAT. The spatial distribution of rainfall has improved significantly in GTS compared to the other two experiments; however SAT experiment also exhibited better prediction of rainfall than CNTL. And the same is reflected in the quantitative prediction rainfall through ETS and bias. GTS as well as SAT experiments captured the dynamic and thermodynamic indices (CAPE, CIN, Lifted index, K- index and TT-index), which

indicate the instability in the atmosphere resulting in the occurrence of TS. The inaccuracy of CNTL analysis results in poor performance of CNTL simulation and with the assimilation of additional observations improves the prediction of TS significantly.

Key words: Thunderstorms, STORM pilot phase, WRF - 3DVAR data assimilation