Abstract

The present work is mainly focused on the observational and mesoscale prediction of leading convective line trailing stratiform (TS) squall lines, over the Gangetic West Bengal (GWB) region of India, during pre-monsoon months. For this purpose, analysis of field observations obtained from Severe Thunderstorm Observations and Regional Modeling (STORM) programme has been performed. The analysis reveals the presence of typical surface pressure variations such as pre-squall meso low, meso high and wake low. Numerical experiments performed using a high resolution mesoscale model, ARW-WRF, have demonstrated reasonable skill in capturing the aforementioned features. In order to improve the model simulations of TS squall lines, the model is customized over the study region through sensitivity study on cloud microphysics (MP), planetary boundary layer (PBL) and cumulus convection parameterization (CP) schemes. Based on observational validation and statistical analysis, the results reveal that TS squall lines are reasonably simulated with the combination of Quasi-Normal Scale Elimination PBL, Grell-Divenyi ensemble CP and Morrison MP schemes. Further, an attempt is made to improve model initial conditions and subsequent forecast through assimilation of conventional (surface and upper-level synoptic observations) and non-conventional (Radar reflectivity and radial velocity) data with different assimilation cycle period (cold start and cyclic mode). To verify the impact of data assimilation, a control experiment (CTRL) without data assimilation is also performed. Model simulated results indicate that the model initial conditions and subsequent forecast is noticeably improved with the assimilation of conventional and non-conventional observations mentioned above. The results reveal that the cold start mode shows better results than that of cyclic and CTRL experiments. It is seen that the assimilation of radar data has a positive impact on both the position of convective cells as well as the rainfall simulated for the analyzed event. Finally, the performance of the customized ARW-WRF model with improved initial conditions (assimilation of available observations) is assessed towards predictions of the thunderstorms in 2013. The results indicate that the TS squall lines are reasonably well predicted by the customized model. The present study advocates the utility in the improved simulation of TS squall lines over GWB region of India.

Keywords: TS Squall line, Gangetic West Bengal, WRF, cloud microphysics, cumulus convection, planetary boundary layer, radar data assimilation