Numerical Modeling of Nor'westers Over Indo-gangetic Plain of West Bengal, India Using WRF Mesoscale Models

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A common feature of the weather during the pre-monsoon season over the Indo-Gangetic plain and northeast India is the outburst of severe local convective storms, commonly known as 'Nor'westers'(as they move from Northwest to Southeast). The severe thunderstorms associated with thunder, squall lines, lightening and hail cause extensive losses in agricultural, damage to structure and also loss of life. Forecasting thunderstorms is one of the most difficult tasks in weather prediction, due to their rather small spatial and temporal extension and the inherent non-linearity of their dynamics and physics. The aim of this study is to determine the usefulness of high resolution WRF-ARW (Advanced Research WRF) and NMM (Non-hydrostatic Mesoscale Model) models when it come to the severe thunderstorm forecasting over Indo-Gangetic plain of West Bengal, India. In this paper, we have made an attempt to diagnose some of the severe squall line events that occurred during the SAARC-STORM field experiment 2009 (3 May 2009, 11 May 2009, 12 May 2009 and 15 May 2009) through the simulated radar reflectivity, cloud top temperature, rainfall, vertical velocity, wind speed, stability indices and other thunderstorm related surface parameters. The model results are validated with observation which collected during the field experiment. A single domain was configured for ARW and NMM models with 3km horizontal spatial resolution for this study. Both models were integrated for a period of 24 hours, starting at 0000 UTC as initial values. The Global Forecast System (GFS) data sets of NCEP with 1.0^0 x 1.0^0 lat/lon grids are used as the initial and boundary conditions.

The use of composite radar reflectivity, brightness temperature and cloud top temperature as derived from Numerical Weather Prediction (NWP) model output have become increasingly popular recently for display of high-resolution numerical model fields to demonstrate the advanced capabilities of these models for severe weather prediction. WRF-ARW and NMM models have well simulated the composite radar reflectivity and cloud top temperature, which clearly show the severe squall line movement as observed in Doppler Weather Radar and Kalpana Satellite imageries. The spatial distribution as well as the intensity of rainfall rates obtained from WRF models are in good agreement with 24-hour observed and TRMM accumulated rainfall. Both ARW and NMM models performed well in capturing the stability indices required for development of a severe unstable convective activity. The results of these analyses demonstrated the capability of 3km WRF mesoscale models in forecasting of severe thunderstorm events. This suggests that high-resolution models have the potential to provide unique and valuable information for forecasters when it comes to the severe thunderstorm forecasting over Indo-Gangetic plain of West Bengal, India.