UNDERSTANDING THE CHARACTERISTICS AND FORECASTING OF NOR'WESTERS USING NUMERICAL WEATHER PREDICTION MODEL

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ABSTRACT

North-Western disturbance abbreviated as Nor'wester and locally termed as 'Kal-Boishakhi' in Bangla is the dominant among the natural hazards during the pre-monsoon season in the South Asian region. The term 'Nor'wester' simply means thunderstorms occurred in the pre-monsoon season. It is accompanied by squally wind with thunder and lightning and torrential rain and cause a huge loss of lives and properties each year. These are very short lived events and highly challenging to be forecasted. In the present paper we studied two such events occurred on May 05, 2008 with squall wind of 76 km/h and May 11, 2009 with squall wind of 72 km/h in Bangladesh by numerical weather prediction (NWP) based Advanced Research WRF (ARW) model V.3.1.1. Low level and upper level wind flow, moisture flux, vertical component of wind, vertical wind shear have been taken into consideration. The model was run with the 6-hourly 1^0X1^0 resolution data as initial and lateral boundary conditions (LBCs) from NCEP and forecast was made for every half an hour and was compared with the radar and satellite imagery. TRMM 3B42RT 3-hourly rainfall data and synoptic data from Bangladesh Meteorological Department (BMD) were used to justify the simulated rainfall structure, development time, location and direction of the two events.

Keywords: Nor'wester, ARW, NWP, TRMM.

1. INTRODUCTION

Nor'wester or 'Kal-Boishakhi' is the most common natural disaster in Bangladesh and adjoining northeastern parts of India during the pre-monsoon season (March-May). These systems develop in this region mainly due to merging of cold dry north-westerly winds and warm moist southerly low level winds from the Bay of Bengal. Few studies (Koteswaran, 1958; Joseph, 1982) have made an attempt to understand the formation and propagation of thunderstorms over the region. Also the forecasting aspects were examined for propagation speed of thunderstorm cells over Kolkata during pre-monsoon seasons (Basu and Mondal, 2002). Simulation of thunderstorms by numerical models has been one of the greatest achievements by the scientists with the advent of high-powered computers. Present study aims to understand the dynamics and physical processes of these nonlinear systems with numerical weather prediction.

2. DATA AND METHODOLOGY

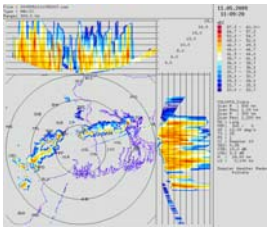
The Weather Research and Forecasting (WRF) model has been used for the simulation of the Nor'wester in this study. The model was run at 9 km horizontal resolutions with 27 vertical levels using initial & boundary conditions obtained from NCEP for both the cases in the present study. Kain-Fritch cumulus scheme and WRF-Single moment 3-class microphysics scheme (simple ice and snow scheme) were used for simulating both the events. Surface layer was treated using Monin-Obukhov with Carslon-Bolan viscous sub-layer option and boundary layer is treated with Yonsei University scheme. Noah 4-layer Land Surface Model (LSM) was utilized with the above combination.

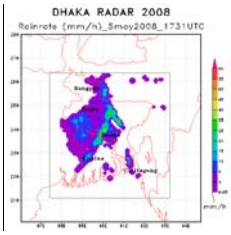
3. RESULTS AND DISCUSSION

3.1 Doppler and Conventional Radar

DWR Kolkata recorded the vertical extent of the system of about 17 km and the RADAR reflectivity 55 dBz on 11 May 2009.

Dhaka radar reflectivity is being converted to rainfall as shown in the right one of the following figure for 5 May 2008 case.

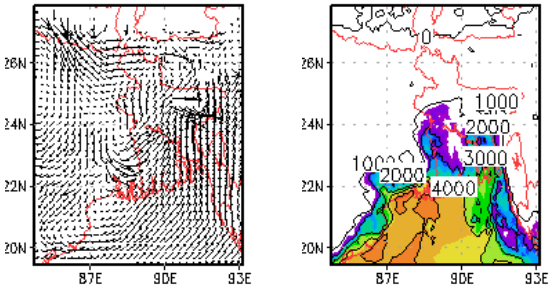




3.2 Simulated Characteristics

3.2.1 Wind and Cape

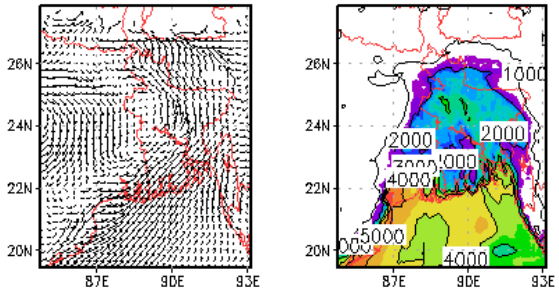
In Bangladesh, the observational data is not enough to compare the phenomena during the Nor'wester. Figure 1(a) depict the wind (m/s) at 850 hPa and 1(b) the convective available potential energy (cape) (J/Kg) as seen on 18Z05May2008.



(a) (b)

Fig. 1 WRF Model simulated parameters (a) Wind (m/s) at 850 hPa, (b) Cape (J/Kg).

Figure 2(a) depict the wind (m/s) at 850 hPa and 2(b) the convective available potential energy (cape) (J/Kg) as seen on 18Z05May2008.



(a) (b)

Fig. 2 WRF Model simulated parameters (a) Wind (m/s) at 850 hPa, (b) Cape (J/Kg).

Other parameters are also analyzed and discussed in the paper.

4. CONCLUSION

WRF model is able to simulate the nor'wester with some lagging in time and shifting of location compared to the observation. However, more experiments are needed, especially on sensitivity experiments and data assimilation for better understanding and forecasting of such events.

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