Simulation of Cyclone Sidr and Analysis of the Rainband Formation Using CReSS

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1. Introduction

Spiral rainband carries the significant importance on the clouds and precipitations occurred during tropical cyclones. Torrential rainfall caused by the rainband of cyclone Sidr is the one of the main causes for damaging the low lying coastal region of Bangladesh. Sidr, a category-4 cyclone was initially formed near Andaman Islands of Indian Ocean on 09 Nov. 2007 and finally hit south-western coast of Bangladesh at 1430 UTC of 15 Nov. 2007 with wind speed of 67 m/s. At the point of landfall, the storm surge was up to 5 m height. As per official report 4861 people died and 67 million people were affected physically and financially. It reveals the essentiality of having tools to predict the cyclone so that people can be made alert well in time. In this background, the numerical study is necessary to predict the cyclones on analyzing the formation process and structure of the rainband of Sidr.

2. Numerical Model & Experimental Design

The numerical model used for the study is CReSS (Cloud Resolving Storm Simulator), which is non-hydrostatic, compressible and terrain following. The spatial resolution for the domain area (Fig. 1a) assortment is 2.5 km x 2.5 km x 0.5 km. The model was executed to simulate cyclone Sidr from 0000 UTC of 14 Nov. to 0000 UTC of 16 Nov. 2007. The initial and boundary conditions of the model are provided with GSM (Global Spectrum Model) model output data of 0.5°×0.5° resolutions at 6 hourly intervals.

3. Result

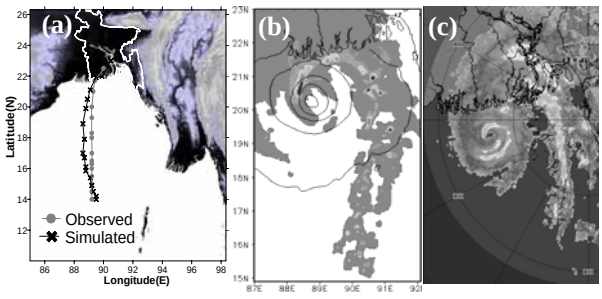

Fig. 1: (a) Simulated and observed tracks with domain area. (b) Simulated rainfall distribution and (c) Radar image at 1200 UTC 15 Nov. 2007

Fig.1a shows the observed track and simulated track by the CReSS model of Sidr for 48 hours duration. And also Figs. 1b and 1c are the simulated rain distribution and radar image of Sidr at 1200 UTC of 15 Nov. respectively. The model simulated track and the rainband of Sidr are found reasonably accurate. The east-west cross section of temperature anomalies, equivalent potential temperature, horizontal and vertical wind velocity, hydrometeors, relative humidity etc. are analyzed to study the structural characteristics of cyclone Sidr.

In this study the formation process of the long spiral rainband of Sidr is also examined. The band is observed stationary in nature i.e the relative position of the band with respect to center of the cyclone is almost equidistant over the period of time. However during the advancement of the storm motion to the north, this spiral band becomes gradually longer on the south. The average increasing rate is 7.2 m/s. After landfall the scenario changes and the band length decreases as shown in Fig. 2.

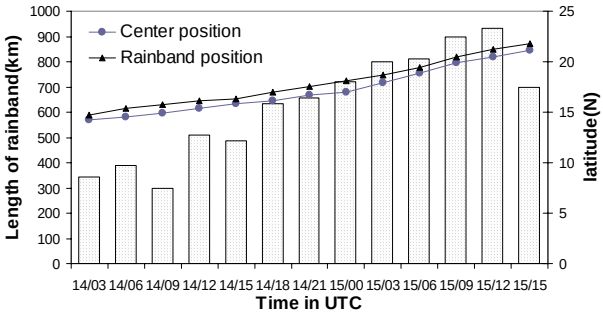

Fig. 2: Time variation of the band length and positions of the rainband

This long band consists of individual deep convective cells. These are well arranged by one after another. At the initial stage while the rainband is yet to form, the strong moist southerly wind produces convergence along the band, which helps to create convective instability. As a result, convection is formed along the rainband. After being formed convective cells move slowly inward along the band and make a mesoscale convective system (MCS) on the north of the Sidr. Every moment the strongest southerly is converging along the band and convective cells are formed on the south of the band and join with the large system to the north. This northern MCS causes heavy precipitation when the cyclone hits on the land and thereafter.