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Development processes of an Arc type system during pre-monsoon in Bangladesh

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1. Introduction

Statistical analysis of radar data revealed that Arc type system dominates in pre-monsoon over Bangladesh (Rafiuddin et al. 2007: MSJ autumn meeting, Sapporo). The Arc type system is usually associated with severe thunderstorm and produces intense rain and strong winds over small areas, which sometimes result in severe damage. Due to lack of observational data it is not possible to know the vertical extension and formation mechanism of the systems. In this article development processes of an Arc type system during pre-monsoon in Bangladesh has been discussed using numerical simulation.

2. Model description

Japanese 25-year Reanalysis (JRA-25) data of resolution 1.25 degree and NCEP Reynolds week mean SST data were used for initial and boundary conditions of PSU/NCAR mesoscale model (MM5) simulation. MM5 run was made for 3 domains (D1, D2 and D3) with the horizontal grid increment of 45 km, 15 km and 5 km respectively. MM5 simulation started at 0000 LST of April 26, 2002 and continued for 42 hours. An hourly output of D3 was used as initial and boundary condition for the model CReSS (Cloud Resolving Storm Simulator) with a single domain of horizontal resolution of 2.5 km. CReSS simulation started at 0600 LST of April 26, 2002 and continued for 36 hours.

3. Results

An Arc type precipitation system was observed by radar on April 26, 2002 (Fig. 1a). CReSS simulation captures the southeastward propagation and shape of the system (Fig. 1b and c) though there were three hours time delay and location shift of the system. The simulated rain rate at a mature stage is ~120 mm/h (Fig. 1b) which is close to radar observation (status 5 = 64~128 mm/h) (Fig. 1a).

Figure 2 shows the vertical sections of the system along line AA'(Fig. 1b) and BB'(Fig. 1c). In the front of the system, low θ_e (< 340 K) is found from 2-8 km levels (Fig. 2a). Below the 1 km level, high θ_e (>348 K) comes from the southwestern part and uplifted over the northwestern low θ_e. The system developed up to 16 km (Fig. 2a) along the large convergence line near the ground. Behind the core of the mixing ratio, low θ_e (< 340 K) extends below 5 km level, which feeds the low θ_e near the surface. The southwestern (along AA' in Fig. 1b) and northeastern (along BB' in Fig. 1c) part of the system moved southeastward (~9 m/s) and eastward (~20 m/s) respectively. Along the BB' convergence becomes weak and system is not so severe and tall (~10 km) (Fig. 2b). The relatively strong rear inflow (northeastern side) pushes the system and the system moves fast.

The low level (~1 km) southwesterly wind (carrying warm moist air) has the important role for the development of the system.

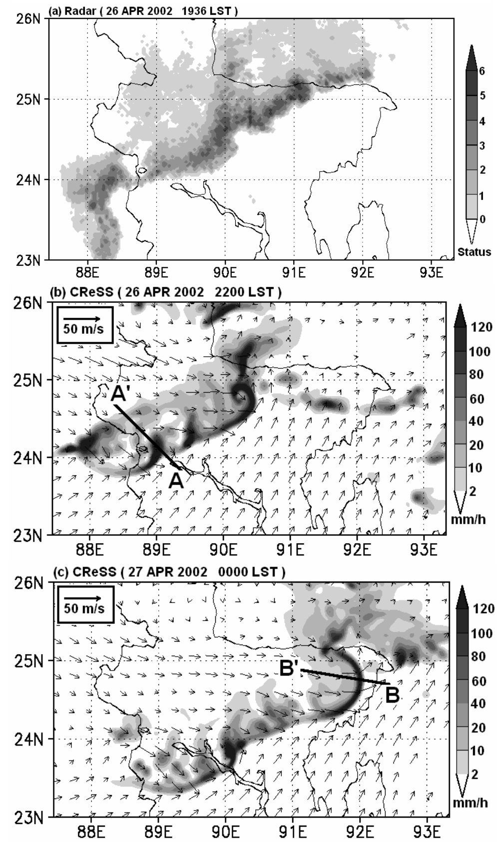

Fig. 1. a) Radar rain rate (shade), b) and c) CReSS simulated rain rate (shade) and wind (vector) at 2200 LST of 26 APR 2002 and 0000 LST of 27 APR 2002.

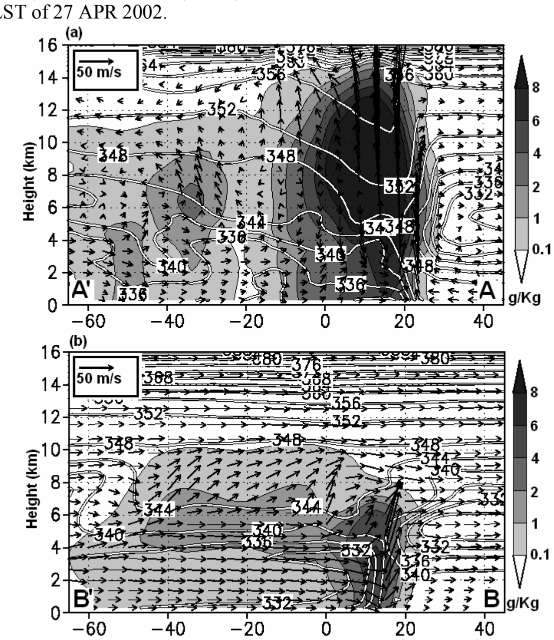

Fig. 2. Vertical cross section along line AA' and BB' in Fig. 1 of mixing ratio of precipitation (qr+qs+qg, shade), θ_e (solid line) and wind (vector, vertical wind is 10 times of horizontal wind).