The moisture variability during pre-monsoon over Bangladesh

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I. INTRODUCTION

In the northeastern region of the Indian subcontinent, the severe local storms, sometimes associated with tornadoes, damaging hail and strong wind, frequency occur during the pre-monsoon season from March to May (e.g., Peterson and Mehta, 1981, 1995; Goldar et al., 2001). Such kind of the disturbances during the pre-monsoon season cause severe damage almost each year. In climatology, the high density of occurrence of tornadoes is located around Bangladesh and the West Bengal, India. The most high season of tornadoes is in April (Peterson and Mehta, 1995). Recently, high thermal instability and vertical wind shear occur in Bangladesh and the northeastern part of India during the pre-monsoon season (Yamane and Hayashi, 2006). There is great potential for severe local storms during the pre-monsoon season in Bangladesh and northeastern part of India. Meanwhile, such kind of favorable environment for the severe local storms during pre-monsoon is not explained yet.

The region of this study has restrictive observation; especially the upper air observation is limited for analysis of vertical condition. To obtain higher time-resolution of the upper air data, we had carried out the intensive observation period (IOP) of the upper air observation during the period from 20th April to 15th May in 2007. During this IOP, we could have two active phases and one inactive phase. From this upper balloon observation, the passage of upper trough was detected around 4,000-5,000m during the active phase (Kiguchi et al., 2008). The southwesterly in lower troposphere was dominant during active phase. This dominance of southwesterly might produced the increase of moisture during the active phase over Bangladesh.

In this study, the pre-monsoon rainfall phenomena over Bangladesh and the northeastern part of India are investigated using wind and moisture fields by the reanalysis and OLR (Outgoing Longwave Radiation; that indicates the convective activity) data during the period from 1984 to 2007. Also, the moisture field during the pre-monsoon period over Bangladesh in 2007 is investigated using OLR and the reanalysis data during the period from March to May in 2007.

We used the reanalysis dataset to investigate the atmospheric condition widely. Wind and specific humidity data are obtained by the daily mean values of the reanalysis of the National Centers for Environmental Prediction / National Center for Atmospheric Research (NCEP/NCAR) (Kalnay et al., 1996). As an indicator of the convective activity, the daily mean interpolated OLR data provided by the National Oceanic and Atmospheric Administration (NOAA) are utilized (Liebmann and Smith, 1996).

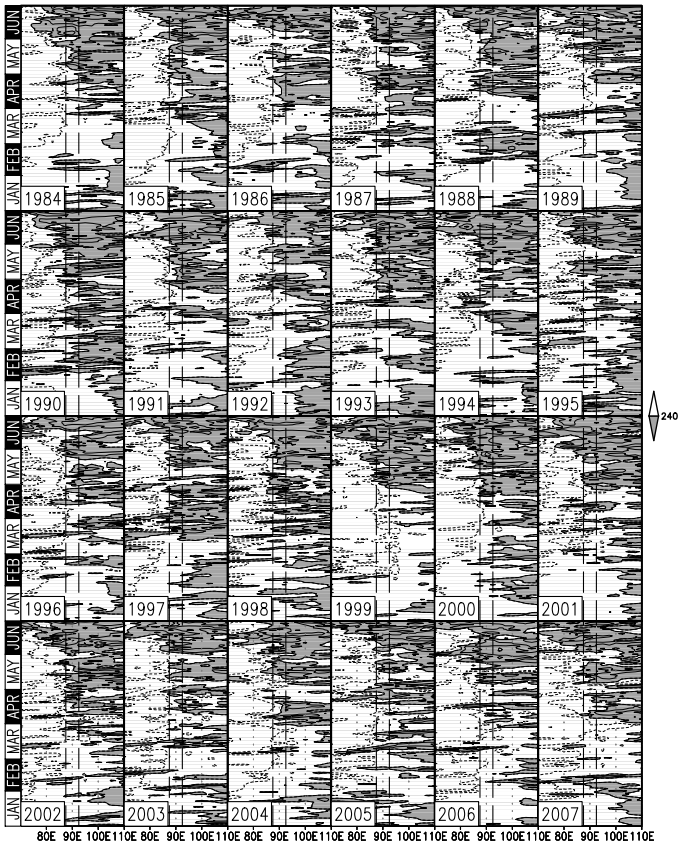

FIG. 1: The time-longitude cross section of area-averaged (22.5^{o}N - 27.5^{o}N) OLR from January to June during the period 1984 to 2007. Shading is less than 240 W/m^2. Dashed line indicates the location of Bangladesh.

II. RESULTS

According to the time-longitude cross section of OLR over Bangladesh (22.5-27.5^{o}N), the active rainfall activity is seen

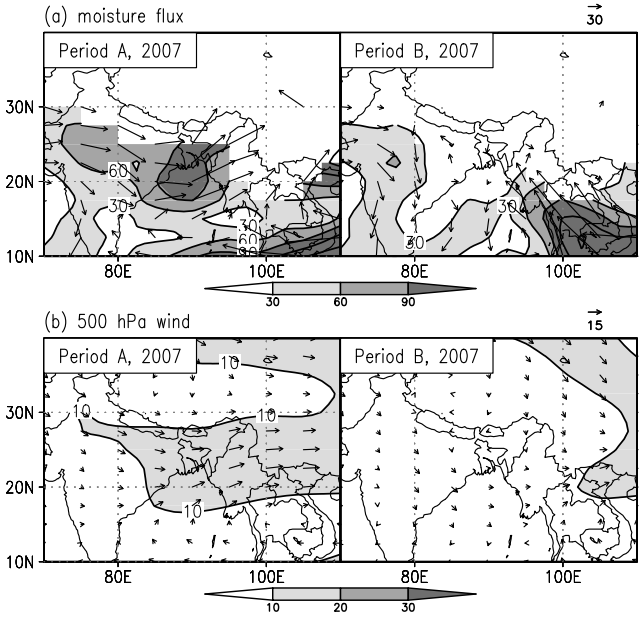

FIG. 2: (a) The composite map of the integrated moisture flux between 925 hPa and 700 hPa during the Period A (left panel) and Period B (right panel) in 2007. (b) The composite map of the wind direction and speed on 500 hPa during the Period A (left panel) and Period B (right panel) in 2007. Shadings of (a) and (b) are more than 30 kg m^{-1} s^{-1} and more than 10 m/s, respectively.

approximately every year before the beginning of June when the averaged monsoon onset occurs (Fig. 1). In addition, it is not seen in the Indian northern part equal to the Bangladesh west in the same latitude zone, however, in the northern part of Myanmar and the southern part of China equal to the Bangladesh east, it is seen the active rainfall activity. It is connected with a rainfall phenomenon of the pre-monsoon period in Bangladesh from the southern part in China, and it is suggested that this pre-monsoon rainfall is a synoptic phenomena. During the rainy season in Okinawa Island and the southern part of China where is located in same latitude of east of Bangladesh, there are the rainfall variability which has active/break phase. The rainfall variability in Bangladesh might affect to that in the southern part of China and Okinawa island.

Concentration of moisture might provide the rainfall activity during the pre-monsoon season in Bangladesh. The horizontal distribution of southwesterly already suggested as considerably brought the increase of a potential temperature and the relative humidity in the lower troposphere from upper air observation in 2007 (Kiguchi et al., 2008). A large lower troposphere integrated moisture flux flows into Bangladesh area from the Indian northern part in period A in contrast with period B when a integrated moisture flux is weak (Fig. 2). The large integrated moisture flux in the northern part of India has already exists, and it is suggested that only the southwesterly from Bay of Bengal is not enough.

III. SUMMARY

In early June, the heavy convective activity appears from Bangladesh to eastward area in almost each year. That means this pre-monsoon rainfall events are synoptic phenomena. The increase of lower tropospheric moisture associated with southwesterly is contributed by the lower tropospheric moisture inflow not only from the Bay of Bengal but also from the northern part of India. The composite analysis in wind system shows the presence of trough located over Bangladesh in upper/middle troposphere. These aspects of phenomena are similar to the case in the inland region of the Indochina Peninsula (Kiguchi and Matsumoto, 2005). In future, we focus to that the rainfall variability in the southern part of China and Okinawa Island be affected by the periodical rainfall activity during pre-monsoon in Bangladesh, or not.

IV. ACKNOWLEDGMENTS

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V. REFERENCES

Goldar R. N., Banerjee S. K., and Debnath G. C., 2001: Tornado in India and neighborhood and its predictability, Sci. Rep. 2/2001, 21 pp., Indian Meteorol. Dep., Pune, India.

Kalnay E., Kanamitsu M., Kistler R., Collins W., Deaven D., Gandin L., Iredell M., Saha S., White G., Woollen J., Zhu Y., Chelliah M., Ebisuzaki W., Higgins W., Janowiak J., Mo K. C., Ropelewski C., Wang J., Leetmaa A., Reynolds R., Jenne R., and Joseph D., 1996: The NCEP/NCAR 40-year reanalysis project. Bull. Amer. Meterorol. Soc., 77 437-471.

Kiguchi M., and Matsumoto J., 2005: The rainfall phenomena during the pre-monsoon period over the Indochina Peninsula in the GAME-IOP year, 1998. J. Meteorol. Soc. Japan, 83 89-106.

Kiguchi M., Yamane Y., Eguchi N., Hayashi T., and Oki T., 2008: Observational study on the pre-monsoon rain over Bangladesh. 24th Conference on Severe Local Storms, Am. Meteorol. Soc., Savannah, GA, USA.

Liebmann B., and Smith C. A., 1996: Description of a complete (interpolated) outgoing longwave radiation dataset. Bull. Amer. Meterorol. Soc., 77 1275-1277.

Peterson R. E., and Mehta K. C., 1981: Climatology of tornadoes of India and Bangladesh. Arch. Meteorol. Geophys. Bioklimatol., Ser.B-29 345-356.

Peterson R. E., and Mehta K. C., 1995: Tornadoes of the Indian subcontinent. 9th International Conference on Wind Engineering, Int. Assoc. of Wind Eng., New Delhi, India.

Yamane Y., and Hayashi T., 2006: Evaluation of environmental conditions for the formation of severe local storms across the Indian subcontinent. Geophys. Res. Lett., 33, L17806, doi:10.1029/2006GL026823.