Severe storms over eastern region of India, Bangladesh plain and northern Bay of Bengal as observed from the TRMM sensors.

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I. INTRODUCTION

Significant work have been carried to study the characteristics of MCSs by using satellite onboard microwave sensors (Nesbitt et al., 2000; Toracinta et al., 2002; Nesbitt and Zipser, 2003; Cecil et al ., 2005; Zipser et al., 2006; Nesbitt et al., 2006). Previous studies have dealt primarily by associating environmental convective parameters with rainfall and rain intensity (Zawadzki and Ro 1978; Zawadzki et al. 1981; Adams and Souza 2009; Myoung and Gammon 2010). There are limited studies of the association of environmental convective parameters with the satellite derived convective indices such as rain height and brightness temperature at 85 Ghz , (Nicholls and Mohr 2010; Geerts and Dejene 2005).

The combined region of north east India, Bangladesh plain and northern Bay of Bengal is one of the most favourable zone for the occurrence of severe storms. The complex topography of the region coupled with suitable environmental and synoptic conditions favours the formation of severe storms . The main objectives of the present work are to study the spatial and temporal variability of convective activities over this region with the help of TRMM sensors and to further associate the satellite derived convective indices with the environmental convective parameters.

II. PRESENTATION OF RESULTS

The Tropical Rainfall Measuring Mission (TRMM) was launched in 1997 (Simpson et al., 1988; Kummerow et al., 1998). It has provided a unique opportunity to study the three dimensional rain field by virtue of an on-board Precipitation Radar (PR), of a Microwave Imager (TMI) and of a Light Imaging Sensors (LIS). The present study is carried over the region stretch between 18^0 to 28^0 N and 85^0 to 95^0 E . The region consists of complex hills (north east part of India), plain (Bangladesh) and oceanic region (northern Bay of Bengal). The present work is carried out using the 13 years of TRMM data during 1998-2010. For the present study, satellite derived, four convective indices are utilized. They are (i). Echo Top Height for 20 dBZ ($ETH_{20\ dBZ}$) from TRMM – PR, (ii). minimum Polarization Corrected Temperature at 85 (PCT_{85}) from TMI (iii). No .of lightening flash from LIS and (iv) Near surface Z (NSZ_{dBZ}) from TRMM-PR. The associated environmental condition of storms are analysed with the help of CAPE and CIN parameters. For these two parameters the NCEP?NCAR Reanalysed gridded data set is utilized (Kalnay et al.,1996),. MCSs over the region are identified by using the criteria as proposed by Mohr and Zipser (1996)

The annual variation of number of MCSs over the study region is provided in Figure 1. Annually the no. of MCSs are varying in the range of 620 to 450. The maximum and minimum no of MCSs are found during 1999 and 2002 respectively. These years were La Nina and El Nino years. Overall, during 2002, 2006 and 2009, the region experienced the deficit of MCSs. All these three years were El Nino Years.

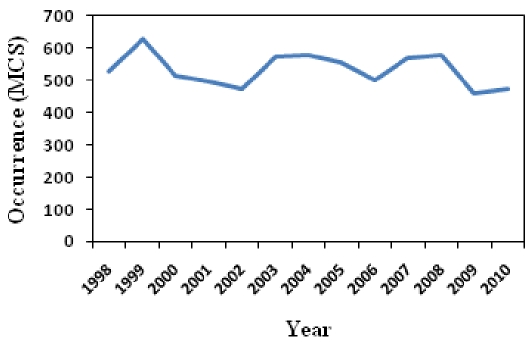

FIG 1. Annual variation of the no. of MCSs over the study region.

The normalized distribution (normalized by maximum value) of the occurrence of ETH_{20dBZ}, min. PCT_{85}, No. of lightening flash and NSZ_{dBZ} over different regions are shown in Figure 2 (a-d) respectively. It is observed that the ETH_{20dBZ} > 10 km are more prevalent over Bangladesh plain and followed by ocean and hill regions.

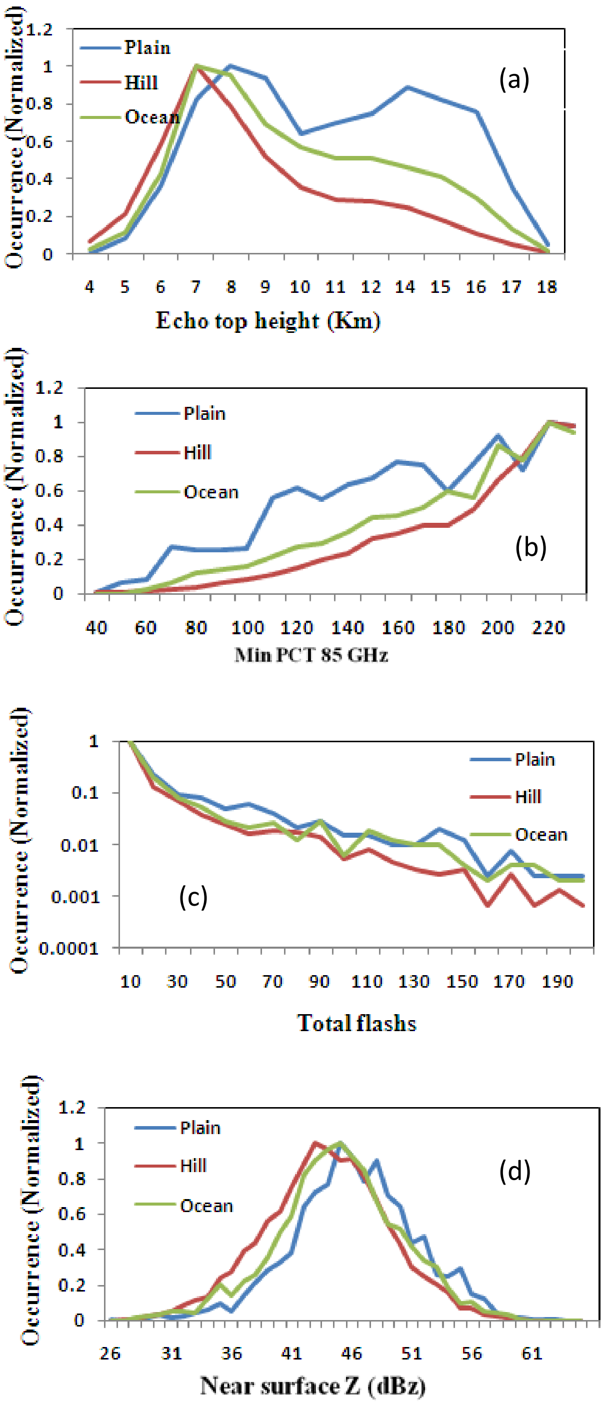

FIGURE 2: Occurrence (Normalized) of various satellite derived convective indices over plain, hill and oceanic region (a). ETH_{20dBZ}, (b) Min. PCT_{85}, (c). Total no. of lightening Flash and (d). NSZ $_{dBZ}$

Similar pattern is also observed for Min. PCT_{85}, total no. of lightening flash and NSZ_{dBZ}

The association between satellite derived convective indices and environmental convective parameters are studied with the help of correlation analysis. The results of the analysis are provided in Table -1. The satellite derived convective indices are best correlated with the of environmental convective parameter (CAPE-CIN) over the plain region of Bangladesh and least over the hilly region of north east India. It is also found that over Bangladesh, $ETH_{20\ dBZ}$ is best correlated (0.64) with CAPE-CIN and followed by total no of Lightening Flash (0.62), NSR_{dBZ} (0.53) and PCT_{85}.

Topography	CAPE-CIN Vs ETH_{20dBZ}	CAPE-CIN Vs min. PCT_{85}	CAPE-CIN Vs Total Flash	CAPE-CIN Vs NSZ $_{dBZ}$
Hill	0.44	0.40	0.36	0.41
Plain	0.64	0.50	0.62	0.53
Ocean	0.55	0.45	0.58	0.49

TABLE 1: Correlation coefficient for satellite derived convective indices and environmental convective parameter

IV. CONCLUSION

MCSs characteristics are studied over the different topographic region of north east part of India (Hill), Bangladesh (plain) and northern Bay of Bengal (Ocean). Satellite derived convective indices are associated with the environmental convective parameter. Distinct characteristics of convective storms are observed over each terrain. The salient features of the results are

(i). Occurrence of MCSs are in accordance with the El Nino and La Nina features over the region i.e. less MCSs during El Nino and more MCSs during La Nina.

(ii). MCSs are stronger over Bangladesh plain followed by northern Bay of Bengal oceanic region and hill region of north east India.

(iii). The environmental convective parameter (CAPE-CIN) is best correlated with the satellite derived indices over the Bangladesh plain and followed by northern Bay of Bengal and north east part of India.

(iv). Over plain and ocean region, the CAPE-CIN is best correlated with ETH_{20dBZ} and followed by total no. of lightening flash, NSZ $_{dBZ}$ and min. PCT_{85}.

(v). Over the hill region, total no. of lightening flash is least correlated with the CAPE-CIN parameter.

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