THE CHARACTERSTICS OF MESOSCALE CONVECTIVE SYSTEMS OVER TROPICS AS OBSERVED FROM TRMM MICROWAVE IMAGER

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I. INTRODUCTION

Mesoscale Convective System (MCS), that occurs with an ensemble of thunderstorms, produces a contiguous precipitation area of the order of 100 km or more in horizontal scale in at least one direction (Houze 1993). MCSs appears in many forms, ranging from a relatively disorganized mass of convective cells to a highly organized convective line producing a large variety of hazardous weather (Fujita 1978, Klimowsky et al. 2004). The study of space and time variations of Mesoscale Convective Systems (MCSs) is important in climate research for the better understanding of the hydrological cycle.

The remote sensing of the MCSs by the satellite onboard sensors is usually carried out in many spectral band such as visible, (Kilonsky and Ramage 1976), infrared (Maddox 1980) and microwave (Mohr and Zipser 1996). At visible and infrared wavelengths, clouds are opaque and precipitation is estimated from the measurements made at the top of the clouds. The advantage of using the microwave portion of the spectrum is that the microwave radiation penetrates the clouds and facilitates the study of the internal structures of the precipitating systems.

II. PRESENTATION OF RESEARCH

The present study is carried out by using the 4 years of TRMM Microwave Imager (TMI) 1B11 data product, during 2004 -07. The main objectives of the present work are to study the following characteristics of the MCSs over different tropical regions i.e. (i). the occurrence of MCSs (ii). the severity of the MCSs and (iii) the shape of the MCSs. For the present study the nine regions between the 20 ^{0}N to 20 ^{0}N, over land (Tropical Africa, Tropical South America and Tropical India), ocean (Tropical Atlantic, Central Pacific, East Pacific and Tropical Indian ocean) and the combined land -ocean region (Central America and Maritime continent) are selected.

The MCSs are identified by an area bounded by PCT_{85} value of 250 ^{0}K of at least 2000 km^2, with a minimum PCT_{85} value of ≤ 225 ^{0}K (Mohr and Zipser 1996). For Polarization Corrected Temperature at 85 GHz channel (PCT_{85}) the following equation is utilized (Spencer et al. 1989).

$$PCT_{85} = 1.818\ Tb85\ V - 0.818\ Tb85\ H \quad (1)$$

where $Tb85$ v and $Tb85$ H are the vertically and horizontally polarized 85 GHz brightness temperatures respectively

The present approach is to detect the total number of MCS structures in a given TMI imagery (85 GHz channel) and thereby to estimate the area of each structure. In a PCT_{85} imagery, two contiguous regions are identified separately through a binary image with the given PCT_{85} thresholds. The area of each precipitating systems for the given threshold level is estimated by using the 8 - bit component connectivity algorithm in binary image (Gonzalez et al. 2007). The image analysis of TMI are carried out with the help of image processing toolbox of MATLAB.

The monthly variation of the occurrence of the MCS per unit area (km^2) over land, ocean and the land - ocean combined region are compared with the total rainfall over the same region. From these analysis it is observed that the occurrence of the MCSs are matching with the wet and dry seasons over each region. The diurnal variation of the normalized values of the occurrence of the MCS (per unit area) over land, ocean and the land - ocean combined region are shown in figure 1 (a, b, c) respectively. The distinct patterns of the diurnal variation of MCSs occurrence is observed. Over land the semidiurnal variation i.e. early morning (03-04 hrs) and late evening (18-19 hrs) maximum, & mid day (12hrs) and pre mid night (21-22 hrs) minimum are quite significant. Whereas over ocean the diurnal variation is most dominant i.e. mid night to morning is maximum and mid day to late night is minimum. Further over the combined region the week diurnal variability is noticed, with maximum during early morning and pre mid night hours and minimum at 14-16 hrs.

The severity of the MCSs are studied by utilizing the minimum PCT_{85} . The normalized value of the occurrence of minimum PCT_{85} over land, ocean and the combined land - ocean region are shown in figure 2 (a, b, c) respectively. Overall significant variability in the occurrence of minimum PCT_{85} is observed over land compared to ocean and combined region. Moreover the MCSs are observed to more severe over land compared to ocean and combined region. Over the ocean the variability and severity is least.

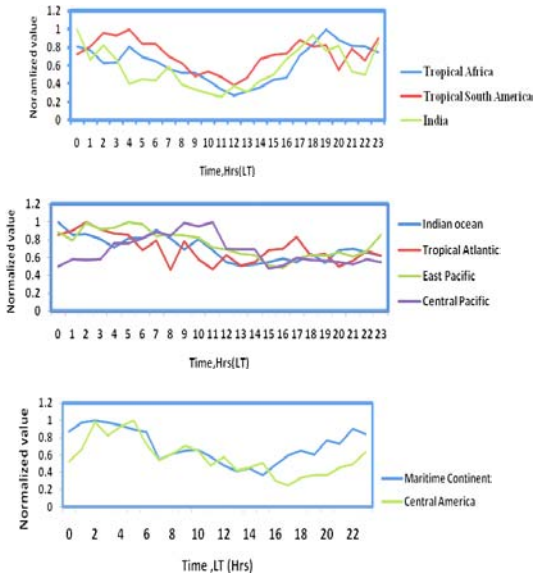

Figure1 : Diurnal variation of MCS population over (a) Land (b) Ocean and (c) Combined region.

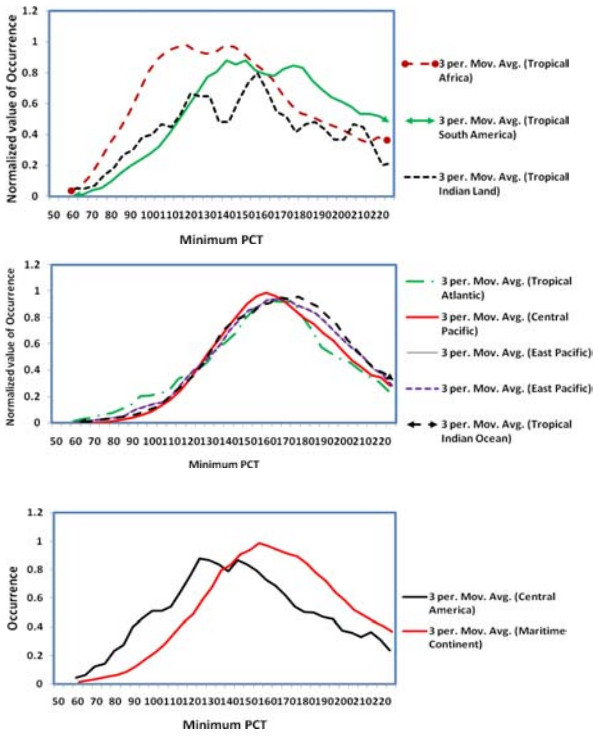

Figure2 : Occurrence of minimum PCT85 over (a) Land (b) Ocean and (c) Combined region.

The frequency distribution of the shape parameter (eccentricity of structure of the MCSs) over land, ocean and the land ocean combined region are studied. The maximum value of the occurrence of eccentricity is 0.9-1.0 which signify the dominant occurrence of the line shaped MCSs.

III. RESULTS AND CONCLUSIONS

The following conclusions are drawn from the present study.

1. In spite of low sampling coverage of TRMM over tropics, it is able to capture the pattern of seasonal and diurnal variability of rain parameters i.e (1). maximum occurrence of MCSs during the wet seasons of each region (2). The strong diurnal and semi diurnal variation over ocean and land respectively and (3) the weak semi diurnal variation over the combined region.

2. The MCSs over land are found to be more severe compared to ocean. Over land the most severe MCS found to be occurs over central Africa and followed by tropical India and tropical south America. The severity of MCSs over all the oceanic region is significantly uniform. Over the combined land - ocean regions the severity over central America is more compared to maritime region.

3. Overall the MCSs are found to be dominated by line shape over all the regions. Relatively, over oceanic region, significant circular shaped MCSs are observed compared to land region

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