JP3.4 **MESOSCALE CONVECTIVE SYSTEMS OCCURRED IN NORTHWESTERN MEXICO DURING NAME**

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## 1. INTRODUCTION

One of the best known cloud systems is the Mesoscale Convective System (MCS), which is a cloud system that occurs in connection with and ensemble of thunderstorms and produces a contiguous precipitation area ~100 kilometers or more horizontal scale in at least one direction (Houze, 1993). To know if a cloud system is a MCS, it is necessary to compute its precipitation area. This can be done using raingauges, but a dense network is needed, one raingauge by 100 $km^2$ approximately (Lebel and Amani, 1991). For this purpose, geostationary satellite images are better, because they cover a big area continuously. Specifically, infrared satellite images can compute cloud-top temperatures and, indirectly, precipitation area. Generally, colder clouds mean greater thickness clouds and rainfall. Threshold cloud top temperatures, to separate rainy areas of non-rainy areas using infrared satellite images, are between 235° and 206°K (Houze, 1993).

On the other hand, Mexico is considered as one of the regions with the highest MCS frequency in the world (Mohr and Zipser, 1996). Few studies have been done about Mexican MCS. Howard and Maddox (1988) studied meso-alpha convective systems in Northern Mexico using enhanced infrared imagery. They classified meso-alpha MCS in three kinds: West coast, lower West coast and East coast. Maddox et al. (1991) classified Northwestern Mexico convective systems in three kinds: multicell convective storms, meso-beta convective systems and meso-alpha convective systems. Farfan and Zehnder (1994) studied moving and stationary MCSs in Northwestern Mexico during SWAMP-90. They found that stationary MCSs remain in the southern portion of Gulf of California; while moving ones develop and move parallel to the Sierra Madre Occidental (SMO). Reyes et al. (1994) suggested, without prove it, that Northwestern Mexico annual rainfall is determined by the number of MCS and tropical cyclones occurring in certain year. Valdes-Manzanilla and Pastrana (2000) made a survey of mexican MCSs during 96-98 using satellite imagery. During that period of study 1086 MCSs were observed. MCSs occur mainly in summer months and mexican coastal zones. In summertime, they are small and short-lived, initiating near sunset, finishing near midnight, and moving from the east. In other seasons, they tend to be longer-lived, and moving from variable directions. They develop mainly in the mexican Pacific Coast and Bay of Campeche. Their average lifetime is seven hours.

Finally, the accomplishment of a field experiment in Northwestern Mexico called North American Monsoon Experiment, (NAME) during summer 2004 (Higgins et al., 2003), whose one of its main objectives is to study the summer convective processes in a coastal zone with complex topography as is the northwest of Mexico, provided a unique opportunity to study MCSs in this region.

The objective of this work is to know the frequency and spatial and temporal distribution of Mesoscale Convective Systems in Northwestern Mexico during NAME using infrared satellite images.

## 2. DATA AND METHODOLOGY

GOES-12 infrared satellite images were used for the present study. They were received in the satellite receiving station of the Mexican Meteorological Service in Mexico City. These

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images were originally in graphical format PCX, but they were transformed to raster format of 8 bits by pixel and 640 x 472 pixels, using a program called PCX2RAS, kindly provided by Marco Antonio Sosa Chiñas.

The study area covers from the US-Mexico border until latitude 20°, between longitude 115° and 105°W, except an area in the Mexican plateau, starting in the US-Mexico border with longitude 108°W and finishing at 105°W and 25°N. The period of study was from July 1st to and August 31st 2004.

For the purpose of this study, a cloud system is identified as a MCS if five criteria are met (Table 1). These criteria are related to those used by Bartels (1984) and Hashem (1996). ASMEIS software was used to find cloud systems that met that criteria (Sosa-Chiñas and Valdes-Manzanilla,1999).

The methodology used was the following:

1) For each cloud system, ASMEIS software computes the greatest lineal length of area bounded by -54°C (219°K) isotherm and determines its centroid of -54°C cloud system.
2) If a cloud system met the criteria to be considered a MCS, then its centroid at different times is used to determine its track.

Reanalysis data of the NCEP global spectral model (Kanamitsu, 1991) were obtained to analyze meteorological conditions associated to MCSs. These data were obtained of NOAA Climate Diagnostic Center (www.cdc.noaa.gov).

## 3. RESULTS

76 MCSs were found during July and August 2004, 10 % more than mean MCSs number observed during period 97-99 (68.7), indicating that summer 2004 was an active monsoon season. 41 MCSs were found in July 2004, 13% more than mean MCSs number observed for that month during 97-99 (36.3). In august 2004, 35 MCSs were observed, 8 % more than mean MCSs number for that month during 97-99 (32.33).

In July 2004, MCSs occur mostly in the coastal plain and Sierrra Madre Occidental, from Nayarit state until U.S. Mexico border (figure 1). Few MCSs tracks were directed toward or over the Gulf of California. MCSs movement was mostly from the southeast.

In August 2004, MCSs occur mostly in the coastal plain and in the Sierra Madre Occidental. Some MCSs tracks were directed toward the Gulf of California, specifically in the southern portion of area of study (figure 2).

From the synoptic point of view, during July and August 2004, there was a ridge at 500 hpa, more to the south and less intense than normal, over region of study (figure 3). It caused subsidence heating and lower heights in the northern Mexican plateau, increasing the east-west gradient between the plateau and coastal plain and intensifying mountain-valley circulation and westerly winds near surface. On the other hand, midtropospheric easterly winds brought dry air from the plateau to the coastal plain, increasing convective instability (moist air below dry air) and the possibility of MCS formation in the coastal plain and Sierra Madre Occidental.

## 4. CONCLUSIONS

The formation of Mesoscale Convective Systems during NAME was more active than normal, due to more favorable meteorological conditions.

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**Table1. Definition of a Mesoscale Convective System based on infrared imagery**

| CRITERION | PHYSICAL CHARACTERISTICS |
|---|---|
| Length | Length scale of cloud area with temperatures <-54°C > 250 km |
| Duration | Minimum length maintained for at least 3 hours |
| Maximum extension | Contiguous cloud shield reaches maximum area |
| Initiation | Length scale criterion is first met |
| Termination | Length scale criterion is no longer met |

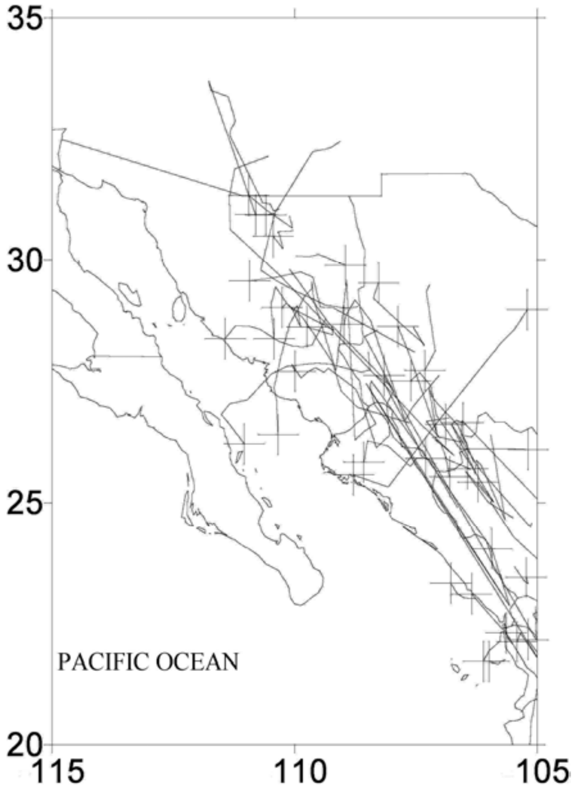


Figure 1. MCSs tracks during July 2004. Plus sign shows final MCSs track positions.

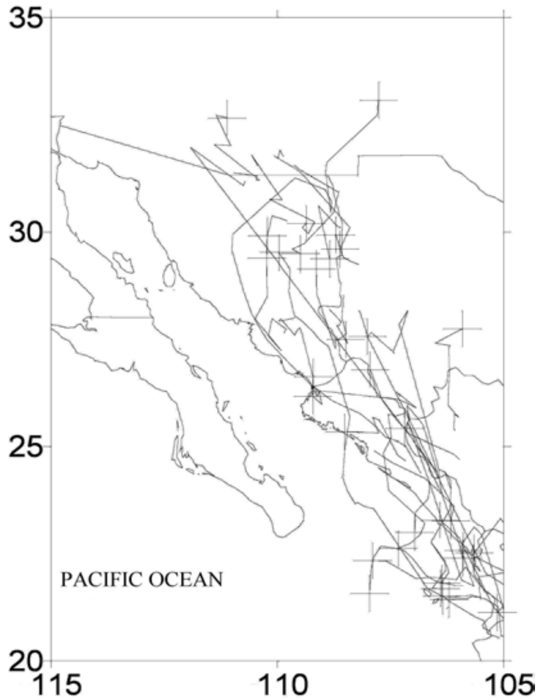


Figure 2. MCSs tracks during August 2004. Plus sign shows final MCSs track position.

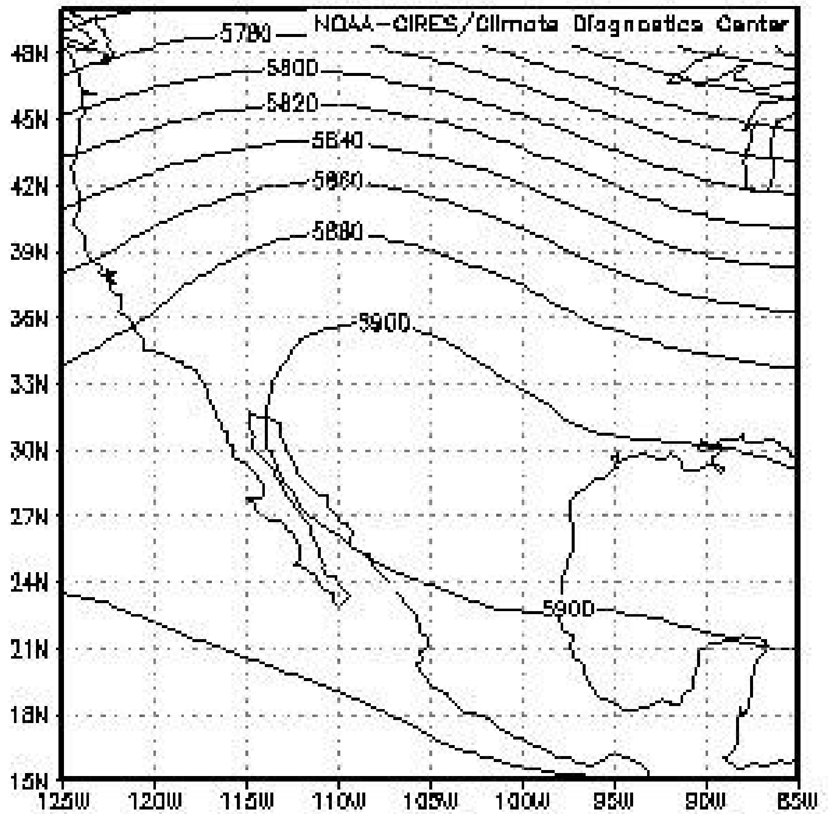


Figure 3. 500 hpa mean heights for July and August 2004.