P2.2 SOME CLIMATOLOGICAL CHARACTERISTICS OF SOUTH AMERICAN MONSOON SYSTEM

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1. INTRODUCTION

The development phase of the South American monsoon system (SAMS) starts during the south hemisphere spring and it is followed by a rapid southward shift of the region of intense convection from northwestern South America to the southern Amazon basin and Brazilian highlands (Kousky, 1999). The decay phase of SAMS is followed by the withdraw of the intense convection near the end of summer and the start of autumn. These patterns can be changed by external influences, as Sea Surface Temperature at Pacific and Atlantic oceans.

Veiga et al. 2002 studied the influences of the Atlantic and the Pacific oceans on the summer monsoon rainfall over South American (SA) and observed that there are areas around those oceans exerting influences on SA monsoon rainfall. Many general characteristics of the SAMS are already known, but peculiar studies concerning the SAMS are still necessary. The main objectives of this article are to find some particularities of the SAMS, as to discover what area of the SA could be considered a monsoon region, to show how the most differential heating is placed, if east-west or north-south, and to find ocean areas that influence monsoon rainfall.

2. DATA AND METHODOLOGY

The variables used in this study are monthly mean data of sea surface temperature (SST) from NCEP-NCAR reanalysis (Kalnay et al. 1996) and precipitation from Global Precipitation Climatology Project (Huffman et al. 1997). These data are given on a 2.5° by 2.5° latitude and longitude grid. The data cover a period of 21 years (1979-1999). The first step in this study is finding an area considered a monsoon region. For that, it was necessary to do the rainfall climatology for each season and to detect the percentile rainfall contribution for each one. With this information we could find both the season and the area of maximum precipitation values. The second step is to discover how the main differential heating is placed, if north-south or east-west. For this it was necessary to convert mm/day of precipitation in K/day of latent heat release (Newell 1972), and to make a meridional and a zonal section, crossing the monsoon area, having the integrated values of the latent heating. The last step is to correlate the precipitation values to that season of greatest contribution of rainfall within a season with the SST along the Atlantic and Pacific oceans for the same season.

3. RESULTS

The present results described here are a continuation of the work of Veiga et al. (2002), and the main results concern the peculiar characteristics of the SAMS. Maps having percentile precipitation information were used. The first map (Fig. 1a) informs the percentile rainfall for December, January and February (DJF), the second one shows the March, April, and May (MAM) percentile rainfall contribution for the total annual rainfall, and so on. As we can see, Fig. 1a shows that the maximum percentile rainfall occurs on Central Brazil, where more than 45% of rainfall falls during the summer. The Figs. 1b and 1c show that during the decay phase of monsoon the rainfall percentile doesn't achieve 30% and 10% on Central Brazil, respectively. During spring the SAMS becomes strong again and the rainfalls over Central Brazil increase (Fig. 1d). In Fig. 1a we see that the SA monsoon region embraces an area between 5°-20° S and 40°- 60° W. Another interesting feature is that the precipitation maximum, about 2700 mm, occurs over the Amazon basin. But if we assume the monsoon definition, we see that the region of monsoon doesn't coincide with the region of precipitation maximum (not showed).

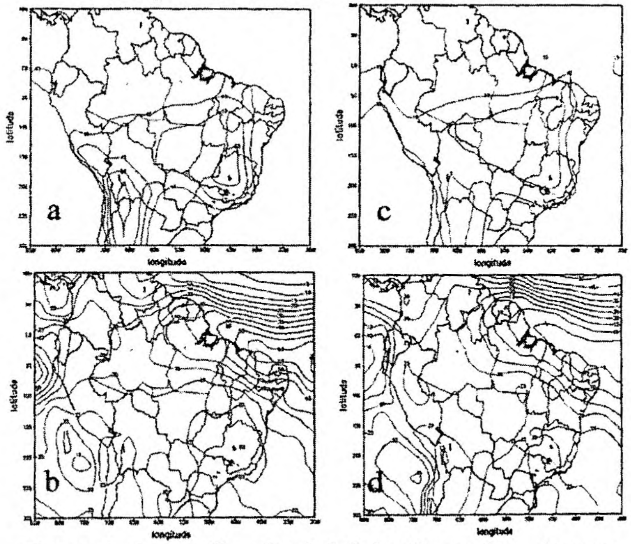

Figure 1. Percentile of rainfall for December, January and February (a), March, April and May (b), June, July and August (c), and September, October and November (d).

To answer the question "how is the most intense differential atmospheric heating placed? If east-west or north-south", Fig. 2. Was made. As we can see, this figure shows that the distribution of latent heating is

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most uniform in the meridional (Fig. 2a) than in the zonal direction (Fig. 2b). It can also be seen that the latent heating is much bigger on the continent than on the oceans. So, the major difference on the atmosphere heating is on the east-west direction, which on the other hand that difference occurs on meridional direction on Asia monsoon. It means that a thermal direct circulation, with ascent motion over the Central Brazil and descent motion on Atlantic ocean, must be maintained and it drives the monsoon during summer times. So, an interesting fact would be to investigate where lies the source of humidity for the monsoon region, if it comes from either the west Atlantic, by direct thermal circulation, or north Atlantic, by the Low Level Jet.

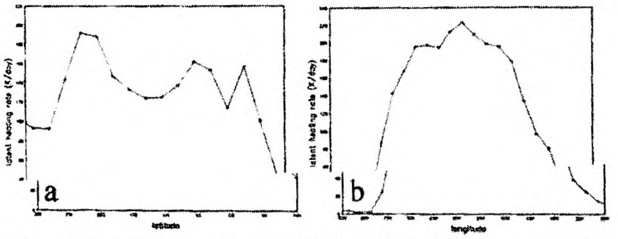

Figure 2. North-south in 45° W and (b) East-west in 15° S (b) distribution of latent heating rate, that represents the atmosphere heating by condensation of water vapor.

With the purpose of identifying some oceanic areas that influence the SAMS, a map was made with correlation fields between SST and rainfall for DJF (Fig. 3). This figure shows the areas on Pacific and Atlantic oceans that are more correlated with the monsoon rainfall. As we can note there are three extensive areas around Pacific exerting significant influence on the monsoon area. This result indicates that an El Niño Southern Oscillation (ENSO) event should alter the pattern of the monsoon rainfall, but this will depend on how strong is the El Niño/La Niña event. Another interesting feature concerning the Atlantic ocean area is that it would influence locally. That can happen through alteration of the direct thermal circulation suggested early.

4. CONCLUSION

Using climatology monthly mean data of precipitation and SST it was possible to show some particular features of the SAMS. Among them, we could find a area in SA with precipitation behavior is similar to that on an Asian monsoon area. This area embraces an area between 5°-20° S and 40°- 60° W. Its climatological rainfall percentile showed that during summer rainfall achieves values above 40% annual total.

During winter, when the SAMS is absent over SA, the total rainfall doesn't achieve 5% on the monsoon area. There are some explanations for this. Among them, during the dry season the latent heat release, the major SAMS driver, is completely absent, the land is cold and there is no thermal contrast between the south Atlantic and the monsoon area. All this facts should contribute to the monsoon's break.

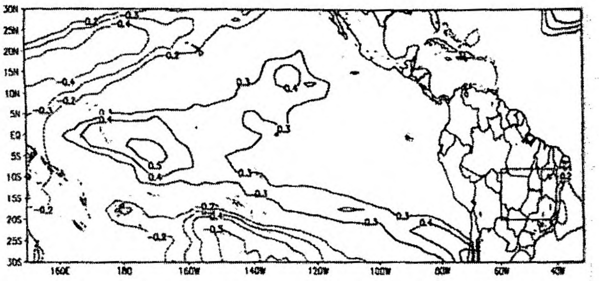

Figure 3. Correlation coefficient between the TSM grid points and monsoon rainfall averaged in the box. Both values of TSM and rainfall are for December, January and February.

We still saw that during summer the zonal atmospheric differential heating is more intense than the meridional differential heating. This could ignite a direct thermal circulation to maintain the monsoon existence. That will be subject of more research. The correlation map showed that the monsoon rainfall is affected by its Atlantic seashore and a large area in the equatorial Pacific which indicates that the monsoon should suffer changes depending how strong are the SST anomalies in that oceans.

4. REFERENCES

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