J4.6 A climate shift in mid-1970's in Northwest Amazonia and Southern Brazil

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1. INTRODUCTION

The shifts in atmospheric and oceanic variables that occurred in the mid-1970s in the North Pacific, termed as climate regime shift, have received much attention in the last decade, and several studies have documented the impact of this climate change.

It is of great interest to determine the impact of this climate regime shift over Brazil, particularly in the rainfall regime because it affects the hydrological cycle, with socioeconomic impacts, primarily in agriculture and water resources.

This work presents evidence of that climate regime shift impact on the precipitation in two extreme regions of Brazil: Northwestern Amazonia (NWA) and Southern Brazil (SB). The analyses were performed on rainfall monthly data from 1951 to 1990, and it is used the sea level pressure (SLP) of NCEP/NCAR reanalysis data.

2. RESULTS

The main features of the interannual variability of the rainfall annual cycle in NWA and SB regions, based on data of two representative stations of these regions, located at 0.6°S/69.2°W and 31.4°S/52.7°W, respectively, are shown in Figure 1. These features are: a) monthly linear trend in the same direction in all months of the year for both regions, with a negative trend in NWA (Fig. 1 a) and a positive trend in SB (Fig. 1 b); b) the linear trend seems to be related to the climate shift around the 70's, as it is shown by the smoothed monthly time series by "LOWESS". The linear trend in the station representative of the NWA region (Fig. 1 a) is statistically significant at 95% (Mann-Kendall test) in March and July. It is necessary to point out that the linear trend in March (November) in NWA (SB) are both spatially coherent and significant at 95% over each region.

Figure 2 depicts another manner of visualizing the impact of the climate regime shift occurred in midd-70's through the behavior of the rainfall PDF's at the representative stations for both regions. The PDF's computed from monthly data of the periods clustered prior and after 1975 shows the following differences: a) the variance of rainfall over NWA is smoother in comparison to rainfall over SB for the two periods; and b) the change in the mean value (prior and after 1975) in SB is less than the one observed in the NWA, which depends on the monthly rainfall intensity.

In NWA (Fig. 2 a), a substantial shift towards lower values is observed when the data is clustered after 1975. The PDF curve is shifted towards the left of the diagram, with a change in both the skewness and kurtosis of the distribution. Also, the apparently bimodal distribution observed prior 1975 disappears, and the larger differences between the distributions are found at around 200 mm and at 400 mm. The climate regime shift in SB has opposite sign in relation to NWA, as shown by the PDF's of monthly precipitation (Fig. 2 b). The PDF curve for the period clustered post 1975 is shifted towards the right of the diagram indicating a change in the distribution parameters, and the maximum differences between the two distributions occurs near to 160 mm and 210 mm.

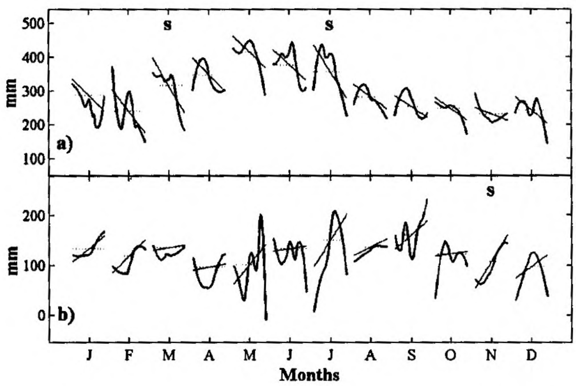

Fig. 1 Rainfall annual cycle variability (1951-1990) in (a) Northwestern Amazonia (0.6° S–69.2° W) and (b) Southern Brazil (31.4° S–52.7° W). Time series smoothed by "LOWESS" (thick line), linear trend (thin line) and monthly mean (dashed line).

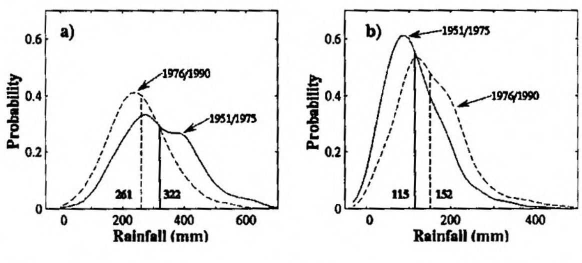

Fig. 2 Probability density function of rainfall monthly distribution for the periods prior and after 1975 in (a) Northwestern Amazonia (0.6° S–69.2° W) and (b) Southern Brazil (31.4° S–52.7° W).

Thus, the climate regime shift observed in mid-70 appears to have modified the amplitude of the rainfall annual cycle, in both the SWA and SB regions.

The series characterizing the austral summer for NWA and austral spring for SB regions (Fig. 3) was constructed from the mean of monthly rainfall value of

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four station in each region for March and September, respectively.

The rainfall variability during the period 1950-1990 (Fig. 3 a-b) is dominated by long time scales in both time series, as evidenced by the smoothed time series, and also by strong interannual variability. Some studies (Liebmann and Marengo 2001; Diaz et al. 1998) indicates that the interannual variance over these regions is contained mostly in scales of the ENOS phenomenon. Besides it, the positive (negative) linear trend in SB (NWA) region is statistically significant at 95% and seems to be consequence of the variability of long time scales. The slope of the linear trend in SB and NWA region is 2.80 mm/year and –3.80 mm/year, respectively.

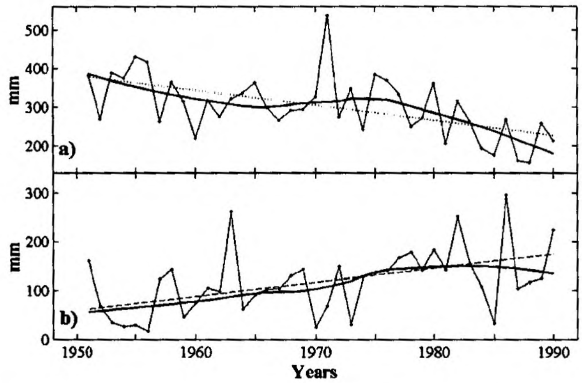

Fig. 3 Rainfall monthly mean of March for Northwestern Amazonia (a) and of November for Southern Brazil (b). Smoothed times series by "LOWESS" (thick line) and linear trend (dashed line).

The Mann-Kendall sequential statistic test (Gossens and Berger 1987) indicates 1976 (1973) as the year when abrupt change in rainfall occurred in NWA (SB) region for the March and September months, respectively. These years were confirmed through the point-change test.

The causes and mechanisms of climate variability in the North Pacific are not fully understood. However, an idea of how that variability affects the climate of Brazil can be obtain through the analysis of composites in order to gain some knowledge on the underlying dynamics or suggestion of some teleconnection mechanism.

The differences of JFM and SON composites for the periods prior and after 1975 are presented in Figure 4. In summer months (Fig 3 a) the rainfall change in NWA appears to be related to changes of the Icelandic Low and the Azores high in the Northern Hemisphere and of the Circumpolar Low, associated with the Antarctic Oscillation (AO), in the Southern Hemisphere. It seems that when both Icelandic Low and the Azores High are intense (positive NAO index) moisture transport into South America is not favored. On the other hand, intensification of the circumpolar low related to the occurrence of blocking events, particularly around the low pressure system centered at 120° W-60° S which modulates the patterns of precipitable water anomalies over South America (Kayano 1999), cam modify rainfall over some regions of Brazil.

In the austral spring months (Fig 4 b) the intensification of the Circumpolar Low is more intense than in summer month for the period after 1975, but the low pressure system centered at 120° W-60° S, has been displaced southeastward. This configuration apparently does not facilitate blocking development.

Finally, an important conclusion is that the likelihood of the teleconnectivity between the North Pacific climate shift and long time variability and the rainfall regime over some regions of Brazil holds a promise for a more predictive long term forecast

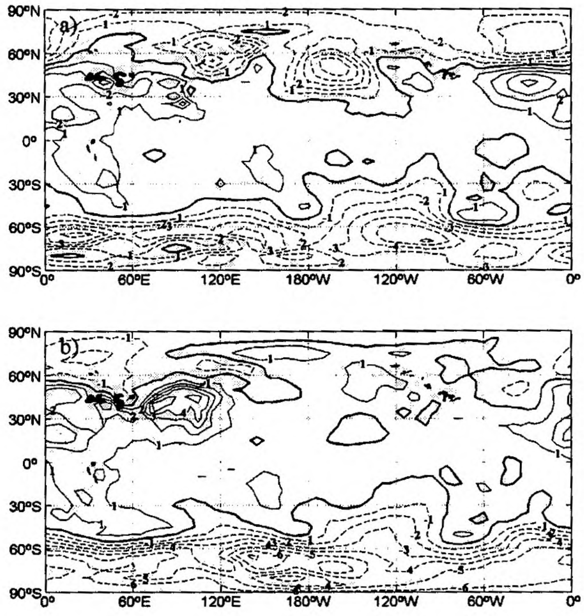

Fig. 4 Seasonal composite of SLP difference between 1976/1990 and 1951/1975 for austral summer (JFM) (a) and for austral spring (SON) (b). Contour interval is 1.0 hPa. Negative contours are dashed. Zero line is thicker.

3. REFERENCES

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