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14. Abstract/Notes

The 1982-83 El Niño/Southern Oscillation (ENSO) was one of the most intense ever recorded and it has affected the climate and weather in South America in several ways causing floods in many areas and droughts in others. Here we will concentrate on two aspects: a) the abnormal dry period during January-February 1983 in central and northern Amazon and the severe drought over Northeast Brazil, from January through June, and b) the extensive flooding in southern Brazil, northern Argentina and Paraguay in May-July 1983. Precipitation analysis for northern South America reveals monthly rainfall values up to 70% below the climatological mean for January-February 1983 in central and northern Amazon and up to 60% below the mean for January-June 1983 (rainy season) in Northeast Brazil. Analysis of the 200 mb velocity potential charts from December 1982 - February 1983 seems to indicate that the cause of that unusual dry spell was an anomalous Walker circulation. Its rising motion was concentrated over equatorial central and eastern Pacific in the region of very warm sea surface temperature (SST) and increased convective activity. Its sinking branch extended over a broad tropical area covering most of the Amazon, Northeast Brazil and Tropical Atlantic. The extensive flooding in southern South America in May-July 1983 was caused primarily by excessive rainfall from a few quasi-stationary frontal systems.

15. Remarks *To be presented at 16th Conference on Hurricanes and Tropical Meteorology, Houston, Texas, May 1985.*

DROUGHTS AND FLOODS IN SOUTH AMERICA DUE TO THE 1982-83 EL NIÑO/SOUTHERN OSCILLATION EPISODE

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1. INTRODUCTION

The 1982-83 El Niño/Southern Oscillation (ENSO) episode was remarkably intense and also its timing was unusual. It has affected the climate and weather globally. South America experienced floods in many areas and droughts in others. It is not completely clear weather climate anomalies throughout the world were indeed related to this recent ENSO episode. Here we will report preliminary results in which we attempt to show that some climate anomalies observed in South America during 1983 seem to be linked to the ENSO episode. We will concentrate on two climate anomalies, namely, the abnormal drought over most of the Amazon and Northeast Brazil and the extensive flooding in southern Brazil, Paraguay and northern Argentina. For excellent reviews on the ENSO phenomenon the reader is referred to Rasmusson and Wallace (1983) and Cane (1983).

2. PRECIPITATION ANOMALIES

2.1 Amazon

Figure 1 shows precipitation deviations from the mean normalized by the mean (called Precipitation Deviation Index, PDI) for northern and northeastern Brazil during January-February 1983. Negative values predominate over most of the Amazon and Northeast Brazil north of about 7°S. We observe values as low as 70% below the mean for a large area in central Amazon. Precipitation was near normal in December 1982 and above normal in March 1983 for the Amazon. The dry spell in the Amazon during January-February was the driest in the last 50 years and it is interesting to remark that precipitation quickly returned to normalcy in March for most of the Amazon.

2.2 Northeast Brazil

Figure 2 shows PDI values for Northeast Brazil during January-June 1983 (rainy season in normal years). Negative values (up to 60% below the average) are observed for most of the region. Northeast Brazil is well known for being a drought-prone region and 1983 was the worst drought it experienced in the last 25 years. The drought had tremendous negative impact upon the economy and society of that over-populated area.

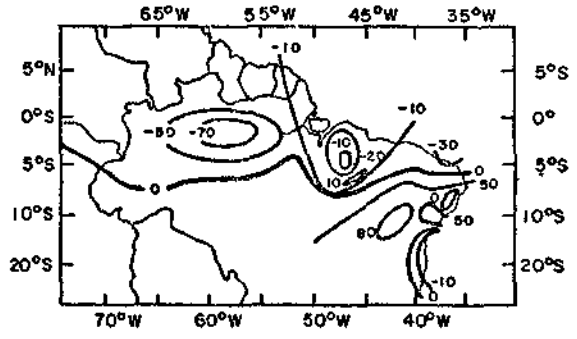

Fig. 1 - Precipitation departure index (precipitation departure from the mean normalized by the mean in percentages) for northern Brazil for January-February 1983.

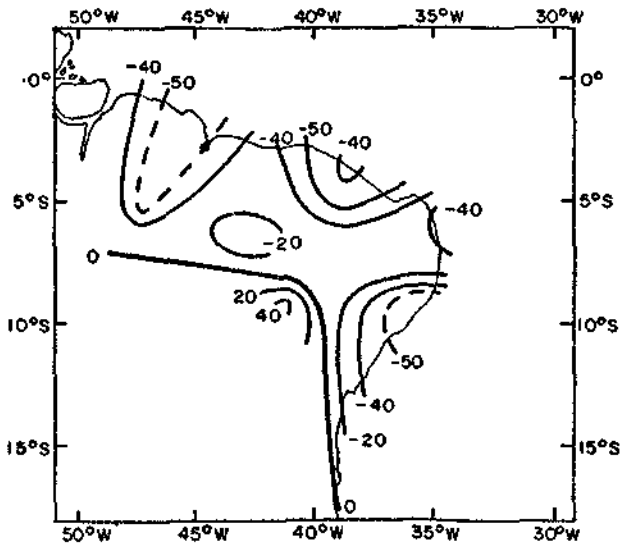

Fig. 2 - Same as in Figure 1 but for Northeast Brazil for the period Jan-Jun 1983.

-2.3 Southern Brazil

Figure 3 shows values of the PDI for southern Brazil and also southern Paraguay and northeastern Argentina during May-July 1983. Positive values are found for most of the region. Values as high as 400% above the average are seen along the Atlantic coast in southern Brazil. Such excessive rainfall had devastating effects due to the extensive floodings it caused. The area affected the most was the Province of Santa Catarina in Brazil.

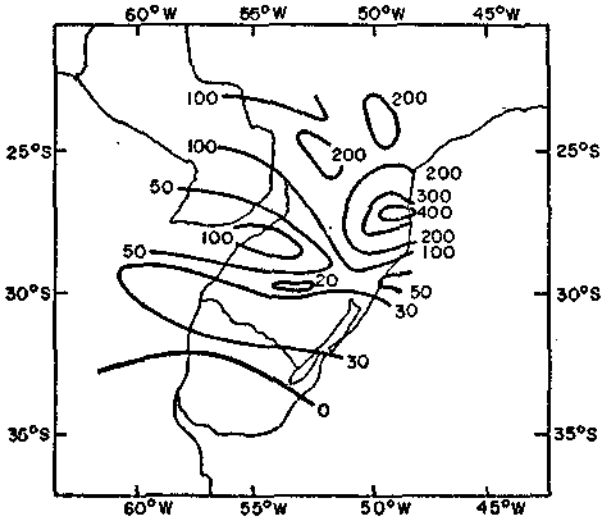

Fig. 3 - Same as Figure 1 but for southern Brazil for the period May-July 1983.

3. DICUSSION

Analysis of the 200mb velocity potential map for December 1982-February 1983 (Fig. 4) seems to indicate that the cause of the unusual dry spell in the Amazon during January-February 1983 (Fig. 1) was an anomalous east-west, thermally direct, circulation (Walker-type cell). Its rising motion was concentrated over central and eastern equatorial Pacific (minimum values of outgoing longwave radiation (OLR) indicating enhanced convective activity were found at about 0°N, 150°W for December 1982-February 1983; Rassmusson an Wallace, 1983) in the region of very warm SST's. Its sinking branch extended over a broad tropical area covering most of the Amazon, Northeast Brazil and tropical Atlantic. Normally the Amazon acts as an important heat source for the atmosphere but apparently it failed to play that role during January-February 1983.

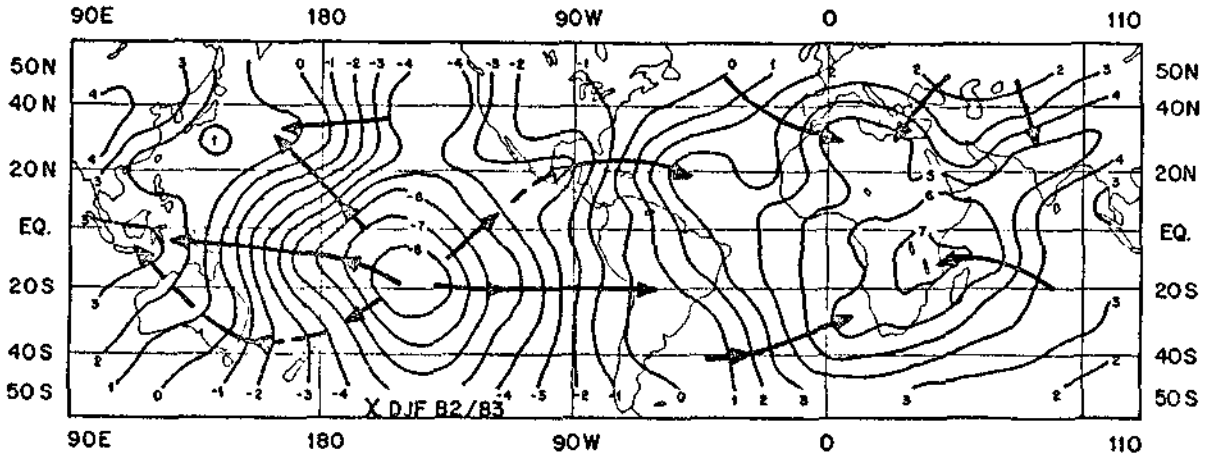

Fig. 4 - 200mb velocity potential (X) for December 1982-February 1983. Contour interval $10^6 m^2 sec^{-1}$. After: Rasmusson and Arkin, 1984.

In the March-May season anomalous warm SST's and equatorial westerlies in the Pacific moved further east to near the coast of South America. Concurrently, maps of OLR (Rasmusson and Wallace, 1983) show a secondary maximum of enhanced convective activity at 0^{o}N, 90^{o}W near the coast. Northeast Brazil's rainy season is centered in March-May for normal years. It is likely that the anomalous heat source due to the enhanced convective activity over eastern Pacific gave rise to an anomalous Walker-type circulation with descending motion over Northeast Brazil during that region's rainy season thus creating the conditions for a severe drought to occur.

The extensive flooding in southern Brazil and adjacent areas during May-July 1983 was caused primarily by excessive rainfall from a few frontal systems or convective cloud clusters which remained quasi-stationary over that region due to a blocking situation. For reasons that are not clearly known it is possible that this atmospheric blocking was related to the anomalously fast subtropical jet stream over South America. Figure 5 shows 200mb wind and OLR anomalies for June-August 1983. The region of maximum wind anomalies over South America roughly coincide with the position of maximum precipitation anomalies. The observed position of maximum enhanced convective activity over eastern equatorial Pacific (Fig. 5, dashed lines) and the position of maximum 200mb wind anomalies to the southeast of it are consistent with the theorethical results of Nobre (1983). He has shown that intense tropical heat sources cause, by a nonlinear mechanism, a strengthening of the subtropical jet stream poleward and to the east of the heat source. It remains to be seen, however, how an unusually fast jet stream would block the migration of frontal systems.

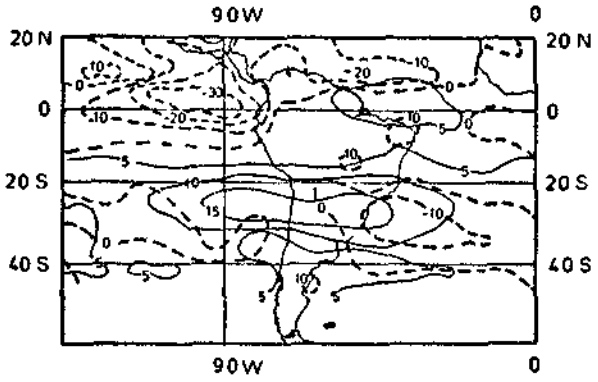

Fig. 5 - 200mb wind anomalies (full line, isotach contour interval 5 m sec^{-1}) and outgoing longwave radiation anomalies (dashed line, contour interval 10Wm^{-2}) for June-August 1983. Adapted from Arkin et al. 1983.

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