Poster Session 2, Climate and Low Frequency Variability
Sixth International Conference on Southern Hemisphere Meteorology and Oceanography

P2.30

Atmospheric circulation features associated with the precipitation variability over the south region of Northeast Brazil

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The atmospheric circulation features associated with the precipitation variability during the main rainy period (NDJ) of the south region of Northeast are determined through the ACP and Cluster analyses. Daily precipitation data and NCEP reanalysis data are used. The meteorological summer systems of South America, as well as the phenomena associated with their variability, such as ENSO, are identified. Positive (negative) anomalies of precipitation in the south region of Northeast are related to the positive (negative) phase of ENSO. It is pointed out that the wet pattern is related to the shift of the South Atlantic Convergence Zone (SACZ) northward and the South Pacific Convergence Zone (SPCZ) eastward. The rainy patterns are also associated with the tropical upper cyclonic vortex situated over the Atlantic Ocean, intense convection over the east region of Amazon and shift of the Bolivian High to the east. The flow at low levels is directed from the Amazon to the south region of Northeast and there is intensification of the northeast trade winds over the northern coast of South America. The dry pattern is associated with the SACZ displaced southwards and the tropical upper cyclonic vortex either close or over the continent. In this case, the Bolivian High is displaced to the west of its climatological position and the wind flow at low levels over South America is directed to southeast Brazil.

2:15 PM, Sunday, 4 April 1999

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P2.30 ATMOSPHERIC CIRCULATION FEATURES ASSOCIATED WITH THE PRECIPITATION VARIABILITY OVER THE SOUTH REGION OF NORTHEAST BRAZIL

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1 - Introduction

The south region of Northeast Brazil (sNEB) is an area of approximately 1 million of Km2, located between 9°S and 18°S and 37°W and 46°W. Most of sNEB experiences spatial and temporal rainfall variability and the causes of the great varibility are not yet fully understood. The main rainy period of this region is NDJ, with maximum rainfall in December, (Kousky and Chu, 1978) and (Chaves, 1999). This work aims to identify atmospheric circulation features associated with precipitation variability over the south region of Northeast Brazil in NDJ.

2 – Data and Methodology

Daily rainfall data of 99 stations from NDJ 1979/1980 to NDJ 1996/1997 were analyzed. Reanalysis data from National Centers for Environmental Prediction (NCEP) were used to analyze wind fields, specific humidity and relative vorticity.

Principal Components Analysis was performed coupled with Cluster Analysis to determine the atmospheric patterns associated with precipitation over sNEB. The " K-means" method of cluster is used (Hartigan, 1979). To determine the relationship between a specific atmospheric pattern and the daily precipitation, a Performatic Index(PI) was used, which is defined as a measure of the relative contribution of a specific pattern of circulation in the total amount of rainfall (Zhang et al. 1997).

$$IP_i = \frac{R_i / n_i}{R / n} \qquad (1)$$

where n_i is the number of occurrence of a specific pattern, R_i the total amount of precipitation during these n_i days and (R/n) represents the climatological daily average of the period of n days. If PI_i is greater (smaller) than 1.0, the specific pattern has (has not) significant contribution in the precipitation of the considered period.

Considering two main clusters which are associated with the precipitation anomalies over sNEB, the composite technique was performed to obtain composites of meteorological fields associated with rainy and dry cases. The statistical significance of the composites was verified applying the Student's test.

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3 - Results

The 700 hPa specific humidity anomaly composites present over the sNEB, opposite sign to those found over east equatorial Pacific Ocean. The rainy pattern, Fig. 1a, display positive anomalies, with orientation NW/SE, associated with the South Atlantic Convergence Zone (SACZ) displaced northward over the sNEB and negative anomalies over eastern equatorial Pacific Ocean. In the region of South Pacific Convergence Zone (SPCZ) an enhancement of the specific humidity is observed. In the dry pattern, Fig. 1b, negative anomalies of specific humidity over sNEB and positive anomalies over east equatorial Pacific Ocean are observed.

Associated with the rainy pattern, the South Atlantic Subtropical Anticyclone (SAA) is displaced eastward, resulting in weaker South Atlantic trade winds over the sNEB, Fig. 2a. The SAA is more intense and displaced westward, in the composite associated with the dry pattern. In this case there is intensification of the trade winds which penetrates into the continental areas, Fig. 2b. Northwest anomalies on the center-south of Brazil, favoring the flow of humidity from Amazonia to south-east of South America is observed in the dry case. In the rainy case the flow is directed from Amazonia to sNEB.

In the relative vorticity anomaly field at 200 hPa a wavetrain pattern extends from the south Pacific Ocean to South America, Fig. 3. The anomalies associated with the rainy case are in quadrature with the anomalies associated with the dry case. Anticyclonic anomalies occur over sNEB in the rainy case and cyclonic anomalies in the dry case. These patterns are similar to high frequency patterns of meridional wind which were associated with displacement of frontal systems over South America, discussed by Cavalcanti and Kayano (1999). The results of the present study indicates the influence of frontal systems on the precipitation over sNEB, which agrees with Kouky (1979).

The wind field anomaly composites at 200hPa display features of the Bolivian High (BH) and the NEB trough, Fig. 4a. In the rainy pattern the trough is located over the Atlantic and the BH is displaced eastward. In the dry pattern the trough axis is over NEB and the BH is displaced southwestward, Fig.4b.

4 - Conclusions

Positive (negative) precipitation anomalies in the south region of Northeast are related to the positive (negative) phase of ENSO. In the intraseasonal scale the rainy pattern is associated with the intensification

of the SPCZ and SACZ displaced northward and the tropical upper cyclonic vortex over Atlantic Ocean. It is also observed shift of the Bolivian High to the east, flow at low levels from Amazonia to sNEB and weakness of the South Atlantic trade winds resulting in a convergence region over sNEB.

The dry pattern is associated with desintensification of ZCPS and ZCAS and with the tropical upper cyclonic vortex either close or over the continent. The Bolivian High is displaced to the west, there is flow from Amazon region to the south and intensification of the South Atlantic trades resulting in convergence of the flow in the south-east of South America. These results agree with those of Nogués-Paegle and Mo (1997), associated with seesaw patterns in the SACZ.

5 – References

Cavalcanti, I.F.A.; M.T.Kayano, 1999. High-frequency patterns of the Atmospheric circulation over the Southern Hemisphere and South America. *Meteorol. Atmos. Phys.*, 69, 179-193.

Chaves, R. R. Precipitation variability over the south region of Northeast Brazil and its association with the atmospheric pattern. MSc. Dissertation, INPE, SJC, Brazil.

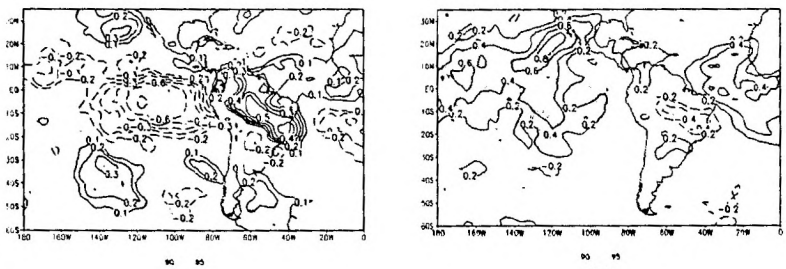
Hartigan, J. A. ; Wong, M. A. Algorithm AS 136: A K-means clustering algorithm. Applied Statistic, v.28, n. 1, p.100-108, 1979.

Kousky, V. E.; Chu, P. S. Fluctuations in annual rainfall for northeast Brazil. J. Meteorol. Soc. Japan, v.56, 1978.

Kousky, V. E. Frontal influences on Northeast Brazil. Mon. Wea. Rev., v.107, p.1140-1153, Set. 1979.

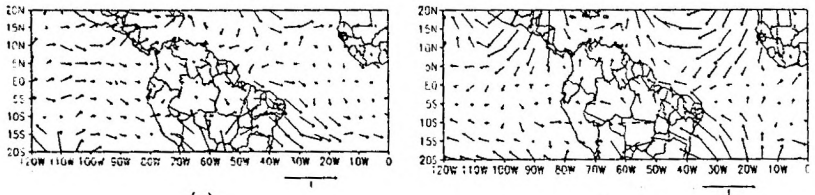
Nogués-Pagle, J.; Mo, K.C. Alternating wet and dry conditions over South America during summer. Mon. Wea. Rev., v.125, p.279-291, Fev. 1997.

Zhang, X.; Wang, X. L.; Corte-Real, J. On the relationships between daily circulation patterns and precipitation in Portugal. J. Geophys. Res., v.102, n.D21, p.13.495-13.507, Jun. 1997.



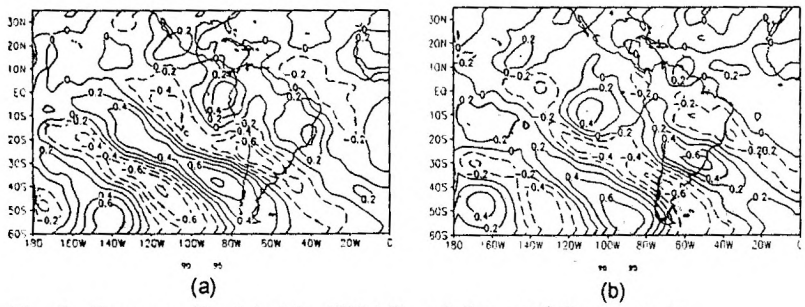
(a) (b)

Fig. 1 - 700 hPa specific humidity anomaly composites associated with positive (a) e negative (b) anomalies of precipitation over sNEB. Areas in shaded present the statistic significance of the composites.



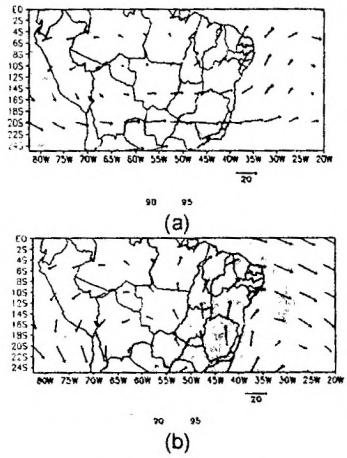
(a) (b)

Fig. 2 - Same as Fig 1 but for 850 hPa wind anomaly composites.



(a) (b)

Fig. 3 - Same as Fig.1 but for 200 hPa relative vorticity anomaly composites.



(a) (b)

Fig. 4 - Same as Fig. 1 but for 200 hPa wind anomaly composites.