

Regional Precipitation Anomalies Associated with the El Niño–Southern Oscillation, Brazil

Anice Garcia¹ and Bruno Renato Baldini²

¹ Associate Professor, Faculty of Agronomy Dr. Francisco Maeda FAFRAM
Rod. Jeronimo Nunes Macedo km 01 – CEP: 144500-000 Ituverava SP Brazil

² Former Student, Faculty of Agronomy Dr. Francisco Maeda FAFRAM
Rod. Jeronimo Nunes Macedo km 01 – CEP: 144500-000 Ituverava SP Brazil

ABSTRACT--- *This study analyses the El Niño-Southern Oscillation (ENSO) climate variability for better understanding of the processes leading to alternated anomalous precipitation regimes in Jeriquara city (São Paulo state, Brazil) (20°18'40S;47°35'21W). The monthly and annual pluviometric data over 1970 to 2000. The results clearly indicated the tendency that the mean monthly precipitation in El Niño phase is higher as compared to the neutral and La Niña phases. Comparing the average total rainfall for the period with the occurrence of ENSO phenomena it can be observed that in general, positives anomalies (excessive rainfall) have occurred during El Niño events and negative anomalies (deficits of precipitation) showing that ENSO (El Nino and La Nina) phenomenon are partially responsible for the precipitation regime over the region During El Niño events, precipitation averages was above normal, while La Niña events lead to precipitation amounts which average was below normal. This pattern of seasonal variation of precipitation in association with ENSO could help water resource managers of the state in decision making.*

Keywords--- ENSO, rainfall, long-term precipitation data.

1. INTRODUCTION

El Niño and La Niña events arise in the tropical Pacific, where strong and extensive interactions between the ocean and atmosphere can lead to warmer or cooler than usual ocean conditions that last several months. The name ‘El Niño’ nowadays is widely used specifically for the anomalous warming of the sea surface temperature that occurs every few years, typically concentrated in the east-central equatorial Pacific. ‘La Niña’ is the term adopted for episodes of cooler-than-normal sea surface temperature in the tropical Pacific that in many ways are opposite to El Niño. These episodes alternate in an irregular inter-annual cycle called the ENSO cycle. ‘ENSO’ stands for ‘El Niño Southern Oscillation’, where ‘Southern Oscillation’ is the historical term for atmospheric changes in the tropical Pacific that accompany both El Niño and La Niña episodes in the ocean[1].The extreme phases of the ENSO phenomenon have been blamed for precipitation anomalies in many areas of the world[2].

The ENSO signal in southern Brazil is opposite to that in northeast Brazil and northern Amazonia, with positive and sometimes extremely large anomalies of rainfall during the rainy season of ENSO years, whereas drought can occur during the positive Southern Oscillation phase[3, 4, 5]. However, some of the negative anomalies, e.g. January and February of 2001, have been associated to the presence of an anomalous circulation in the wind fields at high levels in the atmosphere, over Brazil, which was related to the presence and persistence of meteorological systems called Upper Level-Cyclonic Vortices (ULCV) over the Northeast, and parts of the Southeast, and Center-West regions, over the continent avoiding the formation of clouds responsible for the rainfall over South America[6].

Since precipitation is the main driver for a number of hydrologic processes, understanding the regional impacts of ENSO on precipitation can provide valuable information to water resources managers in this region. The objective of this study was to analyze the influence of ENSO events on the regional precipitation patterns on the long-term precipitation data (31 years).

2. MATERIAL AND METHODS

The monthly precipitation amounts used in this study are extracted from daily station data in a 31 year-period (1970-2000) collected at São Francisco farm in city of Jeriquara, situated in the Northeast region of São Paulo state (20° 18' 40 S and 47° 35' 21W , 920m), Brazil.

The average calculation was carried out according to the following expression:

$$\bar{X} = \frac{1}{N} \sum_{I=1}^N X_I$$

For the discussion of the results the standard deviation (Dp) were calculated as follows:

$$Dp = \frac{\sqrt{\sum (X_I - \bar{X})^2}}{n - 1}$$

The precipitation abnormities of the period of time were observed according to the precipitation deviation formula given bellow:

Positive anomaly: $AP = P - (Pm + Dp)$, if $P > Pm + Dp$

Negative anomaly: $AN = (Pm - Dp) - P$, if $P < Pm - Dp$

Where,

P = precipitation to be analyzed, Pm= average precipitation in 31 years and Dp = precipitation deviation from Normal.

3. RESULTS AND DISCUSSION

In Figure 1, it can be observed the distribution of precipitations for that region (31 years)

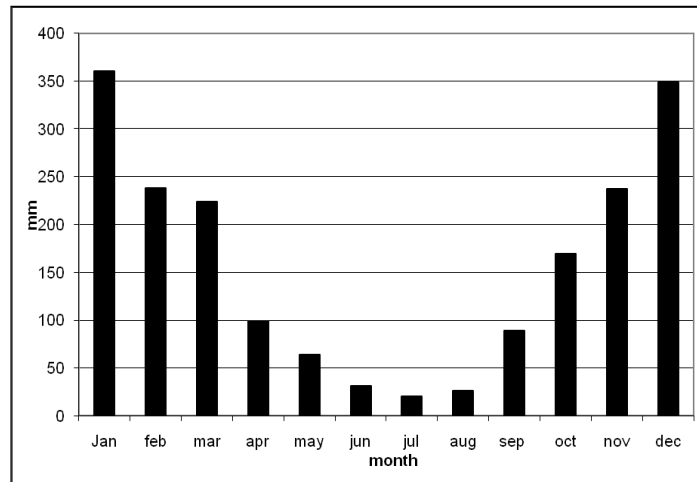


Figure 1. Average monthly rainfall for precipitation data collected within 1970-2000, in Jeriquara – São Paulo state. Brazil.

The months from October to March characterize the humid season for the region, since these six months are responsible for almost 80% of the precipitation of the region, with average monthly rainfall exceeding 150 mm. During the dry season, from April to September, that is found the months whose average rain precipitation completes the other 20% of the rains for this region, with average monthly rainfall of less than 100 mm.

Figure 2 display the annual precipitation and normal annual precipitation (average 31 years) for precipitation data collected within 1970-2000, in Jeriquara – São Paulo state.

The results clearly indicated the tendency that the mean monthly precipitation in El Niño phase is higher as compared to the Neutral and La Niña phases. During Neutral years of ENSO the precipitations patterns showed characteristics in-between La Nina and El Nino phases.

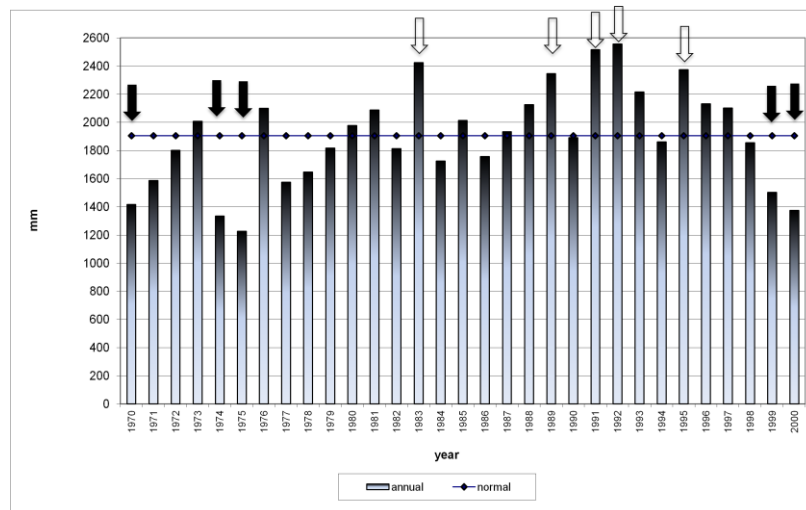


Figure 2: Annual precipitation, Normal annual precipitation (average 31 years) for precipitation data collected within 1970-2000, in Jeriquara – São Paulo state, Brazil. (Dark arrows indicate negative anomalies and light arrows indicate positive anomaly).

Table 1: The phenomena El Niño and La Niña data records (strong and moderate, only).

| El niño | El nina |
|--------------------|--------------------|
| 1972/1973 strong | 1970/1971 moderate |
| 1982/1983 strong | 1973/1976 strong |
| 1986/1988 moderate | 1988/1989 strong |
| 1990/1993 strong | 1998/2001 moderate |
| 1994/1995 moderate | |
| 1997/1998 strong | |

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The average annual total precipitation of the period of 31 years studied is of 1906 mm. Those 31 years of data analyzed in this study, 5 showed positive anomalies and 5 showed negative anomalies. It is possible to point out the prevalent positive anomalies had occurred in 1983, 1989, 1991, 1992 e 1995 when such years had much more rain than average (the anomalies positive were defined as the observed value exceeds the mean value plus standard deviation). And negative anomalies had occurred in 1970, 1974, 1975, 1999 e 2000, in those years there was less rain than average (the anomalies negative were defined as the observed value exceeds the mean value minus standard deviation). The magnitude of anomalies depends on the intensity of the events. Comparing the average total rainfall for the period with the occurrence of ENSO phenomena (Table 1) it can be observed that in general, positives anomalies (excessive rainfall) have occurred during El Niño events and negative anomalies (deficits of precipitation) have occurred during La Niña events, although, there are few years where the near-normal precipitation occurred during ENSO events (1972-1973; 1997-1998). Other authors [7], also observed that in the Southeastern region of Brazil, there is a trend in having negative anomalies in years when La Niña is active. The knowledge about the influence of ENSO on precipitation data may be used to mitigate the impacts of adverse weather conditions.

4. CONCLUSIONS

The humid and dry seasons well are characterized for the region of Jeriquara – São Paulo state, based on the averages of precipitation. ENSO (El Nino and La Nina) phenomenon are partially responsible for the precipitation regime (anomalies) over the region. During El Niño events, precipitation averages was above normal, while La Niña events lead to precipitation amounts which average was below normal. This pattern of seasonal variation of precipitation in association with ENSO could help water resource managers of the state in decision making.

5. REFERENCES

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