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GOVERNO FEDERAL BRASIL PAÍS RICO É PAÍS SEM POBREZA

DETECTION OF CLIMATE TRENDS IN TEMPERATURE AND PRECIPITATION IN THE NORTH-NORTHEAST OF SAO PAULO STATE DURING DRY AND PRE-RAINY SEASON THROUGH THE TIME SERIES ANALYSIS

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ABSTRACT

Through a series of observational temperature and precipitation in the north and northeast of the São Paulo State (NNESP) and global fields of the NCEP-NCAR reanalysis with atmospheric and oceanic indices it was investigated the relationship between regional and global climate variability of recent decades that occurred, during the months from June to September from 1961 to 2010, in the NNESP region. Temperatures experienced a considerable increase (specially the minimum), with positive linear trend of 0.22º C and 0.06 º C / decade (minimum and maximum respectively). Oceanic and atmospheric patterns in dry conditions events were associated with increased large-scale surface subsidence in the South and Central America, a number one wave pattern, a dry phase of the intraseasonal oscillation. Atlantic and Pacific Ocean were generally cooler with possible influence of the Semi-Annual Oscillation. Developing of atmospheric blocking much of the south-central Brazil, accompanied by intensification of the subtropical high, occurs in warm years, with the reverse pattern in cold years. Minimum low mainly occurred with the intensification of temperature gradient in the southern area of the South Atlantic, slightly east of the Antarctic Peninsula, associated with the pattern called Semi-Annual Oscillation (identified in geopotential and pressure fields). A tripole between Antarctica and South Atlantic, off the coast of São Paulo, were observed at periods of extremes temperatures, suggesting an influence of the Antarctic Oscillation. The shift to the warm phase of the Atlantic Multidecadal Oscillation appears to have a decisive influence on rising temperatures and the occurrence of droughts of the 1990s, especially. The recent trend of temperatures stabilization, after the year 1998, indicates that the natural climate variability is important and the causes of a possible global warming should be continue to investigated.

1. INTRODUCTION

An area in the northeast of the state of São Paulo involves important regional economic centers such as the cities of Ribeirão Preto, Franca, Barretos, Araraquara and São Carlos. Agribusiness in this region primarily moves the sectors of the sugar cane, and stands out in the national economic scenario, with high agricultural productivity, growth of the service sector and the income generation and employment. One of the regions with the highest economic growth of Brazil (Quartaroli et.al, 2006). More recently, Butt et.al (2011), in an observational study on the impact of deforestation in the beginning of the rainy season over Rondônia, concluded that a late start of the rainy season may be the result of changes in land use, and this signal can be strengthen in the future: current trends delay can be of the order of 0,6 days per year, and after 30 years of clearing the rainy season is expected to start with 18 days of delay.

So, in this work we investigate: Is it possible to detect recent climate trends in the pattern of temperature and precipitation in the north-northeast of the state of São Paulo, which, for example, can lead to intensification of the dry periods of winter in the north and northeast of the state of São Paulo ?

2. METODOLOGY

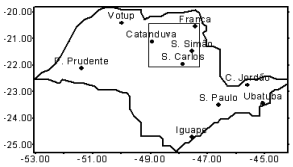
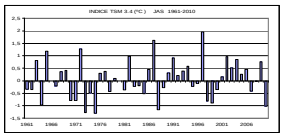


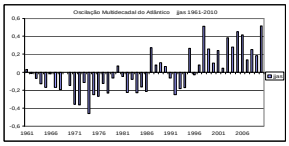
Figure 2.1: Study Area: location of the INMET weather stations in Catanduva, Franca, São Simão and São Carlos.

extreme events => persisted periods without rain (drought) , periods with extreme maximum and minimum average temperatures. June-September 1961-2010, comprising 50 years (winters) temporal daily rainfall series between the months of June-September .

SELECTION CRITERIA: Identification of the number of consecutive days without rain per winter for each station separately
Threshold: percentile of 15%, less than 0.8 mm (millimeters) precipitation would be disconsidered.
composites: 15% or 1 standard deviation:
8/50 driest years and 8/50 years wettest
9/50 warmest years and cooler



(a)



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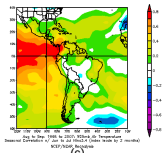

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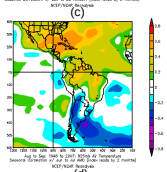


(d)

Figure 2.2 - Monthly values of the TSM 3.4 (a) and AMO Atlantic Multidecadal Oscillation (b) between the years 1961 and 2010, June and September.

Linear correlation between air temperatures at 925 hPa (August and September) and SST indices 2.1 (c) and AMO (d) in June and July (NCEP/NCAR reanalysis). Orange values indicate positive correlation (positive indices and high temperatures). Bluish values indicate negative correlation (positive rates and low temperatures).

It can be observed a shift in the AMO phase around 1995. This have a impact in the center-north area of Brazil, that includes the NNE São Paulo State region (yellow shaded, positive correlation), higher than the tsm 3.4), upper figure.

3. RESULTS AND DISCUSSION

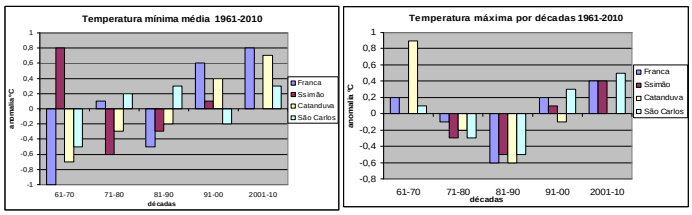
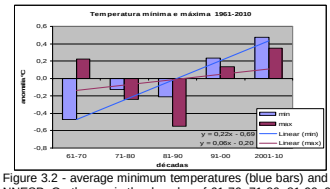


Figure 3.1 – Anomalies of average low and high temperatures per decade in Franca, São Simão, São Carlos and Catanduva stations. On the x axis the decades, and the y-axis the anomaly in °C.



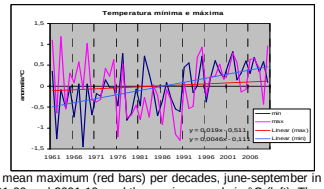


Figure 3.2 - average minimum temperatures (blue bars) and mean maximum (red bars) per decades, june-september in NNESP. On the x axis the decades of 61-70, 71-80, 81-90, 91-00 and 2001-10, and the y-axis anomaly in °C (left). The linear trend of the minimum is shown in blue line and the red line maximum. (Right) the average annual values of minimum (blue) and maximum (red) between the years 1961-2010 at NNESP stations.

composites for low and high temperatures events

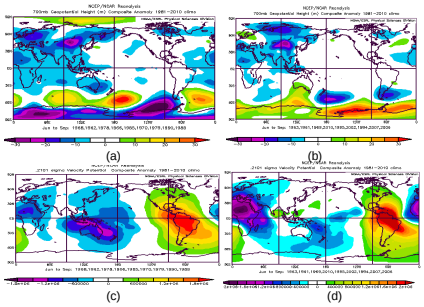
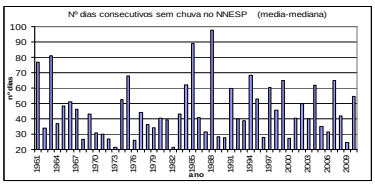


Figure 3.3 : composites to the low (left) and high (right) temperatures.; geopotential fields at 700 hPa in upper side and velocity potential at .2101 sigma leve in lower side.

In figure 3.3 (a), extreme low temperatures composites show a wave train in the geopotential field with predominant low geopotential values in the Antartic region, while a predominant reverse pattern can be observed in figure 3.3 (b). The divergence/ convergence fields show similar structure, but with a more pronounced divergence over Australia and Indonesia adjacents.

consecutive rainless days and decadal variability



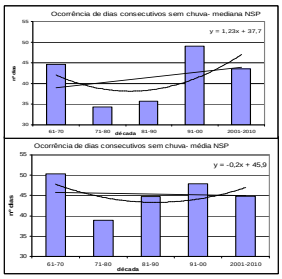


Figure 3.4 - Number of consecutive rainless days per year, between June to September in the NNESP stations. The number of days in the y-axis represents the average value between the mean and median. On the y axis the years 1961-2010 (upper side). At right, the number of yearly occurrence of rainless days, median (upper) and average (lower), with the linear and polinomial second order tendencies.

composites to the driest consecutive events

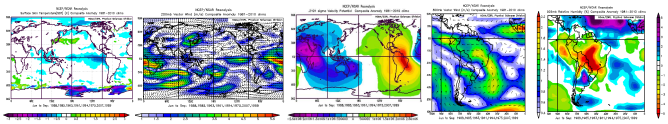


Figure 3.5 : Anomalies composites to the driest consecutive events: Suface skin temperature (a), wind in 200 hPa (b), the velocity potential in .2101 sigma level (c), a zoom in 500 hPa wind fiied (d) and relative humidity in 925 hPa (e).

4. CONCLUSIONS

wave train pattern from Pacific Ocean to South America was observed in the extremes events of low and high temperatures. It was also detectded in the 700 hPa geopotential field, and probably be associated with the Antarctic and Semi-annual Oscillation

The SST patterns of the composites for the driest days showed negative anomalies in the eastern and central Pacific, with slightly negative temperatures in the South Atlantic between latitudes 15ºS and 45ºS. The global atmospheric pattern with wave number 1, suggests the influence of the intraseasonal oscillation in the driest and wettest events. It was observed a blocking system, a high atmospheric pressure over the South America.

5. REFERENCES

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