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# Floating of the Average Temperature in the Area of Mata Pernambucana, Brazil

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**ABSTRACT**

Temperature is a climatic variable associated to the measurements made in air, water and soil, forming different modalities for the purposes of the synoptic and/or climatological analysis. The objective of this study was to analyze the variability of mean air temperatures and their temporal space behavior for the area of Mata Pernambucana composed of 44 municipalities from the period 1950-2017. The values of maximum, mean and minimum air temperatures estimated by the software Estima_T (Cavalcanti *et al*., 2006) were used. Estima_T is software for estimating air temperatures in the Northeast Region of Brazil. The coefficients of the quadratic function were determined for the maximum, average and minimum monthly temperatures as a function of the local coordinates: longitude, latitude and altitude. It was verified that the time series presents a tendency of reduction and a seasonal component with periodicity of 0.7 to 1.4 months. We obtained a good fit for the models of the moving average series selected for the 5 and 10 years of the studied variable, with the expected values being within the confidence interval, which is a satisfactory result, taking into account the uncertainties of the standard error and the weather and climate which may change the expected results. In the agricultural part the risks of greater stresses are presented with the increase of the evapotranspiration and evaporation, the recurrence of the use of irrigated water is not discarded. Altitude and latitude are the physiographic variables that best explain the variation of mean air temperature in the study area.

## INTRODUCTION

Air temperature expresses an energy contained in the environment. Over the course of a day, the energy in the mood of the environment fluctuates between two extreme values, in the others words, minimum and maximum temperature. As this energy goes from one extreme to the other, it acts continuously by stimulating the vital physiological processes of living beings, An example is the development and growth of plant species, such as: perspiration, respiration, germination, growth, flowering and fruiting. At each stage of plant development, there are temperature ranges for perfect development according to Medeiros (2020).

Another fundamental factor in temperature variation is altitude, as it increases in the troposphere the temperature decreases. In tropical regions, this effect is very important to improve environmental comfort. Air temperature stand out among the most commonly used atmospheric variations in the development of environmental impact studies with changes in meteorological and hydrological processes according to Nogueira *et al*. (2012) and Correia *et al*. (2011). The authors agree that air temperature stand out among the most commonly used atmospheric variations in the development of environmental impact studies with changes in meteorological and hydrological processes.

Temperature is a climatic variable associated with measurements performed on air, water and soil, forming different modalities for the purposes of synoptic and/or climatological analysis. The air temperature, namely that collected at the surface, in average, maximum and minimum values, is an important element for several studies including agronomy, geography and others. Its dynamics is influenced by spatial and temporal changes, which determine the formation of homogeneous or contrasting thermally environments.

Medeiros *et al.* (2012), calculate the average daily air temperature using different methods for the municipalities of Parnaíba, Picos and Gilbués, located respectively, in the coastal area, the central region and the semi-arid region in cerrado and desertified lands of the State of Piauí used four methods to calculate the average daily air temperature, adopting as standard or recommended by the Institute National of Meteorology (INMET). The four evaluated methods relative to the standard presented performances classified as “Very Good and Great”, with confidence ranging from 0.83 to 0.98. The results can still be considered in the climatic conditions of the region, in the four methods of use in relation to the standard INMET, which can be used in the daily use statistics.

Bezerra *et al*. (2014) report that the highest average values of the average, maximum and minimum temperatures occur in the Litoral and Sertão Paraibano mesoregion and the mild temperatures are recorded in the Borborema mesoregion and the Agreste mesoregion.

Madeiros *et al.* (2015) used monthly data of air temperature for the Paraiba demonstrated that elevation and latitude are the physiographic variables that best explain the annual air temperature variation and that the mean temperature variability results from the synoptic systems acting during the rainy or dry season such as impacts on the environment.

Medeiros *et al.* (2015) studied the variability of the historical average monthly temperature of the state of Paraíba in the last thirty years, performed the mapping and analyzed their variability. The use of geostatistics presented satisfactory results regarding the estimation of the temperature obtained by the Kriging interpolation method, being consistent with the local climatic characteristics of the region, both in the spatial and seasonal temperature distribution; the spatial temperature distribution showed great variability for all months studied, with a variation of approximately 5 ºC in the annual temperature distribution; February presents the highest temperature values with a variation of 2 ºC; in August, it has the lowest temperature values.

Medeiros *et al.* (2018) performed analyzes of spatiotemporal variability of the average air temperature of the State of Pernambuco distributed by homogeneous regions. They showed that the results of thermal fluctuations are related to elevation and latitude, being one of the physiographic variables that best explain the monthly and annual temperature variation in the study area. The fluctuations in the average temperature result from the synoptic systems acting during the rainy season and the dry season as well as the impacts on the environment. Temperature reductions occurred in accordance with the displacement of the rainy season and the performances and/or contributions of regional and local effects.

The objective is to analyze the variability of average air temperatures and their timeline behavior for the Zona da Mata Pernambucana composed of 44 municipalities between the period 1950 to 2017.

## MATERIALS AND METHODS

The Pernambuco Forest Zone consists of 44 municipalities, with an area of 8,738 km$^2$, equivalent to 8.9% of Pernambuco territory, limited to the north with Paraíba, south with Alagoas, east with the Recife Metropolitan Region and to the west with the Agreste. It has an estimated population of 1,193,661 inhabitants (Institute Brazilian of Geography and Statistics, 2013). Until recently, most of this area was referred to as the "sugarcane region". It is one of the regions with the highest economic potential in the Northeast, due to the available natural resources (water, soil, etc.), the location advantages around the metropolitan region of Recife, with reasonable economic infrastructure (roads, seaports, airports) and abundant contingent. of labor. In this region is concentrated the sugarcane monoculture, with an area of approximately 450 thousand hectares and has employed more than 200 thousand people in harvest seasons (Figure 1).


**Figure 1. Geographic representation of Forest Zone. Source: Adapted by the author. (2019).**

The mesoregion studied is cut by the most important rivers of the state, such as the Capibaribe River, the Ipojuca River and the Ipanema River, as well as smaller rivers such as the Siriji River. The vegetation is composed of Atlantic Forest, which includes medium and large trees and grasses, with a rich fauna.

The main systems responsible for rainfall occurrences are the Intertropical Convergence Zone (ICZ) (Hastenrath *et al.* 1977), the Cold Fronts (Kousky, 1979), the East Disturbances or the East Waves (Yamazaki *et al.* 1977) and the High Level Cyclonic Vortices (HLCV). The ICZ is the main rainfall weather system in the northern sector of NEB, where the state of Pernambuco is located. ICZ typically migrates seasonally from its northernmost position, approximately 12ºN, in August-September, to southernmost positions and, approximately

4ºS, in March-April. It has local and regional contributions such as Formation of instability line aided by Northeast trade winds, effects of sea and land breezes (Medeiros, 2017).

Maximum, average and minimum air temperature values estimated by Estima_T software (Cavalcanti *et al.* 2006). Estima_T is software for estimating air temperatures in the Northeast Region of Brazil. The quadratic function coefficients were determined monthly maximum, average and minimum temperatures as a function of local coordinates: longitude, latitude and altitude according to the authors Cavalcanti *et al.* (2006), given by:

$$T = C_0 + C_1\lambda + C_2Ø + C_3h + C_4\lambda^2 + C_5Ø^2 + C_6h^2 + C_7\lambda Ø + C_8\lambda h + C_9Øh$$

Where:

$C_0$, $C_1$,...., $C_9$ are the constants;

$\lambda$, $\lambda^2$, $\lambda$ Ø, $\lambda$ h longitude;

Ø, $Ø^2$, $\lambda$ Ø latitude;

h, $h^2$, $\lambda$ h, Ø h altitude.

They also estimated the time series of temperature, adding to this the temperature anomaly of the Tropical Atlantic Ocean (Silva et al., 2006).

$$T_{ij} = T_i + AAT_{ij} \qquad i= 1,2,3,...,12 \qquad j= 1950, 1951, 1952,....2015$$

Where:

i= 1,2,3,...,12;

j= 1950, 1951, 1952, 1953,...,2015.

The data obtained by the Estima_T software corresponds to the period 1950-2017, were generated by spreadsheets and the basic statistical calculations are performed to generate graphs and tables and other parameters relevant to the development of the study.

## RESULTS AND DISCUSSION

Table 1 shows the municipalities surrounding the Pernambucana Forest Zone, geographic coordinates (latitude, longitude and altitude).

According to the Köppen climate classification, the Pernambucana Forest Zone records two types of climate: the "Am" type in 12 municipalities and the "As" type predominant in 32 municipalities. Such classification is in agreement with the authors Medeiros *et al.* (2018) and Alvarez *et al.* (2014).

**Table 1. Municipalities, geographical coordinates (latitude, longitude and altitude), followed by climate classification according to the Köppen method for Pernambucana Forest Zone.**

| Municipalities | Latitude º ‘ | Longitude º ‘ | Altitude meters | Köppen Classification |
|---|---|---|---|---|
| Água Preta | -8.7 | -35.5 | 132 | Am |
| Aliança | -7.6 | -35.2 | 94 | As |
| Amaraji | -8.4 | -35.4 | 386 | Am |
| Barreiros | -8.8 | -35.2 | 70 | Am |
| Belém de Maria | -8.6 | -35.8 | 323 | As |
| Buenos Aires | -7.7 | -35.3 | 166 | As |
| Buíque | -8.6 | -37.2 | 616 | As |
| Camutanga | -7.4 | -35.3 | 213 | As |
| Carpina | -7.9 | -35.2 | 134 | As |
| Catende | -8.7 | -35.7 | 256 | As |
| Chã de Alegria | -8.0 | -35.2 | 136 | As |
| Chã Grande | -8.2 | -35.5 | 466 | As |
| Condado | -7.6 | -35.1 | 79 | As |
| Cortês | -8.5 | -35.5 | 409 | Am |
| Escada | -8.4 | -35.2 | 145 | Am |
| Ferreiros | -7.4 | -35.2 | 98 | As |
| Gameleira | -8.6 | -35.4 | 127 | Am |
| Glória do Goitá | -8.0 | -35.3 | 186 | As |
| Itambé | -7.4 | -35.1 | 100 | As |
| Itaquitinga | -7.7 | -35.1 | 97 | As |
| Jaqueira | -8.7 | -35.8 | 302 | As |
| Joaquim Nabuco | -8.6 | -35.5 | 236 | Am |
| Lagoa do Carro | -7.8 | -35.3 | 127 | As |
| Lagoa do Itaenga | -7.9 | -35.3 | 139 | As |
| Macaparana | -7.6 | -35.4 | 460 | As |
| Maraial | -8.8 | -35.8 | 305 | As |
| Nazaré da Mata | -7.7 | -35.2 | 91 | As |
| Palmares | -8.7 | -35.6 | 196 | As |
| Paudalho | -7.9 | -35.2 | 116 | As |
| Pombos | -8.1 | -35.4 | 341 | As |

| | | | | |
|---|---|---|---|---|
| Primavera | -8.3 | -35.3 | 367 | As |
| Quipapá | -8.8 | -36.0 | 555 | As |
| Ribeirão | -8.5 | -35.4 | 151 | Am |
| Rio Formoso | -8.7 | -35.2 | 86 | Am |
| São Benedito do Sul | -8.8 | -36.0 | 460 | As |
| São Bento do Uma | -8.5 | -36.5 | 662 | As |
| S. J. Coroa Grande | -8.9 | -35.1 | 47 | Am |
| Sirinhaém | -8.6 | -35.1 | 60 | Am |
| Tamandaré | -8.8 | -35.1 | 66 | Am |
| Timbaúba | -7.5 | -35.3 | 216 | As |
| Tracunhaém | -7.8 | -35.2 | 112 | As |
| Vicência | -7.7 | -35.3 | 176 | As |
| Vitória Santo Antão | -8.1 | -35.3 | 253 | As |
| Xexéu | -8.8 | -35.6 | 167 | As |

Source: Medeiros (2019).

Figure 2 shows the average inter-city air temperature of Pernambucana Forest Zone in January (a); February (b); March (c); April (d); may (e); June (f); July (g); August (h); September (i); October (j); November (k); December (l); annual (m); temperature anomaly (n) and as monthly temperatures and their percentages (o) from the period 1950-2017.

January shows a trend line with negative angular coefficient and a low $R^2$ (Figure 2). With an average of 25.5 °C; standard deviation 1.07 °C; with the maximum and minimum absolute values of 27.4 °C and 21.4 °C, respectively, with median of the month under study and 25.4 whose value is more likely to occur than the average. We highlight the municipalities of Lagoa do Itaenga, São Bento do Una and Tracunhaém with the lowest average temperature values.

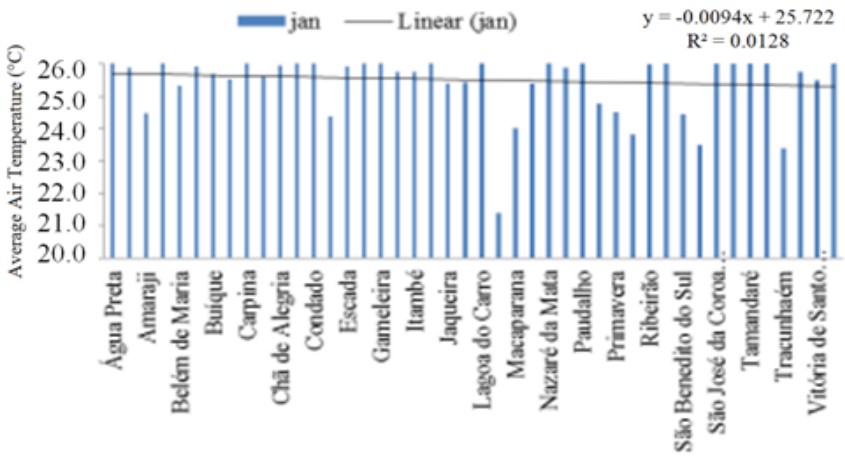


**Figure 2. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of January of 1950-2017. Source: Medeiros (2019).**

February (Figure 3) has an average of 25.5 °C, a median of 25.4 °C, a standard deviation of 1.0 °C and its maximum and minimum absolute values of 26.4 °C and 21.4 °C, respectively. The month understudy has negative angular coefficient trend line and low $R^2$. Lagoa do Itaenga, São Bento do Una and Tracunhaém have the lowest average temperature values, São José da Coroa Grande, Sirinhaém and Tamandaré exceed 26.5 °C. Authors' studies Marengo *et al.* (2007) and Rusticucci *et al.* (2004) corroborate the values presented here.

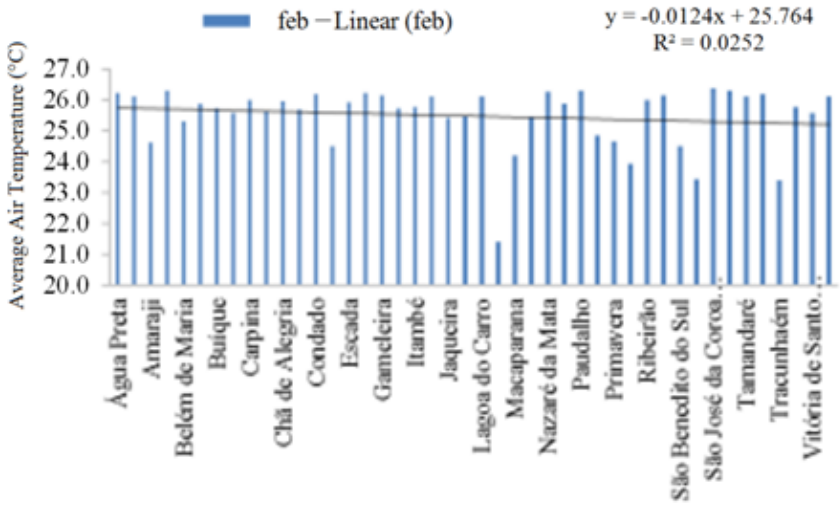


**Figure 3. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of February from 1950-2017. Source: Medeiros (2019).**

It has a negative angular coefficient trend line and a low $R^2$, with an average of 25.4 °C, a median of 25.3 °C, a standard deviation of 1.01 °C, a maximum and minimum absolute value of 26.9 °C and 21.6 °C. The municipality of Lagoa do Itaenga is the one with the lowest thermal value. The São José da Coroa Grande, Sirinhaém and Tamandaré municipalities have the highest thermal values (Figure 4).

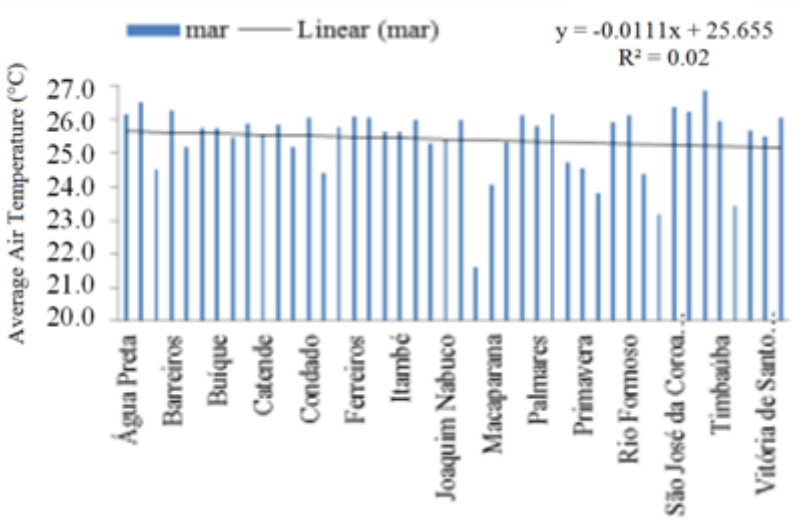


**Figure 4. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of March from 1950-2017. Source: Medeiros (2019).**

Figure 5 shows the inter-municipal average air temperature variability of Pernambuco Forest Zone for the month of April from 1950-2017. With negative angular coefficient trend line and low $R^2$. The municipalities of Lagoa do Itaenga; São Bento do Una and Tracunhaém have the lowest average temperatures. São João da Coroa Grande, Sirinhaém and Tamandaré the highest temperatures.

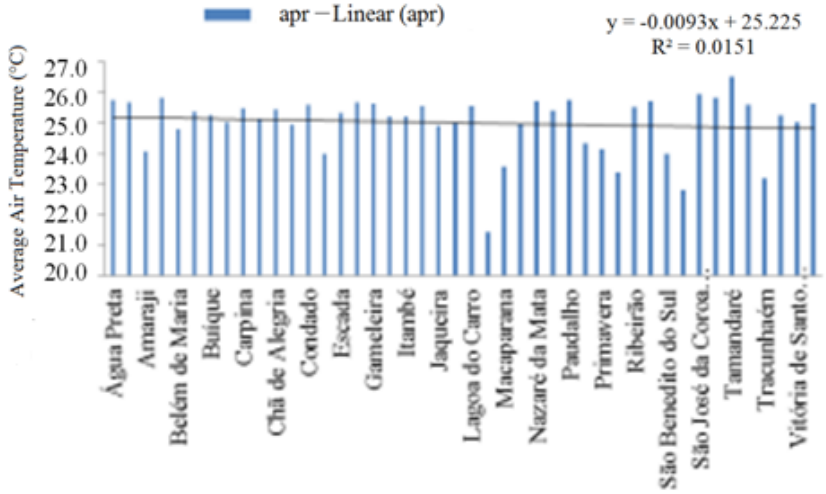


**Figure 5. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of April from 1950-2017. Source: Medeiros (2019).**

Figure 6 shows the inter-municipal average air temperature variability of Pernambuco Forest Zone for the month of May of 1950-2017. With negative angular coefficient trend line and

low $R^2$. The month understudy has a historical average of 24.1 °C, a median of 23.8 °C, a standard deviation of 1.04 °C and the maximum and minimum absolute values of 26.3 °C and 20.9 °C. Noteworthy are the municipalities of Lagoa do Itaenga, São Bento do Una as low temperature and the municipalities of high thermal Aliança and Tamandaré.

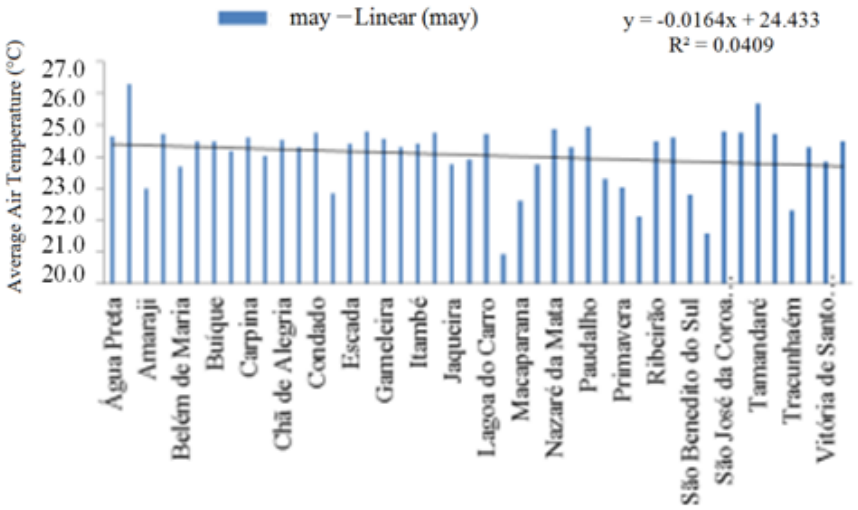


**Figure 6. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of May from 1950-2017. Source: Medeiros (2019).**

Inter-municipal average air temperature variability of Pernambuco Forest Zone, the references for the month of June of the period 1950-2017 are shown in Figure 7. With negative angular trend line and low $R^2$, it has a historical average of 23 °C, a median of 22.6 °C, a standard deviation of 1.11 °C and its absolute maximum and minimum values of 25.5 °C and 20 °C. Highlight the municipalities with lower thermal elevations Lagoa do Carro, Quipapá, São Benedito do Sul and Tracunhaém. The municipalities of Aliança and Tamandaré, as the thermal jump power.

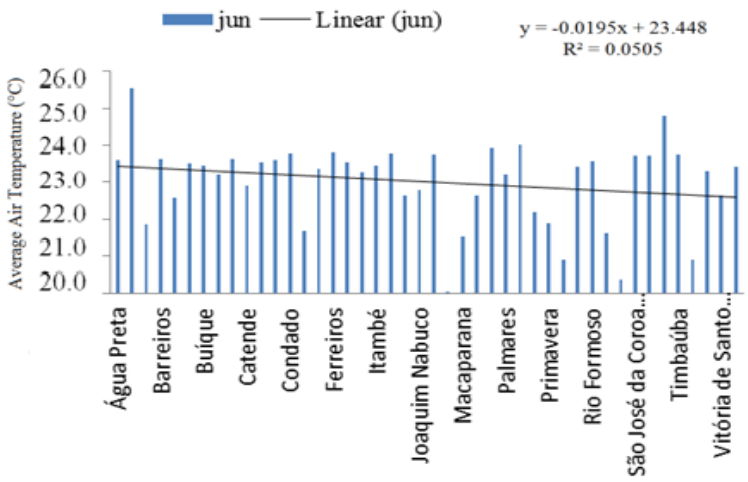


**Figure 7. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of June from 1950-2017. Source: Medeiros (2019).**

In Figure 8, there is a inter-municipal average air temperature variability of Pernambuco Forest Zone for the month of July 1950-2017. July has a historical average of 22.3 °C, a median of 21.8 °C, a standard deviation of 1.21 °C and its absolute maximum and minimum values of 25.4 °C and 19.4 °C respectively. July has the trend line with negative angular coefficient and low $R^2$. Highlight the municipalities of Amaraji, Cortes, Itaenga Lagoon, Macaparana, Primavera, Paudalho, Sao Benedito do Sul, Sao Bento de Uma and Tracunhaém as low average air temperature. The municipalities Aliança and Tamandaré with temperatures above the historical average.

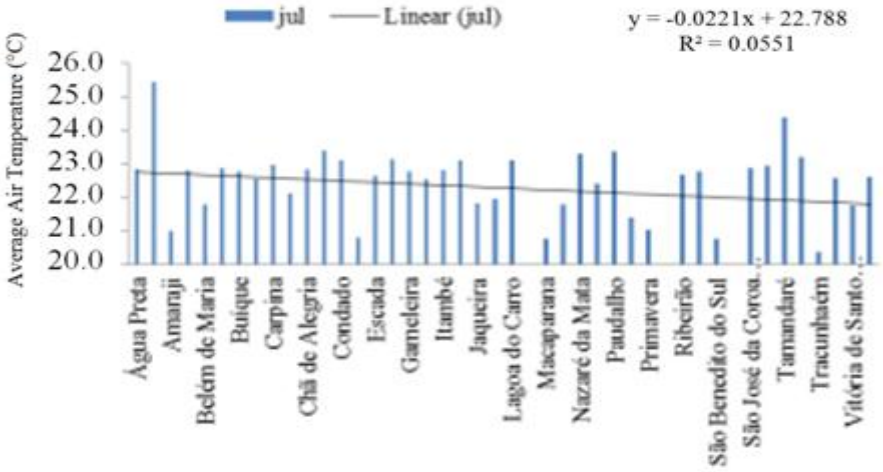


**Figure 8. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of July from 1950-2017. Source: Medeiros (2019).**

The month of August (Figure 9) the lowest average temperatures except for the municipalities of: Alliance; Chã Grande and Tamandaré. The lowest average temperatures

were recorded in the municipalities of: Aliança; Ferreiros; Lagoa do Itaenga; Macaparana; Primavera; Quipapá; São Benedito do Sul; São Bento do Una; Vicência. These fluctuations are due to meso and low scale aided by local and regional effects.

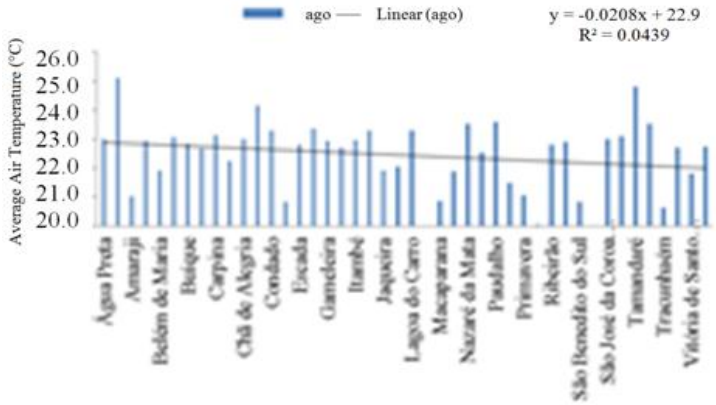


**Figure 9. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of August from 1950-2017. Source: Medeiros (2019).**

For Nobre *et al.* (2007) these climatic changes are related to solar intensity variation, Earth axis rotation inclination variations, Earth orbit eccentricity variations and atmospheric chemical composition variations, among others.

Figure 10 for September presents a negative trend line with low $R^2$. The average temperature fluctuates 19.7 °C in Lagoa do Barro a Aliança with 26.1 °C.

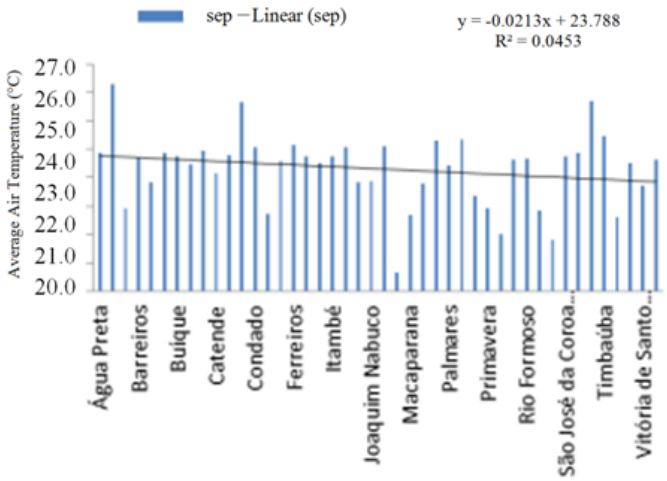


**Figure 10. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of September from 1950-2017. Source: Medeiros (2019).**

With an average temperature of 24.5 °C; median of 24.2 °C; standard deviation of 1.19 °C; maximum and minimum absolute values of 26,9 °C and 20,3 °C. With negative trend line and low $R^2$, (Figure 11). The lowest average temperature indexes were registered in the municipalities of Lagoa do Itaenga; São Bento do Una and Tracunhaém. The municipalities: Aliança, Chã Grande and Tamandaré recorded average temperatures above 26 °C. These thermal variability are related to local and regional effects in accordance with Marengo *et al.* (2008).

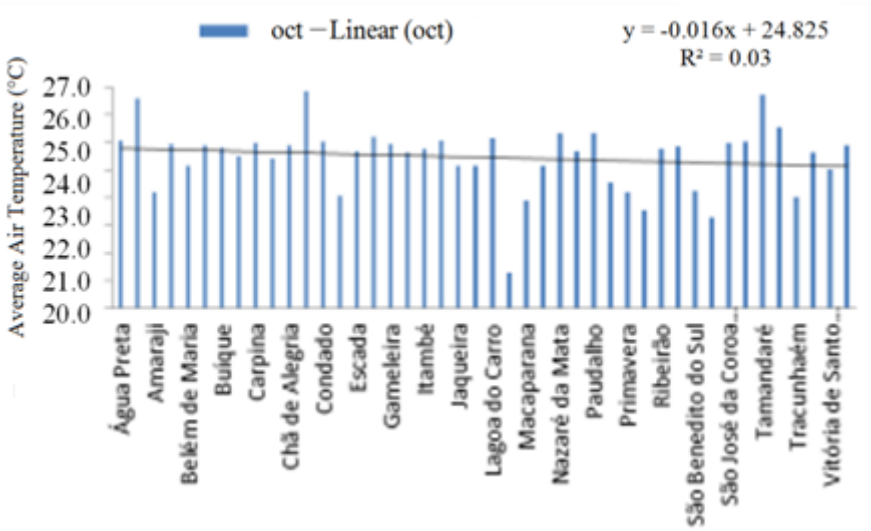


**Figure 11. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of October from 1950-2017. Source: Medeiros (2019).**

It is a consensus among meteorology scientists and the like, that the observed climate trends, especially from the second half of the 20th century onwards, have increased significantly. According to the Intergovernmental Panel on Climate Change (IPCC), these trends observed in the recent past are likely to continue in the same direction in the 21st century (IPCC, 2014). The average temperature variability recorded in this study has similarities with the IPCC studies.

Figure 12 shows the inter-municipal average air temperature variability for the November of Pernambuco Forest Zone from 1950-2017. With an average temperature of 25.2 °C and its extreme values (maximum and minimum) ranging from 20.7 °C to 26.5 °C and a median value of 25 °C. We highlight the following municipalities: Lagoa do Itaenga; São Bento do Una and Tracunhaém as the municipalities with the lowest thermal indexes in November. These thermal oscillations are related to local and regional effects in accordance with Marengo et al. (2008).

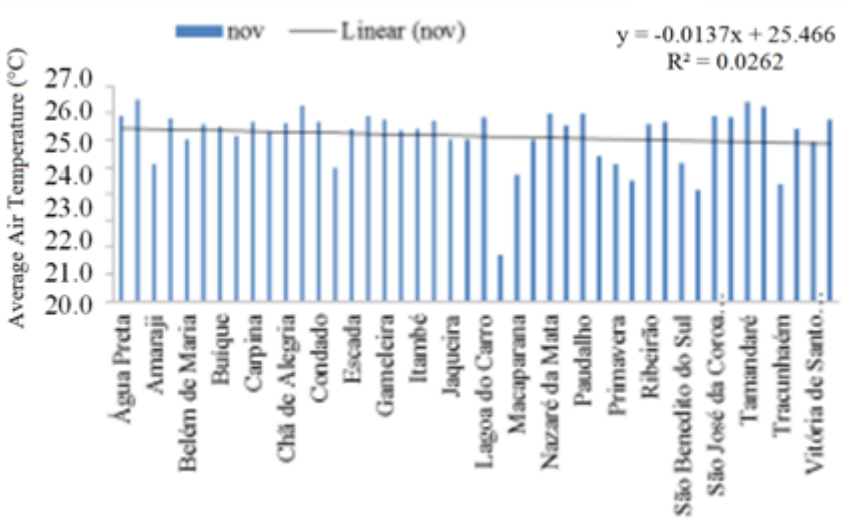


**Figure 12. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of November from 1950-2017. Source: Medeiros (2019).**

The month of December (Figure 21) for area of the Pernambuco Forest Zone in the period 1950-2017 has a negative angular coefficient and $R^2$ of low significance. Noteworthy are the municipalities: Água Branca; Lagoa do Itaenga; Macaparana; São Bento do Una and Tracunhaém with average temperature below 22.4 °C. The municipalities: Aliança; Barreiros; Carpina; Chão Grande; Ferreiros; Gameleira; Lagoa do Carro; Nazaré da Mata; Paudalho; Ribeirão; Rio Famoso; São José da Coroa Grande; Tamandaré and Timbaúba record average temperature above 26.3 °C.

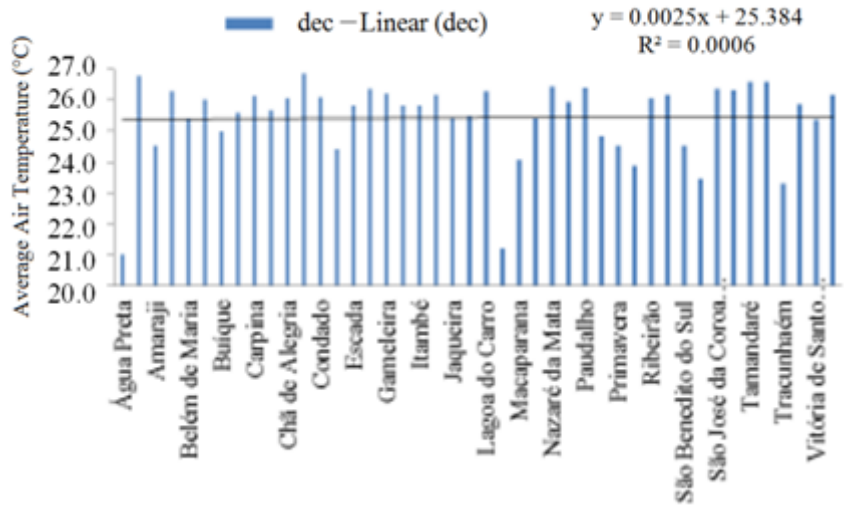


**Figure 13. Inter-municipal average air temperature variability of the Pernambuco Forest Zone for the month of December from 1950-2017. Source: Medeiros (2019).**

The inter-municipal annual average air temperature variability of Pernambuco Forest Zone from 1950-2017 (Figure 14), with an average annual regional temperature of 24.3 °C and its monthly oscillations flowing between 22.3 °C to 25.5 °C. The municipalities: Alliance; Barreiros; Buenos Aires; Carpina; Chã de Alegria; Chão Grande; Condado; Escada; Ferreiros; Gameleira; Glória do Goitá; Itambé; Lagoa do Carro; Nazaré da Mata; Palmares; Paudalho; Ribeirão; Rio Formoso; São José da Coroa Grande; Sirinhaém; Tamandaré; Timbaúba; Vicência; Xexeú with average temperatures above 24.3 °C. Noteworthy are the municipalities: Lagoa do Itaenga; Quipapá and São Bento do Una with an annual average temperature of 20.6 °C; 22.4 °C and 22 °C respectively. Figure 14 has a negative trend line and a low $R^2$, showing that in the coming years there will be a reduction in average temperature.

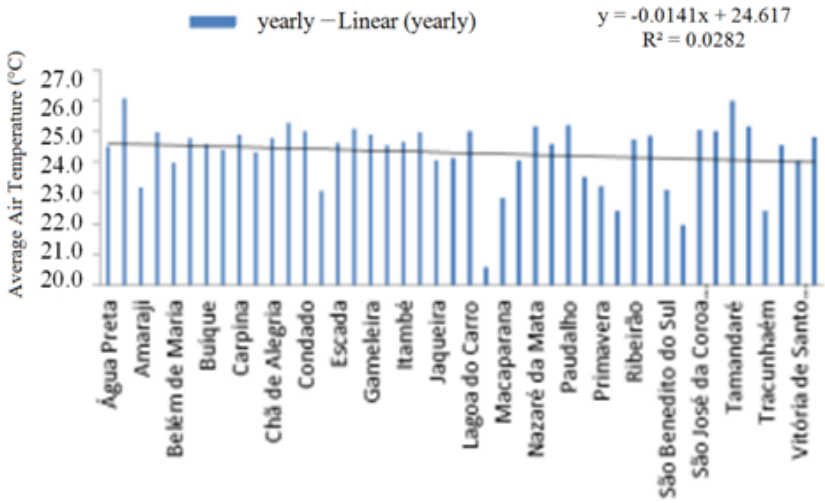


**Figure 14. Inter-municipal anual average air temperature variability of Pernambuco Forest Zone in the period 1950-2017. Source: Medeiros (2019).**

In Figure 15, observe inter-municipal average anomaly fluctuations in the air temperature of Pernambuco Forest Zone in the period 1950-2017. Amaraji, Belém de Maria, Cortês, Jaqueira, Joaquim Nabuco, Lagoa do Itaenga, Macaparana, Maraial, Pombos, Primavera, Quipapá, São Benedito do Sul, São Bento do Una, Tracunhaém, Vitória de Santo Antão presents negative anomalies of average temperature oscillating between 0.2 °C and 3.5 °C. Others municipalities that make up the study area have positive anomalies flowing between 0.1 °C and 2.1 ° C. Anomalous results were found in the authors' studies Marengo *et al.* (2007) and Rusticucci *et al*. (2004).

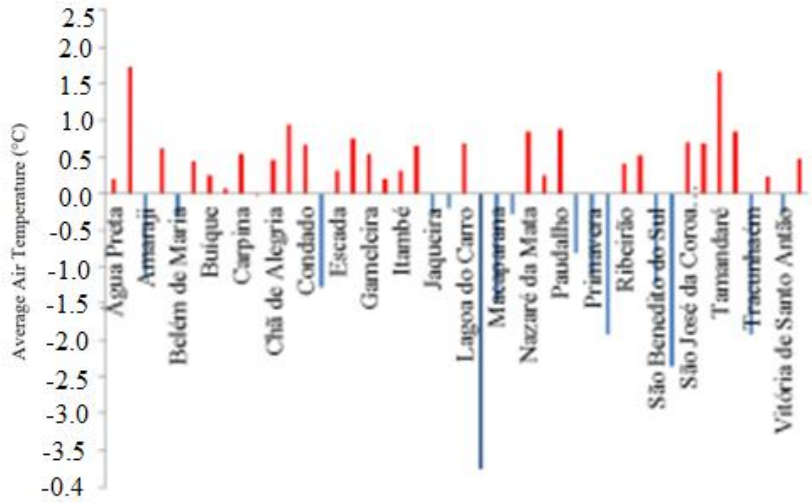


**Figure 15. Inter-municipal average anomaly air temperature variability of Pernambuco Forest Zone from 1950-2017. Source: Medeiros (2019).**

Figure 16, shows the average temperature variability and their respective monthly percentages from 1950-2017. The months of December, January, February and March represent 36% of annual variability and the months from April to November correspond to 64% of annual temperature. From April to November temperature fluctuations have varying intensities between cities. These variabilities are related to regional and local events and the fluctuations of rainy and dry periods.

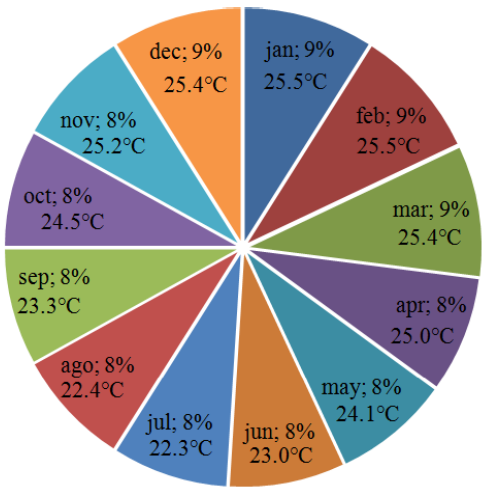


**Figure 16. Inter-municipal average air temperature variability and its respective monthly percentages of Pernambuco Forest Zone from 1950-2017. Source: Medeiros (2019).**

## STATISTICAL ANALYSIS OF THE MONTHLY AVERAGE AIR TEMPERATURE FROM 1950 TO 2017 FOR THE PERNAMBUCO FOREST ZONE AREA

Table 2 shows the monthly linear equations, regression determination coefficients ($R^2$), average annual air temperature from 1950 to 2017 for Pernambuco Forest Zone. The monthly linear equations have negative angular coefficient, the regression determination coefficients ($R^2$) are low significance, with March, April and December having very low significance. Average annual temperatures range from 22.3 °C in July to 25.5 °C in January and February, with an average annual temperature of 24.3 °C. Studies such as Medeiros *et al.* (2015 and 2018) corroborates the results presented here.

**Table 2. Linear equation, regression determination coefficient ($R^2$), average air temperature from 1950 to 2017 for Pernambuco Forest Zone.**

| Months | Linear equation | $R^2$ | Average |
|---|---|---|---|
| Jan | y = -0.0174x + 25,966 | 0.0375 | 25.5 |
| Feb | y= - 0.0153x + 25,895 | 0.0332 | 25.5 |
| Mar | y = - 0.0137x + 25,733 | 0.0287 | 25.4 |
| Apr | y = - 0.0136x + 25,355 | 0.0294 | 25.0 |
| May | y = - 0.0164x + 24,433 | 0.0409 | 24.1 |
| Jun | y = - 0.0195x + 23,448 | 0.0505 | 23.0 |
| Jul | y = - 0.0221x + 22,788 | 0.0551 | 22.3 |
| Aug | y = - 0.0240x + 23,000 | 0.0538 | 22.4 |
| Sep | y = - 0.0240x + 23,873 | 0.0534 | 23.3 |
| Oct | y = - 0.0210x + 24,978 | 0.0449 | 24.5 |
| Nov | y = - 0.0194x + 25,691 | 0.0404 | 25.2 |
| Dec | y = - 0.0013x + 25,547 | 0.0001 | 25.4 |
| Annual | y = - 0.0173x + 24,726 | 0.0375 | 24.3 |

Source: Medeiros (2019).

Table 3 shows the variability of statistical parameters such as mean, median, standard deviation, coefficient of variance, kurtosis, asymmetry, standard error and absolute maximum and minimum air temperature from 1950 to 2017 for the area of Pernambuco Forest Zone.

The median has a behavior similar to the average temperature, except for the months of May to November, the largest fluctuations in standard deviation occur from June to February. Statistically, the coefficients of variance don't have expressive indices of monthly changes, as for the variance parameter, their monthly fluctuations present values with low significance of monthly occurrences. The kurtosis coefficient presents negative and constant values in all months of the year, while the asymmetry coefficients are variable in months from April to August and November, December are negative. Standard errors are outside the limits indicated by the World Meteorological Organization. Absolute maximum and minimum values can be repeated with a variability of 0.7 to 1.4 months.

**Table 3. Statistical parameters such as average, median, standard deviation, coefficient of variance, kurtosis, asymmetry, standard error and absolutes maximum and minimum of average air temperature from 1950 to 2017 for Pernambucano Forest Zone area.**

| Months | Average | Median | Standard Deviation | Coefficient of variance | Kurtosis | Asymmetry | Standard Error | Absolute maximum | Absolute minimum |
|---|---|---|---|---|---|---|---|---|---|
| Jan | 25.6 | 25.4 | 1.2 | 0.0450 | -0.0682 | 0.0008 | 0.1737 | 28.3 | 21.4 |
| Feb | 25.6 | 25.4 | 1.1 | 0.0422 | -0.0682 | 0.0007 | 0.1625 | 27.7 | 21.4 |
| Mar | 25.4 | 25.3 | 1.0 | 0.0407 | -0.0682 | 0.0005 | 0.1561 | 27.3 | 21.6 |
| Apr | 25.0 | 24.9 | 1.0 | 0.0407 | -0.0682 | 0.0000 | 0.1535 | 27.0 | 21.4 |
| May | 24.1 | 23.8 | 1.0 | 0.0432 | -0.0682 | -0.0020 | 0.1568 | 26.3 | 20.9 |
| Jun | 23.0 | 22.6 | 1.1 | 0.0484 | -0.0682 | -0.0198 | 0.1679 | 25.5 | 20.0 |
| Jul | 22.3 | 21.8 | 1.2 | 0.0542 | -0.0682 | -0.0533 | 0.1821 | 25.4 | 19.4 |
| Aug | 22.5 | 21.9 | 1.3 | 0.0592 | -0.0682 | -0.0435 | 0.2006 | 26.1 | 18.9 |
| Sep | 23.3 | 22.8 | 1.3 | 0.0572 | -0.0682 | -0.0130 | 0.2013 | 27.2 | 19.7 |
| Oct | 24.5 | 24.2 | 1.3 | 0.0520 | -0.0682 | -0.0003 | 0.1922 | 28.1 | 20.3 |
| Nov | 25.3 | 25.0 | 1.2 | 0.0491 | -0.0682 | 0.0001 | 0.1871 | 28.6 | 20.7 |
| Dec | 25.5 | 25.5 | 1.4 | 0.0550 | -0.0682 | -0.2463 | 0.2115 | 28.8 | 21.0 |
| Annual | 24.3 | 24.1 | 1.1 | 0.0472 | -0.0682 | -0.0029 | 0.1730 | 27.2 | 20.6 |

Source: Medeiros (2019).

Mean values with increase or decrease in standard deviations may be recorded or may occur in accordance with the authors Katz *et al.* (1992) showed that the relative frequency of extreme events depends on changes in standard deviation and not just the mean.

## AVERAGE MOBILE FOR 5 AND 10 YEARS FOR AVERAGE TEMPERATURE

Figure 17, shows the average annual temperature, historical, moving average for 5 and 10 years from 1950 to 2017 for the municipalities of Zona da Mata Pernambucana. The

probability of repetition of the annual average temperature has its chances of repetition in the next 10 years, except in the municipalities of Tamandaré, Timbaúba, Tracunhaém, Vicência, Vitória de Santo Antão and Xexeú. The probability of repetition for the 5 years occurred in the municipalities of Água Branca to Jaqueira. These results are consistent with the studies by Pereira *et al*. (2015).

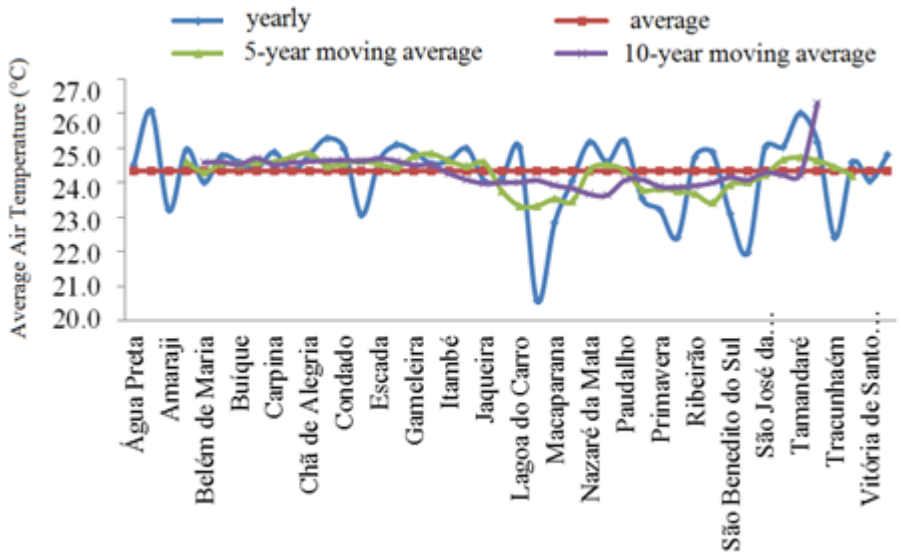


**Figure 17. Average annual temperature, historical, moving averages for 5 and 10 years from 1950 to 2017 for the municipalities of Pernambuco Forest Zone. Source: Medeiros (2019).**

## CONCLUSIONS

It was found that the time series shows a downward trend and a seasonal component with a periodicity of 0.7 to 1.4 months.

A good adjustment was obtained by the moving average series models selected for the 5 and 10 years of the studied variable, and the predicted values were within the confidence interval, which is a satisfactory result, taking into account the uncertainties. Standard Error and weather and climate which can change the expected results.

In agriculture, there is a risk of increased stress as evapotranspiration and evaporation increase, the recurrence of irrigated water use is not ruled out.

Altitude and latitude are the physiographic variables that best explain the variation of the average air temperature in the study area.

The average air temperature fluctuations result from the synoptic systems acting during the rainy and dry periods and these fluctuations may be related to the factors causing and/or inhibiting the interregional and intermunicipal rainfall indices.

The Pernambuco Forest Zone has been shown to reduce the minimum temperature and less hot nights with increased thermal amplitude.

Studies should be performed to understand the temperature fluctuations in the municipalities of Lagoa do Itaenga; São Bento do Una and Tracunhaém, for has different variability from other municipalities.

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