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Bom Jesus Piauí - Brazil and Fluctuations in Amplitudes Thermal Monthly, Annual Quarters and Hot and Cold

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ABSTRACT

The thermal amplitude is defined by the difference between the maximum and minimum temperature indices. The objective is to study the monthly variability of the air temperature range and its warmest and coldest quarters from 1960-2018 to the municipality of Bom Jesus Piauí aiming at the well-being of the population and human survival as well as to reference the main factors affecting this thermal increase, as well as providing information for the energy, agriculture, agribusiness, irrigation and municipal, state and federal decision makers in case of extreme events. It was used the monthly data of the thermal amplitude from 1960 to 2018 provided by the National Institute of Meteorology, which were statistically worked. This study can be a tool for planning and actions aiming at the best way to manage the thermal indices to be used in agriculture, health, thermal comfort of cities and other applications. There is still a need for further studies on the thermal distribution in the Northeast region of Brazil and especially in the region of Bom Jesus Piauí, aiming to identify its thermal patterns. The weather station is surrounded by buildings, dense vegetation and is influenced by the anthropic effects of the region's residents. It is hoped to have contributed information to farmers, agribusinesses, municipal, state and federal decision-making cooperatives, agricultural technicians and the health sector for a better understanding of thermal variability.

INTRODUCTION

Medeiros (2018) showed that the variability of thermal amplitude for the great metropolis Recife is materialized in gains in agriculture, agribusiness, health, education, housing and quality of life, which refers to the satisfaction of needs, both basic and non-basic, of the population. The increasing fluctuations in the thermal amplitude have been due to the lack of city planning, afforestation and the high incidence of fires and deforestation.

Silva et al. (2013) demonstrated that the State of Piauí has different climatic conditions, with fluctuations in rainfall rates whose origin is quite individual, also presenting relatively variable annual average temperatures. The pluviometry precipitations present great spatial and temporal variability, showing two rainy regimes: in the south of the state it rains from November to March; in the center and north, the rainy season starts in December and continues until May.

According to Mascaró (2006) comfort, health and environmental issues of good quality of life for the population are elements that directly influence people's daily lives and behavior. Also according to the author, environmental comfort - is the sum of physical conditions that provide the body with better performance with less energy expenditure and, consequently, a psychophysical sensation of well-being. Labaki et al. (2011) both active and passive activities of city dwellers need environments that are thermally comfortable.

The daily temperature range can negatively affect agricultural crops, as they are critical factors on the rate of growth, development (SEGOVIA et al., 1997; HOCH et al., 2008) and plant productivity, as extreme values during the reproductive phase can cause grain sterility (BURIOL et al., 2000; KUINCHTNER et al., 2007).

Araújo (2012) confirms that changes in urban space cause the various meteorological variables (temperature, relative humidity, wind speed and solar radiation) with thermal influence on the human body, tend to worsen the effects of heatwaves, thus such as the relationship between changes in ventilation, the dispersion of air pollutants and the increase in temperature can affect air quality. Also, according to the author, atmospheric conditions exert a strong influence on society, and the health or disease states of the human organism constitute one of the countless manifestations of this interaction. The author informs that in cities there are many possibilities for work, access to consumer goods, services and life, but they produce a range of problems, especially when the agglomeration of population grows to the level at which people are exposed to various health risks. According to Araújo (2012), depending on the spatial organization of the population in a space, it implies the existence of risk conditions or situations that influence public health and the potentialization of some diseases. The appearance of illnesses can be determined by factors such as social, cultural and environmental factors that act in space and time on populations at risk.

Air temperature is the main variable of thermal comfort. The feeling of comfort is based on the loss of body heat due to the temperature differential between the skin and the air, complemented by other thermoregulatory mechanisms. The body through metabolism produces heat and its losses are less when the air temperature is high or greater when the temperature is low. The difference in temperature between two points in the environment causes the air to move, called natural convection: the hottest part becomes lighter and rises while the colder part descends, providing a feeling of cooling the environment in accordance with Lamberts (1997).

A study on thermal comfort in cities is an important indicator of the impact of urban occupation on microclimate change. These impacts can cause serious problems related to health, quality of life and energy consumption according to Valério (2010).

Viana et al. (2012) state that concerns about thermal comfort are not recent and that human demands for thermal comfort are related to the functioning of their bodies. Man needs to release and/or store enough heat so that his homeothermic condition is guaranteed. However, the human organism reacts to the environment, either through biological and/or physiological reactions or through psychological reactions. Also according to Viana et al. (2012) show that humans have their own thermal regulation, however, this is substantially susceptible to external thermal and abiotic factors in their thermal comfort and discomfort.

In terms of comfort and/or thermal discomfort, there are several realities, whether rural or urban, however, given the grouping of society in cities, worldwide, and the great transformations that have taken place in urban spaces, this problem of environmental comfort has been very pertinent to cities, especially those located in regions of the world characterized by high thermal amplitudes. (Brazil, 2015). According to the author today, it is evident that the population of cities suffers from the consequences of the absence of nature in their built environment, such as the microclimate, in the case of the urban environment created in an anthropic way, whether consciously or unconsciously, man promotes his own thermal comfort/discomfort.

The expansion of natural ventilation and vegetation are resources mentioned in the literature to obtain comfort due to the numerous beneficial functions they perform in the environment. According to the analysis of several works related to urban afforestation and natural ventilation, it is possible to notice the efficiency of these natural resources in mitigating the urban environment, generating a microclimate that provides greater comfort and reduced energy consumption, improving the environmental quality of the places. It is important that professionals who work directly in the organization and construction of urban space actively consider the elements that involve afforestation and urban thermal comfort according to Silva et al. (2011).

However, the term heat island has today become a concept; it carries with it many uncertainties because there is no clear and objective criterion to define it. For example, when comparing two places with the same land use, but on slopes with greater and lesser insolation, this would cause a difference in air temperature between the places, however, this is not enough to say that there is a heat island. In this case, the best terminology would be heat core, since the orientation of the slopes is the factor responsible for the difference that may exist between homogeneous environments. At first, the concept of a heat island is related to human activities on the surface and its repercussion in the lower troposphere, even so, it is not clear in the literature at what moment or what difference in air temperature the existence of the phenomenon in question (Fialho, 2012).

Vitte (2009) draws attention to the importance of the environment, the spatial dimension, perceived as space, territory, landscape, place and/or environment for the composition of the quality of life, being, therefore, able to point out the living conditions and the how the public power is present or not in people's lives. Teixeira *et al.* (2012) demonstrated in an experiment in the village of Companhia de Habitação, municipality of President Prudente, SP, (COHAB), in December 2011, that the situation of thermal discomfort inside the house was very close to the discomfort perceived in the external environment. Residence, demonstrating that the construction pattern and especially the fiber cement roof does not have the appropriate thermal performance to protect the interior of the house from the adverse conditions of the external environment.

Information on the climatic conditions of a given region is necessary so that strategies can be instituted, aimed at the most adequate management of natural resources, thus planning the search for sustainable development and the implementation of viable and safe agricultural practices for the environment. Environment and productivity (Costa Neto et al. 2014).

Among the factors that influence the decline in the quality of life of populations, one can consider the accelerated expansion of cities without proper urban planning. Linked to this factor, the growing increase in the urban population has caused a series of socio-environmental problems, especially in the climatic conditions of these places (Freitas, 2015; Sant'anna Neto, 2011).

The objective is to study the monthly, annual and its hot and cold quarter variability relative to the period of the 1960-2018 series of the thermal amplitude of the air for the municipality of Bom Jesus Piauí, aiming at the well-being of the population and human survival as well as reference the main factors that affect the variability of thermal increase and/or reduction, providing information for the energy, agricultural, agribusiness, irrigation sectors and for municipal, state and federal decision makers in various areas of activity in case of events extremes.

MATERIAL AND METHODS

The municipality of Bom Jesus is located at latitude 09º04'28" south and longitude 44º21'31" west, with an altitude of 277 meters. It has an area of 5,469 km². (Figure 1).

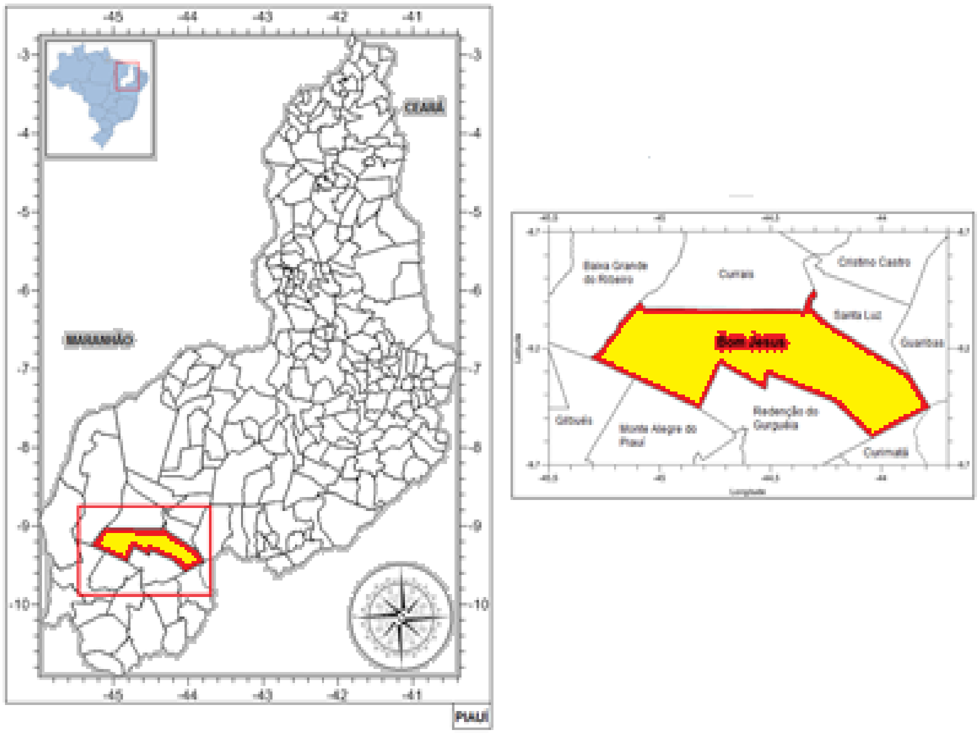

Figure No. 1: Location of the municipality of Bom Jesus Piauí.

Source: Medeiros (2021).

According to Köppen's classification (1928, 1931) the climate is of the Aw' type, (tropical hot and humid, with rain in summer and drought in winter), similar results were found by Medeiros (2016) and Alvarez et al. (2014). Due to the increase in the greenhouse effect, Bom Jesus has undergone changes in its climate, as in years when the El Niño phenomenon occurs, its temperature tends to increase and so also the thermal sensation being higher than 38 ºC, in addition to concentrating the days with extreme rains for the months of January and February. The La Niña phenomenon, on the contrary, brings greater relief to the city, as the effects are an increase in the incidence of rain and a drop in temperatures. Generally, when this phenomenon occurs, there is a rainy season from October to March.

Given the climatological and dynamic information of Northeast Brazil (NEB), the municipality of Bom Jesus has its climate controlled by the spatial and temporal variability of the Convergence Zone of the South Atlantic, and by the vestiges of cold fronts, contribution of high-level cyclonic vortices, since its center is in the ocean, to the formation and intensification of instability lines and convective agglomerates, aided by the Southeast trade winds, the convergence of humidity and the exchange of sensible heat for latent heat and vice versa.

The contributions of local effects, factors that increase cloud cover, air relative humidity and cause rains of moderate to light intensities in almost every month of the year, with the La Niña phenomenon being the main factor for the occurrence of above-average rainfall historic causing floods, flooding, floods, floods and landslides. (Figure 2).

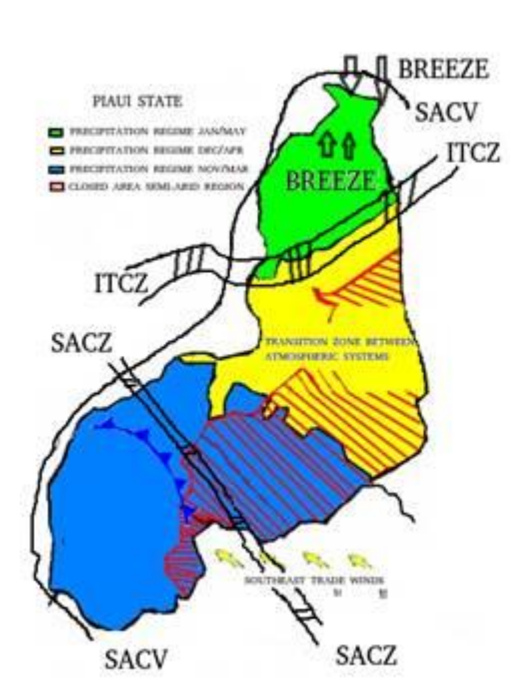

Figure No. 2. Rainfall regimes and main factors in the state Piauí.

Source: Medeiros, (2016).

Thermal range is defined by the difference between the maximum temperature (3:00 pm) and the minimum temperature (5:00 am) of the location or region.

Monthly thermal amplitude data from 1960 to 2018 were used, provided by the National Institute of Meteorology (INMET, 2021) having its location in the geographic coordinates of latitude 09°01'S; longitude 44°11'W with an average altitude above air level of 331.7 meters. The use of the Statistical Package in electronic spreadsheets for the elaboration of graphs with the monthly, annual and cold and hot quarter variability of the studied elements and their minimum, median, maximum, average, standard deviation and coefficient of variances for the area of study.

RESULTS AND DISCUSSION

The maximum, average and minimum temperatures with observed data from 58 years are, respectively, 33.5 °C; 20.4 °C and 27.3 °C (INMET, 2021). The fluctuations of the monthly average thermal amplitudes and their absolute maximum and minimum values are shown in Figure 3. In the maximum thermal amplitude, the months of June and October stand out, and between the months of February to April and the month of July with their peaks of minima and maxima. In the curve of minimum thermal amplitude, the months between April and September stand out, with the highest fluctuations. In the curve of the average thermal amplitude, the highlight is for the months of June to October that register their increases.

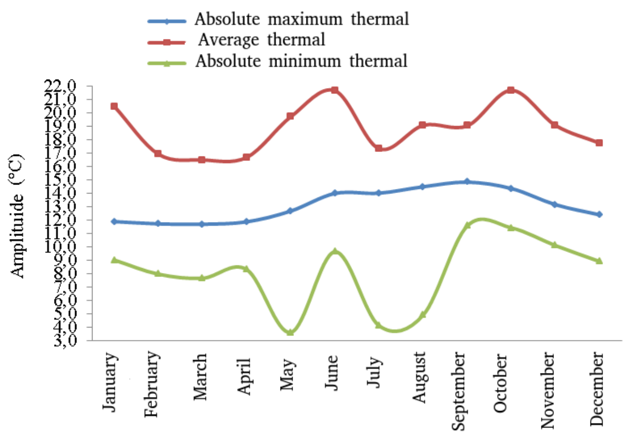

Figure No. 3. Monthly average thermal amplitude, absolute maximum and absolute minimum for the Period from 1960 to 2018, in Bom Jesus - PI.

Source: Medeiros, (2021).

Figure 4 shows the average annual oscillations of the thermal amplitude and its trend line for the period 1960 - 2018, followed by its trend line and R^2 in Bom Jesus Piauí. With a trend line of positive angular coefficient and R^2 with moderate significance, the years 1997-2018 stand out with the highest recorded thermal indices, except for the years 2007, 2012 and 2013 and between 2016-2018. The years 1965, 1971 to 1992 stand out with a thermal amplitude lower than 12°C.

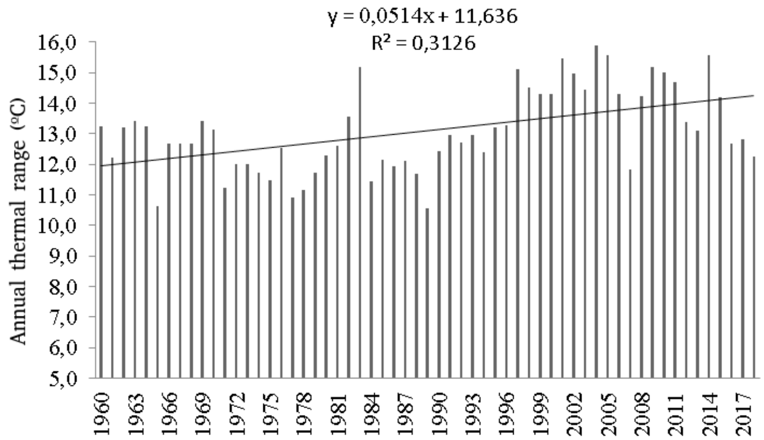

Figure No. 4. Annual thermal amplitude for the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

The thermal amplitudes of the months of January for the period 1960-2018 are represented in Figure 5. The years 1960-1966, 2001-2005, 2013, 2014 and 2016, 2017 stand out with records of low amplitudes below the 12th. In the other years under study, the thermal amplitudes fluctuated between 12.3 °C and 20 °C.

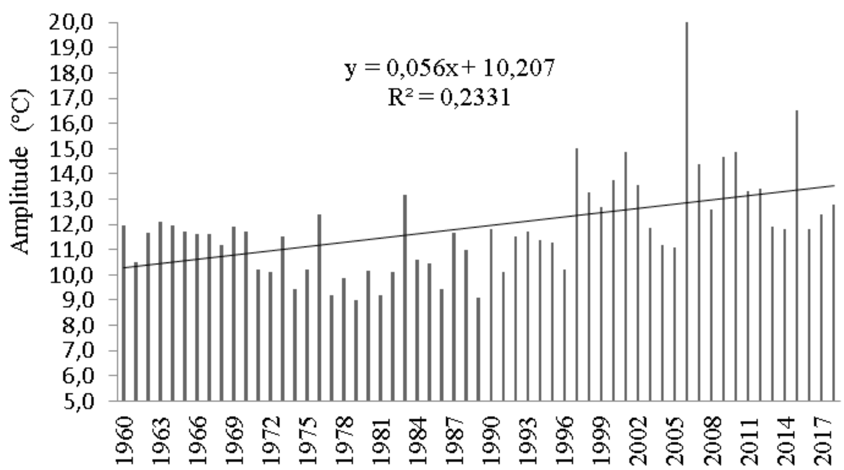

Figure No. 5. Thermal amplitude for the month of January in the period 1960 – 2018, in Bom Jesus - PI.

Source: Medeiros, (2021).

With a trend line and positive linear angular coefficient and R2 with medium significance for the month of February in the period 1960-2018 (Figure 6). The years from 1960 to 1966 and the years from 2016 to 2018 with thermal amplitude below 12 °C stand out, except for 1983, 1987 and 1991, which exceeded 12 °C. Between the years 1967 to 2015, the thermal variability fluctuated between 12.2°C and 17.7 °C. Studies such as the one by Marengo et al. (2008) and Marengo et al. (2015).

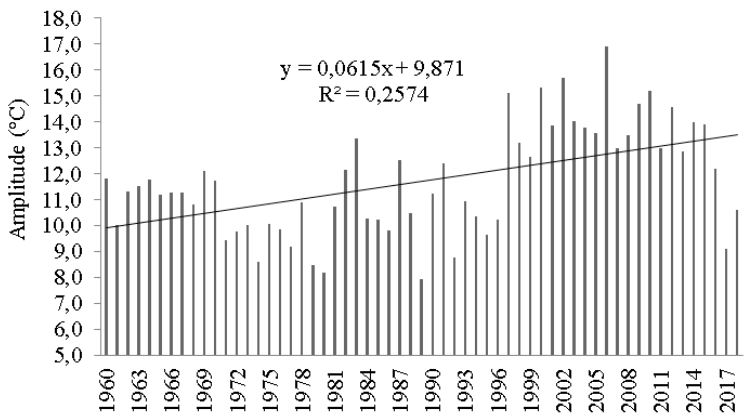

Figure No. 6. Thermal amplitude for the month of February in the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

The month of March in the period 1960 – 2018 has a positive trend line with R^2 of medium significance (Figure 7). The years with low thermal amplitudes lower than 9°C were 1974, 1975, 1978, 1984, 1989. The years 1963, 1983, 1992 and between 1967 and 2014 flowed higher than 12°C, except for the year 2007.

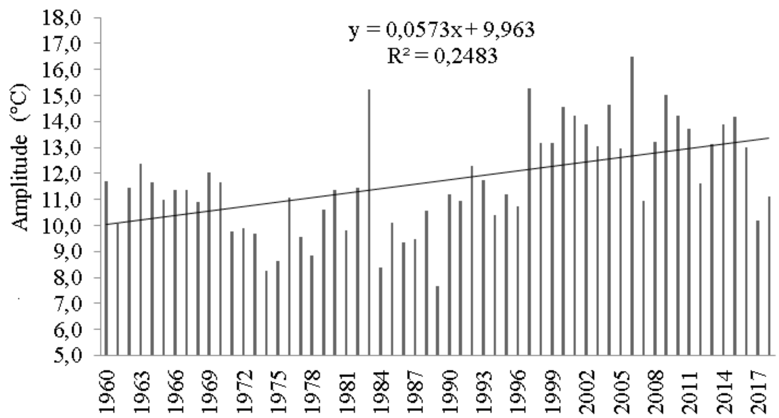

Figure No. 7. Thermal amplitude for the month of March in the period 1960 – 2018, in Bom Jesus PI.

Source: Medeiros (2021).

The month of April in the period 1960 – 2018 presents a positive trend line with R^2 of low significance. The years 1960 – 1973, 1976 to 2018 stand out with thermal amplitude above 9 °C, except for the years 1974, 1977, 1978, 1984, 1989 and 2007 which recorded thermal amplitudes lower than 9 °C according to Figure 8. Studies by Marengo et al. (2015) and Holanda et al. (2020) corroborate the results discussed.

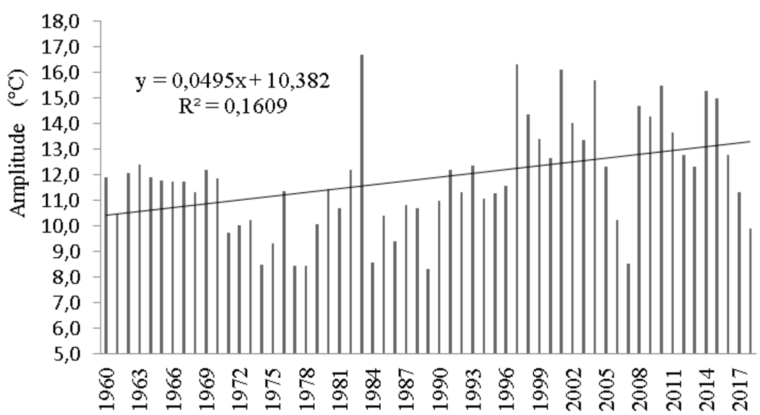

Figure No. 8. Thermal amplitude for the month of April in the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

The years 1965, 1977, 1978, 1989 and 2007 stand out with thermal amplitudes below 10 °C. In other years in studies, oscillations of this parameter are observed, ranging from 10.2 °C to 19.8 °C, respectively. The month of May has a trend line with a positive slope and R^2 of low significance. (Figure 9). Medeiros et al, (2021) and Holanda et al, (2020) corroborate the discussions presented.

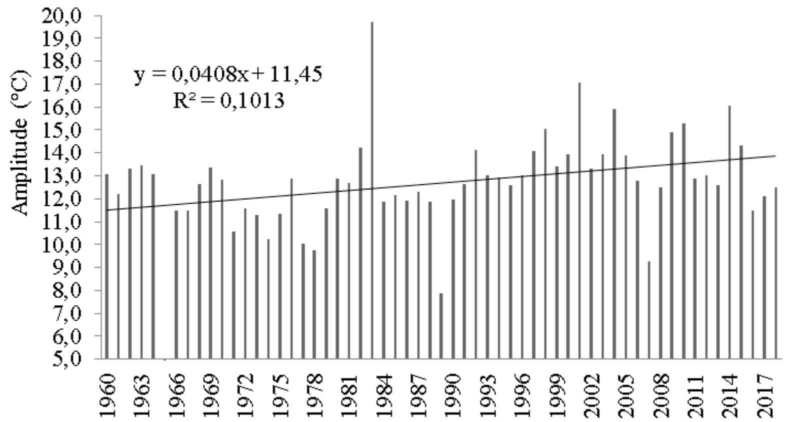

Figure No. 9. Thermal amplitude for the month of May in the period 1960 - 2018, in Bom Jesus – PI.

Source: Medeiros, (2021).

The month of June (Figure 10) has thermal amplitudes lower than 12 °C in the years 1972, 1974, 1977, 1978, 1089 and 2007. The year 1983 was the year of high thermal amplitude. In the other months understudy, oscillations flowing between 12.1 °C and 17.4 °C are recorded. That month has R2 with low significance and a positive slope.

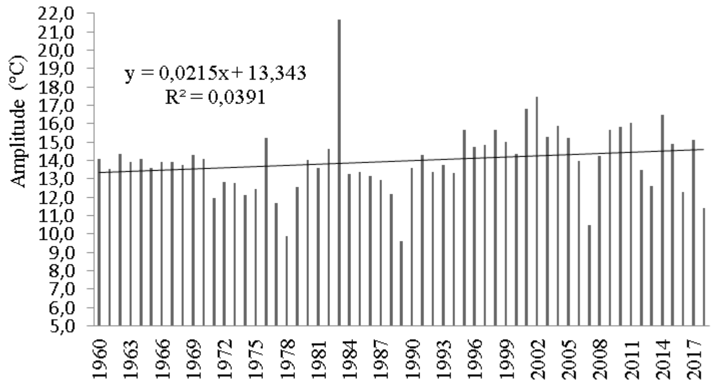

Figure No. 10. Thermal amplitude for the month of June 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

Such variability agrees with the study by Santos et al. (2013) and Marengo et al. (2011). Studies such as the one by Medeiros et al. (2015), Medeiros (2017) and Medeiros (2018) the variability of increases are related to deforestation, fires, planting monocultures and lack of soil protection.

The fluctuations of thermal amplitudes for the month of July between 1960-2018 have a trend line with a positive slope and R^2 of low significance. The years 1978, 1987, 1989, 2007 and 2016 recorded thermal amplitudes below 12 °C. The year 1965 did not register data, in the other years the oscillations of the thermal amplitude fluctuated between 12.3 °C and 17.5 °C. (Figure 11).

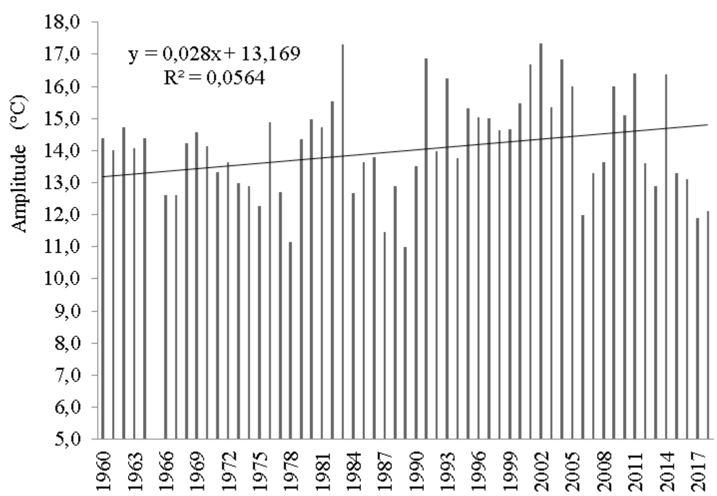

Figure No. 11. Thermal amplitude for the month of July 1960-2018, in Bom Jesus PI.

Source: Medeiros, (2021).

The month of August (Figure 12) of the period 1960 – 2018 has a trend line of positive angular coefficient and R^2 of low significance, highlighting the years 1978, 1987, 2007 and between 2015 and 2018 with thermal amplitudes below 13 °C. The year of 1995 was not registered its respective values of thermal amplitudes. The other year's oscillations between 13.1 °C and 19.8 °C are observed. Studies with similarities were developed by Holanda et al, (2020).

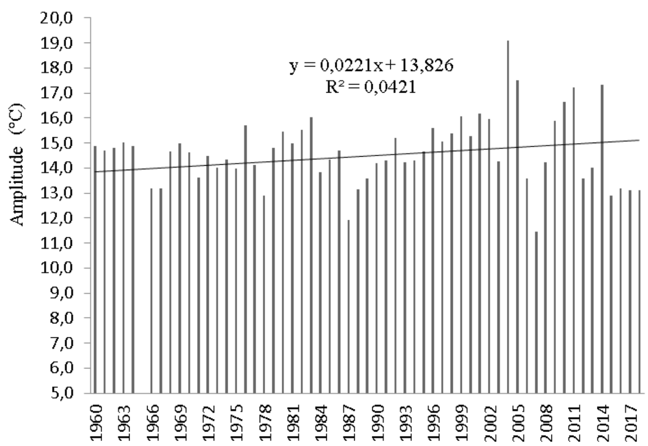

Figure No. 12. Thermal amplitude for the month of August in the period 1960 - 2018, in Bom Jesus – PI.

Source: Medeiros, (2021).

The years 1984, 1987 and 2007 (Figure 13) recorded thermal amplitudes equal to or less than 12 °C, the years 1963, 1964, 1966, 1969, 1970, 1972, 1981, 1995 to 1998, 2000 to 2002, 2004 to 2006, 2008, 2009, 2011 and 2013 recorded oscillations of thermal amplitudes flowing between 12.2 °C and 18 °C.

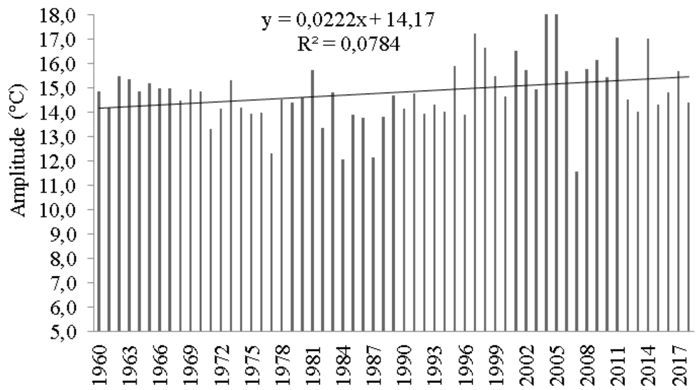

Figure No. 13. Thermal amplitude for the month of September 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

Figure 14 shows the fluctuations in thermal amplitudes in the month of October with a trend line with a positive slope and R^2 of low significance. The years 1971, 1977, 1978, 1984 stand out with thermal amplitudes equal to or less than 12 °C. In other years, the fluctuation of the element under study ranged from 12.1 °C to 21.7 °C. The year 1974 is considered an anomalous year in relation to the others. These anomalies may have occurred due to the influence of fires, lack of rain, bare soil, low cloud cover and high incidences of insolation directly on the earth's surface. (Medeiros, 2021).

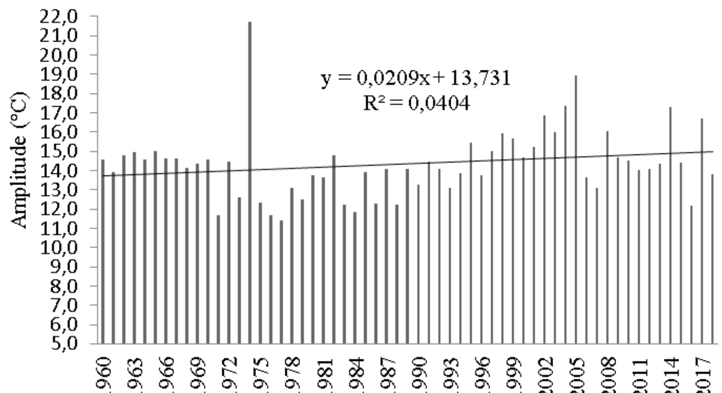

Figure No. 14. Thermal amplitude for the month of October in the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

With thermal amplitude equal to or less than 11 °C recorded in 1971, 1974, 1976, 1979 and 1980. In other years, the variability of the element under study ranged from 11.2 °C to 21.7 °C. The month of November (Figure 15) presents a trend line with a positive slope and R^2 of medium significance. The similarities in the studies by Marengo et al. (2008) corroborate the discussions.

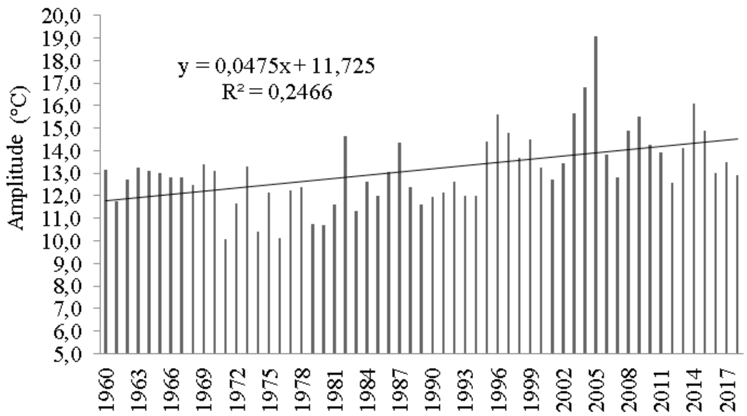

Figure No. 15. Thermal amplitude for the month of November in the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

Figure 16 shows the variability of thermal amplitude fluctuations for the month of December in the period 1960 - 2018, with a trend line and R^2 for the studied area. The years 1974, 1977, 1980, 1988 registered thermal amplitudes lower than 10 °C, in the other years the fluctuations of thermal amplitudes oscillated between 10.3 °C and 17.9 °C.

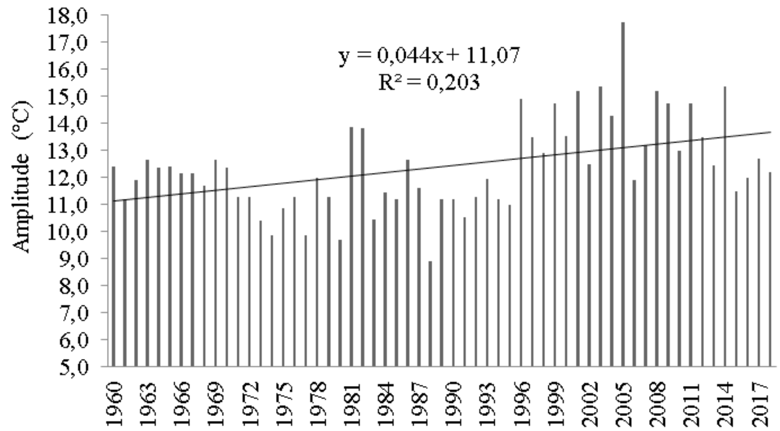

Figure No. 16. Thermal amplitude for the month of December 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

The study is consistent with those of the Intergovernmental Panel on Climate Change (IPCC), these trends observed in the recent past are highly likely to continue in the same direction in the 21st century (IPCC, 2007; IPCC, 2014).

Noteworthy are the variability of fluctuations in thermal amplitudes for the warm quarter (August, September and October) in the period 1960 – 2018. The warm quarter has a positive slope and R^2 with low significance. The oscillations of the thermal amplitude fluctuated between 11.8 °C in the year of 1965 to 18 °C in the years of 2004 and 2005. The years 1965 and 2007 stand out with the smallest registered thermal amplitudes, as the years of 1974, 2004, 2005 and 2014 as the maximum occurrence of thermal amplitudes. (Figure 17).

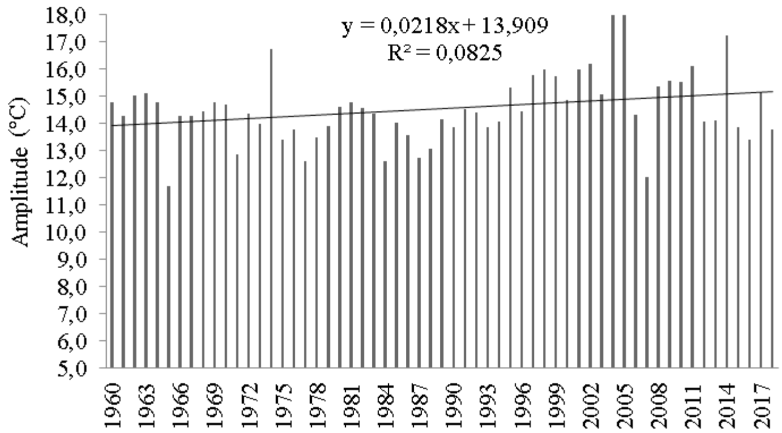

Figure No. 17. Thermal amplitude for the warm quarter of the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

Figure 18 shows the fluctuations in thermal amplitudes for the cold quarter (January, February and March) of the period 1960 - 2018, followed by its trend line and low significance R^2 and in the years 2016 to 2018 they were registered temperature ranges below 12 °C except for 1983. In the years, 1967 to 2015 the cold quarter of the temperature ranges registered its fluctuations between 12.2 °C and 18 °C.

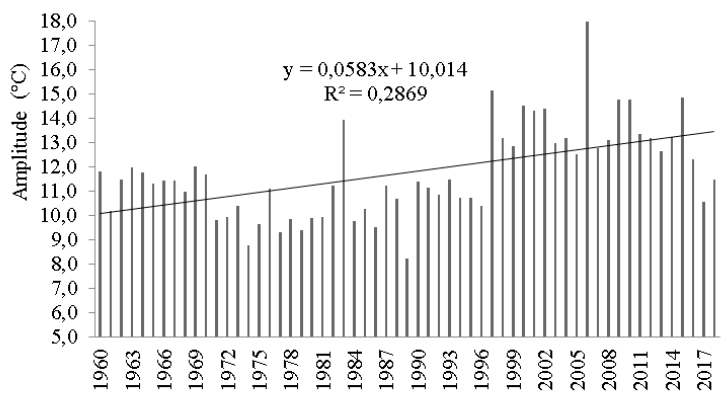

Figure No. 18. Thermal amplitude for the cold quarter of the period 1960 - 2018, in Bom Jesus PI.

Source: Medeiros, (2021).

Figure 19 represents the observed precipitation and its precipitation estimated by moving averages for 5 and 10 years for the area under study. The behavior of the thermal amplitude observed follows the estimates of the moving average for 5 and 10 years, the rhythm of the thermal amplitudes observed with amplitude reduction and flattening between years. The 10-year moving average estimates present values of greater significance than the 5-year one.

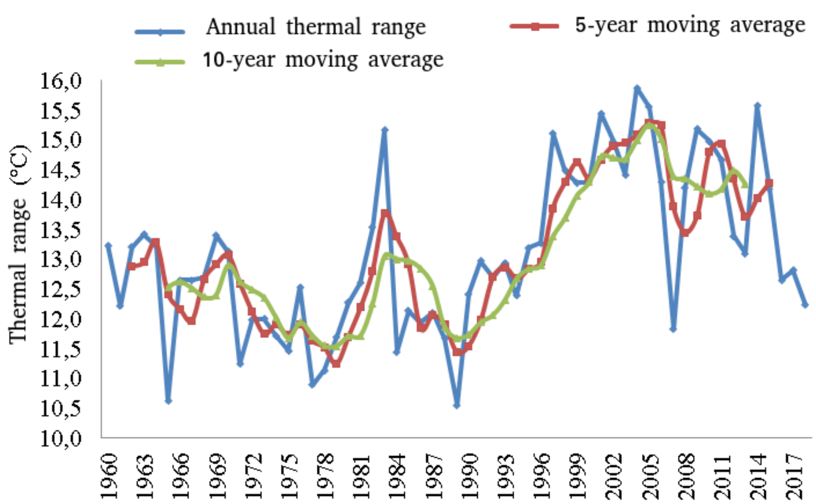

Figure No. 19. Annual thermal amplitude and its moving averages for 5 and 10 years for the municipality of Bom Jesus PI.

Source: Medeiros, (2021).

Table 1 shows the monthly linear equations, regression determination coefficients (R^2), annual average temperature from 1960 to 2018 for the municipal area of Bom Jesus PI. The monthly linear equations are presented with a positive slope, the coefficients of determination of the regression (R^2) are of low significance between the months of May and October, in the other months the significance level is moderate. Monthly average thermal amplitudes range from 11.7 °C in February and March to 14.8 °C in September, with an annual thermal amplitude of 13.1 °C. This oscillation is due to the diversified complex of seasonality in the study area.

Table No. 1. Linear equation, regression determination coefficient (R^2), monthly historical average of the thermal amplitude of the air from 1960 to 2018 for the area of the municipality of Bom Jesus PI

Months	Linear equation	R^2	Average
January	Y=0,0569x + 10,187	0,2162	11,9
February	Y=0,0787x + 0,359	0,3599	11,7
March	Y=0,0675x + 9,762	0,2922	11,7
April	Y=0,0585x + 10,203	0,1929	11,9
May	Y=0,0512x + 11,247	0,1311	12,7
June	Y=0,0317x + 13,491	0,1128	14,0
July	Y=0,0467x + 12,804	0,1328	14,0
August	Y=0,0394x + 13,491	0,1128	14,5
September	Y=0,0277x + 14,064	0,0998	14,8
October	Y=0,0264x + 13,624	0,0554	14,4
November	Y=0,0552x + 11,573	0,2758	13,2
December	Y=0,0567x + 10,824	0,2748	12,4
annual	Y=0,0514x + 11,636	0,3126	13,1

Source: Medeiros, (2021).

Such variability agrees with the study by Santos et al. (2013) who showed that the reductions in the maximum temperature occur mainly due to the greater coverage of cloudiness at these times, in which it changes direct and diffuse radiation, as well as air humidity, in addition to the position of the Earth-Sun relationship in the winter period.

Observing Figure 20, it can be seen that the months of January, February, March and April have the lowest monthly thermal amplitude indices, with an average value for the period of 12 °C, corresponding to 10% of the annual thermal amplitude. The months with the highest thermal amplitude indices range from May to December, corresponding to 5.1% of the annual total, showing over time a characteristic temporal variability of the Brazilian semiarid region that demonstrates the possibility of annual increase in the indices of thermal amplitudes.

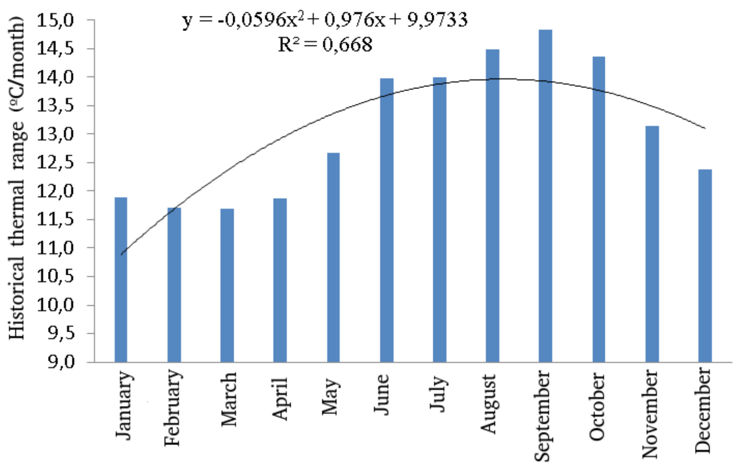

Figure No. 20. Average histogram of thermal amplitude and polynomial trend for the municipality of Bom Jesus PI.

Source: Medeiros, (2021).

Table 2 shows the variability of statistical parameters such as mean, median, standard deviation, coefficient of variance, absolute maximum and minimum of the thermal amplitude of the air from 1960 to 2018 for Bom Jesus Piauí.

Table 2 shows the statistical variability of the mean parameters of the thermal amplitude of the air in the area under study. The median has a different behavior from the average temperature, so the average values are more significant in occurrences. The largest standard deviation fluctuations occur from January to July. Statistically, the variance coefficients do not have significant monthly change indices, as for the variance parameter, their monthly fluctuations present values with low significance of monthly occurrences. Absolute maximum and minimum values can be repeated with a variability of 0.6 to 1.2 months.

Table No. 2. Statistical variability of thermal amplitude parameters (°C) in Bom Jesus PI.

Months	Average (mm)	Median (mm)	Standard deviation (mm)	Coefficient of variation (%)	Absolute maximum (mm)	Absolute minimum (mm)
January	11,9	11,0	2,0	0,2	20,5	9,0
February	11,7	10,5	2,1	0,2	16,9	8,0
March	11,7	10,5	2,0	0,2	16,5	7,6
April	11,9	10,7	2,1	0,2	16,7	8,3
May	12,7	11,9	2,2	0,2	19,7	3,6
June	14,0	12,2	2,1	0,1	21,7	9,6
July	14,0	12,9	2,0	0,1	17,3	4,1
August	14,5	13,1	1,9	0,1	19,1	4,9
September	14,8	13,8	1,4	0,1	19,1	11,6
October	14,4	12,3	1,8	0,1	21,7	11,4
November	13,2	12,4	1,6	0,1	19,1	10,1
December	12,4	11,9	1,7	0,1	17,8	8,9
Annual	13,1	11,7	1,9	0,1	18,8	10,6

Source: Medeiros, (2021).

Galvani (2011) showed that the standard deviation is important to have information on the “degree of dispersion of values in relation to the mean value”. The coefficient of variance is used to make comparisons in relative terms and expresses "the variability of each data set normalized to the mean, in percentage."

Katz (1991) and Katz *et al.* (1992) showed that the relative frequency of extreme events depends on changes in standard deviation and not just on the mean. Katz (1991) assumes that a change in a climate variable that has a probability distribution may result in a change in the shape of its distribution.

CONCLUSIONS

This study can be a tool for planning and actions aimed at the best way to manage thermal indices to be used in agriculture, health, thermal comfort in cities, among many other applications.

There is still a need for more in-depth studies on thermal distribution in the Northeast region of Brazil and especially in the region of Bom Jesus Piauí, aiming to identify its thermal patterns and fluctuations with the help of agriculture and livestock.

The meteorological station is isolated by buildings, dense vegetation and is influenced by the anthropic effects of regional residents.

The dawns are getting hot and muggy while in the afternoons the fluctuations of the thermal sensations remain stationary, this warming in the dawns has been occurring since 2000 due to oscillations in the minimum temperature.

It is expected to have contributed to information to agriculture and livestock, agribusiness, municipal, state and federal decision-making cooperatives, agricultural technicians and the health sector for a better understanding of thermal variability.

Statistically, the variance coefficients do not have significant monthly change indices, as for the variance parameter, their monthly fluctuations present values with low significance of monthly occurrences. Absolute maximum and minimum values can be repeated with a variability of 0.6 to 1.2 months. The monthly linear equations are presented with a positive slope, the coefficients of determination of the regression (R^2) are of low significance between the months of May and October, in the other months the significance level is moderate.

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