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Study of thermal comfort through rhythmic analysis and perception of people

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STUDY OF THERMAL COMFORT THROUGH RHYTHMIC ANALYSIS AND PERCEPTION OF PEOPLE

ESTUDIO DEL CONFORT TÉRMICO MEDIANTE EL ANÁLISIS RÍTMICO Y LA PERCEPCIÓN DE LAS PERSONAS

ESTUDO DO CONFORTO TÉRMICO A PARTIR DE ANÁLISE RÍTMICA E DA PERCEPÇÃO DAS PESSOAS

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Abstract:
This paper evaluates the thermal comfort of a climate event with hot temperature in the city of Palmas, State of Tocantins, in the Northern Region of Brazil, based on rhythmic analysis, relating the climatic data and the perception of the people. The method of rhythmic analysis was chosen because it allows the understanding of the rhythm in a simultaneous and continuous view of the climatic elements, as well as the genesis of the climate. In addition, the mentioned technique offers the possibility of inserting other elements into a single graphic. In this paper, the frequency of responses on the perception of thermal comfort of the respondents, obtained from a survey, was inserted. For this purpose, a period of higher temperatures was selected during the year, in the months of August and September. The episode was marked by two phases. One with predominance of the atlantic Tropical mass and evaluation in the less comfortable category. The second phase showed greater variability, with the presence of Equatorial masses and higher percentages of discomfort evaluation. It was verified that both the genesis of the climate, as well as its dynamics and pace of action, had influence on the respondents' responses. Thus, a useful research line arises in the field of thermal comfort and climatology.
Keywords: Rhythmic analysis; climate; thermal comfort.

Resumen:
El objetivo de este artículo es evaluar el confort térmico de un evento de rigor climático cálido en la ciudad de Palmas, estado de Tocantins, en la Región Norte de Brasil, basado en el análisis rítmico, relacionando los datos climáticos y la percepción de las personas. El método de análisis rítmico fue escogido porque permite la comprensión del ritmo en una visión simultánea y continua de los elementos climáticos, así como la génesis del clima. Además, la técnica mencionada ofrece la posibilidad de insertar otros elementos en un solo gráfico. En este artículo, se insertó la frecuencia de las respuestas sobre la percepción del confort térmico de los respondedores, obtenidas a partir de cuestionario. Para este propósito, se seleccionó un período de más altas temperaturas durante el año, entre los meses de agosto y septiembre. El episodio fue marcado por dos fases. Una con predominio de la Masa Tropical Atlántica que se percibe como la de menor confort térmico. La segunda fase presentó mayor variabilidad, con presencia de las masas ecuatoriales y más bajos porcentuales de confort térmico. Se verificó que tanto la génesis del clima, cuanto su dinámica y ritmo de actuación, influyeron en las respuestas de los entrevistados. Así, surge una línea de investigación útil en el campo del confort térmico y de la climatología.
Palabras clave: Análisis rítmico; clima; confort térmico.

Resumo:
Este artigo tem como objetivo avaliar o conforto térmico de um evento de rigor climático quente na cidade de Palmas (TO), na Região Norte do Brasil, a partir da análise rítmica, relacionando os dados climáticos e a percepção das pessoas. O método de análise rítmica foi escolhido porque permite a compreensão do ritmo em uma visão simultânea e contínua dos elementos climáticos, bem como a gênese do clima. Além disso, a técnica mencionada oferece a possibilidade de inserir outros elementos em um único gráfico. Neste artigo, foi inserida a frequência das respostas sobre a percepção do conforto térmico dos respondentes, obtidas a partir de questionário. Para este propósito, foi selecionado um período de mais altas temperaturas durante o ano, entre os meses de agosto e setembro. O episódio foi marcado por duas fases. Uma com predominância da Massa Tropical Atlântica e avaliação menos desconfortável. A segunda fase apresentou maior

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variabilidade, com presença das Massas Equatoriais e maiores percentuais de avaliação de desconforto. Verificou-se que, tanto a gênese do clima, quanto a sua dinâmica e ritmo de atuação, teve influência nas respostas dos entrevistados. Sendo assim, surge uma linha de investigação proveitosa no campo do conforto térmico e da climatologia.
Palavras-chave: Análise rítmica; clima; conforto térmico.

INTRODUCTION

Climate is a determining factor of comfort for people, especially in outdoor areas, which are not only susceptible to bad weather, but also difficult to immediate human control, which means via instruments or other mechanisms that are not those with decisive power in urban planning. In this research, the understanding of climate is consistent with Sorre's theory (SORRE, 1951), when dealing with climatic studies through a more geographic approach, which means, of a more biological and human sense, in which the climate is understood as the habitual sequence of states (related to the circulation of the atmosphere, to the action of the air masses, that is, to the origin of the types of weather). According to Souza (2016), in the climate concept of Sorre (1951) "the continuity and discontinuity of the occurrence of the types of weather lead to very different results in terms of living reality", and here it is complemented by the reality perceived and lived by the people. The concept of Sorre (1951) arises in opposition to the static concept of the Austrian meteorologist Julius Hann (1908), who defined the climate as the set of meteorological phenomena that characterize the average condition of the atmosphere in each place of the earth.

Based on concept of Sorre (1951), Monteiro (1971), whose work is a pioneer in Brazil and recognized worldwide, developed a technique, called rhythmic analysis, that consists of evaluating the rhythm of the climate in a certain locality using absolute climatic data in a single graph, in conjunction with its genesis. This characteristic is very different from the climatic weather evaluation, which works with the averages and other statistical treatments of the climatic data, but does not exclude the latter, having a character complementary to the statistical analysis. The dynamic approach does not invalidate the static analysis of the climate, but complements the latter, assuming a different attitude in the projections in time and space and in the form of climate synthesis (ZAVATTINI; BOIN, 2013). It is a qualitative-quantitative technique: quantitative, because it presents measurable climatic data (air temperature and humidity, precipitation, wind speed and direction, and others); and qualitative by the insertion of the genesis of the climate (atmospheric actuating systems).

Although in small numbers, there are already some works under this concept being developed in the state of Tocantins, mainly from a research project in execution in the Laboratory of Geo-environmental Analysis at the Universidade Federal do Tocantins (UFT), and by the master's and doctoral programs in this and other universities. Examples such as Souza, Gomes and Rocha (2014), Pinto (2013) and Silva (2013), on climate aspects in Tocantins, and specifically in the city of Palmas, Freitas (2015) and Silva (2018), have been developed using Monteiro's technique (MONTEIRO, 1971).

The rhythmic analysis is used in this research in conjunction with people's perception of their thermal comfort, because this is a referential in the channels of human perception of the

climate (MONTEIRO; MENDONÇA, 2011). For the American Society of Heating, Refrigerating and Air Conditioning Engineers – ASHRAE (2017), thermal comfort is defined as "that condition of mind that expresses satisfaction with the thermal environment", which means, it is a conceptually subjective phenomenon, linked to perception of people.

However, the tradition in research that relates thermal comfort to a bioclimatic characterization, does not include the understanding of the genetic and dynamic character of the climate, being restricted to a more meteorological character, in which the human aspect is less considered. Rare works such as Gobo (2013) present such a technique, even if by complementary analysis to the statistical analysis. For this reason, the present proposal can bring different perspectives to this field of study, as much to the field of the geographic analysis of the climate, as to the field of the thermal comfort.

The choice of the research theme in the city of Palmas is due to the reduced academic production on climate and thermal comfort in the North Region of the Brazil, a reduction that was aggravated in that city. The North Region has a shortage of more detailed studies covering the theme of thermal comfort and climate, both on a regional scale and on the urban climate scale, especially from the point of view of the climate genesis and dynamic. The academic production of climatology is concentrated in the South and Southeast regions of Brazil, especially in the state of São Paulo (ZAVATTINI, 2004). In specific studies on urban climate, geographer Francisco Mendonça presents case studies regarding 30 years of research in Brazil, of which 5.8% were applied to the North Region, which amounts to only eight studies of the 139 surveys in total (MONTEIRO; MENDONÇA, 2011). Among the works of thermal comfort in open areas, the shortage is even greater. In a specific survey between 1990 and 2011, Rossi (2012) did not identify any work on comfort in open spaces in the North Region being presented at the National Encounters of Comfort in the Built Environment (Encontros Nacionais de Conforto no Ambiente Construído – ENCAC – held in Latin America). Among the papers presented in the last editions, few were developed in the North Region and Tocantins, for instance, Silva, Ferreira and Silva (2015) on open spaces in the city of Palmas.

The choice of the city of Palmas is also due to the characteristics in its urban planning. The city entered history for being the last planned capital of the XX century, being constructed and occupied with the developing discourse – from the fifty years in five to the twenty years in two – as in the geopolitical discourse of country integration (SILVA, 2010). It was founded in May 20, 1989 to be the capital of Tocantins, a state created as a result of the territorial dismembering of the north region of the state of Goiás.

From the genetic point of view of the climate, the city under study is subject to the air masses operating in the state, with the common occurrence of high temperatures: "in terms of climatic genesis, Tocantins' territory is affected especially by air masses with expressive heat, originated both in the equatorial range and in the tropical/subtropical area of the planet (SOUZA, 2016). The high temperatures are also identified in the record of their meteorological stations.

Due to its recent implantation, the meteorological data of the city of Palmas, are still scarce. The meteorological data of the conventional station of the National Institute of Meteorology

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of Brazil (Instituto Nacional de Meteorologia – INMET) began their registration in 1993 and the digital station in late 2004. In the registry of these data, collected in the Meteorological Database for Teaching and Research (Banco de Dados Meteorológicos para Ensino e Pesquisa – BDMEP), on INMET's website (INMET, 2015), between 2004 and 2013, monthly averages of maximum temperatures reached 38.6ºC in September 2011. In this same period, the lowest monthly average of minimum temperatures was 19.6ºC in July of 2005, while the highest monthly average minimum temperatures were 25.4ºC in September 2010. The highest temperatures are generally recorded in more recent years, as presented by Lima, Barbosa e Silva (2014), in a comparison of the data of the Provisional Climatological Normal (RAMOS; SANTOS; FORTES, 2009) and the averages of 14 years of data (2000 to 2013).

The technique of rhythmic analysis allows the insertion of several elements correlated to the climatic rhythm, not only the universally known climatic data, depending on the research focus. For example, Silva's master thesis (SILVA, 2013), which has inserted the phenological phases of soybean in the chart, considering that its objective was to understand the relationship between climate genesis and dynamics and the production of this grain in the city of Pedro Afonso, state of Tocantins. In the case of episodic studies, rhythmic analysis charts can be reduced, evaluated according to the period to be analyzed and the object of study. As an example, Souza (2010) presents a graphic of a spring/summer episode studied in the city of Palmas, between September 2009 and March 2010, evaluating the rain episodes that caused floods and several impacts in the city, including identification of event reports in local newspapers. In this research, it will be related the perception of the people regarding their thermal comfort, using questionnaires as a resource.

The objective of this paper is to evaluate the thermal comfort of an episode of extreme climate conditions in the city of Palmas, state of Tocantins, Brazil, from the rhythmic analysis, relating the climatic data with the perception of people. It is important to clarify that this work was based on an article of our authorship originally published in the XIV ENCAC (National Meeting of Comfort in the Built Environment), held in Brazil (SILVA et al. 2017).

MATERIAL AND METHODS

The methodology of choice was the rhythmic analysis, according to the practical proposal of Monteiro (1971). The methodological procedure consisted in the following phases:

a Bibliographic research and elaboration of a survey;

b Selection of an episode of analysis for the research;;

c Application of the survey;

d Collection of climate data and correspondent data needed for the identification of the acting atmospheric systems;

e Elaboration of the rhythmic analysis graphic of the selected episode;

f Analysis of thermic comfort, through the evaluation of the frequency of answers in the graphic of rhythmic analysis.

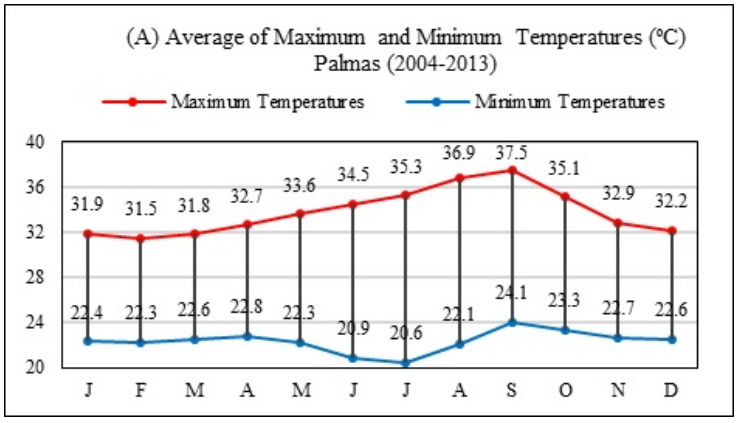
THE TECHNIQUE OF RHYTHMIC ANALYSIS AND THE SELECTION OF THE ANALYSIS EPISODE

Rhythmic analysis involves absolute, daily, and in certain circumstances, time data, necessary for understanding rhythm. It consists of the assembly of a graphic of simultaneous representation of the elements of the climate in an at least daily frequency, coupling the graphical representation of the action alteration of the different masses of air, representing the meteorological systems involved in the atmospheric circulation. In this way, it allows the qualitative analysis of the types of weather in a continuous sequence. Time segments are selected, leading to the analysis of years taken as patterns, and the episodic analysis of local and microclimatic phenomena, providing the understanding of continuity and sequence. In this research is analyzed an episode of hot weather in the city of Palmas.

The application of the technique begins with the selection of the analysis episode, and next by the collection of climate data and identification of the active masses. For the evaluation of the analysis period, the climate data of the 10 years period prior to the research was verified, from 2004 to 2013, in the conventional station of the INMET. It was selected for analysis the period between the months of August and September, as they are both months with the highest temperatures and lowest air humidity during the year. As verified in Figure 1, in the month of September was recorded the highest average of maximum temperatures, with 37,5ºC, followed by the month of August, with 36,9ºC; in September was also recorded the highest average of minimum temperatures, with 24,1 ºC, while in August was recorded the lowest average of relative humidity, with 40,6, followed by the month of September, with 44,1%.

Initially, were selected 30 days for the analysis, comprehending the second half of August and the first half of September, as being the most significative for the evaluation and for the application of the survey, considering the period of five days before and after this period for the elaboration of the graphic of rhythmic analysis, with the objective of obtaining a better understanding of the previous and posterior rhythm in relation to the interviews. However, this period had to be extended, because it was considered important to wait for the first rain of September. Therefore, the period of the final analysis was comprehended between August 10 and September 24, 2014.

Fig. 1 Average of the maximum and minimum temperatures (A), and Average of the relative humidity (B), in Palmas, between 2004 and 2013.



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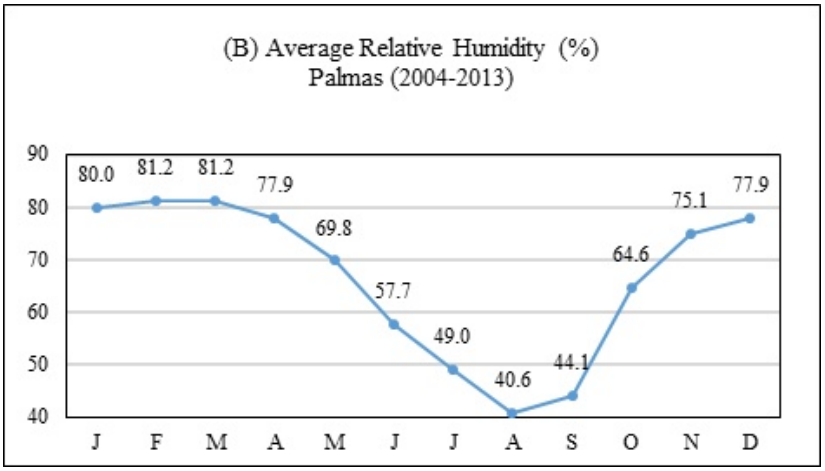
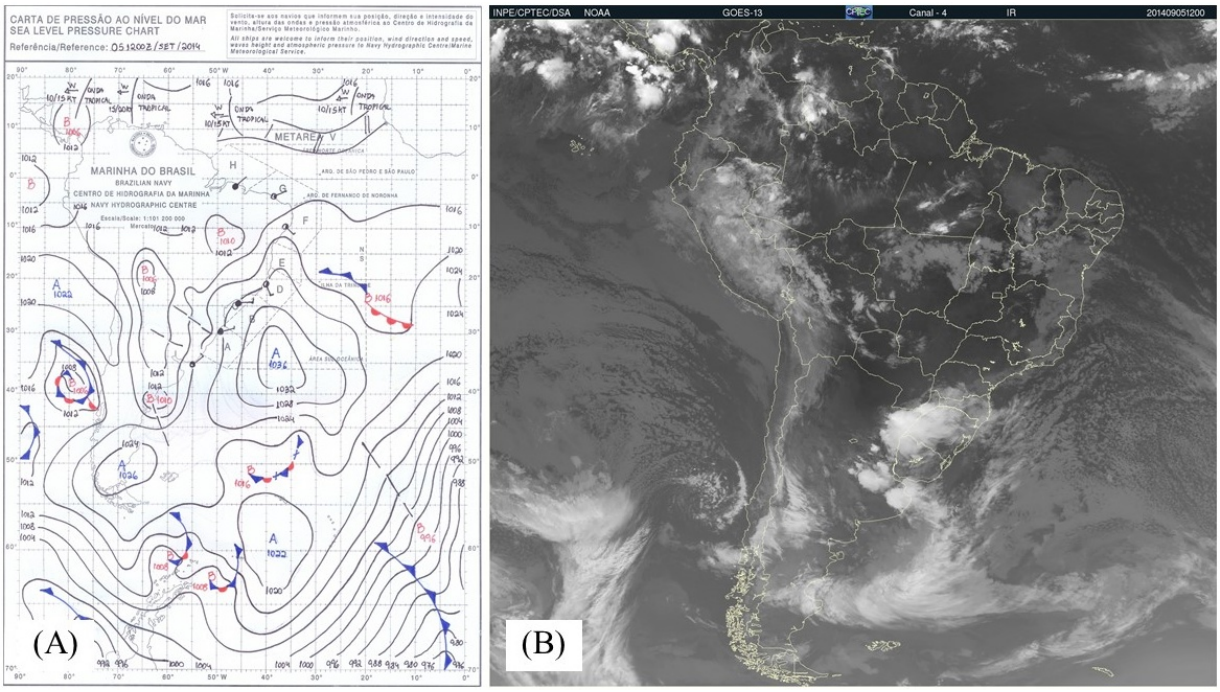


Reference: INMET (2015).

In the moment that the data of the conventional INMET station were released in the website of the institution, they were organized and tabulated in a software of electronic spreadsheet, where the graphics were also elaborated. It were collected the daily data of air temperature (maximum and minimum) and precipitation (of the conventional station); and data from the relative air humidity, cloudiness, wind speed and direction (of the automatic station) at 12h and 18h UTC (Universal Coordinated Time), which corresponds to 9 am and 15 pm in the local time, for the identification of the active masses in the morning and afternoon. To identify the active air masses other resources are needed, besides climate data, such as synoptic charts and satellite images. It were used synoptic charts from the Brazilian Navy, and orbital images of the GOES satellite, both available on line, according to the example in Figure 2. Posteriorly, the data were organized in a software of slides presentation, and the answer frequency of the subjects was inserted, obtained through the survey.

Fig. 2 Synoptic chart (A), and satellite images (B) for the day 05 of set. 2014 at 12:00 UTC, used to identify atmospheric systems.



Reference: Marinha do Brasil (2015); CPTEC/INPE (2015)

ELABORATION OF THE SURVEYS AND PLACE OF APPLICATION

For a better understanding of the perception of thermic comfort of the interviewees, it were considered aspects such as the perception of the thermic condition, thermic preference and evaluation of the comfort of the interviewed population were. Such variables are described also in the recommendations of the ISO 10551 (1995). According to this standard, three different scales must be applied in the following order: scale of perception of the personal thermal state; evaluative scale; and thermal preference scale. The standard presents the perception of the thermal state such as hot, neutrality and cold perception; the evaluative scale of the judgment of comfort/discomfort in the environment; and the preference scale, as implied by the denomination, is how the subject would like the thermal state to be in the moment, warmer, absence of change, or cooler. The recommendations of standard were used with some simplifications regarding the content of the questions and the scale of the answers, with the inclusion of some complementary questions, for the proper identification and characterization of the interviewee. It were performed pre-tests for the verification and understanding of the applied questions. It was not stablished a minimum or maximum age limit, nor a defined education level, as the survey presented questions that were simple and of easy understanding, as demonstrated by the pre-test. The final applied survey is found on Figure 3.

Fig.3 Survey applied in the research.

SURVEY			
Local: _____		Date: _____/_____/_____	Hour: _____ : _____
Personal data:	Age: _____	Weight: _____	Height: _____
Gender:	O Female	O Male	O Not stated
Where did you live before Palmas?	City:		State:
How long have you live in Palmas?	What period of theday do yougo to the location?		For how long?
Years/Months: _____ or Since: _____	O Morning O Night	O Afternoon O None in special	Hours: _____ Minutes: _____
How are you feeling now?		Do you find this .... ?	Would you prefer to be ... ?
O hot O warm O slightly warm O neutral	O slightly cool O cool O cold O Did not answered	O Comfortable O Uncomfortable O Did not answered	O cooler O without change O warmer O Did not answered
Observations:			

The INMET weather station is located in the city's macrodivided area, which is bordered to the west by the lake of the Lajeado Hydroelectric Power Plant, known as Palmas Lake, to the east by Serra do Carmo, known as Serra de Lajeado, to the north by Água Fria River and to the south by Taquaruçu Grande River. The surveys were applied in the central area of the city, near the Girassóis Square and Juscelino Kubitschek Avenue (area between 104 North and 104 South), which are areas of great movement of bystanders and near the weather station. The location of the weather station and the application sites of the surveys is shown in Figure 4.

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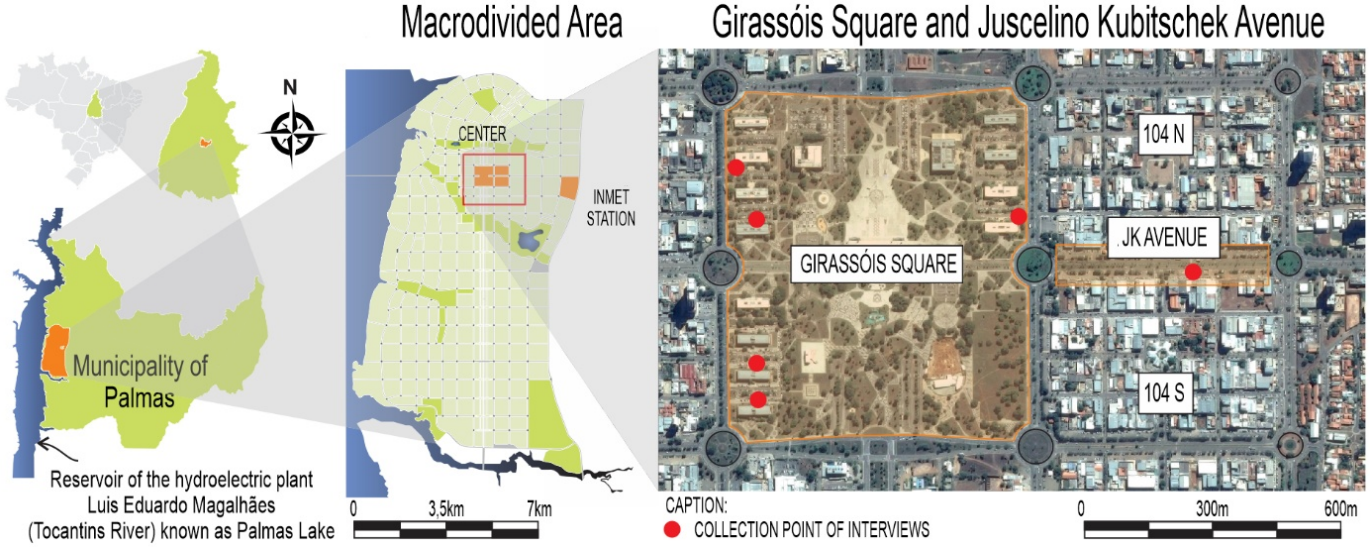
Fig.4 Location of the INMET Weather Station and the application sites of the questionnaires.



Reference: Google Maps (2015).

Surveys were applied within 10 days of the selected episode, on August 15, 18, 22, 25 and 29, and on September 01, 05, 12, 17 and 19, in order to having a more equitable distribution, and does not coinciding with local and national holidays. The determination of the sample followed the recommendations of Fonseca and Martins (2010), for qualitative variables, considering the last census of the city population, with a confidence level of 95.5% and an accepted sampling error of 5%, thus obtaining the sample size of 400 people. However, considering the time of application of the survey and the possibility of 10 days of application, it was decided to apply 800 surveys. The application considered the homogeneous distribution in the time and days of the collection, with 10 surveys per hour being applied, between 8 am and 12 noon in the morning and between 2 pm and 6 pm in the afternoon period. All surveys were considered valid, totaling a sample of 800 respondents.

RESULTS AND DISCUSSION

The results on the characterization of the interviewees and the graph of rhythmic analysis that includes the climatic data, their genesis and the interview answers are presented.

CHARACTERIZATION OF THE INTERVIEWEES

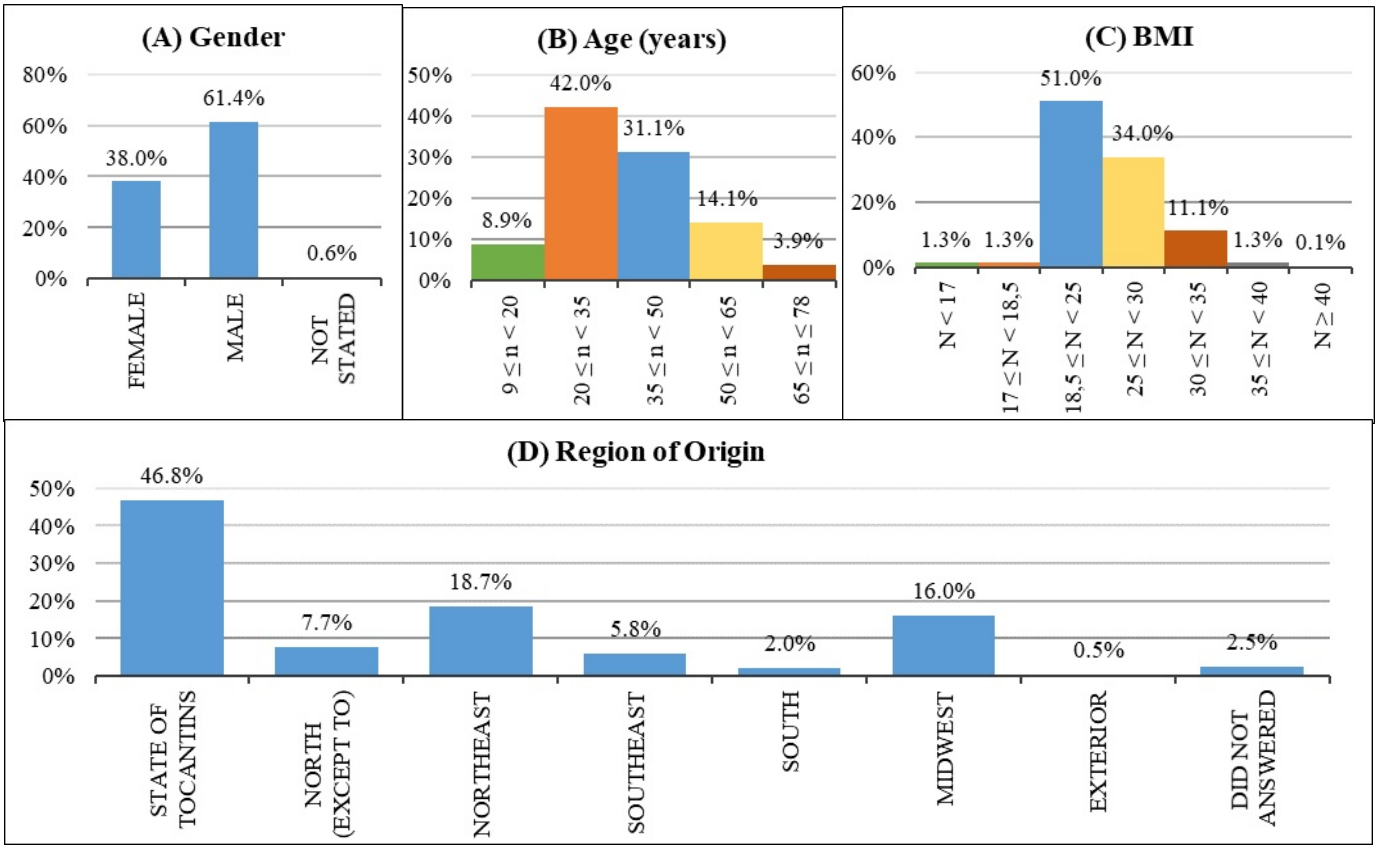
Through the answers obtained in the 800 surveys, it was possible to perform a characterization of the interviewees, which are arranged in the following figures, containing the following information: gender, age, Body Mass Index (BMI), region of previous origin, time of residence in Palmas and time of permanence in the area.

The sample of 800 respondents comprised a predominantly male population, corresponding to 61.4%, and 38.0% female, with 0.6% not declaring the gender (Figure 5A). Among the wide range of age groups, a young population predominated, with 42.0% covering the range 20-35 years of age, according to Figure 5B. As for BMI (Figure 5C), which measures the body mass of the

individuals, a population with healthy BMI ranged from 18.5 to 25, with 51%, followed by 34% of the population with a BMI between 25 and 30, characterized as overweight. The percentages of BMI corresponding to thinness, below 18.5, and obesity, above 30, were greatly reduced.

Regarding the origin area (place of residence before living in Palmas), as can be seen in Figure 5D, 54.5% of the population interviewed came from the North region, with 46.8% coming from the state of Tocantins. Of the latter, only two interviewees were born in Palmas, the others lived previously in the countryside of the state. Secondarily, the respondents came from the Northeast region, with 18.7%, followed by 16.0% from the Midwest, 75.8% from the Southeast, 2% from the South and 0.5% were foreigners. The time classes of housing in Palmas (Figure 5E) show that 36.0% of the interviewees already lived in the city between 10 and 20 years prior, and 28.9% between 1 and 10 years. A significant proportion, 25.0%, had lived in Palmas for more than 20 years, since the period when the city was established, and few lived for less than a year, only 6.8% of respondents. The majority of the interviewees attended the place for more than 4 hours, corresponding to 36.0% of the interviewees, followed by 22.1% who remained from 1 to 2 hours, 21.8% from 2 to 4 hours and 13.8% from 15 minutes to 1 hour (Figure 5F).

Fig.5 Histogram relative frequency of: (A) gender, (B) age, (C) Body Mass Index (BMI), (D) region of origin, (E) time of residence in Palmas and (F) time of permanence in the place.



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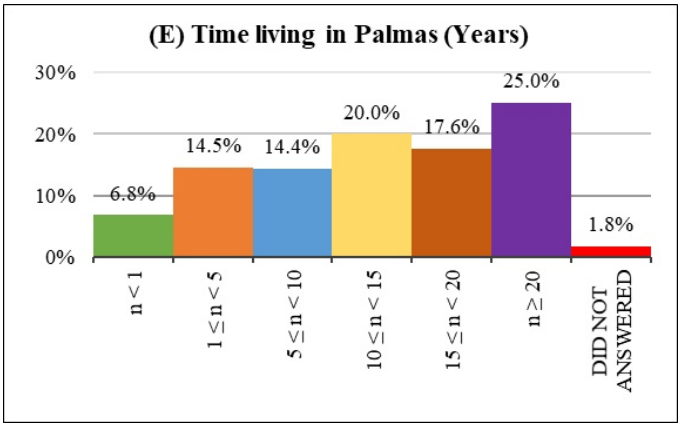
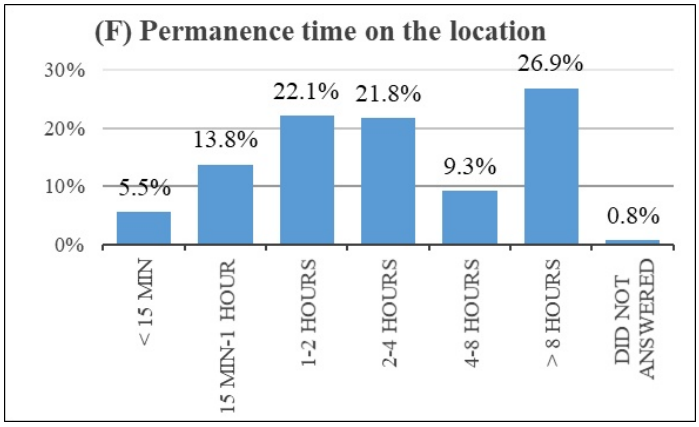




The general characterization of the interviewees shows a very young part of the population, with a healthy BMI, coming from the countryside the state, living in the city for a long period of time, and frequenting the place for an extended period of time.

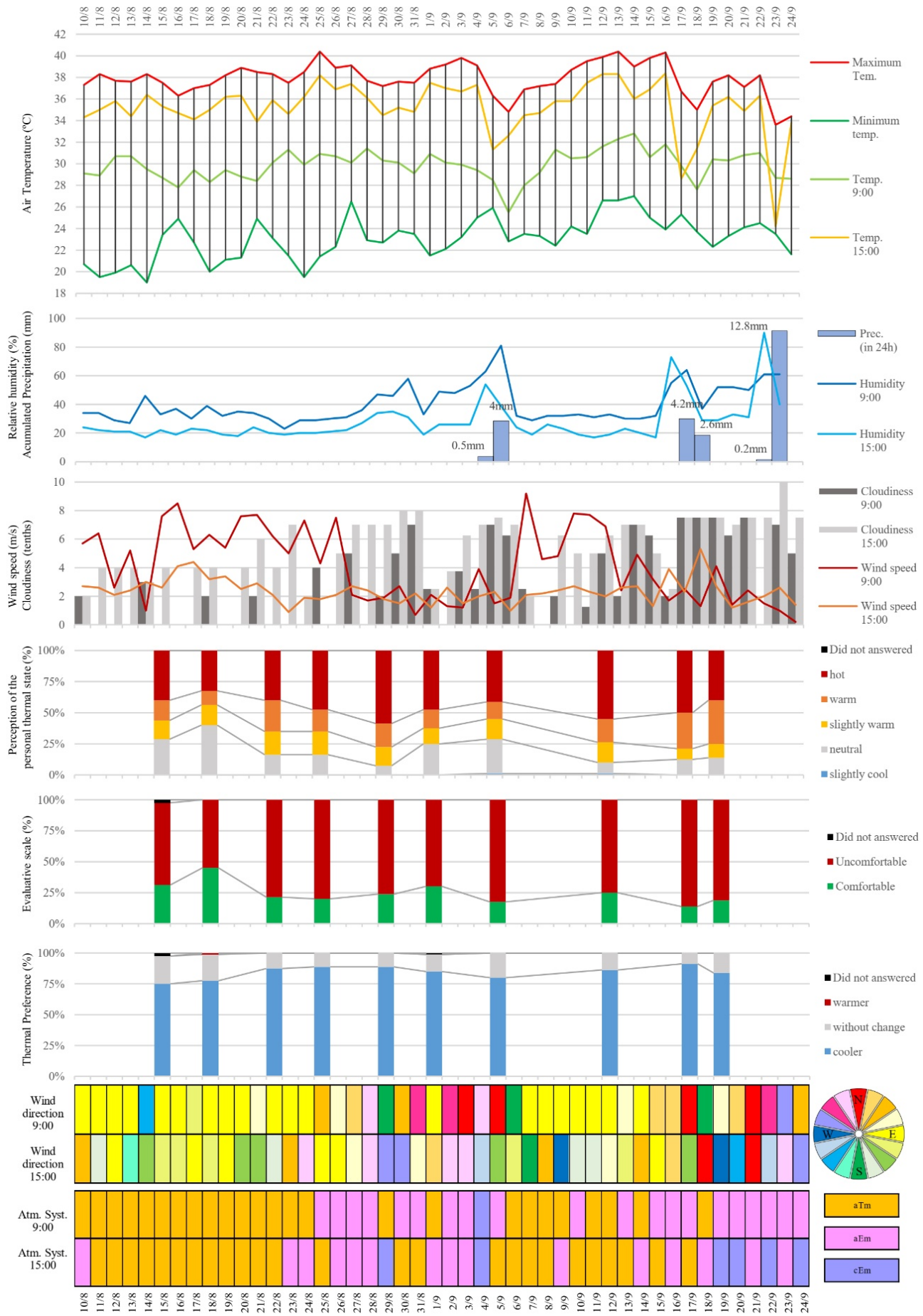
RHYTHMIC ANALYSIS OF THE EPISODE FROM AUGUST 10 TO SEPTEMBER 24, 2014 IN PALMAS

The results collected in the INMET in the selected period and the interviews are presented in the graph of rhythmic analysis, according to Figure 6.

In climatic terms, the collection period corresponds to the end of winter and early spring, which marks the end of the dry season and the beginning of the rainy season. It was observed the predominance of atlantic Tropical mass (aTm) at the beginning of the analysis period, from August 10 to 22, and in a small portion of the month of September, between days 05 and 13, but with some presence of the atlantic Equatorial mass (aEm). Between August 23 and September 4, and from September 14, there is a predominance of aEm, with some occurrence of the continental Equatorial mass (cEm). The cEm has a greater presence from September 19, in the afternoon period. The aTm in September is marked by higher humidity and higher temperatures, which amounts to a greater weather instability, so much that it presents greater competition with aEm and cEm.

In the first line of the graphic, temperatures have often exceeded 38ºC, reaching a peak of 40.4ºC (September 13). The thermal amplitude in the month of August was higher than in the month of September. The whole period presented a thermal amplitude higher than 10ºC, surpassing 18ºC in August, on days 11, 14, 24 and 25 (under aTm and aEm). The days with the lowest thermal amplitude were in the month of September, not exceeding 12ºC on days 5, 16, 17, 18 and 23. On these same days, the relative humidity presented its highest values, in the morning at the beginning of September and in the afternoon at the end of the month. The precipitation is recorded at 9:00, corresponded to the total accumulated for the last 24 hours. At the beginning of September, rainfall was associated with the aTm, with low wind speeds from the south and southeast. At the end of the same month (days 18, 19 and 24), rain was associated with aEm, with north, northeast and northwest winds, with lower airspeed on September 24th. Although it was not responsible for the precipitation identified in the period, the cEm was present on days of low atmospheric pressure, but with little air humidity, insufficient to provoke an incidence of rain.

Fig. 6 Episodic rhythmic analysis and perception of people, Palmas, August 10 to September 24, 2014.



Reference: INMET (2015).

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Air velocity remained high in August in the morning between days 15 and 26, with the aTm predominating. During the month of September, the air velocity presented greater variation, obtaining higher values in the morning period between days 7 and 12, and higher values, but not as high in the afternoon period on days 16 and 18. In general, the high velocity of the winds was not associated with the presence of rain, but with the aTm with the highest pressure. As of August 30, relative air humidity had not exceeded 50% and no precipitation was recorded, which means that the elevation of air humidity is associated with the presence of rainfall. The rains occurred in isolation, but at the end of September, with a higher maximum temperature (days 03, 12, 13, 15 and 16). During this period, the cloudiness increased greatly, especially in the evening period.

The graphics of the survey answers show that, in general, the climate for the interviewees is evaluated as uncomfortable, reaching in a few days a rate of almost 90% of discomfort, with a tendency to perceive the thermal state as hot (ranging from slightly warm to hot) by more than 50% every day, just as the preference for the thermal state as being cooler was always above 75% of the responses. There was no perception response of the thermal state as being “cool” and “cold”.

Regarding the comfort evaluation of the interviewees, a reduction of the percentage of comfortable votes was observed in the month of September, and in the whole period, it was noticed that the reduction of the comfort response was associated to aEm and cEm at some time of day (25th and 29th August 5th, 17th and 19th of September). August 18 had the highest percentage of comfortable votes, with 45%, followed by August 15, with 30%, both with aTm performance, and also with higher wind speeds in the morning. In these two days, it was also noticed that the maximum and minimum temperatures recorded were lower, compared to the month of September. The highest percentage of discomfort responses were on September 17, with 86%, followed by the September 15 of the same month, with 83%. An important factor was observed, that these two days preceded the first incidence of rainfall (September 06 with 4mm and September 18 with 4.2mm), elevation of maximum temperature and minimum temperature, with lower thermal amplitude and peaks in the relative humidity of air. On both days, the aEm was active in the morning and the aTm in the afternoon (period of greatest instability).

With the perception of their thermal state, the interviewees’ answers also presented a higher percentage of neutrality on August 15 and 18 (with 29% and 40%, respectively), with a lower percentage of perception of the thermal state as being “warm” (16% and 11%) and “hot” (40% and 33%). The lowest percentage of “neutral” votes occurred on August 29 (8%) and on September 12 (9%), while the “hot” percentage of votes was higher, 59% and 55%, respectively. In these two days, the comfort vote obtained an intermediate percentage. The aTm (September 12) and aTm and cEm (August 29) masses were active.

Regarding the thermal preference, the changes were a bit more subtle. In almost every interview days, most respondents preferred the thermal state to be cooler, even if the neutrality vote, in the case of thermal perception, and comfort, in the case of the evaluation, were larger. Again, August 15 and 18 presented the highest percentages of respondents who did not want changes (23% and 21%), but the percentage of those who preferred the “cooler” classification was still very high (75% and 78%). The days August 22, 25 and 29, and September 17, presented the highest percentages

of people who wanted changes to "cooler" with 88%, 89%, 89%, and 91% of responses. Two of these days had distinctive characteristics: in the evaluation of comfort, on September 17 with a lower percentage of comfort vote; and on August 29, with a higher percentage of perception of the thermal state as being "hot".

The period analyzed was marked by a transition: until August 22, with a more stable aTm predominance, absence of rainfall, higher air velocities, low cloudiness, low air humidity and high thermal amplitude, comfort evaluation in the less disconfortable category, perception of the thermal state as being more neutral and reduced preference to changes; as of August 23 and in September there was greater variability in the predominance of atmospheric systems, with the prevalence of aEm, alternating sometimes with aTm throughout the day and cEm in the afternoon, with higher wind speed variation, with isolated moments of greater air humidity and greater cloudiness, when rainfall occurs, in addition to a greater variation in people's responses, but with higher percentages of discomfort assessment, perception of the thermal state as being "hot" and preference to a cooler climate.

CONCLUSION

In general, in the perception of people, the city presented a pattern of discomfort. This result was not surprising, considering the characteristics of high temperatures in the period selected for analysis, still identified in the general climatic characterization, and confirmed in the episode, which exceeded a 40ºC temperature peak. However, analyzing the results from a point of view of the participation of the atmospheric systems and their characteristics, it was possible to relate the influence of it on the people's answers, in which a close relation was perceived. Even in a short-term research, considering its exploratory nature, it was verified that both the genetic origin of the climate, its dynamics and rhythm of action, had an influence on the responses of the interviewees.

At the moment of greater weather stability, with the action of the atlantic Tropical mass when closer to the continent, a tendency was observed to less severe answers of the people. In the period when there was a greater variation in the performance of atmospheric systems, with the introduction of the Equatorial masses, atlantic and continental, and retreat from the atlantic Tropical mass to the ocean, the responses of the people showed an increase of extreme percentages of discomfort and hot. During this second phase of the selected episode, there was a small sequence of days with relative stability (from 06 to 12 September), again by the approach of the atlantic Tropical mass, when it was also verified the reduction of people's perception of discomfort and hot.

The research demonstrated what had already been highlighted by Souza (2016) in the introduction, that the alternation of weather conditions, with moments of continuity and discontinuity, influence the reality perceived by the people, thus confirming the Sorre's theory of climate, both the inseparability of the climate of biological concerns, and the importance given to human sensitivity. This result was only possible using the technique proposed by Monteiro (1971). The technique of rhythmic analysis, with its simultaneous and continuous vision, allowed the

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understanding of the weather rhythm, proving to be an efficient technique for application in other proposals of conjunction with the thermal comfort.

Thus, a useful research line arises in front of the field of thermal comfort and climatology, opening possibilities for the occurrence of new researches that carry out the conjunction of the two fields of study.

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