Mercator, Fortaleza, v. 22, e22026, 2023. ISSN:1984-2201

CLIMATE, TROPICALITY OF THE BRAZILIAN CENTRAL PLATEAU, AND TUBERCULOSIS LOAD

https://doi.org/10.4215/rm2023.e22026.

Brandão, E.C. [a*] - Borsato, V.A. [b] - Steinke, E.T. [c]
Evangelista, M.S.N. [d]

(a) Master in Nursing.
ORCID: https://orcid.org/0000-0003-0672-3536. **LATTES:** http://lattes.cnpq.br/9393264022993379.
(b) PhD in Ecology of Continental Aquatic Environments.
ORCID: https://orcid.org/0009-0002-8180-3106. **LATTES:** http://lattes.cnpq.br/9383374351131038.
(c) PhD in Ecology.
ORCID: http://orcid.org/0000-0002-9728-2053. **LATTES:** http://lattes.cnpq.br/3758831342495343.
(d) PhD in Interunits.
ORCID: http://orcid.org/0000-0002-4074-6101. **LATTES:** http://lattes.cnpq.br/6587364159444556.

MERCATOR

ARTICLE

Article history:
Received 21 March, 2023
Accepted 15 August, 2023
Published 30 Dezember, 2023

(*) CORRESPONDING AUTHOR
Address: UNB. Darcy Ribeiro ICC Ala Sul, sala CSS 72, Cep: 70.910-900, Asa Norte, Brasília (DF) Phone: (+55 61) 3107-7223
E-mail: erlaynebrandaoenf@gmail.com

Abstract

The current literature has pointed out an influence of climatic and environmental aspects on tuberculosis (TB) burden. Among the main influences, the effects of climate stand out. The present study aims to identify whether the tropicality of the Brazilian Central Plateau increases TB burden in the Federal District, Brazil. This is an ecological study carried out with 1,291 new TB cases notified to the Notifiable Diseases Information System of the State Health Department of the Federal District. We studied the participation of air masses and the cases of tuberculosis during the summers from 2006 to 2017. For the rhythmic analysis, we considered the summer of 2006, as it was the year with the highest frequency of TB cases. We used Pearson's correlation test. The most frequent types in the summers were the continental Equatorial mass, with a 77.5% frequency, and the Atlantic Tropical mass, 13.8%. We observed no correlation between the performance of atmospheric systems and TB cases; that is, meterological variables showed no contribution to the greater burden of TB in the Federal District.

Keywords: Tuberculosis. Climate. Air Masses. Climate Changes. Effects of Climate Change.

Resumo / Resumen

CLIMA, TROPICALIDADE DO PLANALTO CENTRAL BRASILEIRO E A CARGA DA TUBERCULOSE

A literatura atual vem apontando uma influência dos aspectos climáticos e ambientais na carga da tuberculose (TB). Entre as principais influencias, destacam-se os efeitos do clima sobre a carga de tuberculose. O estudo objetiva identificar se a tropicalidade do Planalto Central incrementa a carga da tuberculose no Distrito Federal-Brasil. Trata-se de um estudo ecológico, realizado com 1.291 casos novos de TB, notificados ao Sistema de Informação de Agravos de Notificação da Secretaria Estadual de Saúde do Distrito Federal. Estudou-se as participações das massas de ar e os casos de tuberculose dos verões de 2006 a 2017. Na análise rítmica, considerou-se o verão de 2006, por ser o ano com maior frequência de casos de TB. Foi utilizado o teste de correlação de Pearson. As massas de ar com maiores participações nos verões, foram a massa equatorial continental com 77,5% e, a massa tropical atlântica, 13,8%. A atuação dos sistemas atmosféricos não apresentou correlação com os casos de TB, ou seja, os elementos do tempo não contribuíram para a maior carga da TB no Distrito Federal.

Palavras-chave: Tuberculose. Clima. Massa de ar. Mudança climática. Efeitos do clima.

CLIMA, TROPICALIDAD DEL PLANAL CENTRAL BRASILEÑO Y CARGA DE TUBERCULOSIS

La literatura actual ha señalado una influencia de los aspectos climáticos y ambientales en la carga de tuberculosis (TB). Entre las principales influencias destacan los efectos del clima sobre la carga de tuberculosis. El estudio tiene como objetivo identificar si la tropicalidad de la Meseta Central aumenta la carga de tuberculosis en el Distrito Federal-Brasil. Se trata de un estudio ecológico, realizado con 1.291 nuevos casos de TB, notificados al Sistema de Información de Enfermedades Notificables de la Secretaría de Salud del Estado del Distrito Federal. Se estudió la participación de masas de aire y casos de tuberculosis en los veranos de 2006 a 2017. En el análisis rítmico se consideró el verano de 2006, por ser el año con mayor frecuencia de casos de tuberculosis. Se utilizó la prueba de correlación de Pearson. Las masas de aire con mayor participación en los veranos, fueron la masa ecuatorial continental con 77,5% y la masa tropical atlántica, 13,8%. El desempeño de los sistemas atmosféricos no se correlacionó con los casos de TB, es decir, los elementos del tiempo no contribuyeron a la mayor carga de TB en el Distrito Federal.

Palabras-clave: Tuberculosis. Clima. Masa de aire. Cambio Climático. Efectos Climáticos.

INTRODUCTION

Geographic and environmental factors such as air pollution, altitude, wind, as well as solar radiation, temperature, air humidity, and precipitation seem to interfere with tuberculosis (TB) infection (SARKAR et al., 2017; REY et al., 2016; CAO et al., 2016; BEIRANVAND et al., 2016; MOOSAZADEH et al., 2013). In summer, higher temperatures accounted for a higher incidence of TB in the United Kingdom, and in the Eastern Cape, South Africa, in winter; people were more exposed to bacilliferous sick patients due to staying indoors longer and, therefore, increasing the risk of TB transmission (KOH et al., 2013; AZEEZ et al., 2016). In the Federal District-Brazil (2003-2012), 95.8% of TB cases occurred with average air humidity between 31.0% to 69.0%; in China, the incidence of TB increased with a rise in relative humidity (FERNANDES et al., 2017; GUO et al., 2017). Also, wind speed showed an influence on the transmissibility and incidence of TB. High wind speed can dilute or concentrate bacterial suspension, reducing or increasing the transmission of the disease depending on each space (MOOSAZADEH et al., 2013; SEDIGHNIA; KALHORI, 2018). The spread of TB was also particularly associated with other factors of social vulnerability, such as pockets of poverty and urban agglomerations with high population density (ACOSTA; BASSANESI, 2018).

Moreover, the use of geographical climatology and rhythmic analysis allows us to characterize the types of atmospheric weather and to monitor their rhythms through the measures observed at meteorological stations (MONTEIRO, 1971). This allows us to correlate this information with the TB epidemiological data observed over time and understand the association of climatic factors with the disease (MONTEIRO, 1971). Consequently, our study provides an understanding of the climate dynamics, the impacts, and possible interactions involved, in this case, with tuberculosis (OGASHAWARA, 2012).

The relationship between climatic and environmental factors, geographic environment, and the population with TB is a problem that requires more accurate investigation. It is key to understand the determinants that put this population at risk, both in terms of knowing the environmental factors for disease contraction and creating strategies that support tuberculosis prevention and control services. Studies have highlighted the influence of variations in atmospheric weather on disease occurence, including TB, taking into consideration the interpretation of regional atmospheric circulation and the elements affecting the daily lives of the populations in the areas studied (BARROS, 2006).

TB in the Federal District of Brazil presents itself as a medium-burden disease (12/100,000 population), with annual fluctuations in the cases reported in the historical time series analysis (2006-2017) (DISTRITO FEDERAL, 2019). Due to these fluctuations, the need to identify the dynamics of weather is justified, considering the influence of air masses and the use of rhythmic analysis. The objective of the present study was to investigate if the tropicality of the Brazilian Central Plateau increases the burden of TB in the Federal District. For the analysis of the influence of air masses, we considered the summer seasons in a 12-year period and evaluated the summer of 2006 in the rhythmic analysis, beginning on December 20, 2005 and ending on March 22, 2006, due to the higher report of new TB cases in the Federal District. Note that the summer season in the Southern Hemisphere occurs from December to March. Finally, we investigated the summer seasons as they are the ones that present the greatest weather adversity, as a consequence of the succession of air masses that flow over the Midwest region of Brazil. For this reason, relating the number of TB cases to the climatic dynamic can reveal the existing environmental relationships to this disease.

METHODOLOGY

The Brazilian Federal District (FD) is located in an area of 5,814 square kilometers in the Central Plateau of Brazil, belonging to the Paraná, São Francisco, and Tocantins-Araguaia basins in the Cerrado Biome (AB'SABER, 1967). The FD has dry winters and rainy summers (BARROS, 2003). Other climatic aspects of the FD include, between the months of April to September, high insolation, reduced cloud cover rates, intense evaporation, low relative humidity, reduced rainfall, and great daily thermal amplitude. From October to March, the FD receives less sunlight, which increases cloud cover, reduces evaporation, and increases relative humidity. Rainfall is intensified and thermal amplitude is moderately reduced since the maximum temperatures are maintained and the minimum temperatures are high

(BARROS, 2006). The region has a flat-to-rolling topography with levels between 830 and 1,000 meters, becoming a watershed in the region's hydrographic basins (STEINKE, 2004).

This is an ecological study carried out with 1,291 new cases of TB registered with the Federal District Department Information System for Notifiable Diseases between the summers from 2006-2017 (LIMA-COSTA, 2003). A 12-year historical series was selected, as TB is a chronic disease. The summer seasons with the highest TB load were from the years 2006, 2012, and 2017. We considered the air mass from the summer of 2005 because TB is a disease with an incubation period of at least one year. Our data were obtained from the data-processing department of the Brazilian Unified Health System (DATASUS) concerning the following types of registers: new case, unknow, and post-mortem. We excluded cases of TB due to a change in diagnosis, multidrug-resistant TB, and change in regimen due to drug intolerance, in addition to cases ignored/blank, recurrence, and re-treatment after default. We considered as “TB case” the person who, regardless of the clinical form, tested positive in bacilloscopy or culture or in the rapid molecular test for TB; or cases without laboratory confirmation, evaluated by clinical criteria and with results of imaging or histological exams suggestive of TB (BRAZIL, 2019).

The daily climatic variables analyzed were the minimum, mean, and maximum air temperatures, atmospheric pressure, precipitation, relative humidity, atmospheric system (air masses) and wind speed obtained from the Brazilian National Institute of Meteorology website (INMET, 2020).

In the analysis, we used Pearson's correlation coefficient formula, which measures the degree of linear correlation between two quantitative variables, given below (Siqueira and Tibúrcio, 2011):

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

Where x are the averages of air mass participation (matrix 1) and y is the number of TB cases in the year (matrix 2).

This study was approved by the Research Ethics Committee of the University of Brasília, Opinion No. 2,946,280.

ATMOSPHERIC SYSTEM ANALYSIS MODEL

In this analysis, the model is supposed to assist in understanding the behavior of TB according to the dynamics of air mass movements and weather conditions in the Federal District. In this case, we investigated the masses under the temporal and spatial scales. For the temporal aspect, we included the daily movement of air masses and also the summer seasons between 2005 and 2017. On the spatial scale, although the referential is specific, we read and interpreted the synoptic charts on the regional scale. We used the synoptic charts from the Brazilian Navy for noon GMT[1]. We also ensured the identification of the air masses by relying on the interpretation of Goes-10 satellite images from CPTEC-IMPE, a methodology proposed by Pédelaborde (PÉDELABORDE, 1970).

Data from each summer were organized in Excel® spreadsheets, assigned numerical values, and then converted into percentages of performance of the identified atmospheric system. The results obtained were subjected to statistical treatments such as standard deviation and Pearson correlation coefficient using Excel applications (MOORE; KIRKLAND, 2007). The atmospheric systems considered in this study were those active in the FD in the rainy season: Weather Fronts (WF), continental Tropical mass (cT), Atlantic maritime Tropical mass (mT), Atlantic maritime Polar mass (mP) and Continental Equatorial mass (cE) (ZAVATTINI; BOIN, 2013).

RHYTHMIC ANALYSIS TECHNIQUE

According to Zavattini and Boin (2013), although the statistical treatment helps to delimit the investigated problem, sometimes it cannot, by itself, explain the phenomenon since the answer may lie in the relationship between atmospheric dynamics and the other elements of the geographical scenario. For this reason, the use the technique of rhythmic analysis is beneficial.

Rhythmic Analysis is a technique proposed by Monteiro (1971) that aims to individualize the types of atmospheric weather and thus monitor each one's succession together with the measures observed by a meteorological station. By incorporating a geographical phenomenon, as in this case with TB occurrence, it is possible to identify whether there is a relationship between this geographical phenomenon and the climatic conditions of the region studied (BARROS, 2006; OSHIMA et al., 2018).

Rhythmic analysis is an innovative technique in the analysis of geographic climatology capable of analyzing atmospheric dynamics through the interactions that take place within the climatic elements of a given location (MONTEIRO, 1971). However, this analysis is only possible when the atmospheric systems that affect the region have been identified. In our study, the meteorological data and the atmospheric systems were displayed in graphs, in which the elements of climate were systematized in three temporal sections. Atmospheric systems were identified from synoptic charts and data were obtained from meteorological stations. For rhythmic analysis, we used the software Ritmo Análise (MONTEIRO, 1971; BORSATO; BORSATO, 2009). In the present study, although the evaluation uses the entire period (2006-2017), we will present three intervals, starting on December 20, 2005 until March 22, 2006, for a total of 93 days.

THE INFLUENCE OF ATMOSPHERIC SYSTEMS IN THE FEDERAL DISTRICT AND BRAZIL ON THE DYNAMICS OF TUBERCULOSIS

THE FEDERAL DISTRICT

The Federal District is located in the Brazilian Central Plateau, where five air masses and several other atmospheric systems operate, which are: mP, mT, cT, mE, cE, WF, and the South Atlantic Convergence Zone (BORSATO, 2016). All air masses are widely modified when they move away from their source regions, except the cE that preserves the original characteristics in its entire area of influence (BORSATO, 2016). Therefore, when the cE moves over the Central Plateau, as the mass is hot and humid, it warms the region. Given the region receives perpendicular rays from the sun, the air mass gains heat and sometimes the atmospheric pressure decreases. This observed low pressure streamlines convective currents, increasing rainfall rates (BORSATO, 2016).

CT in the Federal District is characterized by low atmospheric pressure, high temperatures, and low relative humidity. These masses are intensified when they advance through Central Brazil, gain heat, and the relative humidity reaches values below 30.0%, accounting for heat waves (BORSATO, 2016; BORSATO; HEIRA, 2015). The center of origin of the cT is the Gran Chaco Region, which, according to meteorological features, is called the Chaco Thermal Low (SELUCHI; SAULO, 2012). This air mass actively affects the weather in southern states and, mainly, in the Central-West region of Brazil. In turn, the effects of cT in the Federal District are limited to isolated episodes and the air mass flows over the region especially in the summer (BORSATO, 2016).

Additionally, it is observed that the cE expands and retracts following the succession of the seasons. For Nimer, cE is formed over the warm continent, where the calm and weak winds of depression dominate, especially in the summer (NIMER, 1996). The author adds that this mechanism is responsible for the distribution of humidity at altitude and also for the development of large clouds (cumulonimbus) and abundant rains (NIMER, 1996). In the winter, with the retreat of cT and cE, the high pressure masses expand from the coast and often flow over the Federal District.

In the Amazon region, which is the source region for the cE, the high relative humidity and low atmospheric pressure are consequences of low latitude and evapotranspiration. As cE expands, it brings moisture and heat to Central Brazil by means of moist air currents and maintains daily convectional rainfalls (MARENGO et al., 2004). Fronts are narrow strips of converging air that are configured and advances to the north of a Polar mass. As the tropical hot air has a lower density, the cold air of the Polar mass advances in the form of a wedge and raises the less dense air that destabilizes the areas of higher humidity. This configuration is more evident in the south and north of the Tropic of Capricorn, causing a band of intense cloudiness, which loses its characteristics as the Polar air assimilates heat from the displaced areas (BORSATO, 2016).

BRAZIL

To strengthen the understanding of the dynamics and the main characteristics of atmospheric systems in the Central-West region of Brazil, we observed the need to describe the masses that flow over Brazil, which is a country with large territorial dimensions. The predominant landforms of the country are the old plateaus and plains. Brazil is affected by five air masses and the front system, and is not the source region for any of the air masses that operate in the country, except the continental Equatorial mass, which is raised in the Legal Amazon, and expands beyond the boundries of the Brazilian territory (BORSATO, 2006).

Above all, the summer season in Brazil is dominated by low pressure systems, but high pressure systems are sometimes manifested by the Atlantic Polar mass or Atlantic Tropical mass. The source region for the Atlantic Tropical mass and the Equatorial Atlantic mass is the semi-permanent anticyclone over the South Atlantic, called the South Atlantic Subtropical High (SASH) (VIANELLO; MAIA, 1986). This anticyclone is a disperser of winds that advance into the interior of Brazil, dragging humid airs that are characterized as weather states of atmospheric stability. This characterization takes shape and expands to the eastern region of Brazil, from the coast of Bahia to the south of the State of São Paulo and sporadically beyond these locations, moving into the interior of Brazil, and, frequently, into the Federal District region (BASTOS; FERREIRA, 2000). However, in the colder months, the interiorization of these winds expand, and often, the mass extends to the Cetral-West region of Brazil.

In turn, the SASH also drives the Atlantic Equatorial mass, and the winds, when going around the center of the SASH, approach the coast of Northeast Brazil and are drawn to the interior and to the Intertropical Convergence Zone (ITCZ) (NIMER, 1996). This air body is called the Atlantic Equatorial mass. On the Northeast coast, the mE still reserves the anticyclonal characteristics, therefore, in the area where this air mass operates, atmospheric stability prevails.

The fifth air mass that flows over Brazil is the Atlantic Polar mass, which is very active in winter. In this season, the aPm advances preferentially through the interior of the continent and, sometimes, reaches the South of the Amazon region, causing cold weather (VIANELLO; MAIA, 1986). In summer, the mP is less intense and active because it advances preferentially across the Atlantic, but even so, ridges extend into the interior of the continent and impose their characteristics, but with less intensity (Borsato, 2006). Thus, sporadically, the mP moves over Central Brazil, and when advancing into the interior of the country, the high pressure air masses take on the local hydrothermal properties, with profound modifications, affecting weather conditions (BORSATO, 2006).

For this reason, sometimes, the Southeast region is taken over by the air of this continental tropical mass. As it is a continental system in a region of low relative humidity, high temperatures and rainfalls are limited to isolated episodes – influenced by seasonality – and, therefore, occur in spring and summer (SANTA'ANNA NETO, 1995).

RESULTS AND DATA DISCUSSION

The Federal District Health Department registered 4,067 new cases of tuberculosis between 2006 and 2017. Of this total, 1,291 people had tuberculosis in the summer, and 2006, 2007, and 2015 were the years with the highest occurrence of TB, representing 11.0%, 9.9%, and 10.3% of the total cases, respectively.

By comparing the influence of air masses in the summers of 2006, 2007, and 2015 with the other summers of the historical series, we observed that the continental Equatorial mass behaved normal, that is, with 89.8% interannual variation in 2011 (year with more participation), and 66.7% in 2017 (year with less participation) (Figure 1). Data processing and synaptic chart analysis showed that in the summer, the Federal District and the Central-West region of Brazil were dominated by the continental Equatorial mass 77.5% of the time (Figure 1). In the correlation analysis with the cases of tuberculosis and the summers of the entire period, the index found was 0.116 (Figure 2).

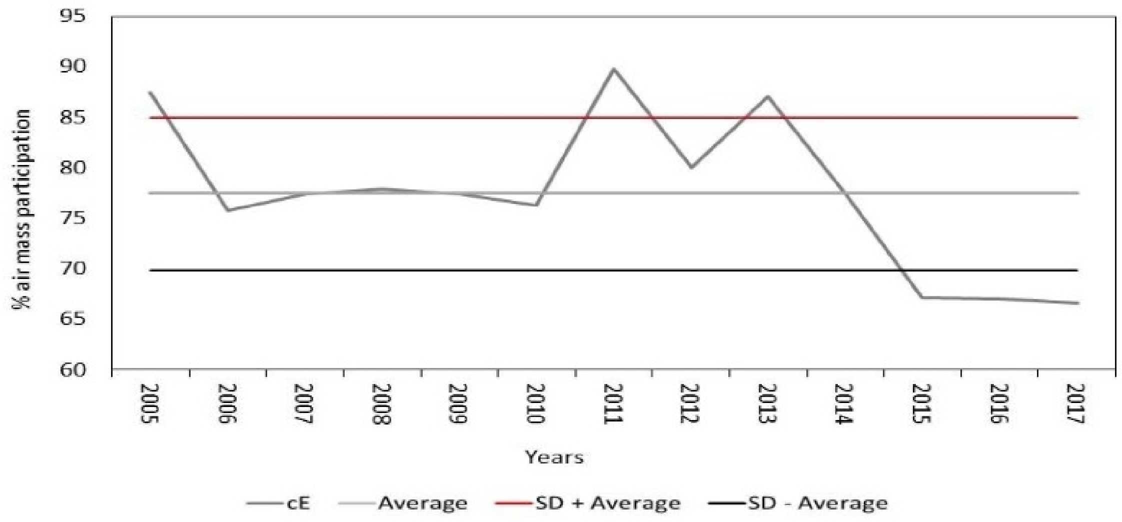

Figure 1 - Participation of cE in the states of time for the period 2005-2017 in the Federal District. Legend: cE* annual average (Continental Equatorial Mass) series average; Standard deviation + (SD + average); Standard deviation – (SD – average).

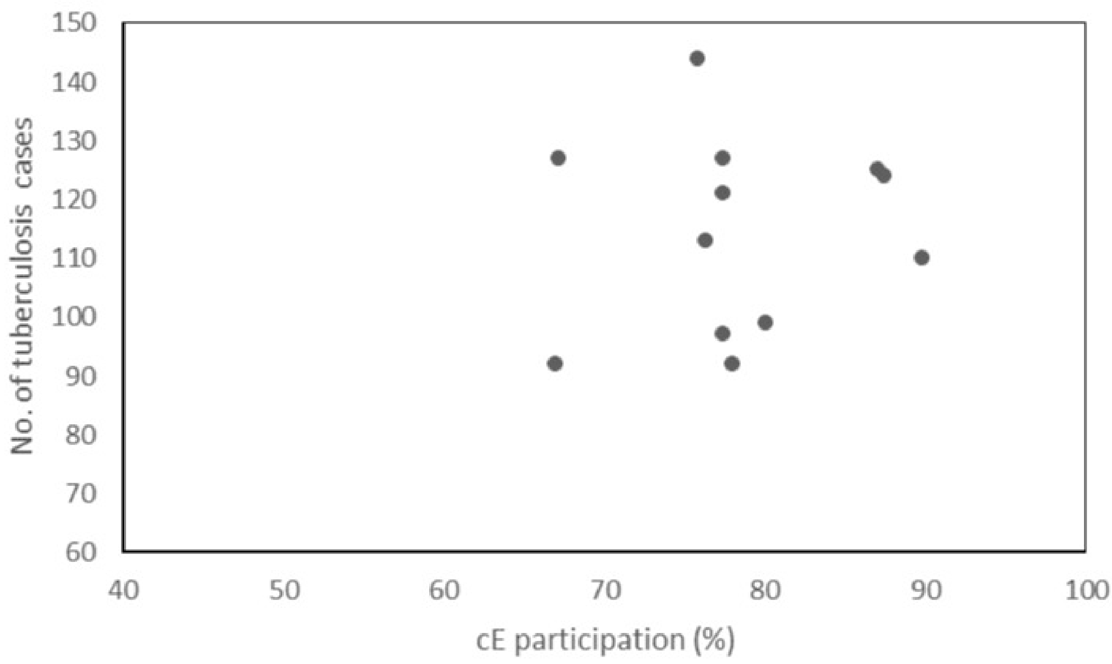

Figure 2 - Dispersion, relationship between cE (%) and total cases of tuberculosis in the summers of January, February, March, and April 2006-2017. Federal District

During summers in the Federal District, cE was accompanied by high temperature and increased humidity and precipitation (BARROS, 2006). In this sense, in summers, cEm becomes slightly unstable by surface heating – which it suffers when it comes into contact with the continent – and it is also strengthened, at first, by the orographic effect of the Atlantic system (MONTEIRO, 1963). Moreover, cEm expands and contracts with the passing of the seasons, making this high warming in the southern hemisphere, during the summer, cause the expansion of this air mass, with displacement throughout the Brazilian territory, from the Central Plateau to the southern region of the country (BORSATO, 2006).

It is noteworthy that the analysis in the Federal District showed that the observed changes were more accentuated for the masses of stronger high-pressure areas. Thus, low-pressure air masses prevailed in the summer and provided characteristic weather conditions (hot days, reduced daily thermal amplitude, and daily convective rainfalls) (BORSATO, 2016). On days influenced by mT or mP, changes in weather conditions were marked, considering that there were few days in the season that presented with low relative humidity and low cloud cover (BORSATO, 2016).

In the 12 years studied, the second air mass with greater participation in the Federal District region was aTm. In this case, we observed a participation of 22.6% in 2016, an average of 13.8%, standard deviation of ± 5.9, and a lower participation in 2012, of 1.1% (Figure 3). The Federal District is within the tropical climate zone and has a dry-wet climate, influenced by tropical, equatorial, and polar masses. However, in the studied period, equatorial and tropical masses prevailed (BARROS, 2006).

In the event of dry weather, be it autumn or winter, mT was present for several days over the Federal District. A study revealed that the climate was associated with an increase in hospital admissions due to respiratory diseases (Barros, 2006). However, despite the influence of mT in summers in the Federal District, the air mass showed no association with an increase in TB cases.

A study carried out in the southern region of Brazil, in Londrina, state of Paraná, analyzing the number of hospitalizations due to respiratory illnesses in the dry period showed that mT acted in 43.3% of the chronological time in June 2018. Although mT has moisture content when it forms in the Atlantic Ocean, that moisture is located in its basal portion, which is lost when this air mass meets Serra do Mar, and, as it progresses inland, it always presents with low humidity, a similar weather condition to the one found in the Federal District region during the period analyzed (OSHIMA et al., 2018).

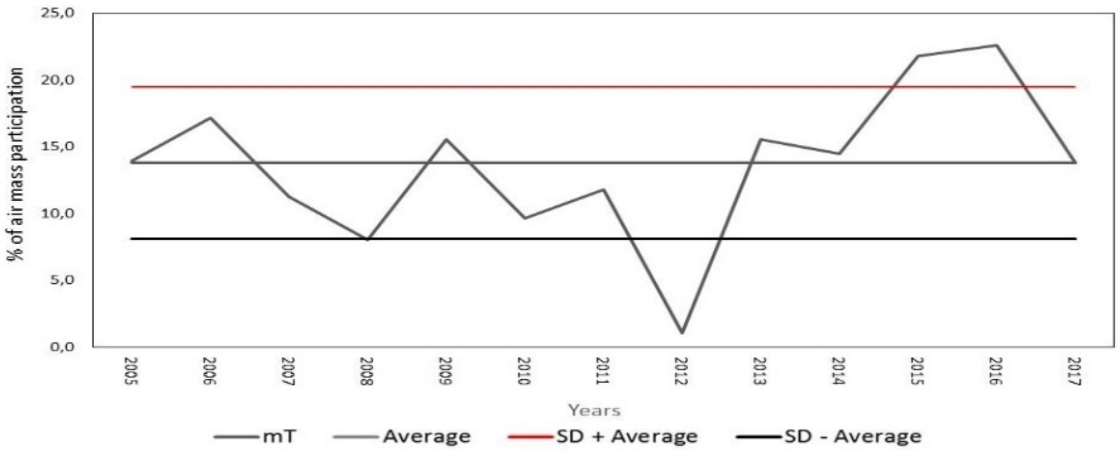

Figure 3 - Participation of mT in the weather for the period 2005-2017 in the Federal District. Legend: mT* annual average (Atlantic maritime Tropical mass) series average; Standard deviation + (SD + average); Standard deviation – (SD – average).

The correlation analysis of tuberculosis cases and the summers studied showed no relationship between the time of participation of mT and the burden of tuberculosis in the Federal District, with a correlation index of -0.156 (Figure 4).

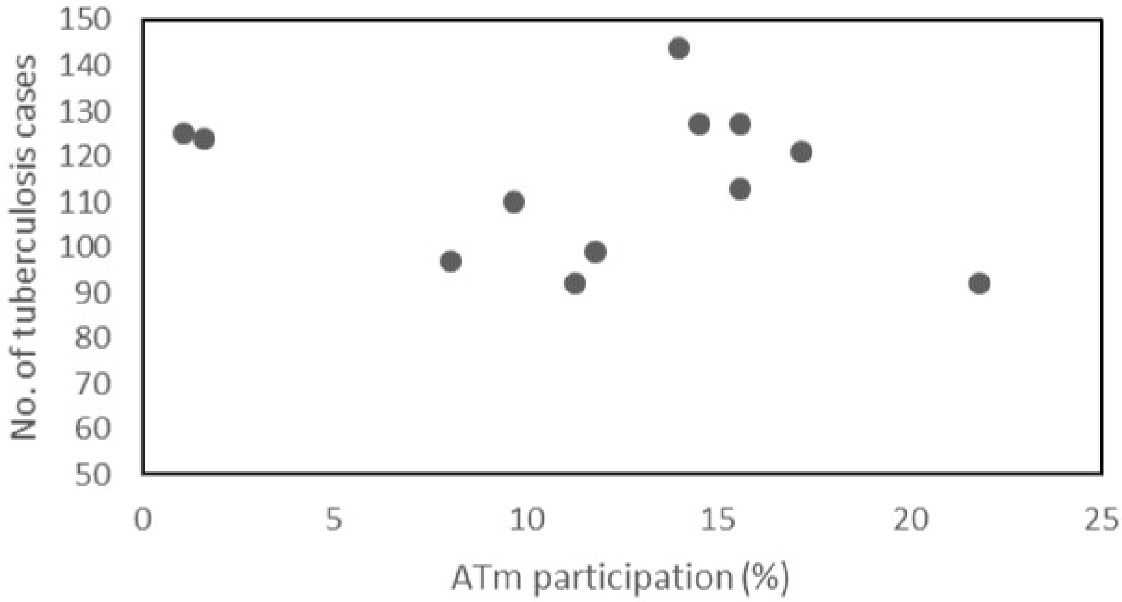

Figure 4 - Dispersion figure, relationship between mT (%) and total cases of tuberculosis in the summers of January, February, March, and April 2005-2017. Federal District

In this study, front systems had an average of 2.1% of performance, the year with the highest participation being 2008, with 7.5% of performance and a standard deviation of ± 2.7. However, in the twelve years of the series evaluated, for six years, the participation of front systems observed was zero. The front systems acted more actively and intensely in the states in the southern region of Brazil, and as they moved northwards, the thermal contrasts deteriorated, and the instability decreased. Therefore, they rarely reached the Central Plateau region. Moreover, the weather states provided by the front systems are more noticeable in the winter season in the Federal District (BORSATO, 2006). It should be noted that, at the time frontal systems advanced, the region was influenced by cE, which is an unstable system, yet no changes in atmospheric weather were reported. The changes would be more pronounced with the advance of mP since, in the summer season, this mass advances preferentially into the interior of the Atlantic and, rarely, extending into the interior of Brazil, although it flows over the Central Plateau region (BORSATO, 2016). Therefore, the participation of this air mass in the state of the weather for the summer of 2007 in the Federal District was insignificant. Finally, this air mass also showed no correlation with the number of tuberculosis cases, and, therefore, this correlation index was not evaluated (insufficient values to perform the operation).

In the rhythmic analysis, although we evaluated the entire period, we present in this article the results for the summer of 2006 in three temporal sections (Graphs 5A, 5B, and 5C) and omitted the other graphs. In the first cut (Figure 5A), from December 20, 2005 to January 19, 2006, we observed that January 3, 2006 revealed a higher peak of relative humidity, at 91.7%, while December 30, 2005 revealed low atmospheric pressure (879.6 hPa), leading to precipitation of 29.2 mm, and consequently, a drop in maximum, minimum, and average temperatures (20.4º C, 17.2º C, and 18.0º C, respectively).

Considering Figure 5B, it is worth noting that the mT strongly influenced weather in the period from January 20 to January 26, 2006, causing days without precipitation and high air temperatures, with the minimum temperatures ranging from 18.2º C to 19.3° C, and maximum from 27.2º C to 31.6º C.

Figure 5C reveals that cE prevailed in most of the period (February 20 to March 22, 2006), resulting in rainy and humid days, with about 70.0% relative humidity most days.

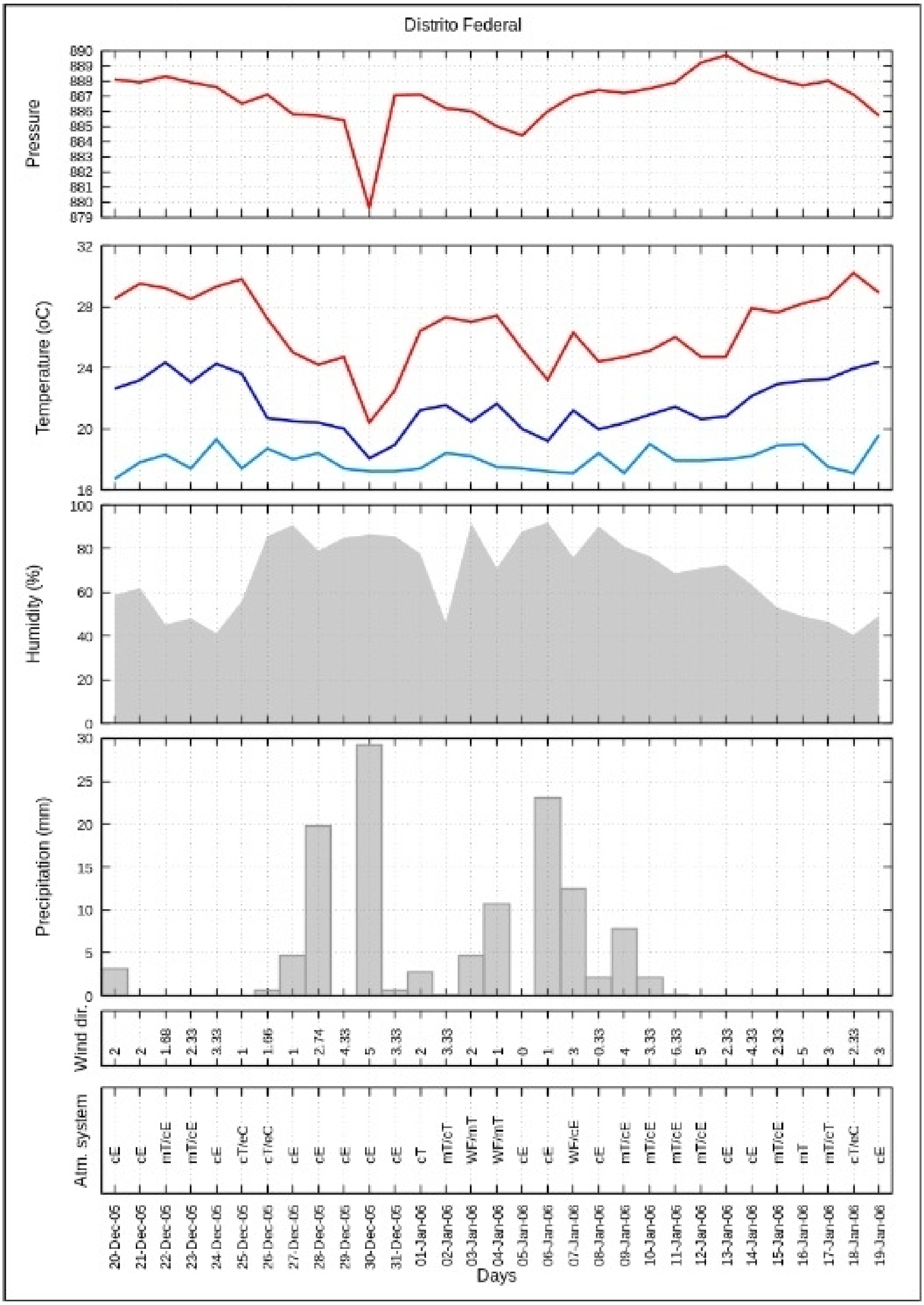

Figure 5A - Synthesis of the rhythmic analysis for the period December 20, 2005 - January 19, 2006, Federal District. Legend: 1st table shows the atmospheric pressure in hectopascal (hPa); the 2nd - medium and minimum temperature; the 3rd - relative humidity; the 4th – precipitation; the 5th – wind direction (wind dir.); and the 6th - active atmospheric systems (Atm. System)

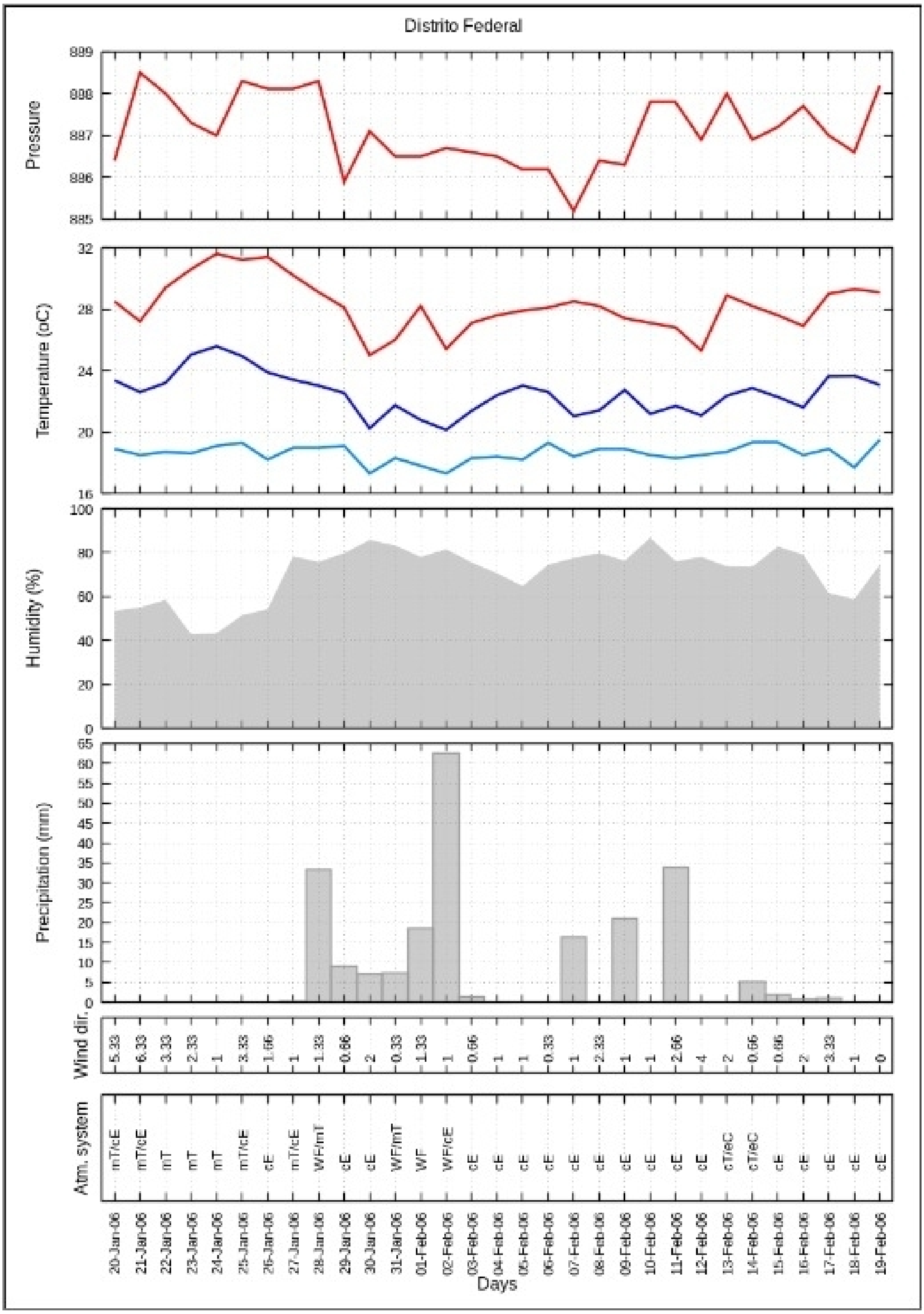

Figure 5B - Synthesis of rhythmic analysis for the period from January 20 to February 19, 2006, Federal District. Legend: The 1st table shows the atmospheric pressure in hectopascal (hPa); the 2nd - medium and minimum temperature; the 3rd - relative humidity; the 4th – precipitation; the 5th - wind direction(wind dir.); and the 6th - active atmospheric systems (Atm. System)

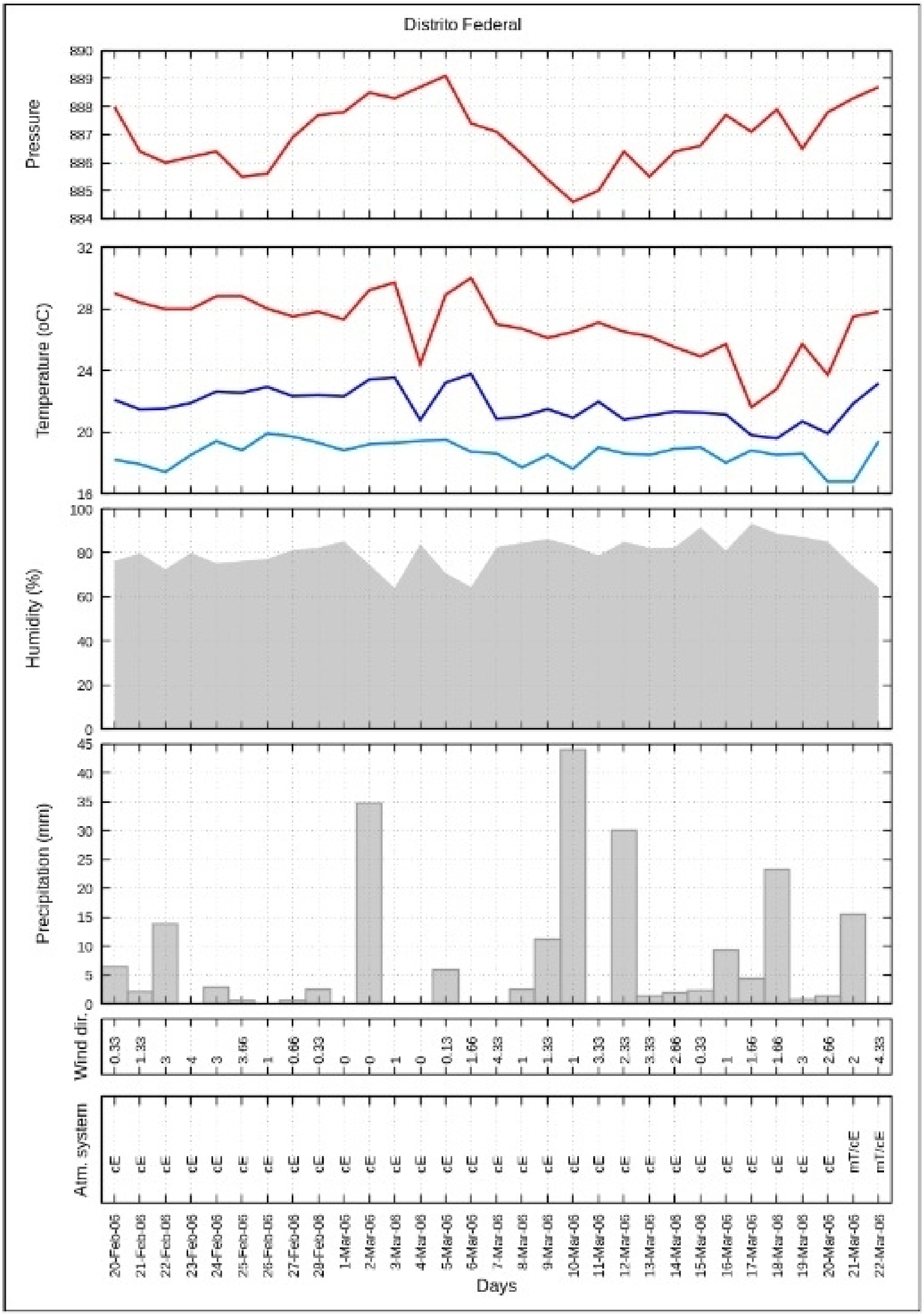

Figure 5C - Synthesis of rhythmic analysis for the period from February 20 to March 22, 2006, Federal District. Legend: The 1st table shows the atmospheric pressure in hectopascal (hPa); the 2nd - medium and minimum temperature; the 3rd - relative humidity; the 4th – precipitation; the 5th - wind direction(wind dir.); and the 6th - active atmospheric systems (Atm. System)

The rhythmic analysis (Graphs 5A, 5B, and 5C) presented for the summer of 2006 showed the participation of air masses in the weather conditions and reinforced the usual data for the Federal District region – in which the hot, humid cE prevailed, causing daily convective rainfalls – and highlighted the preservation of the original characteristics of the air mass in the entire area of influence (Barros, 2006; Borsato, 2016). It is worth mentioning that, in this season, the time of operation of the cE exceeds the sum of the duration of the other air masses for the period, with a predominance of low pressure, high relative humidity, and high temperatures, resulting in the frequent rainfalls (BORSATO, 2016). The increased cloud cover and frequent rainfalls soften the temperatures, so, on days with greater precipitation, the temperature showed less maximum and minimum variations, as pointed out by Nimer (NIMER, 1996).

In the days when the Atlantic maritime Tropical mass prevailed in the Central-West region, lower cloud cover was observed and, therefore, greater daily thermal amplitude is seen, as mentioned by Borsato (BORSATO; HIRA, 2015).

Among the limitations of this study we can mention the absence of daily data on tuberculosis in the DATASUS registration system. We can also consider that the summer period in Brazil is the period for the end-of-the-year holidays and carnival, which may have delayed the diagnosis of people with TB carried out in primary care. Another limitation was the lack of studies in other states or countries involving the use of the rhythmic analysis model and other diseases.

CONCLUSION

The results of the analysis of the state of weather, considering the summer and the incidence of TB, showed that the most frequent air masses in the summers in the Federal District were the cE and mT, between 2006 and 2017. As for the rhythmic approach, cE prevailed, causing high cloud coverage and, as a consequence, frequent rainfall and less variation in temperature. The components of weather revealed no contribution to the conditions of the atmosphere being associated with the greater burden of TB in the Federal District, thus showing no correlation with the cases of tuberculosis and the state of weather of cE and mT. However, studies involving other types of weather are key to understanding whether there is an influence of these factors on the occurrence of tuberculosis, as well as understanding the dynamics of the climate and its relationship with biological phenomena that occur in the atmosphere and the environment.

NOTES

1- Greenwich Mean Time

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Author's Affiliation

Brandão, E.C. - University of Brasilia.
Borsato, V.A. - Professor at the State University of Paraná.
Steinke, E.T. - Professor at the University of Brasilia.
Evangelista, M.S.N. - Professor at the University of Brasilia.

Authors' Contribution

Brandão, E.C. - The author prepared the entire text.
Borsato, V.A. - The author prepared the entire text.
Steinke, E.T. - The author prepared the entire text.
Evangelista, M.S.N. - The author prepared the entire text.

Editors in Charge

Jader de Oliveira Santos
Lidriana de Souza Pinheiro