Geotemas, Pau dos Ferros, RN, Brasil
ISSN: 2236-255X, v. 15, 2025.

CLASSIFICATION OF THE RAINFALL REGIME IN THE CITY OF OURINHOS-SP IN THE PERIOD FROM 1937 TO 2023

Classificação do regime pluviométrico na cidade de Ourinhos-SP no período de 1937-2023

Clasificación del régimen de precipitaciones en la ciudad de Ourinhos-SP de 1937 a 2023

Rafaela Melissa Andrade Ferreira
Universidade Estadual Paulista ''Júlio de Mesquita Filho'' – UNESP/Presidente Prudente
E-mail: rafaela.andrade-ferreira@unesp.br

Article History
Reveived: 01 february, 2025
Accepted: 26 august, 2025
Published: 13 october, 2025

https://doi.org/10.33237/ 10.33237/2236-255X.2025.6814

ABSTRACT

This study aimed to characterize the rainfall regime of the city of Ourinhos, São Paulo, using the box plot technique as described by Galvani and Luchiari (2004), applied to the historical series of monthly precipitation from 1937 to 2023. Through this approach, rainfall intervals were classified into five categories: "super dry," "dry," "normal," "wet," and "super wet." Additionally, absolute frequency calculations were employed to determine the number of years in each category, allowing an analysis of the distribution and variability of the rainfall regime over time. The method gave conditions to identify seasonal patterns and the occurrence of extreme events, highlighting the characteristic behavior of the dry and rainy season months. The analysis revealed that the "normal" category predominated throughout the year, reflecting a relative climate stability in Ourinhos. The "dry" and "wet" categories also showed significant frequencies, while extreme events, classified as "super dry" and "super wet", occurred less frequently, being more evident in specific months, such as August and September for dry events and January and December for wet events. These patterns are aligned with the region's tropical climate characteristics, characterized by a well-defined dry season in winter and a rainy season in summer.

Keywords: Statistical technique; Characteristics; Rainfall**.**

RESUMO

O presente estudo teve como objetivo caracterizar o regime pluviométrico da cidade de Ourinhos, São Paulo, utilizando a técnica do box plot conforme Galvani e Luchiari (2004) aplicada à série histórica de precipitação mensal no período de 1937 a 2023. A partir dessa abordagem, foram definidos intervalos de classificação das chuvas em cinco categorias: "super seco", "seco", "normal", "úmido" e "super úmido". Além disso, utilizou-se o cálculo de frequência absoluta para determinar a quantidade de anos em cada categoria, permitindo analisar a distribuição e a variabilidade do regime de precipitação ao longo do tempo. O método possibilitou evidenciar padrões sazonais e a ocorrência de eventos extremos, destacando o comportamento característico dos meses da estação seca e chuvosa. A análise revelou que a categoria "normal" predominou em todos os meses do ano, refletindo uma relativa estabilidade climática em Ourinhos. As categorias "seco" e "úmido" também apresentaram frequências significativas, enquanto os eventos extremos, classificados como "super seco" e "super úmido", ocorreram com menor frequência, sendo mais evidentes em meses específicos, como agosto e setembro para eventos secos e janeiro e dezembro para eventos úmidos. Esses padrões estão alinhados às características climáticas tropicais da região, marcadas por uma estação seca bem definida no inverno e uma estação chuvosa.

Palavras-chave: Técnica estatística; Características; Chuvas.

RESUMEN

El presente estudio tuvo como objetivo caracterizar el régimen de lluvias de la ciudad de Ourinhos, en São Paulo, mediante la técnica de diagrama de caja (box plot) descrita por Galvani y Luchiari (2004), aplicada a la serie histórica de precipitaciones mensuales de 1937 a 2023. A través de este enfoque, los intervalos de lluvia se clasificaron en cinco categorías: “super seco”, “seco”, “normal”, “húmedo” y “super húmedo”. Además, se utilizaron cálculos de frecuencia absoluta para determinar el número de años en cada categoría, lo que permitió analizar la distribución y variabilidad del régimen de precipitaciones a lo largo del tiempo. Este método posibilitó identificar patrones estacionales y la ocurrencia de eventos extremos, destacando el comportamiento característico de los meses de estación seca y lluviosa. El análisis reveló que la categoría “normal” predominó a lo largo de todo el año, reflejando una relativa estabilidad climática en Ourinhos. Las categorías “seco” y “húmedo” también presentaron frecuencias significativas, mientras que los eventos extremos, clasificados como “super seco” y “super húmedo”, ocurrieron con menor frecuencia, siendo más evidentes en meses específicos como agosto y septiembre para los eventos secos, y enero y diciembre para los eventos húmedos. Estos patrones se corresponden con las características del clima tropical de la región, marcado por una estación seca bien definida en invierno y una estación lluviosa en verano.

Palabras clave: Técnica estadística; Características; Precipitaciones.

1 INTRODUCTION

The concept of precipitation regime is related to the temporal and spatial distribution of rainfall throughout the year in a specific region. It is influenced by climatic factors such as standards of atmospheric circulation, temperature, pressure, and proximity of water bodies. In this sense, tropical regions, for example, usually have well-defined precipitation regimes, characterized by periods of higher and lower rainfall intensity. In contrast, arid or semi-arid areas may have scarce and irregular rainfall, which partially affects the availability of water resources.

Thus, it can be concluded that understanding the precipitation regime of a region is essential for the planning and sustainable management of water resources, as this analysis allows the prediction of periods of higher risk of droughts or floods, as well as providing information for the implementation of agricultural and urban practices adapted to local weather conditions. Thus, precipitation and its associated behavior not only influence natural cycles but can also impact the socioeconomic and environmental dynamics of the communities.

According to Varejão Silva (2006), rainfall behavior is intrinsically linked to the temporal and spatial variability of precipitation, standing out as one of the fundamental elements in the climate characterization of a region. Thus, it is not only summed up to the total volumes of precipitation, but also to its distribution throughout the year, with periods defined of higher or lower frequency and intensity. In addition, rainfall analysis should consider dynamic actors, such as air masses and atmospheric systems, and geographical factors, such as relief, latitude, and proximity of large water bodies (Monteiro, 1962; 1971; Zavattini, 2000; Fontão, 2021).

Historically, geographic climatology sought to classify precipitation dynamics considering the idea of standard years, which represent specific periods as a reference for analysis. These standard years are defined based on statistical characteristics, such as median or values within precise intervals, which reflect the average, extreme or typical precipitation conditions in a historical series (Monteiro, 1973; Barros and Zavattini, 2009). Through this approach, it is possible to identify years that exemplify distinct climate patterns, such as "dry", "moist" or "normal" years, offering a clearer portrait of rainfall variation over time.

The integration of advanced climate models and remote sensing data is also key in this process. Remote sensing technology allows real-time precipitation monitoring by providing satellite images that cover large areas and can detect changes in the rainfall regime even in remote regions. According to Shekede (2024), when combined with climatic models that simulate atmospheric behavior, these data reveal a more accurate prediction of precipitation standards.

This classification is especially valid for regional climate studies as it allows comparing the observed data in specific years with the established standard years. Thus, it becomes possible to evaluate deviations regarding climate normality, analyze trends and rainfall extremes and better understand seasonal or interannual variations. In addition, the concept of standard years provides an objective basis for correlating local climate events with global phenomena such as El Niño or La Niña, as several authors have already done (Silva et al., 2017; Oliveira et al., 2020; Emiliano et al., 2024).

One of the most used statistical techniques to delineate rain patterns in historical time series is frequency analysis or probability distribution. This procedure calculates the probability of occurrence of specific rainfall values, such as total annual or monthly precipitation. This technique allows the classification, for example, of the frequency of years with water deficit or surplus, establishing behavioral patterns over decades. Thus, the selection of standard years becomes more accurate and grounded, as it is based on statistical parameters such as average, median, standard deviation and probabilities of extreme events (Silvestre, 2016; Limberguer, 2016).

Additionally, many climatological studies establish groups of clustering or hierarchical classification to identify regions and periods with similar rainfall behavior (Zerouali et al., 2022; Salhi et al., 2024).

In this sort of approach, meteorological stations or data from different areas are segmented into groups based on the similarity of their rainfall patterns, which reveals homogeneous zones in terms of precipitation. These groups can then be associated with their respective standard years, aiding in understanding how droughts or intense rainfall events are spatially distributed (Oliveira-Júnior et al., 2022).

It is worth noting that the use of long time series, combined with the application of trend and seasonality techniques, is also relevant in analysing rainfall patterns. As Baldo et al. (2021) argue, through the decomposition of time series, it is possible to identify trend components (whether precipitation increases or decreases over decades), seasonal components (repetitive annual or seasonal patterns), and longer-term cycles.

This information substantiates studies that attempt to relate local climate variability to regional or even global-scale factors, providing support for the selection of representative standard years.

Given these perspectives, this paper aimed to characterize the rainfall pattern of the city of Ourinhos, located in the state of São Paulo, using the box plot technique.

This statistical methodology was applied to describe the distribution of monthly precipitation data throughout the historical series, allowing for the identification of extreme values, such as maximums and minimums, in addition to defining quartiles and medians. The technique enabled a detailed analysis of precipitation categories, such as super-dry, dry, normal, wet, and super-wet periods, contributing to understanding local climate characteristics and giving support for studies related to climate variability and trends in the region.

Finally, with advances in remote sensing and climate modelling technologies, it is now possible to integrate satellite data, reanalysis, and numerical simulations to complement surface rainfall observations.

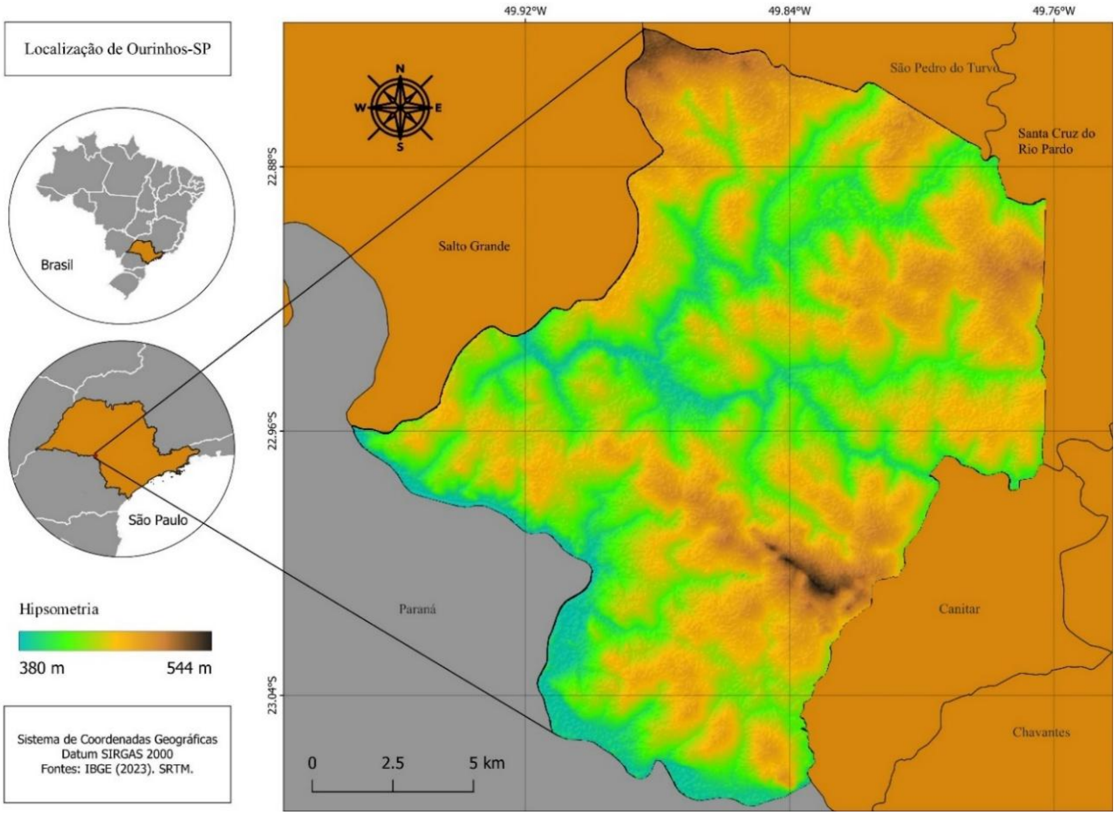
Combining this information broadens the spatial and temporal scope of climatological studies, enabling a more refined analysis of rainfall patterns. It means that the selection of standard years now relies on multiple sources of evidence, ensuring greater reliability in the diagnosis and understanding of the mechanisms responsible for rainfall variability in different regions.

2 METHODOLOGICAL PROCEDURES

2.1 Characterization of the study area (physical environment)

The city of Ourinhos is in western São Paulo state (Figure 01), near the border with Paraná state. It is approximately 370 km from the state capital. With a territorial area of 296 km², the city had a population of 103,970 inhabitants, according to the 2022 Demographic Census conducted by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE).

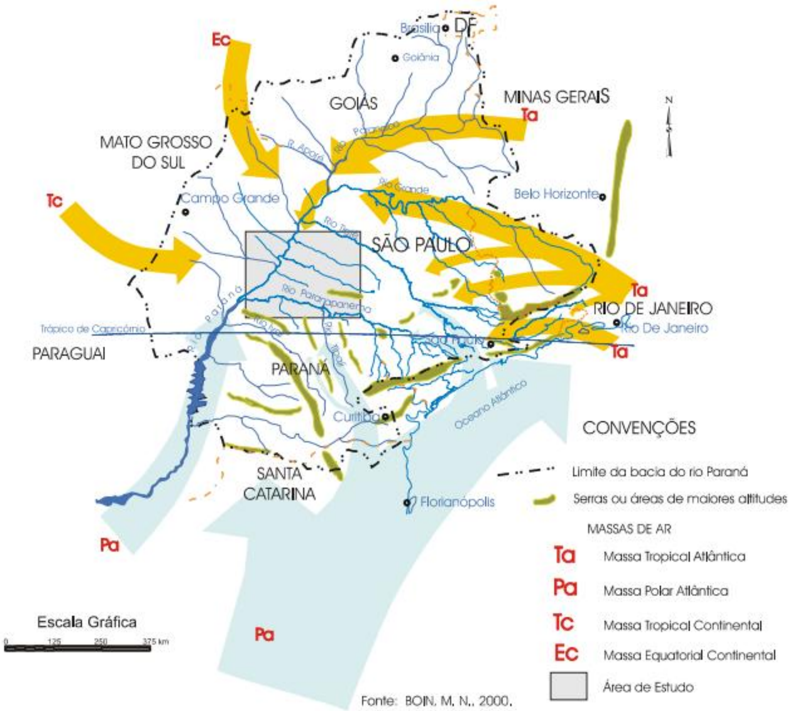
Figure 01 - Location of the city of Ourinhos and hypsometric characteristics of the municipality



Source: Produced by the author (2025)

The climate in Ourinhos is tropical, with a more pronounced dry season in winter and a rainy summer. This pattern directly reflects the alternating action of the air masses described in Figure 02.

Figure 02 – Trajectory of air masses



Source: Boin (2000)

In the western portion of São Paulo, yellow arrows indicate the predominant influence of the Atlantic Tropical mass (Tropical Atlântica - TA). According to the map, this mass moves from the coast to the inland, finding the mountains and elevated areas that can facilitate or hinder its progression. In addition, the red color of the Atlantic Polar mass (Polar Atlântica - PA) points to the advance of cold air from the south, especially significant in winter, although it may reach the interior of the state in other times of the year under special circulation conditions (Boin and Zavattini, 2005).

Another important air mass in this system is the Continental Tropical mass (Tropical Continental - TC), whose thick yellow arrows show the displacement from the driest and warmer lands of the center-west towards the west of São Paulo. This mass has influence primarily in periods of higher heat when circulation favors the incursion of dry air towards the areas of São Paulo. Finally, in blue, the Continental Equatorial mass (Equatorial Continental - EC) is shown, which is formed in the most humid areas of the Amazon and eventually can extend its influence on the state, even less than the others.

These different air masses combine dynamically throughout the year, providing huge climate variability to the west of São Paulo. The map also illustrates how relief and watersheds (highlighting the Tietê and the Paranapanema rivers) influence the displacement of air masses, favoring or limiting the input of front systems, especially in the fall and winter. Thus, the interpretation of arrows and areas delimited on the map reinforces the importance of physical factors in understanding the region's climatic patterns.

According to Perusi (2022), Ourinhos is part of the 11th Marilia Administrative Region and integrates the Middle Paranapanema River Basin Committee (Comitê da Bacia Hidrográfica do Médio Paranapanema - CBH-MP), Water Resources Management Unit (Unidade de Gerenciamento de Recursos Hídricos - UGRHI 17), especially the main rivers: Pardo and Turvo. Additionally, the municipality is located in the Geotectonic Unit of the Paraná Sedimentary Basin (Unidade Geotectônica da Bacia Sedimentar do Paraná), in the São Bento Group, Serra Geral formation.

Regarding geological characteristics, the main extrusive rock is basalt of aphanitic texture, characterized by extremely thin minerals, which disintegrate, forming predominantly clay-composed soils (IPT, 1981). According to Ross and Moroz (1997), the area integrates the morfoesculture of the São Paulo Western Plateau (Planalto Ocidental Paulista), characterized by large and soft hills, with rounded tops and inclinations ranging from 10% to 20%.

The hypsometric analysis of the city of Ourinhos shows a relief with altitudes ranging from approximately 380 meters, in the lower and near drainage areas, up to about 544 meters, in the highest portions.

The map of Figure 1 shows the distribution of altimetric quotas in color gradients ranging from blue/greenish, indicating the lower areas, to yellow/orangish, representing the highest quotas. Thus, it can be seen that the lower altitude zones are concentrated in the southern region and southwest of the municipality, coincident with the proximity of the Paranapanema River and areas of floodplains. The highest altitudes are distributed to the northeast and at specific points where there is more rolling terrain.

Observing the predominant green stain in the middle portion of the municipality, a more smoothly wavy topography is noted, which suggests transition reliefs between the low-altitude areas near the river and the higher points to the north and east. This pattern indicates the presence of hills and valleys that make up the typical relief of cuestas and sedimentation areas in regional watersheds. The different shades on the map still allow you to identify small levels and higher tops, possibly corresponding to geological structures resistant to erosion or to water dividers.

In the far north and northeast of Ourinhos, where the colors near the orange or brown appear, there are the highest altitudes, around 500 to 544 meters. This portion of the municipality has more intense slopes compared to the marginal plains of the rivers, favoring the existence of more pronounced and potentially different agricultural activities compared to the lower areas. In short, the hypsometry of Ourinhos reflects the transition between the Paranapanema river plain and the interior relief of São Paulo, giving the municipality a mosaic of moderate altitudes.

2.2 Tabulation, organization and treatment of rainfall data

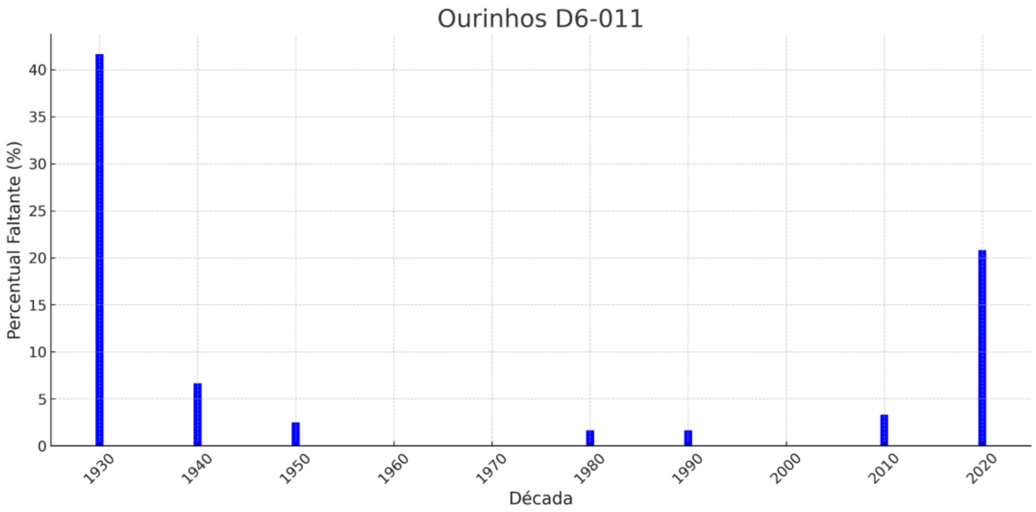
The precipitation data used in this study were obtained secondarily from the Department of Water and Electric Energy of the State of São Paulo (Departamento de Águas e Energia Elétrica - DAEE-SP), an institution recognized for the collection and availability of hydrometeorological information in the state. The data was obtained from the rain gauge station in Ourinhos, identified by prefix D6-011, with an altitude of 460 meters, latitude 22° 59' 00'' S and longitude 49° 50' 00'' W.

There was a particular care to evaluate the discontinuous data present in the historical series, ensuring a careful analysis of these gaps. After this initial stage, adequate statistical treatments were performed to consistently fill the missing data, guaranteeing the quality and reliability of the information used in the study.

The chart presented in Figure 03 presents a temporal analysis of the quality of the meteorological data records of the Ourinhos D6-011 station, highlighting the percentage of missing data per decade. There is a clear tendency to reduce missing values over the decades, with a relatively high ratio in the 1930s, when records were still more susceptible to failures. From 1940, there is a considerable improvement in data quality, reflected in absence percentages that quickly fall to extremely low levels, especially in the 1950s onwards.

This behavior suggests that, over time, data collection and registration processes have been improved, either by the advancement of technology, the implementation of best practices, or the greater frequency of maintenance of the meteorological stations. These improvements are evidenced in the 1960s and 1970s, which have practically no gaps in the data.

Figure 03 – Percentage of missing data per decade



Source: Produced by the author

Thus, the missing data in the historical series were filled using the Inverse Distance Weighting method, an approach that considers spatial proximity between available rainfall. This method ensures greater accuracy in completing by giving greater weight to information from locations closer to the point with missing data (Ruezzene et al., 2021; Corbo et al., 2024).

The Inverse Distance Weighting method (IDW) is a technique widely used in space analysis for completing missing data. It is based on the principle that closer points have greater influence on estimating value in a location with missing data than more distant points. For this, weight is attributed inversely proportional to the distance between the point of interest and the neighboring points with available data. Thus, the smaller the distance, the greater the weight awarded, and, consequently, the greater the contribution of this point to the calculation (Liu et al., 2022; Ghomlaghi, 2022).

After completing the missing data using the inverse distance weighting method, the consistency method was applied through the double mass curve. This technique is useful for evaluating the homogeneity and consistency of data over time, identifying changes in the historical series due to changes in instruments, measurement methods, or environmental conditions (Araújo et al., 2023; Ferreira, 2024). This analysis allows for necessary adjustments to ensure the reliability and coherence of the data used in the study.

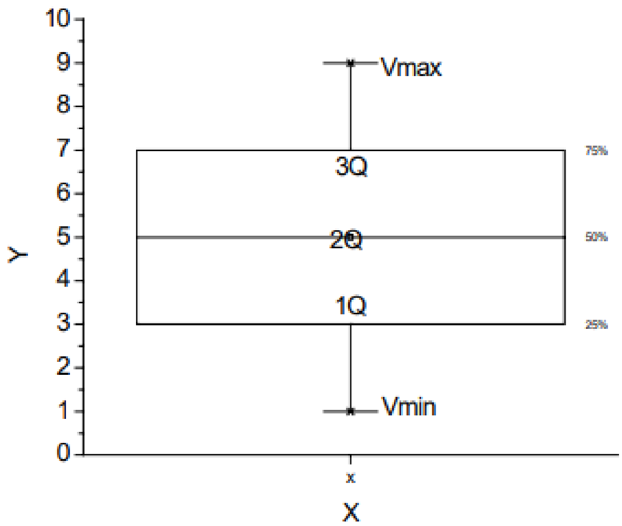
After applying data completion and consistency methods to the historical series, the temporal cut of 1937 to 2023 was defined to perform the rainfall in the municipality of Ourinhos. The plot box technique was applied to evaluate the rainfall. This method provides a visual representation of the data, allowing you to identify the distribution, dispersion, and presence of possible atypical values (outliers).

Traditionally, the technique has been widely used to detect rain variations and categorize standard years (Monteiro, 1971; Tavares, 1976; Schneider, 2014). According to Galvani and Luchiari (2004) and Fontão and Ferreira (2022), this type of categorization, based on a monthly rather than annual temporal scale, makes it possible to analyze the precipitation behavior in detail month by month, which is considered an advantage.

In the interpretation of the box plot chart, the maximum value (Vmax) of a series corresponds to the largest number recorded, while the minimum (Vmin) value represents the smallest. Although these values may seem irrelevant, they help identify the interval in which data is distributed, providing an idea of the amplitude of the analyzed set. The median, in turn, is especially useful in extensive series, in which the presence of extreme values can distort the average, influencing results by underestimating or overlooking analyzes.

Quartiles divide a data set into four equal parts, each containing 25% of the series' values. Thus, we have the first quartile (1st Q), the second quartile (2nd Q), which corresponds to the median, and the third quartile (3rd Q). To calculate the first and third quartiles, we used the same method applied to determine the median. However, in the case of the first quartile, only the values between the minimum and the median are considered. For the third quartile, the values between the median and the maximum are used. Figure 04 represents this dynamic.

Figure 04 - Representation of box plot for an arbitrary data set



Source: Galvani and Luchiari (2004)

We performed statistical calculations and quartile determination using Python, aided by the Matplotlib library to visualize the data in charts. The intervals adopted for the monthly rainy rating were defined based on the distribution of the values of the historical series, considering five categories (Table 01). The 5% of the lowest values in the series were classified as "super dry", while the 5% largest were defined as "super wet". The values between the minimum (Vmin) and the first quartile (1st Q) were classified as "dry", those between the first and third quartile (3rd Q) as "normal", and, finally, the data between the third quartile and the maximum (Vmax) were classified as "wet".

Table 01 - Categorization of intervals adopted for monthly rains

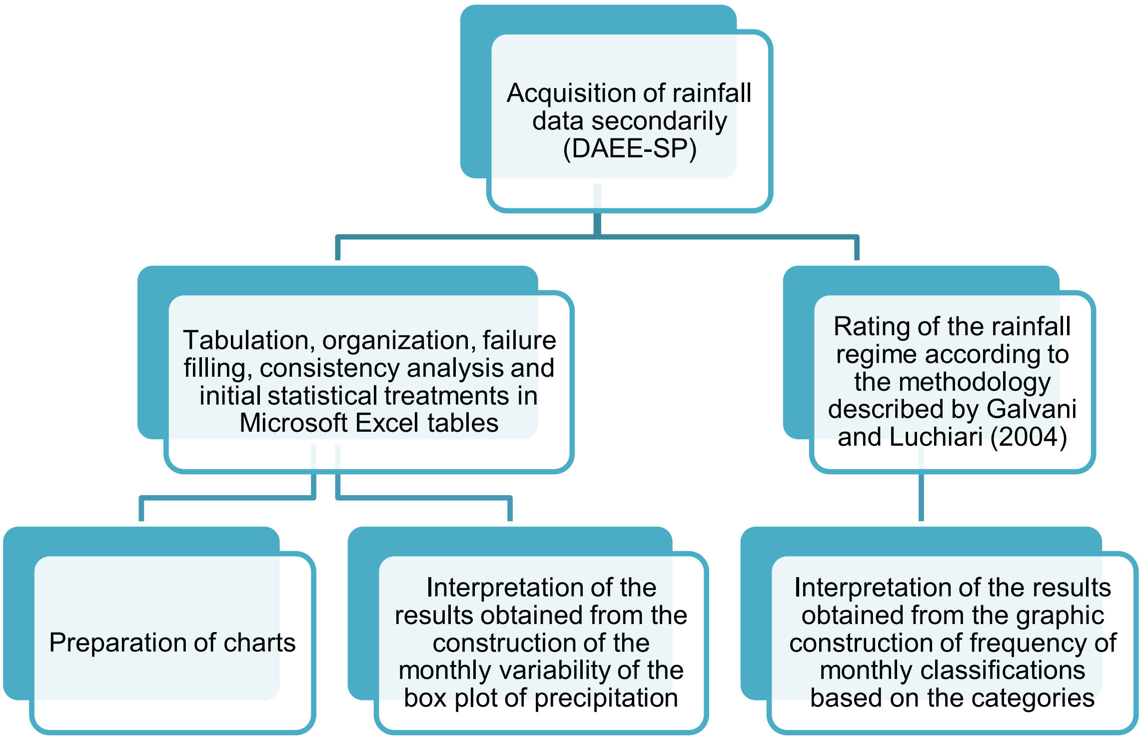
Monthly rains (mm)	Classification
5% of the lowest values in the series	Super dry
5% of the highest values in the series	Super wet
Between Vmin and the first quartile	Dry
Between the first quartile and the third quartile	Normal
Between the third quartile and the Vmax	Wet

Source: Adapted from Galvani and Luchiari (2004)

To verify the number of years classified in each of the defined categories, we adopted the absolute frequency calculation. This method allowed accounting for the number of years in which the monthly precipitation values fell into each classification, such as "super dry", "dry", "normal", "wet" and "super wet", providing a precise quantitative analysis of rainfall distribution.

To perform the calculation, it is necessary primarily to define the intervals or categories that will be analyzed, as was done for the classification of monthly rains (super dry, dry, normal, wet and super wet). Then we verified how many series of data belong to each of these categories, making a simple count. A flowchart of all methodological processes is displayed in Figure 05.

Figura 05 - Flowchart of the methodological steps of the research



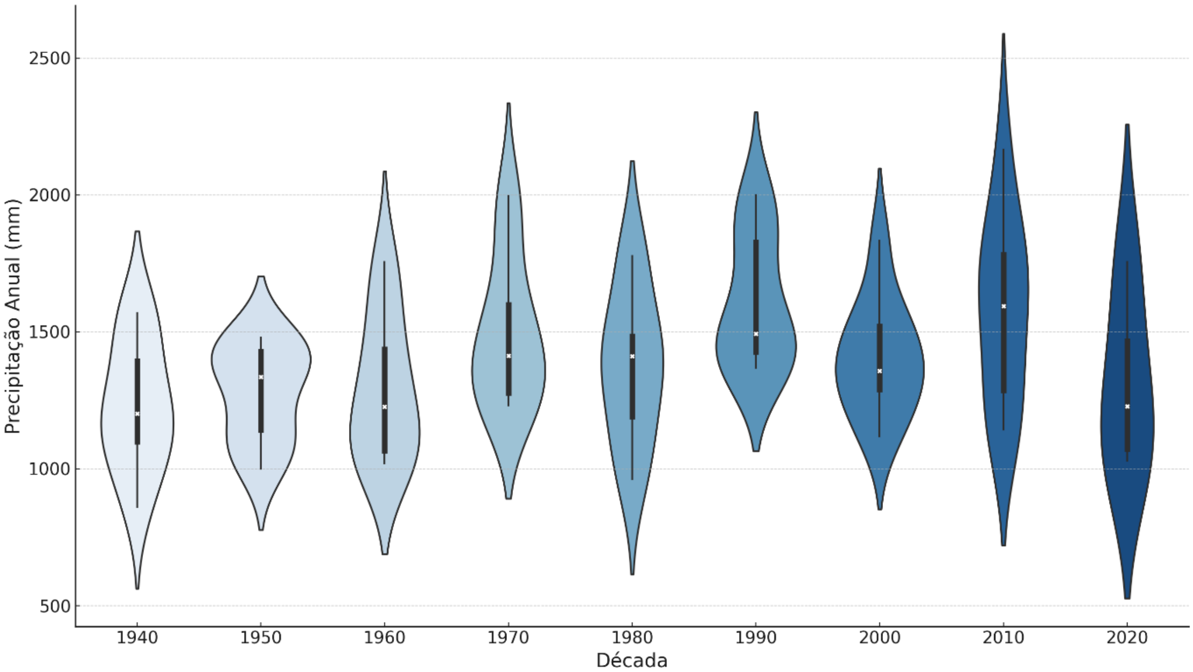
Source: Produced by the author (2025).

3 RESULTS AND DISCUSSIONS

The chart presented in Figure 06 presents an analysis of annual precipitation in Ourinhos, organized by decades, using violin plot to represent data distribution. There is a significant variation over the given period, both with respect to the amplitude and the central precipitation standard.

During the 1940s and 1950s, precipitation had a narrower distribution, indicating lower interannual variability, with centered values around 1500 mm per year. From the 1960s onwards, the amplitude increases, suggesting greater instability in rain records, especially in 1965, which recorded about 1755 mm of annual precipitation, the highest accumulation in the decade.

Figure 06 - Temporal variability of precipitation totals in the city of Ourinhos throughout the historical series



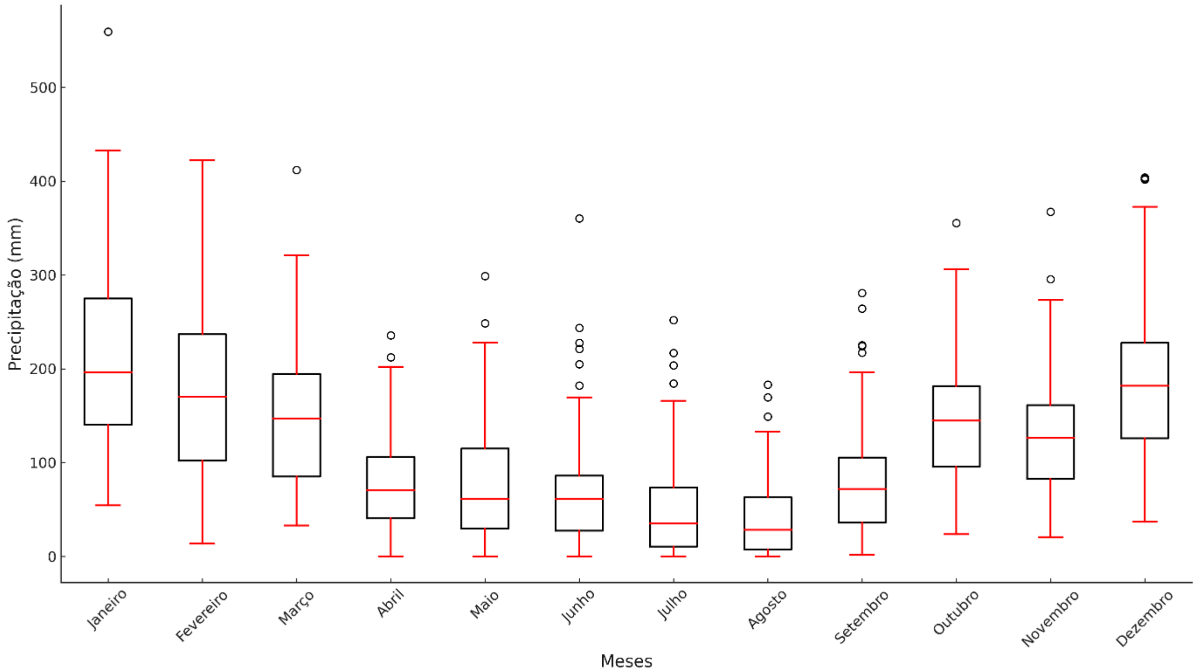
Source: Produced by the author (2025)

Between the 1970s and 1990s, variability remains high, with the width of violins expanding, especially at the higher ends. This specifies years with significantly above the historical average, such as 1997 and 1998, respectively. This result was also identified by Berezuk (2006) and Silva (2008). In the 2000s, the standard seemed slightly stable, although with a wide range of values, suggesting precipitation exceptionalities. In the 2010s and early 2020s, violins show much greater amplitude as a centralization around high values, with peaks near 2000 mm. This indicates a trend of increasing average annual precipitation and a higher frequency of extreme events. On the other hand, analyzing the data monthly, the box plot chart of precipitation in Ourinhos provides detailed information on quartiles, median, outliers and maximum and minimum values of each month.

The median, represented by the horizontal line inside each box, reflects the central value of precipitation each month. In January and February, the median is high, being close to 200 mm, indicating that half of the values recorded in these months are above or below that point. These months also have interquartile intervals (between the first and third quartiles), reflecting significant variability of precipitation.

The maximum and minimum values, represented by the whisker limits, show the range of precipitation within 1.5 times the interquartile interval (IQR). January, for example, features higher whiskers that reach near 400 mm, indicating that in typical (habitual) years, precipitation can reach these levels without being considered an outlier. On the other hand, June and July have inferior and superior whiskers remarkably close, with a median below 50 mm, showing a decrease in rainfall and low variability in the winter months.

Figure 07 – Monthly Box Plot for the city of Ourinhos



Source: Produced by the author (2025)

Outliers are another important highlight, indicating extreme monthly precipitation events. They are present in several months, such as January, February, December and even September, when there are points above the upper whispers.

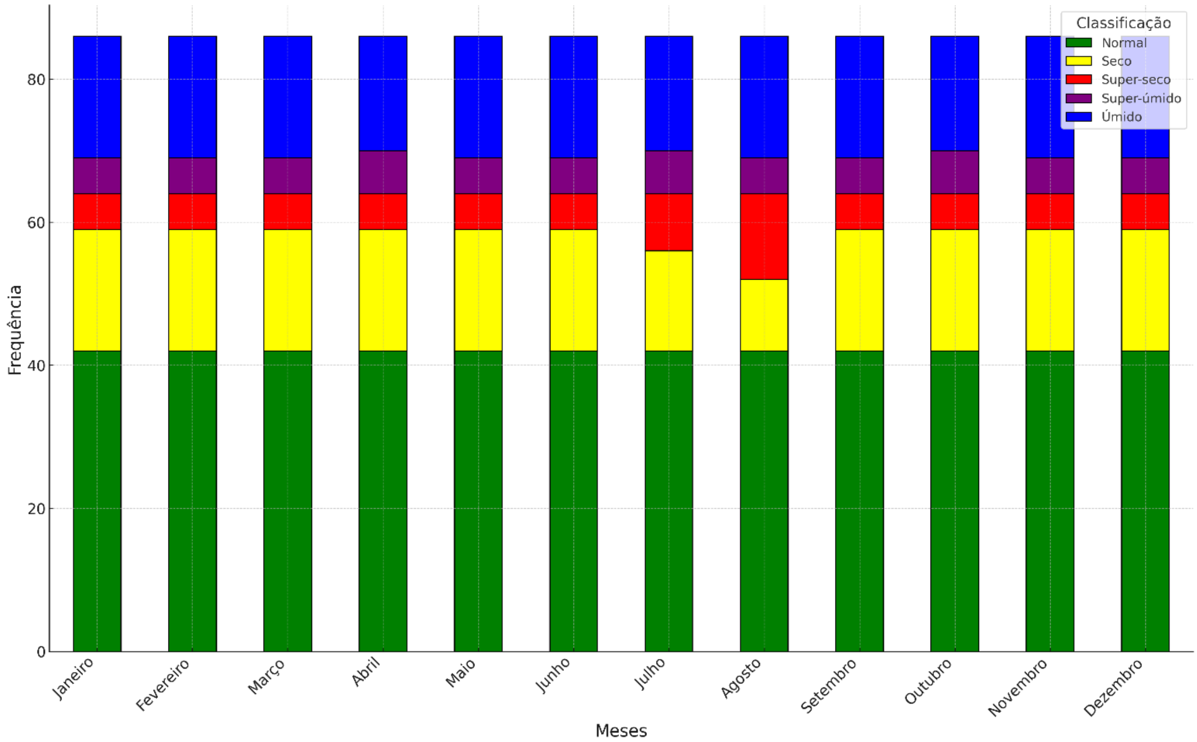
These extreme values represent years in which rainfall occurred significantly above normal, possibly associated with atypical climate events such as intense cold fronts or low-pressure systems. In contrast, the months from June to August have few or no outliers. It is noteworthy that the largest monthly accumulation was 570 mm in January 2005. According to the Climate Bulletin, the performance of front systems, the configuration of an episode of SACZ and the development of areas of instability throughout the month provided more intense rainfall in Southeast Brazil.

The maximum values are more evident in the summer and early spring months, with January, December and February registering rainfall over 400 mm in a few years, while the minimum values in these months rarely reach zero. In winter (June to August), the amplitude is much lower, with the maximum values hardly exceeding 50 mm, and the minimum often close to or equal to zero, indicating low periods in the rains.

Finally, the interquartile interval (the box area) varies significantly throughout the year, being higher in the rainy months, such as January, February and December, and lower in dry months, such as July and August. This seasonal variation reflects the climate characteristics of Ourinhos, marked by a rainfall regime concentrated in summer and a well-defined dry season in winter. The analysis of quartiles, median and outliers confirms a consistent seasonal climate standard, with important implications for water resource management and local agriculture.

Therefore, the chart presented in Figure 08 demonstrates the frequency of years classified into five precipitation categories for each month of the year: "Super Dry", "Dry", "Normal", "Wet" and "Super Wet". In a first analysis, it is noted that the "normal" category dominates the distribution in every month, represented by the highest absolute frequency. It indicates that most of the annual rainfall is aligned with the median data.

Figure 08 – Classification of intervals adopted for monthly rains considering the frequency of occurrence



Source: Produced by the author (2025)

The "dry" and "wet" categories also occur with significant regularity every month, highlighting the natural variability of the rainfall, but still within non-extreme intervals. This feature stresses that while there are variations of rain over the years, most of the months tend to stay close to a central standard with less harsh deviations.

Contrariwise, the extreme categories, "super dry" and "super wet", occur less frequently, standing out only in specific months. This indicates that extreme precipitation events are relatively extraordinary in the region, which is expected in long-term climate series. Even so, its presence, although limited, can have significant impacts on the social and environmental dynamics of the site.

An interesting point to note is the differentiated behavior of a few months, such as August and September, which have a higher proportion of extreme classifications in the "Super Dry" category. This pattern may be associated with specific winter climate characteristics. This season tends to be drier in the Ourinhos region, directly influencing the precipitation values of these months.

However, months like January, February and December, belonging to the rainy season, present a higher recurrence in the "wet" category, reinforcing the seasonal standard of the rainfall. This behavior confirms the influence of the tropical climate with a well-defined rainy season, highlighting the importance of analyzing these standards to understand interannual variability and the possible impacts of climate change in the region.

4 FINAL CONSIDERATIONS

The analyzes carried out in this study demonstrated the efficiency of the Box Plot technique to describe the Ourinhos rainfall regime, in São Paulo. This methodology allowed a detailed description of the distribution of monthly precipitation throughout the historical series, providing valuable information about local climate variability. The identification of extreme values, as maximum and minimum, as well as the delimitation of the quartiles and the median, highlighted the patterns of rain behavior, emphasizing the capacity of the technique in representing both typical and atypical events.

The classification of precipitation in five categories – super dry, dry, normal, wet, and super wet – revealed not only the predominance of the "normal" category in all months, but also the frequency and periods of extreme events. This detail is essential to understanding the seasonal and interannual dynamics of rainfall in the region, providing subsidies for the analysis of climatic patterns. The technique was particularly effective in highlighting months such as August and September, marked by a higher incidence of dry events, and the months of the rainy season, such as January and December, with more numerous humid events.

The use of absolute frequency calculation as a complement to the box plot technique was equally relevant to quantify the presence of each category over the years. This intersection of information enabled a more robust analysis, capable of identifying climate trends and specific seasonality.

Therefore, the application of the box plot technique proved to be an efficient and versatile statistical tool for climate analysis, especially in the study of precipitation. Its ability to simplify and interpret complex data reinforces its value for regional studies other than this one in respect to Ourinhos. These results contribute positively to the understanding of climate variability and can be used in water resource planning and management, mitigation of climate extreme impacts and the formulation of adaptive strategies for different sectors affected by climate change.

5 ACKNOWLEDGMENTS

The main author is grateful to the Coordenação de Pessoal de Nível Superior (CAPES) for the Doctoral Scholarship granted for this scientific research. The author also thanks the Programa de Pós-graduação em Geografia da Universidade Estadual Paulista ‘’Júlio de Mesquita Filho" - Presidente Prudente campus, for the physical space granted to the accomplishment of this study.

REFERENCES

ARAÚJO, A.R.; ANDRADE, F.J.; NASCIMENTO, J.C.; MARTINS, R, A. Análise de métodos de preenchimento de falhas em dados pluviométricos para a Região de Planejamento Sudoeste de Mato Grosso, Brasil. **Revista Brasileira de Geografia Física**, v. 16, n. 04, p. 2271-2286, 2023.

BALDO, M.C.; SOUZA, E.H.D.; GONÇALVES, R.L. Tendência da precipitação anual e do número de dias com chuva no município de Alto Piquiri-PR por meio do teste de Mann-Kendall. **Formação** (Online), v. 28, n. 53, 2021.

BARROS, J. R..; ZAVATTINI, J.A. Bases conceituais em climatologia geográfica. **Mercator,** v. 8, n. 16, p. 255-261, 2009.

BEREZUK, A. G. B. G.; NETO, J. L. S. Eventos climáticos extremos no oeste paulista e norte do Paraná, nos anos de 1997, 1998 e 2001. **Revista Brasileira de Climatologia**, v. 2, 2006.

BOIN, M. N. **Chuvas e erosões no Oeste Paulista:** uma análise climatológica aplicada**.** 2000. 264 p. Tese (Doutorado em Geociências e Meio Ambiente) – IGCE/UNESP, Rio Claro.

BOIN, M. N..; ZAVATTINI, J. A. Variações do ritmo pluvial no Oeste Paulista: gênese e impactos erosivos. **Geografia**, v. 30, n. 1, p. 115-139, 2005.

CORBO, A. R.; OLIVEIRA, J. C.; SILVA, M. P.; BARBOSA, F. G. Técnicas individuais e combinadas para preenchimento de falhas em dados diários de precipitação no município de São Gonçalo (RJ)**. Revista Brasileira de Climatologia**, v. 35, p. 401-427, 2024.

EMILIANO, V.M.; MOURA, F.P.; ALMEIDA, L.N.R.; SOUSA, G.H. Variabilidade pluviométrica na área paulista da bacia hidrográfica do rio Ribeira de Iguape (Brasil) e a influência do ENOS, a partir da técnica Box-Plot. **Terr@ Plural**, v. 18, p. 1-21, 2024.

FERREIRA, R.M. A. F.; FONTAO, P. A. B. F. Controle e qualidade dos dados de precipitação para complementação de falhas em estações situadas na região metropolitana do Recife-PE. In: LISTO, F. de L. R.; LISTO, D. G. da S.; SANTOS, H. M. dos; BISPO, C.de O. (org.). **SIG's e Gestão de Conflitos Ambientais:** A Cartografia na Resolução de Injustiças Sociais. 1. ed. Recife-PE: MapGeo - Mapeamentos e Soluções Geográficas, Empresa Jr, 2024. p. 275-285.

FONTÃO, P. A. B. A escola brasileira de climatologia geográfica: perspectivas atuais e futuras do paradigma do ritmo climático. **Perspectivas Geográficas**, p. 10, 2021.

FONTÃO, P. A. B..; FERREIRA, R. M. A. As chuvas no Sistema Cantareira: avaliação dos reflexos no manancial visando a segurança hídrica da região metropolitana de São Paulo. **Revista de Geografia-ppgeo-ufjf,** v. 12, n. 2, p. 218-238, 2022.

GALVANI, E..; LUCHIARI, A. Critérios para classificação de anos com regime pluviométrico normal, seco e úmido. Aracajú **Anais...** Simpósio Brasileiro de Climatologia Geográfica, 6, 2004, p. 20-29.

GHOMLAGHI, A..; NASSERI, M..; BAYAT, B. How to enhance the inverse distance weighting method to detect the precipitation pattern in a large-scale watershed. **Hydrological Sciences Journal**, v. 67, n. 13, p. 2014-2028, 2022.

LIU, Y.; ZHANG, W.; HU, M.; CHEN, L.; WANG, T. An assessment of statistical interpolation methods suited for gridded rainfall datasets**. International Journal of Climatology**, v. 42, n. 5, p. 2754-2772, 2022.

LIMBERGUER, L. Estudos de teleconexões atmosféricas e possibilidades de avanços na climatologia geográfica: conceitos, fontes de dados e técnicas. **Revista Brasileira de Climatologia**, v. 19, 2016.

MONTEIRO, C. A. de F. Análise rítmica em climatologia: problemas da atualidade climática em São Paulo e achegas para um programa de trabalho. **Climatologia**, n. 1, p. 1-21, 1971.

MONTEIRO, C. A. de F. Da necessidade de um caráter genético à classificação climática: algumas considerações metodológicas a propósito do Brasil meridional. **Revista Geográfica**, Rio de Janeiro, v. 31, n. 57, 1962. p. 29-44.

MONTEIRO, C. A. de F. A Dinâmica Climática e as Chuvas no Estado de São Paulo - estudo geográfico sob forma de atlas. São Paulo: Universidade de São Paulo/ Instituto de Geografia, 1973. 129 p.

OLIVEIRA, T. A.; LIMA, C. F.; PEREIRA, M. V.; COSTA, J. C. Variabilidade pluviométrica no município de Juiz de Fora-MG no período de 1910-2018: investigação a partir da técnica do box plot. **Revista Brasileira de Climatologia**, v. 26, 2020.

OLIVEIRA-JÚNIOR, J. F. D.; SOUSA, B.G.; NASCIMENTO, V. P.; RODRIGUES, A. L. Urban rainfall in the Capitals of Brazil: Variability, trend, and wavelet analysis. **Atmospheric Research**, v. 267, p. 105984, 2022.

PERUSI, M. C..; DEMARCHI, J. C..; PIROLI, E. L.; FERREIRA, J. J.; DOS SANTOS G., E. Alberto.; FUZZO, F. da S. Determinação do potencial natural de erosão (PNE) e degradação do solo associada a rodovias no município de Ourinhos/SP. **Formação (Online),** v. 29, n. 54, p. 357–386, 2022. DOI: 10.33081/formacao.v29i54.8934.

ROSS, J. L. S.; MOROZ, I. C. M. Mapa geomorfológico do Estado de São Paulo. São Paulo: USP-FFLCH/IPT/FAPESP, 1997. v. 1. 1 mapa. Escala: 1:500.000.
RUEZZENE, C.B.; PEREIRA, D.H.; SILVA, R.C.; COSTA, L, F. Preenchimento de falhas em dados de precipitação através de métodos tradicionais e por inteligência artificial. **Revista Brasileira de Climatologia**, v. 29, p. 177-204, 2021.

SALHI, H.; BENSAID, M.; AOUAD, R.; DJILALI, A. Evaluation of the spatial distribution of the extreme rainfall across Algeria country. **Environmental Earth Sciences**, v. 83, n. 14, p. 440, 2024.

SCHNEIDER, H..; SILVA, C.A da. O uso do modelo box plot na identificação de anos-padrão secos, chuvosos e habituais na microrregião de Dourados, Mato Grosso do Sul. **Revista do Departamento de Geografia,** v. 27, p. 131-146, 2014.

SHEKEDE, M. D..; SHOKO, C..; DUBE, T. Opportunities, progress, and prospects in remote sensing of climate variability. **Remote Sensing of Climate**, p. 407-417, 2024.

SILVA, M. R.; MOURA, F. P. de.; JARDIM, C. H.O diagrama de caixa (Box Plot) aplicado à análise da distribuição temporal das chuvas em Januária, Belo Horizonte e Sete Lagoas, Minas Gerais-Brasil. **Revista Brasileira de Geografia Física**, 2017.

SILVA, D. F.; PRELA-PANTANO.; A.; SANT'ANNA NETO, J. L. Variabilidade da precipitação e produtividade agrícola na região do Médio Paranapanema, SP. **Revista Brasileira de Climatologia**, v. 3, 2021. DOI: 10.5380/abclima.v3i0.25431. Disponível em: https://ojs.ufgd.edu.br/rbclima/article/view/13519. Acesso em: 21 jan. 2025.

TAVARES, A. C. Critérios de escolha de anos padrões para análise rítmica. **Geografia**, n. 1, v. 1, Rio Claro, abril 1976, p. 79-87.

VAREJÃO-SILVA, M. A. **Meteorologia e climatologia**. Versão Digital 2. Recife, 2006. 449 p. Disponível em: http://www.agritempo.gov.br.

ZAVATTINI, J. A. O paradigma da análise rítmica e a climatologia geográfica brasileira. **Geografia**, p. 25-44, 2000.

ZEROUALI, B.; DJOUDI, N.; BOUCHERIT, A.; SLIMANI, K. A new regionalization of rainfall patterns based on wavelet transform information and hierarchical cluster analysis in northeastern Algeria**. Theoretical and Applied Climatology**, v. 147, n. 3, p. 1489-1510, 2022.

***