Revista Brasileira de Climatologia
Brazilian Journal of Climatology

OPEN ACCESS

UFGD Editora

REPRESENTATION OF RHYTHMIC ANALYSIS GRAPHS IN CLIMATOLOGY USING DASHBOARDS

Representação de gráficos de análise rítmica em Climatologia por meio de dashboards

Representación de gráficos de análisis rítmico en Climatología mediante tablero de instrumentos

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Abstract: In the geographical climatology approach, climate is understood as the succession of different types of weather that recur over the years. In this context, rhythmic analysis graphs play a crucial role, as they are able to portray this succession, simultaneously representing the meteorological elements in their daily evolution over the sample of standard years (usual and exceptional). However, static graphs have limitations when dealing with large volumes of data, which makes their analysis, interpretation and correlation difficult. In order to overcome these limitations, this study demonstrates the potential of developing and using dynamic and interactive rhythm analysis graphs via a dashboard. Essentially, the work presents a methodological proposal for advancing rhythmic analysis by constructing graphs using Power BI software. Was used daily data on the main meteorological elements recorded by the conventional station in Goiânia-GO, administered by the National Institute of Meteorology. As representative standard years for the usual, dry and rainy regimes, were selected the years of 1997, 2015 and 2005, respectively. The dashboard was structured with the capacity for interactive and dynamic navigation, and was made available digitally via an access link. It is important to note its effectiveness in preparing and visualizing rhythmic analysis graphs, highlighting the significant improvement in the ability to read the data and compare the standard years. Therefore, this is an innovative contribution to rhythmic analysis in geographic climatology.

Keywords: Geographical Climatology. Rhythm. Goiânia-GO.

Resumo: Na abordagem da Climatologia geográfica, o clima é compreendido como a sucessão dos diferentes tipos do tempo que se repetem ao longo dos anos. Nesse contexto, os gráficos de análise rítmica desempenham um papel crucial, pois têm a capacidade de retratar essa sucessão, representando de forma simultânea os elementos meteorológicos, em sua evolução diária ao longo do recorte amostral dos anos-padrão (habituais e excepcionais). Todavia, os gráficos estáticos apresentam limitações ao lidar com o grande volume de dados, o que dificulta sua análise, interpretação e correlação. Com o intuito de superar essas limitações, este estudo demonstra o potencial do desenvolvimento e emprego de gráficos de análise rítmica dinâmicos e interativos por meio de um dashboard. Essencialmente, o trabalho apresenta uma proposta metodológica para avançar na análise rítmica, mediante a construção dos gráficos por intermédio do software Power BI. Foram utilizados dados diários dos principais elementos meteorológicos, registrados pela estação convencional de Goiânia-GO, administrada pelo Instituto Nacional de Meteorologia. Como anos-padrão representativos para os regimes habitual, seco e chuvoso, foram selecionados 1997, 2015 e 2005, respectivamente. O dashboard foi estruturado com a capacidade de navegação interativa e dinâmica, sendo disponibilizado de forma digital, por meio de um endereço eletrônico de acesso. Importante frisar sua eficácia na elaboração e visualização dos gráficos de análise rítmica, destacando a significativa melhoria na capacidade de leitura dos dados e comparação entre os anos-padrão. Portanto, apresenta-se uma contribuição inovadora à análise rítmica em climatologia geográfica.

Palavras-chave: Climatologia Geográfica. Ritmo. Goiânia-GO.

Resumen: En el enfoque de la climatología geográfica, el clima se entiende como la sucesión de diferentes tipos meteorológicos atmosféricos que se repiten a lo largo de los años. En este contexto, los gráficos de análisis rítmico desempeñan un papel crucial, ya que son capaces de retratar esta sucesión, representando simultáneamente los elementos meteorológicos en su evolución diaria a lo largo de la muestra de años estándar (habituales y excepcionales). Sin embargo, los gráficos estáticos presentan limitaciones cuando se trata de grandes volúmenes de datos, lo que dificulta su lectura, análisis, correlación e interpretación. Para superar estas limitaciones, este estudio demuestra el potencial de desarrollar y emplear gráficos de análisis rítmico dinámicos e interactivos mediante un cuadro de mandos. En esencia, el trabajo presenta una propuesta metodológica para avanzar en el análisis rítmico mediante la construcción de gráficos utilizando el software Power BI. Se utilizaron datos diarios de los principales elementos meteorológicos, registrados por la estación convencional de Goiânia-GO, administrada por el Instituto Nacional de Meteorología. Se seleccionaron como años estándar representativos de los regímenes habitual, seco y lluvioso, los años 1997, 2015 y 2005, respectivamente. El cuadro de mando se estructuró con capacidad de navegación interactiva y dinámica, y se puso a disposición digitalmente mediante un enlace de acceso. Cabe destacar su eficacia en la elaboración y visualización de gráficos de análisis rítmico, destacando la mejora significativa en la capacidad de lectura de los datos y de comparación de los años estándar. Por lo tanto, se trata de una contribución innovadora al análisis rítmico en climatología geográfica.

Palabras clave: Climatología Geográfica. Ritmo. Goiânia-GO.

Submitted on: 12/07/2024
Accepted for publication on: 01/11/2024
Published on: 08/11/2024

“So the problem is not so much to see what nobody has yet seen, as to think what nobody has yet thought concerning that which everybody sees” (Schopenhauer, 1891, p. 93)

1. INTRODUCTION

Geographic Climatology advocates the analysis of climatic reality based on daily or episodic events, as opposed to the abstraction provided by the use of arithmetic averages (Barros; Zavattini, 2009). This approach is based on concept of climatic rhythm by Monteiro (1971, p. 10), as the "successive and continuous chain of atmospheric states and their articulations in the sense of returning to the same states”.

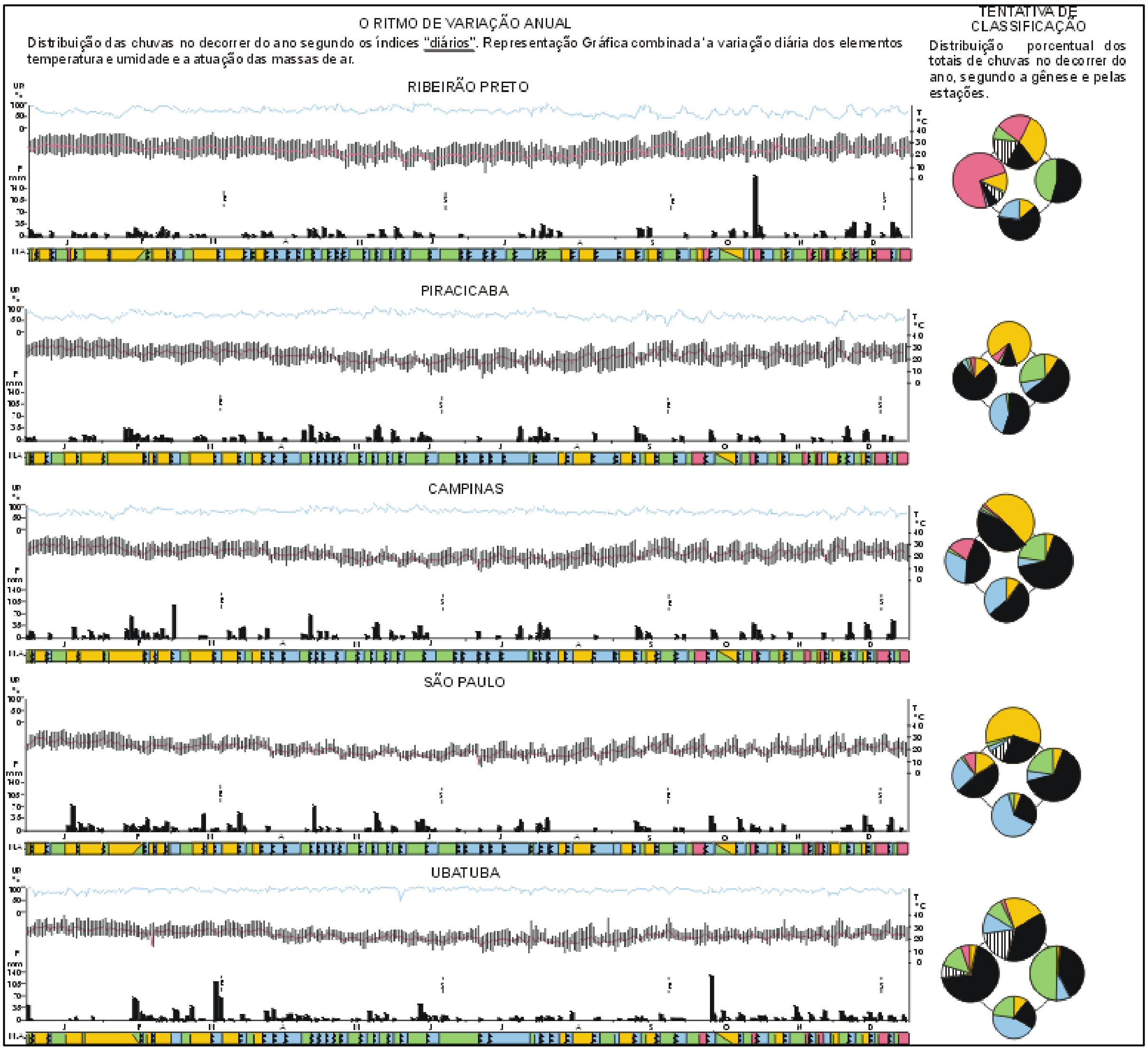
In the field of Geographical Climatology, rhythm analysis graphs are a crucial tool for perceiving and analyzing rhythm. These graphs allow the simultaneous representation of the daily variation of the main meteorological elements (air temperature, precipitation, humidity, pressure, cloudiness, winds, etc.), as well as indicating the atmospheric systems acting in the regional framework. In this way, as well as portraying the succession and rhythm of weather types, they provide insights into understanding the genesis of the climate (Monteiro, 1971).

The scientific literature offers several examples of these graphs. Figure 1 shows the remarkable graph from classic work by Monteiro (1973), who proposed both the approach and the method of rhythmic analysis. In this study, the author represented the daily variation in rainfall, air temperature, and relative humidity at selected stations in the state of São Paulo, relating them to circulation mechanisms and the genesis of atmospheric weather types.

Since then, other researchers have followed this approach, as evidenced in the studies by Zavattini (1990), Sant'Anna Neto (1990), Barros (2006), Borsato (2007), Pinto (2013), Vasques (2017) and Fontão *et al*. (2018), among others. For example, the graphs developed by Boin (2000) for the dry standard year of 1985 in Presidente Prudente - SP (Figure 2) and by Soares (2015) for the rainy standard year of 2009 in Fortaleza - CE (Figure 3) are examples of how these techniques are applied in different regions.

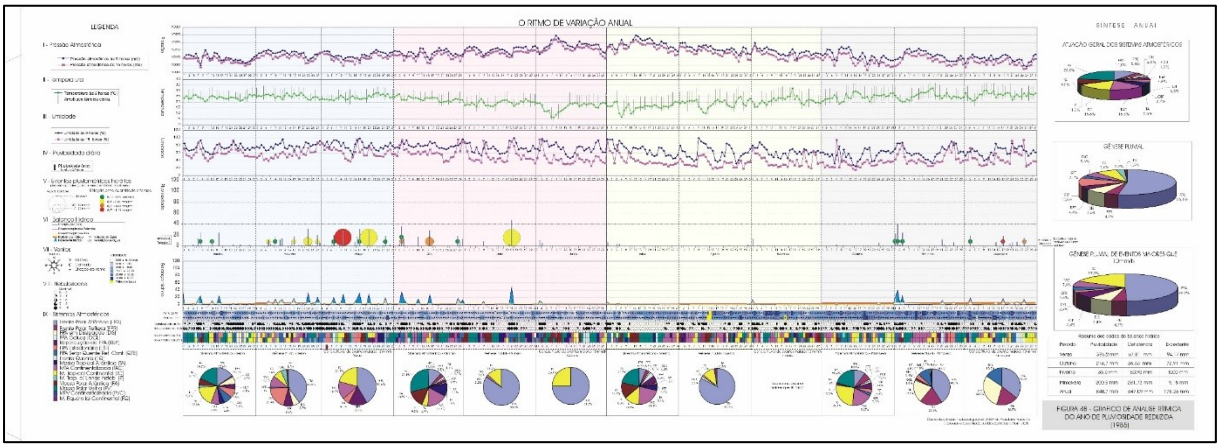
As can be seen, rhythmic analysis graphs generally cover one year (standard year), requiring the creation of three graphs to represent the usual, dry, and rainy regimes. However, due to the daily scale, the length of the annual period, and the volume of data involved, the alphanumeric elements in these graphs tend to be small in size, which can make them difficult to interpret.

Figure 1 - Rhythmic analysis graph of São Paulo cities for the rainy standard year of 1956.



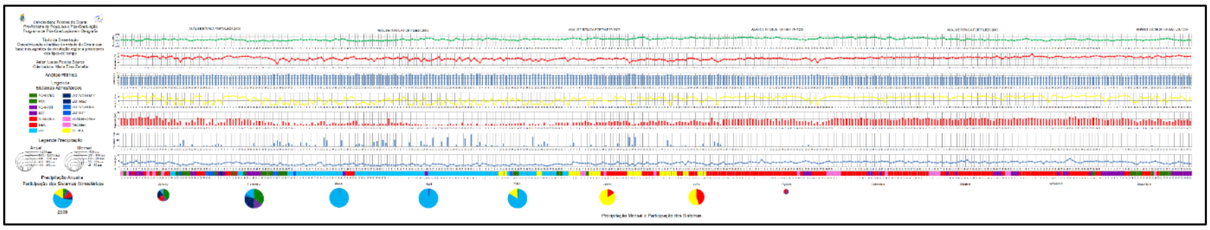
Source: Monteiro (1973).

Figure 2 - Rhythmic analysis graph for Presidente Prudente (SP) for the dry standard year of 1985.



Source: Boin (2000).

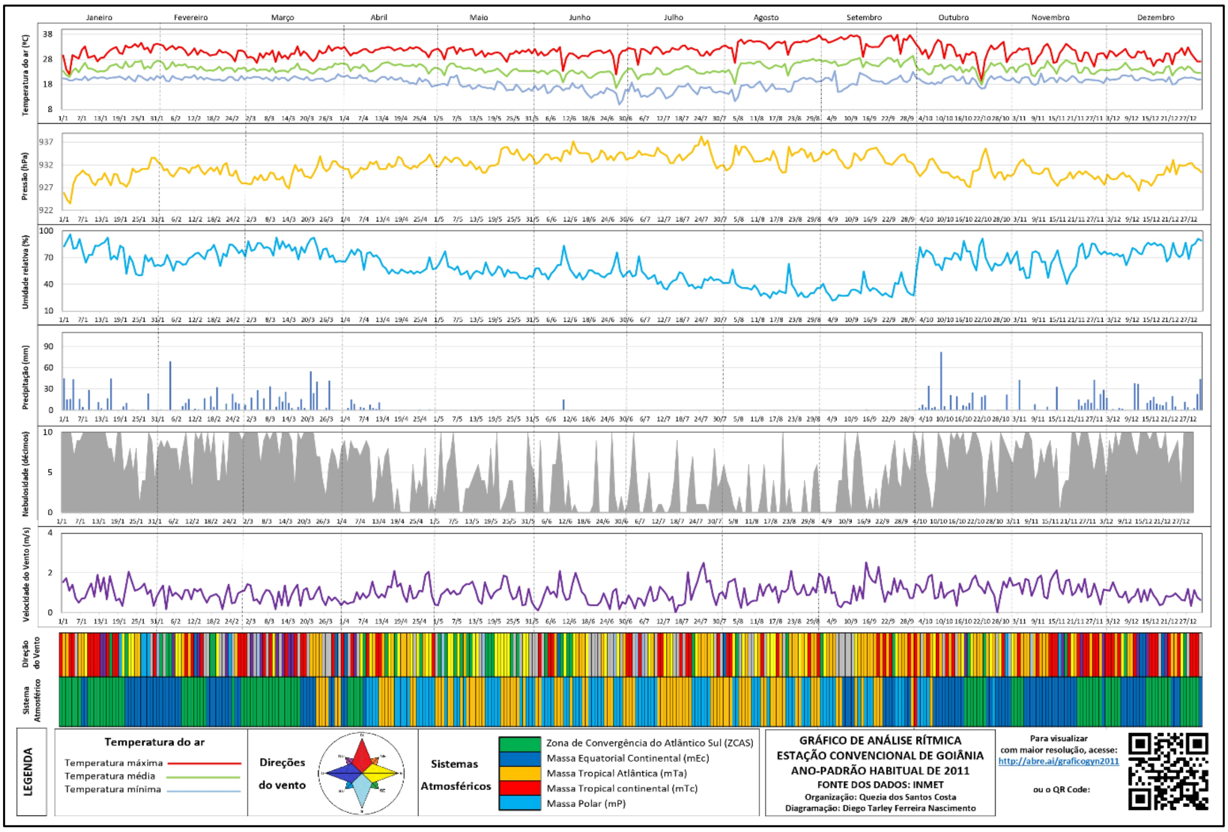
Figure 3 - Rhythmic analysis graph for Fortaleza (CE) for the 2009 rainy standard year.



Source: Soares (2015).

To get around these limitations, Nascimento and Novais (2020) developed a rhythmic analysis graph for the 2011 usual standard year in Goiânia - GO, providing a link and a QR Code (Quick Response Code, which can be scanned using cell phones equipped with a camera) to access the higher resolution image. However, reading and comparing the data between the usual, dry, and rainy standard years is still somewhat limited, especially due to the size of the fonts and the layout of the texts and numbers.

Figure 4 - Rhythm analysis graph for Goiânia (GO) for the 2011 standard year.



Source: Nascimento and Novais (2020). Note: link to view in more detail: https://abre.ai/graficogyn2011.

Furthermore, despite the development of a graphic interface by Borsato and Borsato (2014), called "RitmoAnálise", exclusively aimed at drawing up rhythm analysis graphs, these graphs are still predominantly drawn up using Microsoft Office Excel spreadsheet software, followed by manual diagramming using image editing software.

In this sense, before demonstrating the potential for drawing up rhythmic analysis graphs using dashboards, the following subsection provides a brief explanation and contextualization, with a history of their implementation and prospects for application of dashboards in different areas.

1.2. Brief Explanation ff Dashboards

The dashboard, a resource used for visualizing and analyzing data sets, offers a quick and targeted overview of the most relevant data and information (Sarikaya *et al*., 2019; Bach *et al*., 2022). According to Few (2006) and Janes, Sillitti, and Succi (2013), dashboards provide a panoramic view of what the user needs to know to communicate information and guide decision-making.

The term dashboard can be translated into Portuguese as *painel* and is used for various purposes, such as control, indicators, information, and management. In French, it is called *tableau*, and in Spanish, *tablero de instrumentos* or *cuadro de mandos*. According to the Cambridge Academic Contente Dictionary (2007, p. 342), the original English term refers to the part of "a car that contains some of the controls used for driving and the devices for measuring speed and distance" or "a device, a computer program, etc. that shows information and statistics about how the device, program, etc. is working, which you can use to control it".

Dashboards thus have their origins in the instrument panels of motor vehicles (Figure 5), which display basic information about their operation, such as speed, fuel level, engine temperature and speed, and oil pressure (Pauwels *et al*., 2009). Since the first automotive speedometer was patented by German engineer Otto Schulze in 1902, vehicle dashboards have incorporated odometers and other measuring instruments, such as fuel levels and engine temperature (Janes; Sillitti; Succi, 2013), currently also including other safety and driver assistance features.

Figure 5 - Example of a vehicle dashboard.

Source: https://sonhoemquatrorodas.com.br/servicos-painel-e-eletrica/.

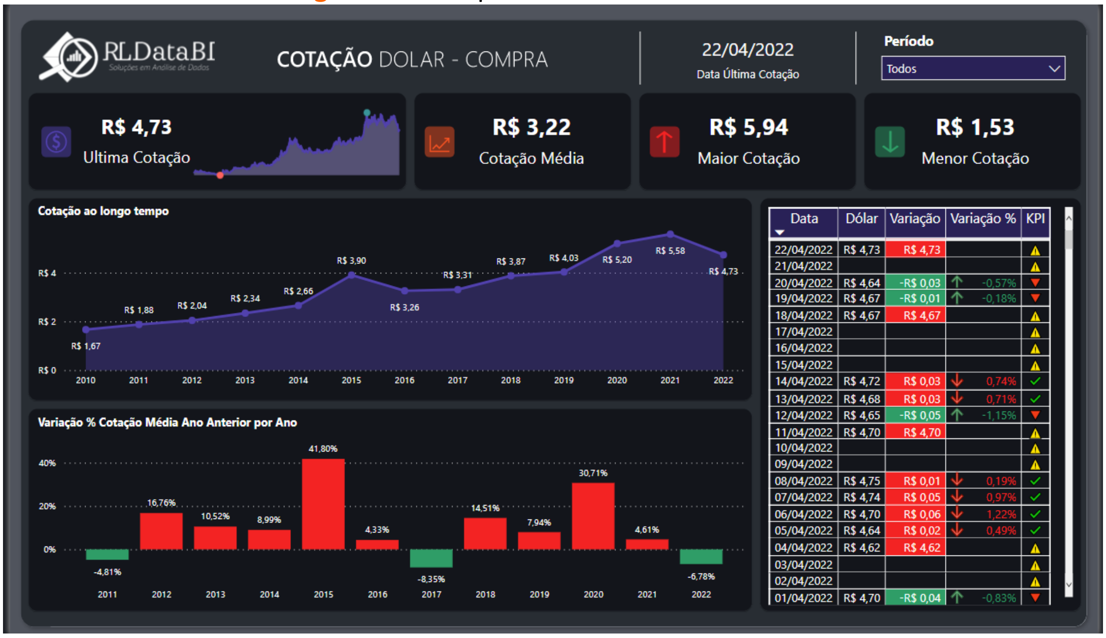
Another historical reference to dashboards is presented by Mattern (2015), who highlights the various panels present in the Operations Control Room in Houston, Texas (USA), for monitoring and guiding the launches of rockets and space missions by NASA (National Aeronautics and Space Administration), as can be seen in Figure 6. The ability of these panels to monitor information and provide support for decision-making is exemplified by the famous phrase "Houston, we've had a problem here", uttered by astronaut Jack Swigert during Apollo 13's trip to the Moon on April 11, 1970, after a serious equipment failure, followed by an explosion, which frightened those responsible for controlling and monitoring the mission, as emphasized by Nogueira (2019).

Figure 6 – Mission Control Center dashboard, Houston, 1965.

Source: https://placesjournal.org/article/mission-control-a-history-of-the-urban-dashboard/.

In the 1970s, dashboards mainly comprised digital panels used as Decision Support Systems (DSS). From the 1990s onwards, a series of dashboards were developed internally in large corporate organizations to provide real-time information on indicators and guide decision-making (Bastos, 2010). As an example, Figure 7 shows a dashboard in the financial area for monitoring the dollar exchange rate.

Figure 7 - Example of a financial dashboard.



Source: Rafael Lima - blog xperiun.com.

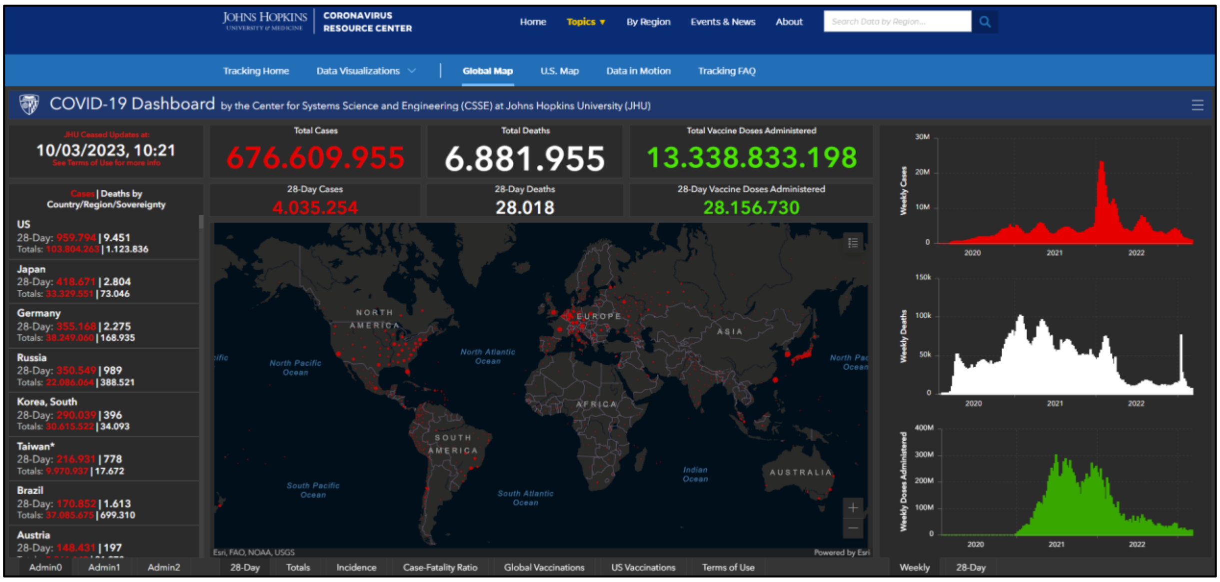
Since then, these dashboards have been widely used in various contexts, covering applications, purposes, and users in the areas of business, education, health, energy, transportation, and smart cities, among others (Sarikaya *et al*., 2019; Bach *et al*., 2022). Examples of dashboards that are more relevant to geographic science include those developed in the context of smart cities and the coronavirus pandemic (COVID-19), illustrated by Figures 8 and 9, respectively.

Smart city dashboards have become increasingly common, especially since the 1990s. These dashboards represent a series of data from the environment, system, and infrastructure of the urban space, through maps and graphs. They incorporate public administration data and official statistics, along with other operational data relating to the provision of services to the population (transportation, health, security, etc.) and/or environmental conditions, to display information on the performance, structure, pattern, and trends of cities (Kitchin; McArdle, 2016).

Figure 8 - Example of a dashboard for urban monitoring in Amsterdam (Netherlands).

Source: https://www.geodan.com/knowledge-and-innovation/managing-urban-processes-intelligently-with-the-amsterdam-smart-city-dashboard/.

Figure 9 – Example of a dashboard for monitoring the novel coronavirus pandemic.



Source: https://coronavirus.jhu.edu/map.html (data no longer updated after 03/10/2023).

In turn, the dashboards developed by institutions and government agencies during the COVID-19 pandemic provided a view of the spread of the disease at different cartographic scales, through alphanumeric elements, maps, and graphs (Richter; Nascimento, 2021). However, it is important to mention the limitations of these panels, such as the inability to represent the complex patterns of viral spread and the different impacts on local communities (Everts, 2020).

While it is not the purpose of this text to demonstrate all the applications of dashboards, the following describes the scope, resources, and interactivity provided by dashboards that demonstrate their use in rhythmic analysis in geographic climatology. Initially, it is important to note that a dashboard comprises a structured representation in a mosaic of numerical, textual, and graphical elements. More relevant numerical data is generally expressed by "cards" (with larger or more prominent font), while larger volumes of data are indicated by tables. The temporal dynamics, proportion or sum, and comparison of data are usually portrayed by graphs (line, pie, column, or bar graphs, for example). In addition, other elements, such as maps, can be used to express the spatial linkage of data.

The dashboard's greatest potential as a graphical representation is to provide dynamic, interactive, and interconnected data visualization, using filters and segmentations that allow for customization and personalization of the visualization (Kitchin; Maalsen; Mcardle, 2016). The same authors point out that

> "Dashboards provide a visual means to organize and interact with data, enabling users to drill down into data sets, filter out uninteresting data, select an item or group of data and retrieve details, view relationships among items, extract sub-collections, and to overlay and interconnect disparate data, enabling summary-to-detail exploration within a single visualization system (Kitchin; Maalsen; Mcardle, 2016, p. 94).

Although dashboards are widely used in various fields, they are little covered in the scientific literature (Yigitbasioglu; Velcu, 2012). This highlights the importance of addressing their application in geographic climatology, describing the systematization, structure, design, and tools for interactivity and dynamism in rhythmic analysis graphics.

In this context, this study aims to demonstrate the potential for dynamic and interactive representation and visualization of rhythm analysis charts using a dashboard. The main aim is to contribute to rhythmic analysis in Geographical Climatology, following the future perspective presented by Monteiro (1969), to improve the approach and theoretical-methodological path conceived by the author.

2. METODOLOGY

2.1 Study area

The area under study comprises the municipality of Goiânia, capital of the state of Goiás, located in the Midwest region of Brazil, in the coordinates 16°27'1” and 16°49'55” South latitude and 49°4'37” and 49°27'1” West longitude. The municipality has a territorial area of 729 km², and a population of 1,437,366 inhabitants, according to the last demographic census carried out by the Brazilian Institute of Geography and Statistics (IBGE, 2022).

Goiânia is located in the core area of the cerrado biome and has a predominantly flat terrain, characterized by tabular plateaus (Casseti, 1991), with an average altitude of 785 m. According to the Koppen-Geiger climate classification, the municipality is represented by the Aw typology, consistent with a semi-humid tropical climate, with a seven-month rainy season (October to April) and five months of drought (May to September), as explained by Luiz (2012). This marked seasonality is a reflection of the alternating action of atmospheric systems, as the continental equatorial mass and the South Atlantic Convergence Zone (SACZ) predominate in the summer and winter, responsible for the formation of precipitation events, which are interspersed with the predominance of the Altantic tropical mass, which results in atmospheric stability, little cloudiness and low levels of relative humidity during the winter and fall (Monteiro, 1951; Casseti, 1999; Neves, 2018; Nascimento; Oliveira, 2021).

2.2 Methodological procedures

The methodological process was based on five sequential stages. The initial stage included a survey and literature review of three aspects. The first concerned the rhythmic analysis approach, intending to understand the theoretical and practical foundations of this methodology. The second related to the definition and use of dashboards, and involved the analysis of various sources to obtain a comprehensive understanding of this data visualization tool. Finally, we compiled rhythmic analysis charts developed in previous studies, selecting relevant examples that represented different approaches and applications of this technique.

The next stage involved compiling, organizing, and processing the data. Daily data on temperature (maximum, average, and minimum), atmospheric pressure, relative humidity, rainfall, cloudiness wind direction, and speed were acquired from the Meteorological Database of the National Meteorological Institute (INMET). The data refers to the years as samples of the usual (1997), dry (2015), and rainy (2005) regime, defined for the area in question by Nascimento, Souza Neto, and Nunes (2015) and Nascimento and Deus (2017).

A fundamental aspect of rhythmic analysis graphs is the representation of the daily action of atmospheric systems, as recommended by Monteiro (1971). To identify the atmospheric systems operating in the region on each day of the three selected years, we used the synoptic charts of the Brazilian Navy, referring to the time of 12 UTC (9 a.m. in Brasília Official Time), and GOES images made available by the Center for Weather Forecasting and Climate Studies (CPETC/INPE), in color composition and with temperature enhancement.

Based on the literature survey and the examples compiled, the rhythmic analysis graphs were drawn up using Microsoft's Power BI software. However, before organizing the data and drawing up the graphs, it was necessary to familiarize oneself with the dashboard by taking part in courses, mainly aimed at drawing up dashboards for the Business Intelligence (BI) area, using software such as Power BI and Tableau. Power BI (Microsoft) was chosen for this work due to its free nature, variety of interfaces and tools, and greater accessibility in terms of publishing and sharing dashboards produced on the platform.

After this stage, the data was organized and formatted in Excel spreadsheets (Microsoft), converting the data types for some meteorological variables, such as wind direction and the acting atmospheric system, changing them from "text" to "numeric", as well as defining the corresponding color symbology. During this process, the absence of atmospheric pressure data was observed for the usual year of 1997, while the other variables were present in the three selected years.

Subsequently, the spreadsheet was inserted into Power Query, linked to Power BI, and the rhythmic analysis charts were created. As the main objective of this work is to demonstrate the development and potential use of rhythmic analysis graphs using a dashboard, the next topic "Results and Discussions" will cover in detail the structure, design, tools, and functionalities used, as well as the interactivity and dynamism in the visualization, analysis, and interpretation of data and information.

3. RESULTS AND DISCUSSION

Goiânia's rhythmic analysis graphs for the usual (1997), dry (2015), and rainy (2005) standard years, developed in an interactive and dynamic dashboard using Power BI software, can be accessed at the following link: https://www.bit.ly/analiseritmicagoiania[1].

Looking at the rhythmic analysis graphs from the dashboard, you can see the ability to visualize the data interactively. In addition, the standardization and dynamism of the graphs for the usual, dry, and rainy standard years and their sharing on the internet allow for better analysis, correlation, and interpretation of the data, and the perception of the rhythm in its daily succession - compared to a statistical representation with limited graphic resolution.

The design of the dashboard was based on examples of graphics from Monteiro's initial proposal (1971) and other authors in the literature, such as Zavattini (1990), Barros (2006), Boin (2000), Zandonadi (2013), Pinto (2013), Armond (2014), and Vasques (2017). In general, the horizontally stacked and vertically aligned graphs represent the different meteorological parameters. The design took into account the types of graphs usually used to represent some meteorological elements, such as the line graph for temperature and the column graph for precipitation, while the area graph was used for the other parameters.

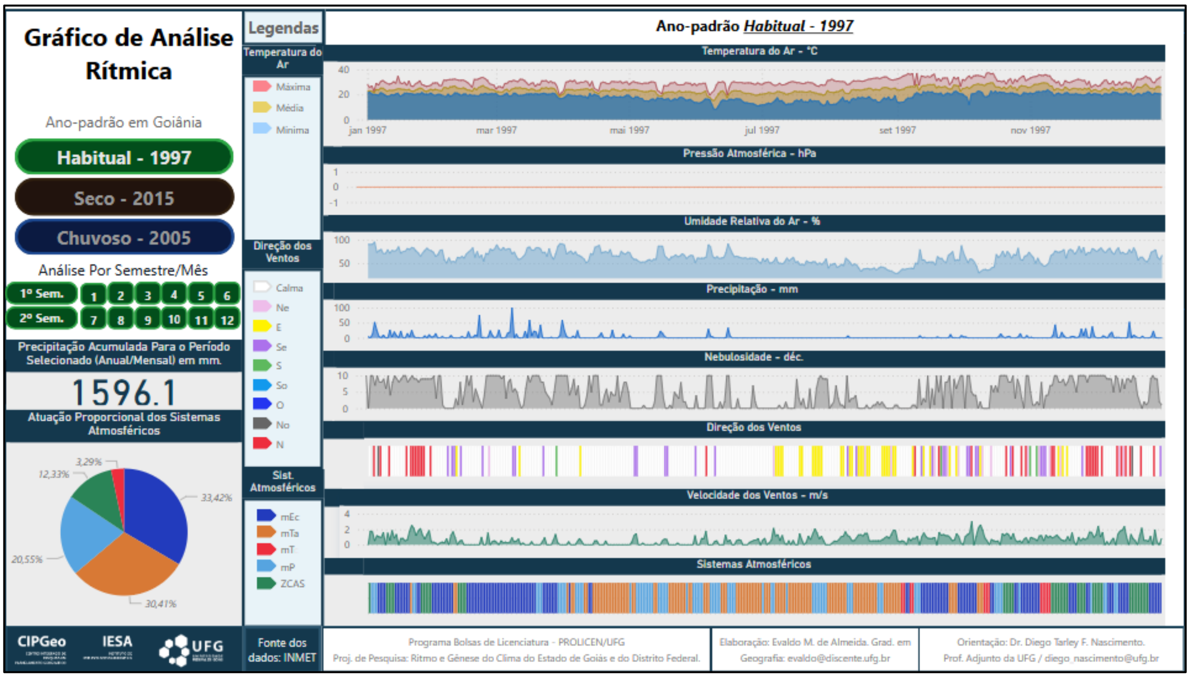
The colors usually used for some meteorological parameters were used, for example: red for maximum temperature and blue for minimum temperature, precipitation, and humidity. For the other parameters, were indicated according to the precepts of semiology and visual semantics of Gestalt theories and laws (Chang; Dooley; Touvini, 2001).

A dashboard structure based on three pages was used to represent the three standard years. From the main interface, can access the rhythmic analysis graphs for the standard years usual in 1997 (Figure 10), dry in 2015 (Figure 11), and rainy in 2005 (Figure 12), using the navigation buttons available in the menu on the left, with the respective text markers detailing

[1] If the link is not available via the shortener, you can also access the dashboard by pressing the "ctrl" key on your keyboard and clicking on the pictures on the following pages.

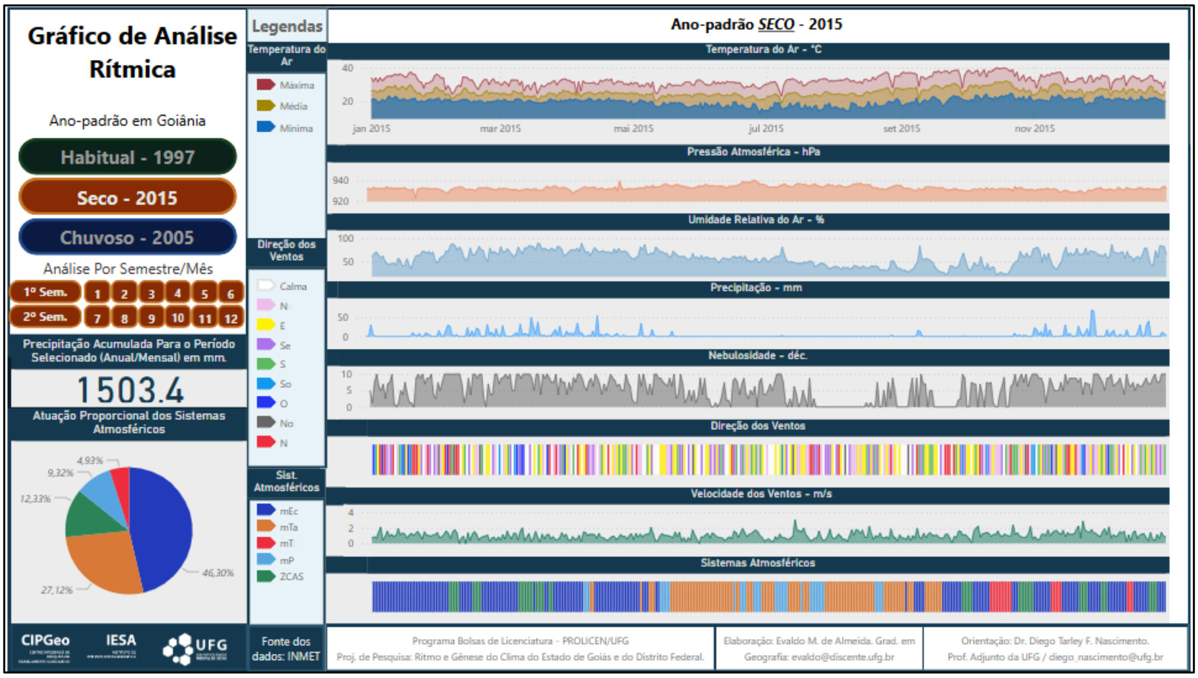
the usual, dry, and rainy regime. Visualizing the data through the dashboard allows a quick and dynamic comparison between the usual year and the exceptionally dry and rainy ones, noting the change between these regimes not only in terms of the records of climatic parameters but also concerning the succession of weather types and climatic rhythms.

Figure 10 - Rhythmic Analysis Chart for Goiânia - Usual Standard Year (1997).



Source: authors (2024).

Figure 11 - Rhythmic Analysis Graph for Goiânia - Dry Standard Year (2015).



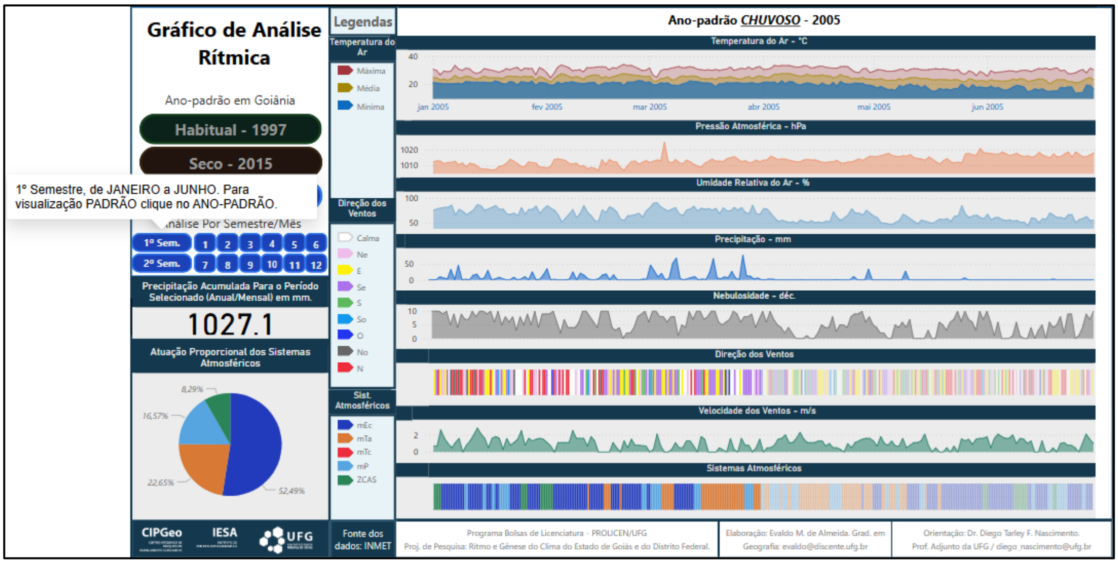
Source: authors (2024).

Figure 12 - Rhythmic Analysis Graph for Goiânia - Rainy Standard Year (2005).

Source: authors (2024).

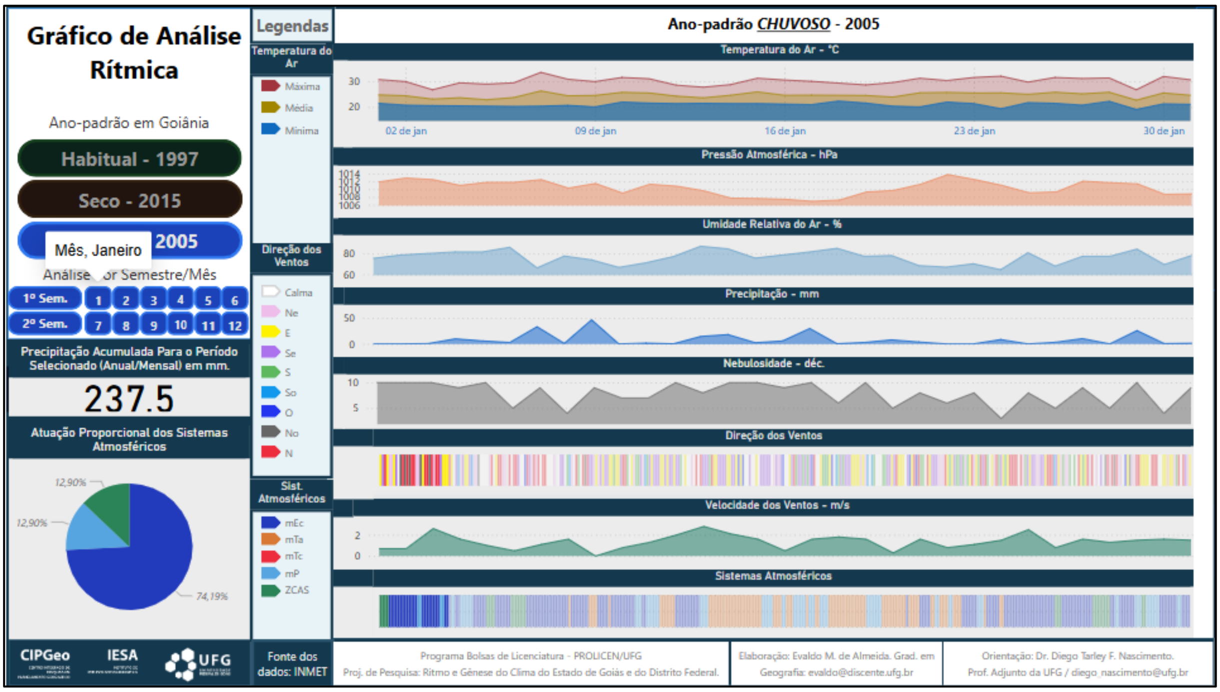
In the menu to the left of the dashboard, there are markers capable of changing the graphs to a six-monthly (Figure 13) or monthly scale (Figure 14). The prospect of interacting with the panel to change the standard year, or the time frame from annual to half-yearly or monthly, as well as the dynamic navigation of the representation itself, is one of the main expectations regarding the potential of using the dashboard to build rhythmic analysis graphs.

Figure 13 – Filters for altering the rhythmic analysis graphs for the time scale of the first half of the 2005 rainfall pattern year.



Source: authors (2024).

Figure 14 – Application of filters to alter the rhythmic analysis graphs for the monthly time scale of January 2005.

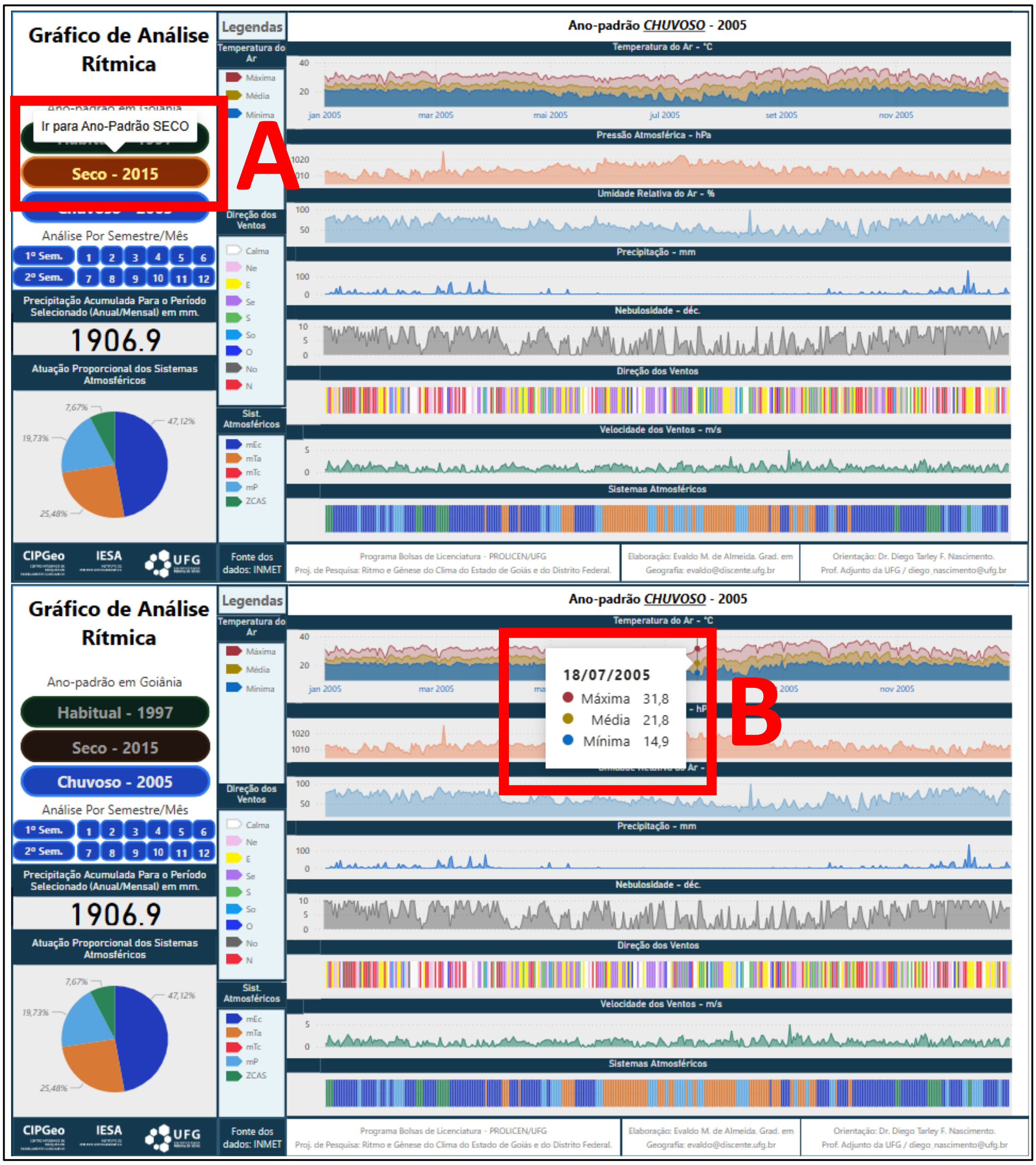


Source: authors (2024).

When hover over a graphic element, an informative text bubble appears, describing the action that will take place when you click on the button (Figure 15-A) or detailing the textual and numerical information in each field. For example, when you hover the mouse over a specific day in each graph, the text bubble details the date and the value recorded by the climate parameter on that day (Figure 15-B).

Figure 15 also shows a graph with the percentage of atmospheric systems that act during each standard year, allowing a quick perception of the differentiated action of atmospheric systems between the usual and exceptional regimes. It is important to note that the information, both on the accumulated rainfall on the card and the proportional action of the atmospheric systems on the graph, changes automatically when the temporal filters (half-yearly and monthly) are applied.

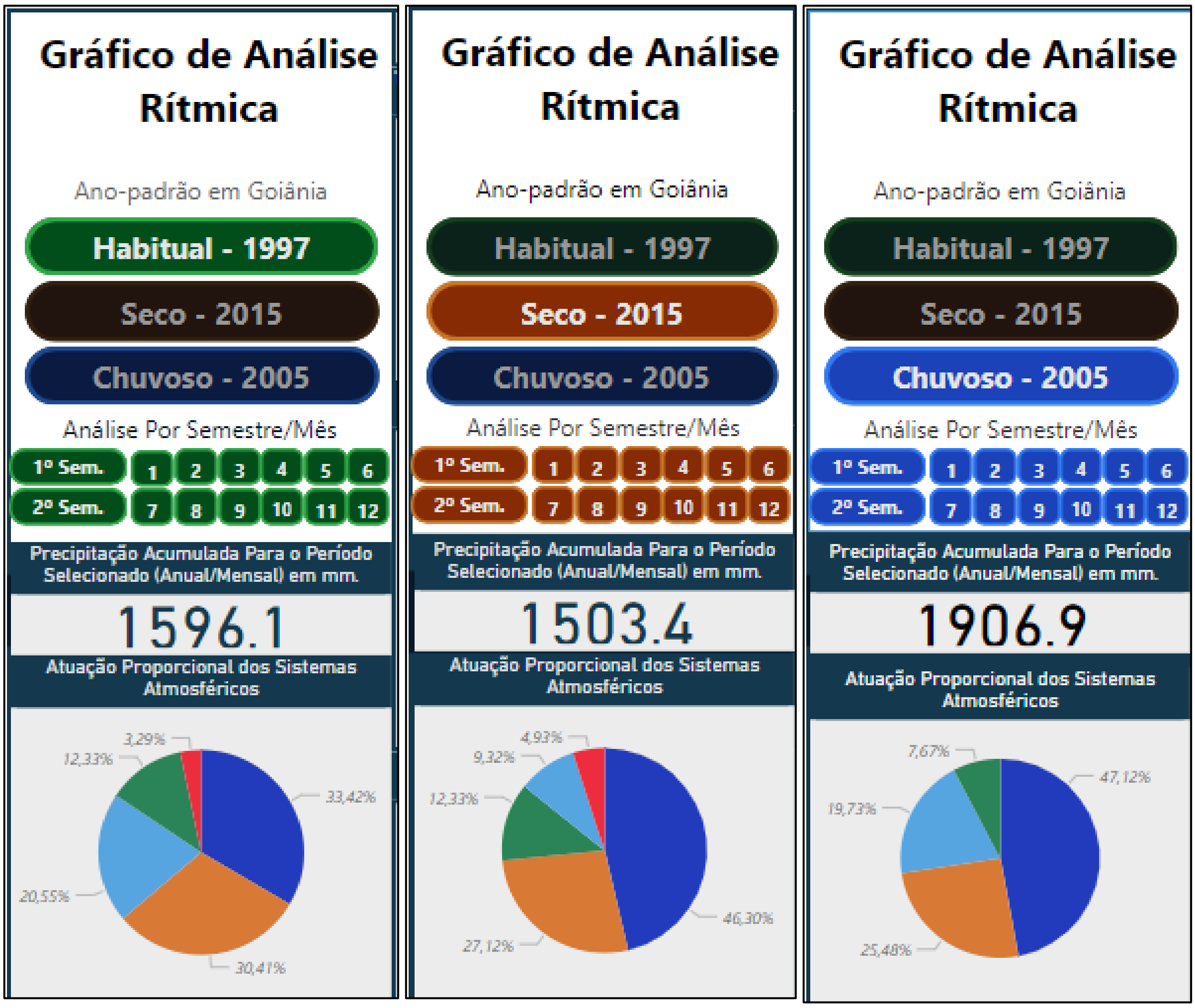
Figure 15 – Text informing you of the action when you click on each button / filter (A) or detailing the date and records of the climate parameters (B).



Source: authors (2024).

Another interesting feature can be seen in the central part of the menu on the left of the dashboard, with a card indicating the total annual rainfall for each standard year (Figure 16). The values are automatically altered according to the selection of the standard year, making it possible to compare the volumes recorded between the years considered normal and those that are exceptionally dry or rainy. In the case of Goiânia, there was a volume of 1,596mm in the usual year of 1997, a reduction to 1,503mm in the dry year of 2015, and an increase to 1,906mm in the rainy year of 2005.

Figure 16 – Cards showing the total annual rainfall and graphs of the percentage action of atmospheric systems, which change automatically depending on the selection of the standard year.



Source: authors (2024).

However, given such potential and so many analytical possibilities, it is worth highlighting some limitations of using dashboards to represent the graphs and support rhythmic analysis. Firstly, it is worth mentioning that these graphs are intended for specific audiences or users with prior knowledge of climatology and rhythmic analysis, and that general audiences would certainly not understand and/or would have difficulty analyzing and interpreting the data.

Sarikaya *et al*. (2019, p. 684) points out that "The visual and functional aspects of a dashboard typically reflect the intended audience, their domain and visualization experience, and their agency relationship with the data." Thus, while some dashboards have a general audience, others are aimed at specific users. This is the case with the rhythmic analysis graph on a dashboard, which requires expertise and familiarity with the topic, the type of representation, and the rhythmic analysis itself. Thus, a challenge is to provide support for users who do not have these skills and competencies, as pointed out by Erkerson (2010) and Kitchin, Maalsen, and McArdle (2016).

However, even in the face of this limitation, the proposal is promising, firstly because it can be implemented in free, publicly accessible software (Power BI), or in private software that is more accessible to the scientific community (Excel). It can be applied to different locations and contexts, with adaptation and complementation, in line with what was suggested by Monteiro (1969, p. 68) concerning "efforts to develop analytical techniques, which, at best, would be an 'addition' and never their 'replacement'" in the scope of geographical climatology.

4. FINAL CONSIDERATIONS

The proposal to create rhythm analysis graphs is not a new approach or analytical technique, but rather an extension of the geographical climatology approach advocated by Monteiro (1971) and used in various climatology studies. This paper presents an innovative proposal for representing and analyzing climatic rhythms, using dashboards created using Power BI software.

The design of rhythm analysis graphs using a dashboard is promising as it provides interactivity and dynamism in data visualization, allowing the application of temporal filters and expanding the visualization layout. Sharing the dashboard on the internet makes it easier to make the graphs available and prevents loss of data visualization quality. In addition, the platform developed as a dashboard can be incorporated into a web page, and can even be accessed from smartphones.

Despite its limitations, such as the need for users to have prior knowledge of climatology and rhythmic analysis, the proposal can be implemented in publicly accessible software, such as Power BI, or in private software that is more accessible to the scientific community, such as Excel. Therefore, it is not considered to be a perfect and finished proposal, it can (and should) be improved and applied to different locations and contexts.

Thus, there are several new possibilities in the field of Climatology and Geography itself, to improve understanding of the climate complex using new representation and analytical techniques.

ACKNOWLEDGMENTS

The authors would like to thank the National Council for Scientific and Technological Development (CNPq), for awarding a Research Productivity grant (process 305318/2022-5) to the first author, and the Federal University of Goiás (UFG), for the grant linked to the Undergraduate Scholarship Program (PROLICEN) to the second author.

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