Howden Re

Climate overview of Brazil and global climate impacts

5th edition
July 2025

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MeteoIA

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For more information on the datasets and methodologies used by MeteoIA in this report, or to learn about our reinsurance brokerage solutions, please contact Howden Re's team at report.brasil@howdenre.com.

Summary

Recent weather events in Brazil and worldwide

Rainfall conditions, drought evolution, river basin conditions and severe weather events in Brazil and worldwide

A recap: regional highlights of rainfall behaviour in Brazil

The 4th edition of this report, published in April 2025, presented Brazilian MIA Climate model forecasts for the April–June quarter of this year (figure 1).

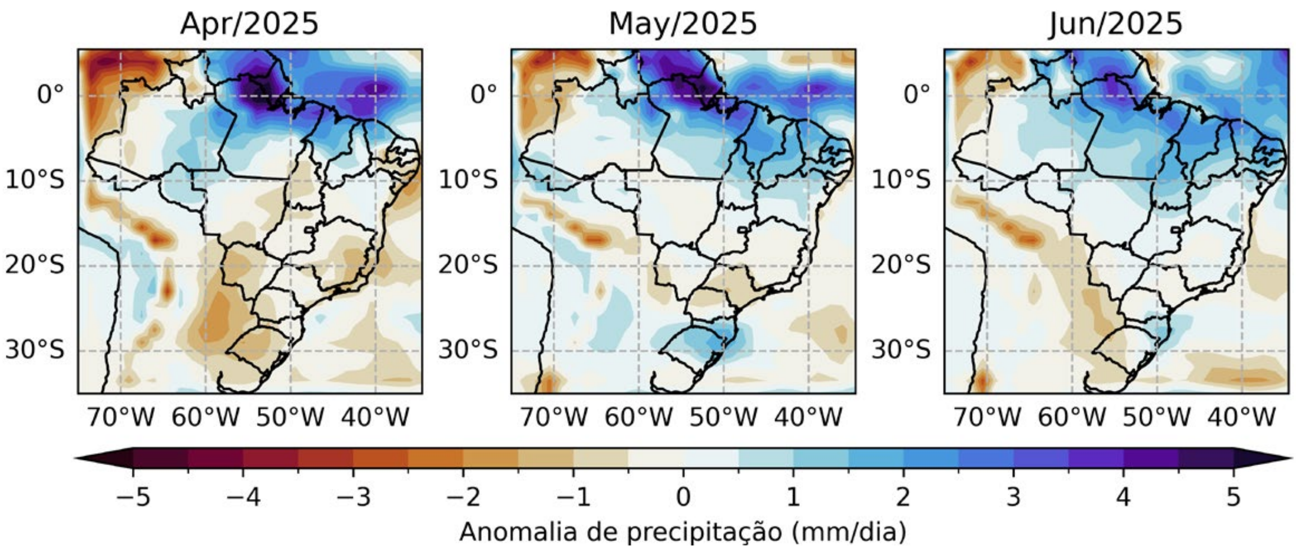
The model showed strong alignment and a high degree of accuracy in predicting precipitation anomalies across various regions of the country, particularly projections for the north-central part of the North region and the western part of the South region, which demonstrated high precision compared to observed data.

Despite the overall above-average performance, significant regional variations were identified in other areas of the country.

These discrepancies may be influenced by smaller-scale and short-duration atmospheric systems, as well as seasonal changes in major large-scale climate signals (such as the North Atlantic Oscillation and the Madden-Julian Oscillation), which affect long-term predictability.

The most recent runs of the MIA Climate model also revealed a marginal shift from previous forecasts. For example, the transition from a below-average rainfall pattern in Bahia in April to near-average conditions in May, reflect the dynamic evolution of regional atmospheric conditions.

Figure 1 - Forecast for precipitation anomaly for the months of May to June 2025, based on the April 2025 run (Source: MIA Climate)



In order to assess the accuracy of the forecasts compared to actual observed experience, this report presents a comparison between the precipitation anomalies predicted by the April and May 2025 MIA Climate model forecasts and the consolidated data from the MERGE-INPE product (details in the definitions section at the end of the report).

April 2025

Precipitation anomalies forecasted by the MIA Climate model for April 2025 showed strong alignment with the observed data (MERGE-INPE) across several regions of Brazil (figures 2 and 3).

North Region

- Accurate projections of above-average rainfall in northern Amapá and northern Roraima
- Correct forecast of below-average rainfall in central Pará and northern Tocantins

Northeast Region	• High accuracy in indicating significantly below-average rainfall in Maranhão and northern Piauí • In western Maranhão, the model predicted average rainfall, but observations showed above-average volumes
Southeast Region	• Overall, rainfall volumes were close to the historical average • Notable accuracy in São Paulo, where the model correctly forecasted slightly below-average rainfall
South Region	• Both the MIA Climate model and MERGE-INPE data indicated below-average rainfall in western Rio Grande do Sul and western Paraná

Figure 2 - Precipitation forecast for the month of April (Source: MIA Climate)

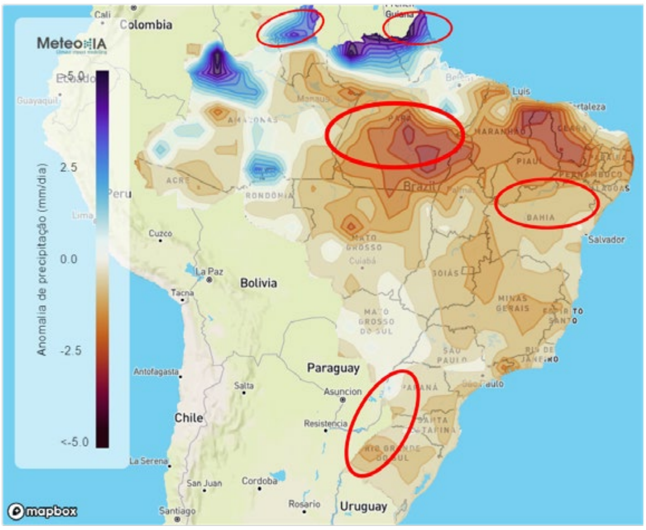
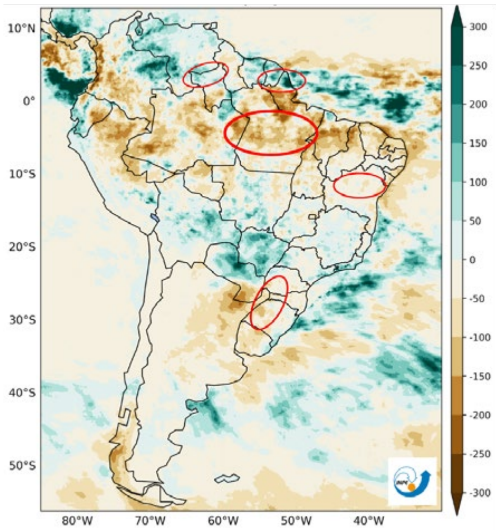


Figure 3 - Precipitation observed in the month of April (Source: INPE, MERGE)



May 2025

In May 2025, the MIA Climate model maintained good levels of accuracy across several regions of Brazil, especially in the South, parts of the Midwest, and some areas of the North and Northeast (figures 4 and 5).

North Region

- Correct forecast of below-average rainfall in central Pará and south-central Amapá
- Accurate prediction of alternating periods of more and less rainfall between Amazonas and Roraima

Northeast Region

- The model indicated below-average rainfall in Maranhão, Piauí, and Ceará, which was indeed observed (with some differences in intensity)
- Along the coast (Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia), rainfall volumes were above average, with totals exceeding 100 mm above the climatological norm
- This increase in rainfall is related to the onset of the winter rainy season in the region, associated with the influence of:
  - Easterly Wave Disturbances (DOLs)
  - Instability Lines (LIs)
  - Sea breezes
  - An intensified and continent-shifted South Atlantic Subtropical High (SASH).

South Region

- Correct forecast of above-average rainfall in western Rio Grande do Sul
- Below-average rainfall in western Paraná, in line with MIA Climate forecasts

Figure 4 - Precipitation forecast for the month of May (Source: MIA Climate)

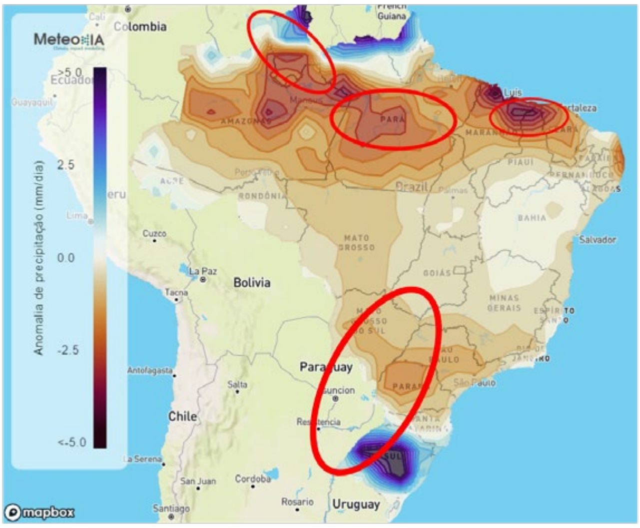
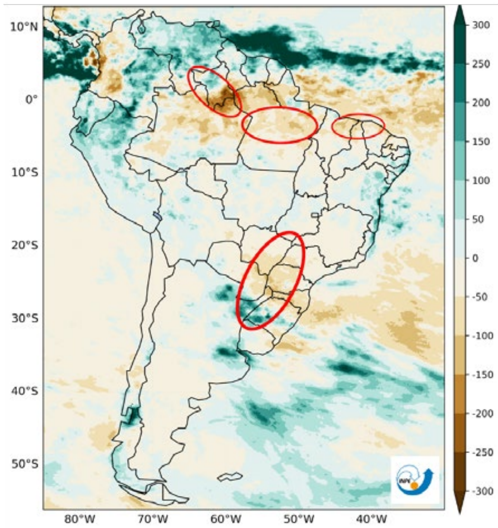


Figure 5 - Precipitation observed in the month of April (Source: INPE, MERGE)



Update on drought conditions and the situation of river basins in Brazil

According to the drought monitoring maps produced by the National Centre for Monitoring and Early Warning of Natural Disasters (Cemaden) (figures 6 and 7), improvements in drought conditions were observed in some regions of the country in March 2025.

Above-average rainfall contributed to the reduction of mild drought in Ceará and northern Maranhão, and also helped improve areas classified as moderate drought in the northern region.

On the other hand, the lack of rainfall in certain areas of the Northeast worsened drought conditions, especially in Pernambuco, Bahia, southeastern Piauí, western Alagoas, and Sergipe.

In the Southeast, the recorded conditions indicated the presence of mild to moderate drought, with emphasis on the central-northern portion of Minas Gerais. In the South region, drought conditions worsened in the mountainous areas of Santa Catarina and northeastern Rio Grande do Sul, where the situation evolved from mild to severe drought.

In the Midwest, moderate drought expanded between Goiás and Mato Grosso, while areas in western Mato Grosso and northwestern Goiás showed a reduction in mild drought due to improved precipitation indexes.

In April 2025, above-average rainfall in the Southeast and Midwest regions contributed to improvements in drought indicators, resulting in the retreat of mild and moderate drought categories in much of these areas.

However, in the Northeast, the situation worsened with the spread of severe drought in the states of Maranhão, Piauí, Pernambuco, and Bahia, as well as the expansion of moderate drought in Paraíba and mild drought in Ceará and Rio Grande do Norte.

In the South region, the persistence of water deficit led to the intensification of severe drought in western Rio Grande do Sul and moderate drought in southwestern Paraná.

Figure 6 - Drought monitor of March 2025
(Source: Cemaden)

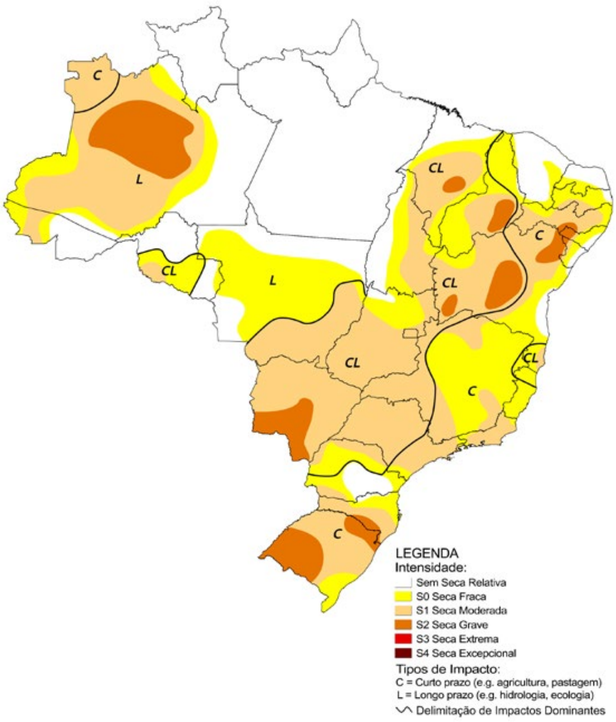
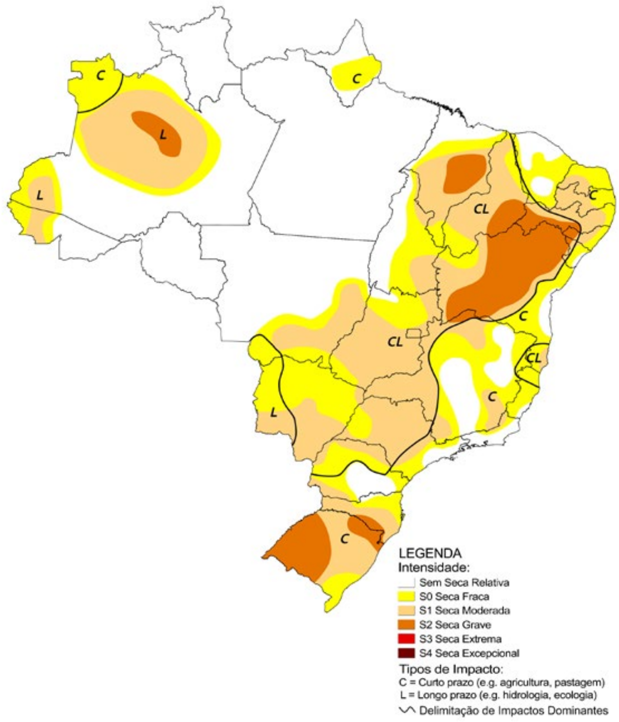


Figure 7 - Drought monitor of April 2025
(Source: Cemaden)



In May 2025, water storage levels in the main reservoirs across Brazil showed significant variability among the subsystems that make up the National Interconnected System (SIN): North, Northeast, South, and Southeast/Midwest (figure 8).

Although part of the national territory presents favourable hydrological conditions, the overall scenario requires attention, particularly due to the critical situation observed in the Southern Subsystem. The North and Northeast subsystems recorded high storage levels, with volumes above the historical average for the period.

This supports continued hydroelectric generation in these regions and reduces the need to activate thermoelectric plants. However, both systems have a lower tariff weight compared to the Southeast/Midwest and South subsystems, with limited direct influence on the definition of the electricity tariff flag.

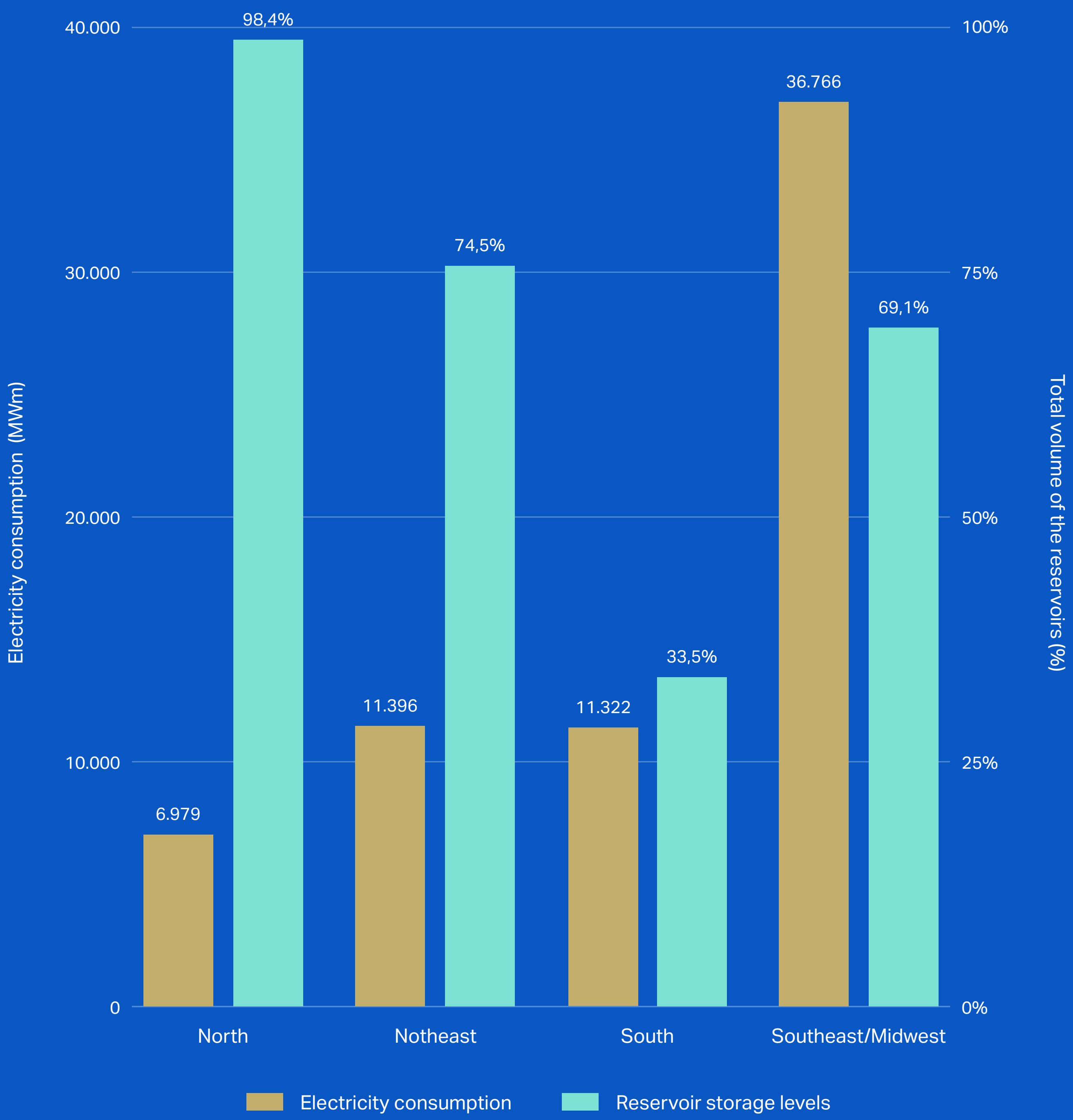
In contrast, the Southern Subsystem is facing a critical hydrological situation, with an average storage level of only 33% of usable volume. River basins such as Jacuí, Capivari, and Uruguay are operating at reduced levels, reflecting a recent history of below-average rainfall.

Recent studies, such as the one conducted by Rodrigo Cesar et al. (2024), published in the journal "Theoretical and Applied Climatology", indicate that the increase in extreme events intensifies the hydrological cycle by increasing surface and river runoff and, consequently, reducing water retention in reservoirs.

This process highlights the impacts of climate change on water systems and the growing vulnerability of the energy sector. Water scarcity in the South limits its power generation capacity and increases dependence on thermal sources and energy exchange with other subsystems, putting pressure on operational costs.

These conditions were decisive for the activation of the yellow flag tariff in May and the red flag tariff level 1 in June, which implies an additional charge of R$ 4.46 per 100 kWh consumed, reflecting the less favourable conditions for hydroelectric generation in the country.

Figure 8 - Reservoir storage levels and electricity consumption in SIN subsystems in May 202 (Source: Operador Nacional do Sistema Elétrico, Comercialização de Energia Elétrica)



Notable extreme weather events in Brazil and around the world

Global temperature extremes

March 2025 recorded the highest temperature ever observed in European history and the second highest globally, according to the Copernicus Climate Change Service (C3S) bulletin. Several other regions around the world experienced above-average temperatures, with notable anomalies in the Arctic, North America, North Africa, and parts of Asia.

Additionally, March saw the lowest extent of Northern Hemisphere sea ice since satellite measurements began in 1979. April 2025 was the second warmest April ever recorded since the beginning of the historical series.

According to C3S, the global average air temperature anomaly relative to the pre-industrial period (1850–1900) reached +1.51 °C. In Europe, the average land surface temperature was 9.38 °C, representing an increase of 1.01 °C compared to the 1991–2020 climatological average for April.

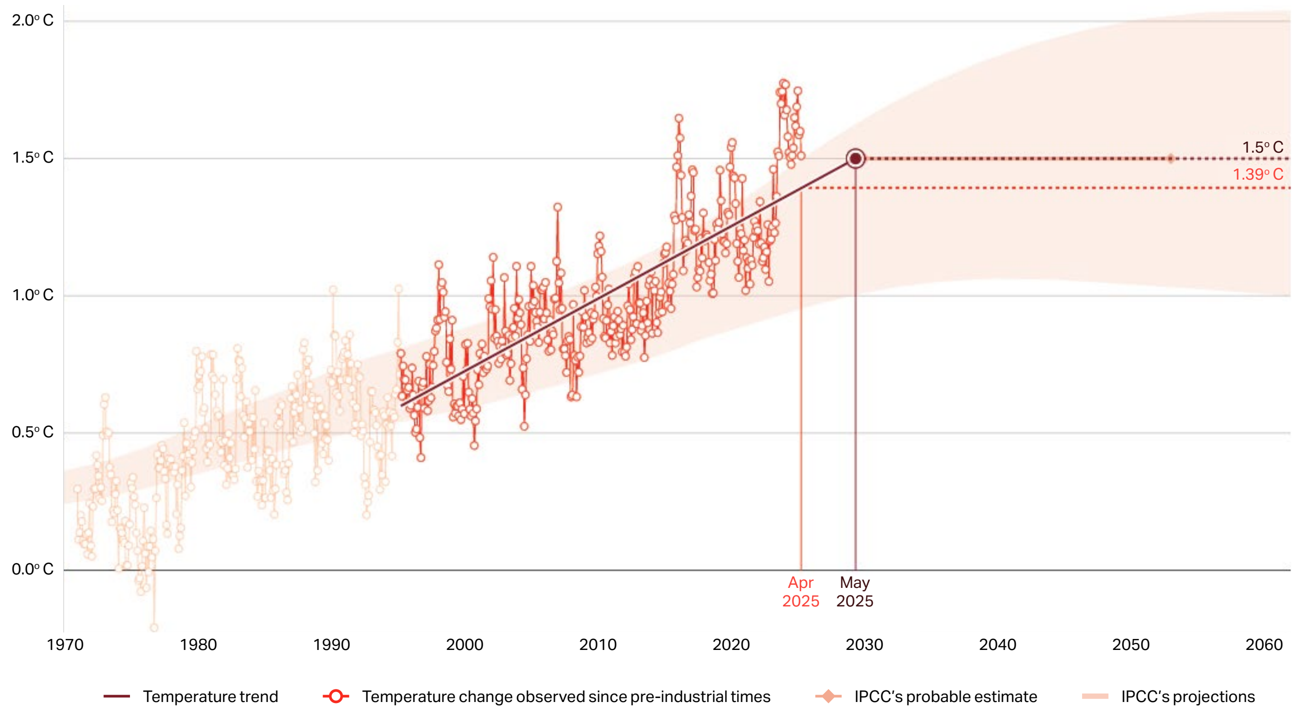
Figure 9 shows the evolution of global average warming since 1970, based on temperature anomalies relative to the pre-industrial period. The shaded area indicates the uncertainty associated with projections from the Intergovernmental Panel on Climate Change (IPCC), reflecting the expected variability within the error margins of climate models.

The solid line represents the observed trend over time. The continued advance of global warming has direct implications for agriculture, affecting the frequency of extreme events, agricultural productivity, and water regimes in various regions of the world.

Human activity has caused irreversible changes in ocean dynamics and across the cryosphere. As a result, there is an increase in the occurrence of extreme weather events, with significant impacts on human health—especially among vulnerable communities in Africa, Asia, Central and South America, small island states, and the Arctic.

Groups such as Indigenous peoples, smallholder farmers, and low-income families are increasingly exposed to food and water insecurity, as highlighted in the IPCC AR6 Report (2023, p. 11).

Figure 9 - Evolution of global average temperature anomalies (1970–present) and projections through 2060 relative to the pre-industrial period (Source: Copernicus, IPCC)



At the end of May, the collapse of a glacier in Switzerland drew international attention to the potential impacts of climate imbalance.

The event occurred in the southern Valais region, Wallis, severely affecting the alpine village of Blatten after large masses of ice broke off from the Birch Glacier.

Geological instability in the region, monitored since the beginning of the month, prompted the precautionary evacuation of residents. However, the collapse on May 28 buried much of the village, causing significant structural damage.

Local authorities emphasised that, although it is not yet possible to establish a direct causal link with global warming, the accelerated retreat of glaciers and increased instability in high mountain areas have been associated with climate change in various parts of the world.

The episode prompted the Swiss government to suspend diplomatic engagements to closely monitor the situation.

Brazilian precipitation extremes

Several regions of Brazil experienced significant rainfall volumes in April 2025, with totals exceeding the climatological normals for the 1991–2020 period, according to data from the National Institute of Meteorology (INMET), as shown in figure 10.

In the Midwest, the weather station at the Federal University of Rondonópolis (UFR) in Mato Grosso recorded the highest monthly total since the beginning of its local historical series.

Other municipalities in the region also reported significant volumes, such as Coxim (MS) and Cuiabá (MT), where monthly totals more than doubled the expected average for the month.

In the Southeast, the state of São Paulo recorded rainfall totals above the April climatology, with highlights at the Interlagos station (240 mm) and Campos do Jordão (225 mm).

In the state of Rio de Janeiro, where climatological values range between 80 and 100 mm for the month, the records were widely exceeded. Notably, the Teresópolis station (National Park) accumulated 689 mm during the period, a value significantly above the historical average.

Figure 10 - Rainfall totals in April 2025 and comparison with historical averages in the Southeast and Midwest regions of Brazil (Source: INMET, Cemaden)

Location	Accumulated rainfall (mm) in April 2025	Climatological normal (1991–2020, mm)
Teresópolis (P. Nacional)	689.4	80–100
Duque de Caxias (RJ)	347.2	80–100
Alto da Boa Vista (RJ)	357.0	80–100
Pico do Couto (RJ)	319.2	80–100
Nova Friburgo (RJ)	319.8	80–100
Interlagos (São Paulo)	240.2	80
Campos do Jordão (SP)	225.4	80
Cuiabá (MT)	370.8	100-140
Rio Brilhante (MS)	322.8	100
Coxim (MS)	362.2	80–140
Cassilândia (MS)	293.6	80
Dourados (MS)	282.4	100-140

The precipitation anomalies observed in the state of Rio de Janeiro in April 2025 were directly associated with the occurrence of a severe weather event.

The main meteorological configuration involved the presence of a cold front linked to a low-pressure area, formed from a polar air mass that moved over the ocean.

This frontal system was intensified by the presence of a trough in the South Atlantic, which had already been active for several days, contributing to increased moisture convergence over regions with elevated topography, especially in mountainous areas.

A trough refers to a region in the atmosphere where there is a wave-like dip in wind flow, rotating clockwise in the Southern Hemisphere.

Additionally, a high-pressure system (anticyclone), positioned almost stationary behind the cold front, reinforced the moisture channel, amplifying atmospheric instability. The combination of these factors resulted in episodes of intense and persistent rainfall.

Between April 5 and 7, rainfall totals exceeded 300 mm in less than 72 hours, with notable amounts in the municipalities of Teresópolis (409 mm), Petrópolis (370 mm), and Angra dos Reis (304 mm). Similar episodes have affected the region in the past.

On February 15, 2022, the city of Petrópolis recorded between 258 mm and 260 mm of rain in just a few hours—an amount that exceeded the average for the entire month.

Tragically, the event resulted in 235 deaths, two missing people, and was considered the most devastating disaster in the municipality's history by Cemaden.

According to a study led by Oda and published in the journal "Urban Climate" (2024), despite the existence of local risk management instruments, the combination of meteorological, geographic, and socioeconomic factors continues to favour the recurrence of tragedies associated with extreme hydrometeorological events.

April 2025

In Brazil

April 2025 was marked by significant rainfall volumes across various regions of Brazil, with totals exceeding the climatological normals for the 1991–2020 period, according to data from the National Institute of Meteorology (INMET), as shown in figure 10.

In the Midwest, the weather station at the Federal University of Rondonópolis (UFR), in Mato Grosso, recorded the highest monthly total since the beginning of its local historical series.

Other municipalities in the region also reported significant rainfall volumes, such as Coxim (MS) and Cuiabá (MT), where monthly totals were more than twice the expected average for the month.

In the Southeast, the state of São Paulo recorded rainfall above the April climatological average, with highlights including Interlagos (240 mm) and Campos do Jordão (225 mm).

The heavy rainfall observed in Rio de Janeiro in April 2025 was associated with a severe weather event involving a cold front linked to a low-pressure area, formed from a polar air mass that moved over the ocean (figure 9).

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Worldwide

In the United States, more than 150 tornadoes and heavy rainfall struck the South and Midwest regions, causing flooding, thousands of injuries, and around 24 deaths.

At the end of the month, additional rainfall caused widespread flooding in central Oklahoma and Texas, resulting in road closures and at least two fatalities.

May 2025

In Brazil

Approximately one year after the most severe climate disaster in its history — which caused an estimated R$11.4 billion in damage, affected 478 municipalities, and left 175 dead (Marengo et al., 2024) — Rio Grande do Sul once again faced significant rainfall.

Despite more than R$100 billion allocated by the federal government for reconstruction and infrastructure efforts, new episodes of intense rainfall between May 8 and 9 caused urban flooding, road blockages, damage to schools, and the displacement of families.

The Cachoeira do Sul municipality recorded 225.2 mm in just 24 hours, and Faxinal do Soturno accumulated 191.8 mm in the same period. In Santa Maria, totals ranged from 120 mm to 162 mm, according to data from CEMADEN and INMET.

These episodes highlight the urgency of consistent investment in preventive measures, not just emergency responses, especially given the increasing frequency and severity of such events.

The Northeast was also impacted by extreme rainfall in May, with totals exceeding 400 mm in less than 15 days in several municipalities, including Alto da Boa Vista (AL), Cabo de Santo Agostinho (PE), Recife (PE), and João Pessoa (PB), according to INMET and CEMADEN data.

Some of these events were associated with Easterly Wave Disturbances (DOLs), which contributed to instability over coastal areas. The rainfall caused flooding, landslides, and road blockages, especially in capital cities, where high urban density and saturated soils amplified the impacts.

Following the passage of the cold front, a post-frontal high-pressure system with anticyclonic circulation (counterclockwise in the Southern Hemisphere) contributed to the transport of cold air into the interior of the continent.

As a result, significantly low temperatures were recorded, with frost occurring in the states of Rio Grande do Sul and Santa Catarina. In the mountainous region of Rio Grande do Sul, weather stations recorded minimum temperatures between 0.1 °C and 0.8 °C on May 29.

Snow was also reported in municipalities in Santa Catarina, particularly in the Serra do Rio do Rastro, which was temporarily closed due to snow accumulation on the road.

This episode also marked the first occurrence of ‘friagem’ in 2025—a term used to describe cold fronts that reach northern Brazil. The cold air mass reached states such as Rondônia, Acre, and southern Amazonas, causing a sharp drop in temperatures.

Worldwide

In the last week of May, a tornado struck the city of Puerto Varas, in the Los Lagos Region of southern Chile, causing significant destruction (figure 11).

It is estimated that around 250 homes and commercial structures were destroyed, along with vehicles, large trees, and power outages affecting more than 11,000 people. This phenomenon was associated with a low-pressure system linked to a polar air mass.

As it crossed the Andes Mountains, the system contributed to the formation of an intense cold front related to an extratropical cyclone, which drove the advance of cold air into Brazilian territory in the following days.

The combination of atmospheric instability and the region's rugged terrain created favourable conditions for tornado development.

Figure 11 - Debris after the tornado struck the city of Puerto Varas on May 25, 2025, in the province of Llanquihue, Los Lagos Region, southern Chile (Source: UChile - Universidad de Chile)

Forecasted climate conditions for June, July, and August 2025

What are teleconnections, and how they are influencing the rainfall regime in Brazil

Why do some crops suffer from excessive rainfall while others are affected by prolonged drought, even during similar times of the year?

The answer often lies in atmospheric phenomena occurring thousands of kilometres away. Events like El Niño have the potential to significantly alter rainfall and temperature patterns in Brazil, directly affecting the agricultural calendar, planting schedules, and crop productivity.

These phenomena are part of what are known as climate teleconnections — patterns of atmospheric and oceanic variability on a global scale, capable of linking different regions of the planet through dynamic interactions that influence atmospheric circulation.

In Brazil, climate variability is significantly influenced by these systems. With no defined time scale, they can last for weeks or decades. Among the main teleconnection patterns that modulate Brazil's climate, the El Niño–Southern Oscillation (ENSO) stands out.

Its effects propagate through Rossby waves — large disturbances in the jet stream that move slowly and transport energy over long distances (Hoskins & Ambrizzi, 1993).

These waves influence the formation of cyclones and anticyclones, affecting tropical convection organisation, cold front movement, and regional rainfall distribution.

Other climate signals also play important roles in modulating the climate of South America, particularly Brazil:

- **ENSO (El Niño–Southern Oscillation):** ocean-atmosphere interaction in the equatorial Pacific. For analysis, it is recommended to jointly consider the Oceanic Niño Index (ONI) and the Southern Oscillation Index (SOI)
- **ONI (Oceanic Niño Index):** represents Sea Surface Temperature (SST) anomalies in the Niño 3.4 region (5°N–5°S; 120°W–170°W), considered the most representative of ENSO. El Niño episodes occur when average anomalies exceed +0.5 °C for at least three consecutive months; La Niña when they fall below -0.5 °C
- **SOI (Southern Oscillation Index): b**ased on the atmospheric pressure difference between Tahiti and Darwin (Australia). Negative values indicate El Niño conditions; positive values indicate La Niña
- **AAO (Antarctic Oscillation) or SAM (Southern Annular Mode):** refers to pressure oscillation between mid and high latitudes in the Southern Hemisphere. In the positive phase, westerly winds intensify and shift to higher latitudes, hindering cold fronts from entering the continent. In the negative phase, cold fronts and extratropical systems more frequently advance over southern Brazil, also influencing temperature anomalies
- **AMM (Atlantic Meridional Mode):** ocean-atmosphere interaction pattern in the Tropical Atlantic, related to SST distribution between the northern and southern sectors. In the positive phase, North Atlantic warming shifts the Intertropical Convergence Zone (ITCZ) northward, reducing rainfall in northeastern Brazil. In the negative phase, warmer South Atlantic waters favour moisture convergence and increased rainfall in the region
- **PDO (Pacific Decadal Oscillation):** long-term SST oscillation in the North Pacific. In the negative phase, cooler waters dominate the ocean interior and warmer waters appear near the North American west coast, affecting planetary wave propagation and rainfall distribution across the Americas

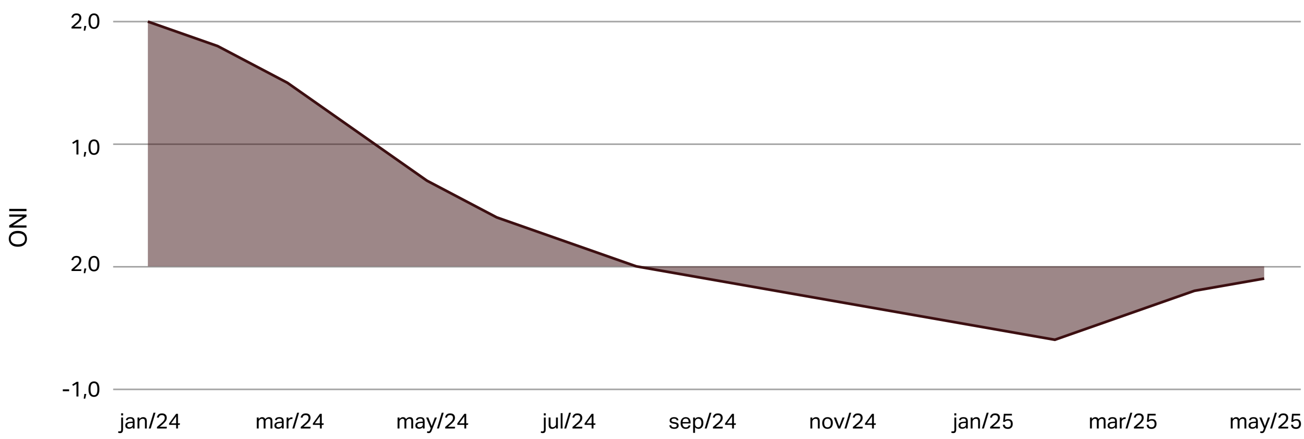
In the first quarter of 2025, the main climate indices showed varied signals, resulting in distinct regional impacts on Brazil's rainfall regime. The ENSO phenomenon remained in a neutral condition, while the SOI recorded a value of +0.4 in April, suggesting a weak influence associated with the La Niña phase.

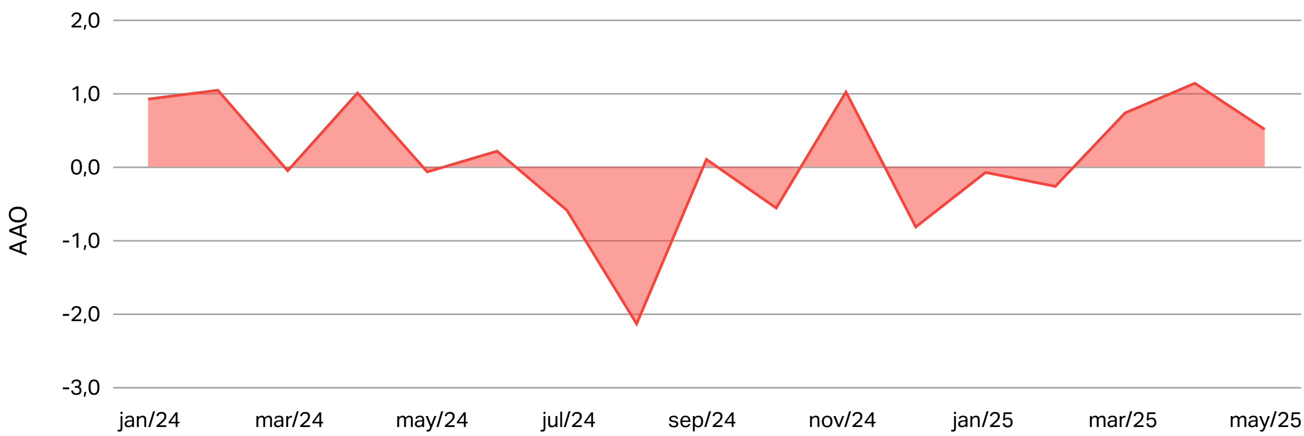
The Antarctic Oscillation (AAO) entered a positive phase between February and May, which may have limited the activity of cold fronts in the South and Southeast regions, reducing rainfall in key agricultural areas.

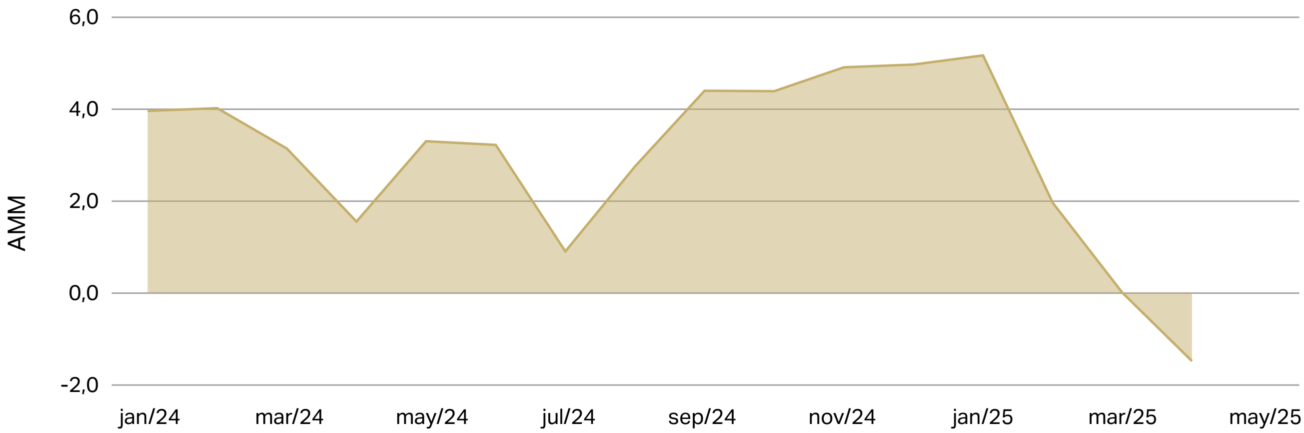
At the same time, the Pacific Decadal Oscillation (PDO) remained in a negative phase throughout the period. In March, the Atlantic Meridional Mode (AMM) shifted to a negative phase, indicating anomalous warming of tropical South Atlantic waters. This condition favoured increased moisture convergence over the Northeast, contributing to the intensified rainfall observed in the region in May.

The combination of these factors helps explain the reduction in rainfall in the South and Southeast of the country, increased rainfall in the Northeast, and more regular precipitation in parts of the Midwest. In these areas, especially in second-crop corn-producing regions, ENSO neutrality combined with the positive AAO phase benefited crop development.

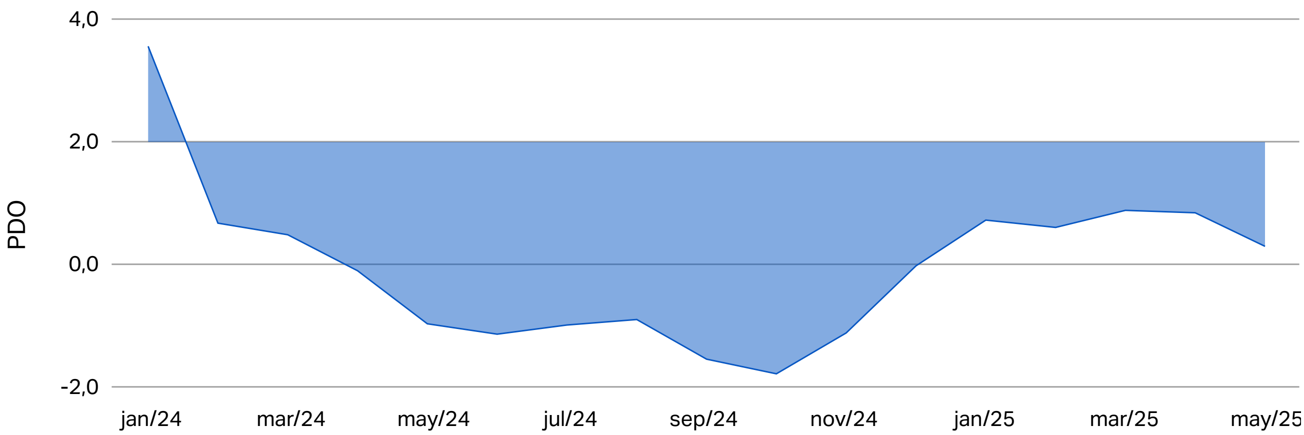
Figure 12 - Chart of climate indexes from January 2024 to May 2025 (Source: NOAA)



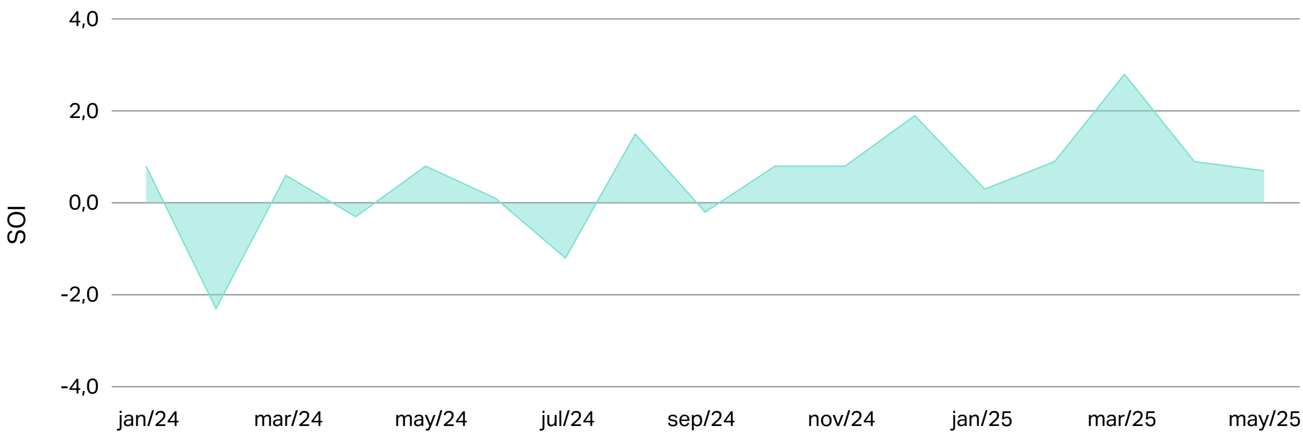




AMM
6,0
4,0
2,0
0,0
-2,0
jan/24 mar/24 may/24 jul/24 sep/24 nov/24 jan/25 mar/25 may/25



PDO
4,0
2,0
0,0
-2,0
jan/24 mar/24 may/24 jul/24 sep/24 nov/24 jan/25 mar/25 may/25



SOI
4,0
2,0
0,0
-2,0
-4,0
jan/24 mar/24 may/24 jul/24 sep/24 nov/24 jan/25 mar/25 may/25

As the positive phase of the Antarctic Oscillation (AAO) hinders the advance of cold fronts over the continent, favouring their diversion toward the ocean, winters tend to be drier in southern Brazil and warmer in the Southeast and Midwest regions (Reboita et al., 2009).

When combined with a negative phase of the Pacific Decadal Oscillation (PDO), as observed in early 2025, this configuration can significantly impact the agricultural sector.

Studies by Kayano et al. (2009), published in the International Journal of Climatology, also show that variability in sea surface temperatures in the South Atlantic, North Atlantic, and Eastern Equatorial Pacific modulates the rainfall regime in southern Brazil and Uruguay — with a tendency for increased precipitation during El Niño events and reduced rainfall during La Niña. In the southwestern Amazon, however, an opposite response is observed.

According to the latest projections, there is approximately a 74% probability of ENSO-neutral conditions persisting during the months of June, July, and August 2025.

This scenario, combined with the continued positive phase of the AAO, tends to favour below-average rainfall and above-normal temperatures in the south-central part of the country.

These climatic factors may negatively affect the development of winter crops, as well as impact the management and productivity of second-crop corn during the harvest period.

Regional climate trends in Brazil: temperature and precipitation forecast for winter 2025

What will the winter be like in Brazil?

As of late May and early June, residents in Brazil's South, Southeast, and Midwest regions were already experiencing the effects of falling temperatures in their daily lives. The big question now—especially for sectors that depend on this information—is: what will the winter of 2025 be like without the influence of El Niño or La Niña?

Precipitation anomalies forecasted by the MIA Climate model for the June–July–August 2025 quarter indicate a pattern of predominantly below-average rainfall in the North region, with greater variability across the rest of the country (figure 13).

Even so, the highest rainfall totals are expected in northern Roraima and along the border between Pará and Amapá, with isolated areas of above-average precipitation.

At the beginning of winter, the model points to above-average rainfall in parts of Mato Grosso do Sul, São Paulo, southern Minas Gerais, and Rio de Janeiro. In contrast, below-average volumes are forecast for northern Amazonas, southern Roraima, and much of the South Region.

For July, the trend is for below-average precipitation in the South Region, a pattern that also extends to the Southeast and Midwest, except for Goiás, where rainfall is expected to remain near historical averages.

In the Northeast, Rio Grande do Norte, Paraíba, and Pernambuco are expected to see above-average precipitation.

In August, the forecast indicates rainfall totals within or slightly above average in the Midwest, Northeast, and Paraná, while Rio Grande do Sul and Santa Catarina are expected to continue experiencing below-average rainfall.

Figure 13 - Forecast for precipitation anomalies in Brazil for the June–August 2025 quarter (Source: MIA Climate)

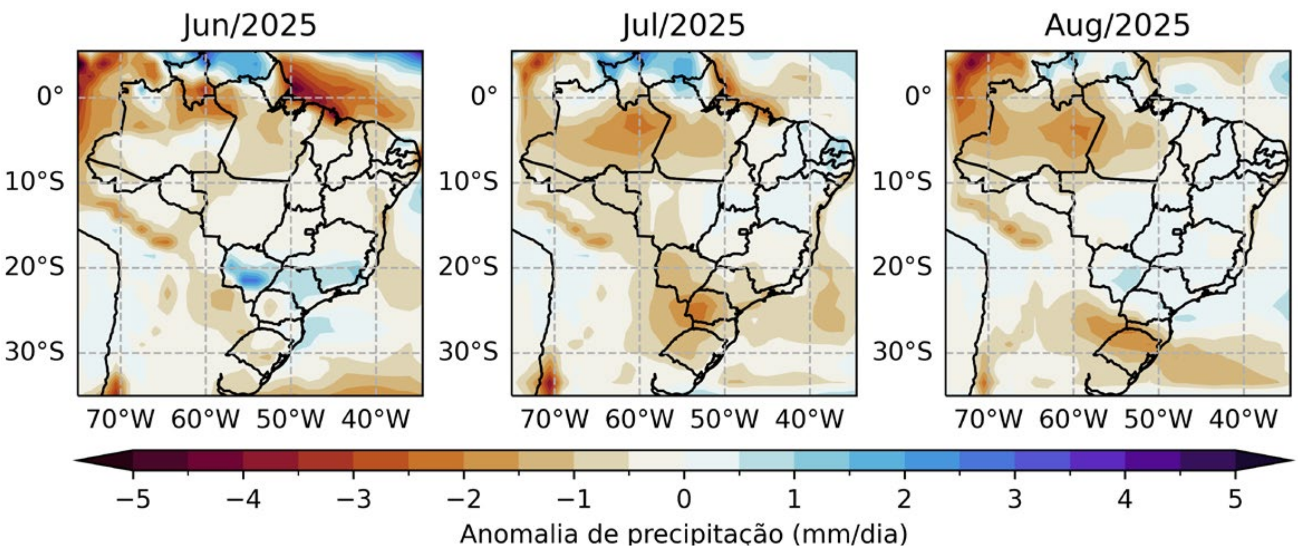
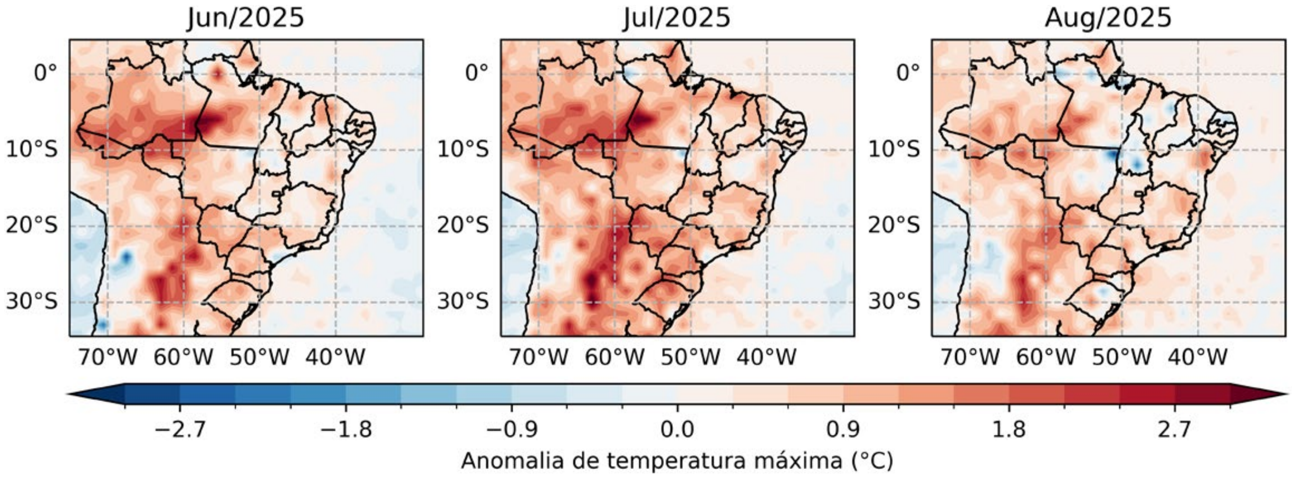


Figure 14 shows the MIA Climate model forecast for maximum temperature anomalies (°C) in Brazil during the June–August 2025 quarter. A widespread pattern of positive anomalies is observed, with emphasis on the Midwest and North regions, especially in June and July.

In August, most of the country is expected to record slightly above-average temperatures, except for Tocantins, northwestern Pará, and Mato Grosso, where below-average temperatures are projected.

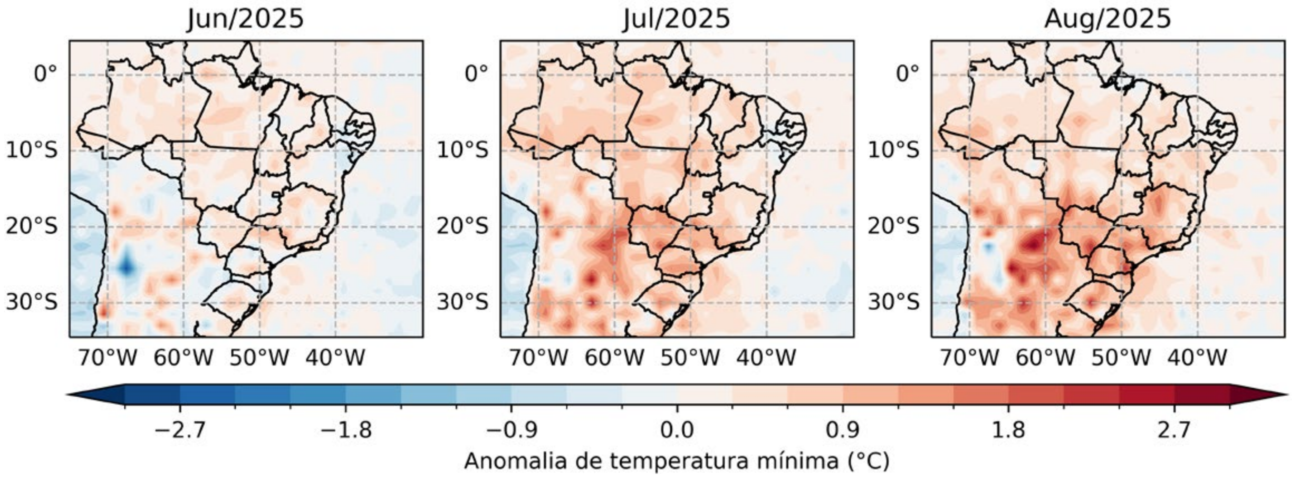
Figure 14 - Forecast for maximum temperature anomalies (°C) in Brazil for the June–August 2025 quarter (Source: MIA Climate)



Minimum temperature anomalies also indicate a positive pattern throughout the winter of 2025. In general, the season is expected to begin with minimum temperatures close to the historical average.

However, in July—and more intensely in August—minimum temperatures tend to remain above average, especially in the south-central regions of Brazil. This behaviour may signal an increase in the frequency of heatwave episodes during the period (figure 15).

Figure 15 - Forecast for minimum temperature anomalies (°C) in Brazil for the June–August 2025 quarter (Source: MIA Climate)



Outlook for Brazilian agriculture: focus on second crop corn and wheat

Corn plays a strategic role in the Brazilian economy as it is the second most produced grain in the country, only behind soybeans. The harvest of the first corn crop in Paraná was completed in the last week of May, with a historical average yield of approximately 10.8 thousand kilograms per hectare—the highest ever recorded in the state.

According to the National Supply Company (Conab), the second corn crop has begun harvesting in some areas and shows good prospects for the 2024/25 cycle. In April 2025, estimated production was 97.89 million tons, with an average yield of 5,794 kg/ha over a planted area of 16.90 million hectares.

By May, the estimate had risen to 99.80 million tons, reflecting an average yield of 5,875 kg/ha and a slight increase in cultivated area to 16.99 million hectares. These figures indicate consistent productivity gains compared to previous cycles.

The growth of national production is directly related to the use of modern technologies, efficient management, and reliable climate forecasts—essential factors for mitigating risks and ensuring the crop's sustainability.

In March and April, second-crop corn benefited from adequate rainfall in most producing regions, which helped recover fields which were planted later than usual. However, some areas faced water stress in March, such as eastern Goiás, the Triângulo Mineiro/Alto Paranaíba region, northwestern Minas Gerais, and parts of Paraná (Midwest, West, and Southwest).

In Minas Gerais, despite favourable weather conditions, crops sown within the ideal window (February) showed reduced ear development due to dry spells. In Mato Grosso, second-crop corn also faced early-cycle challenges, compromising initial performance. In Paraná, although rainfall was irregular throughout the cycle, many fields still maintain good yield potential.

The second-crop harvest takes place between June and August in the main producing states. The beginning of winter is expected to bring above-average rainfall in some regions, such as Mato Grosso do Sul and São Paulo, benefiting the crops.

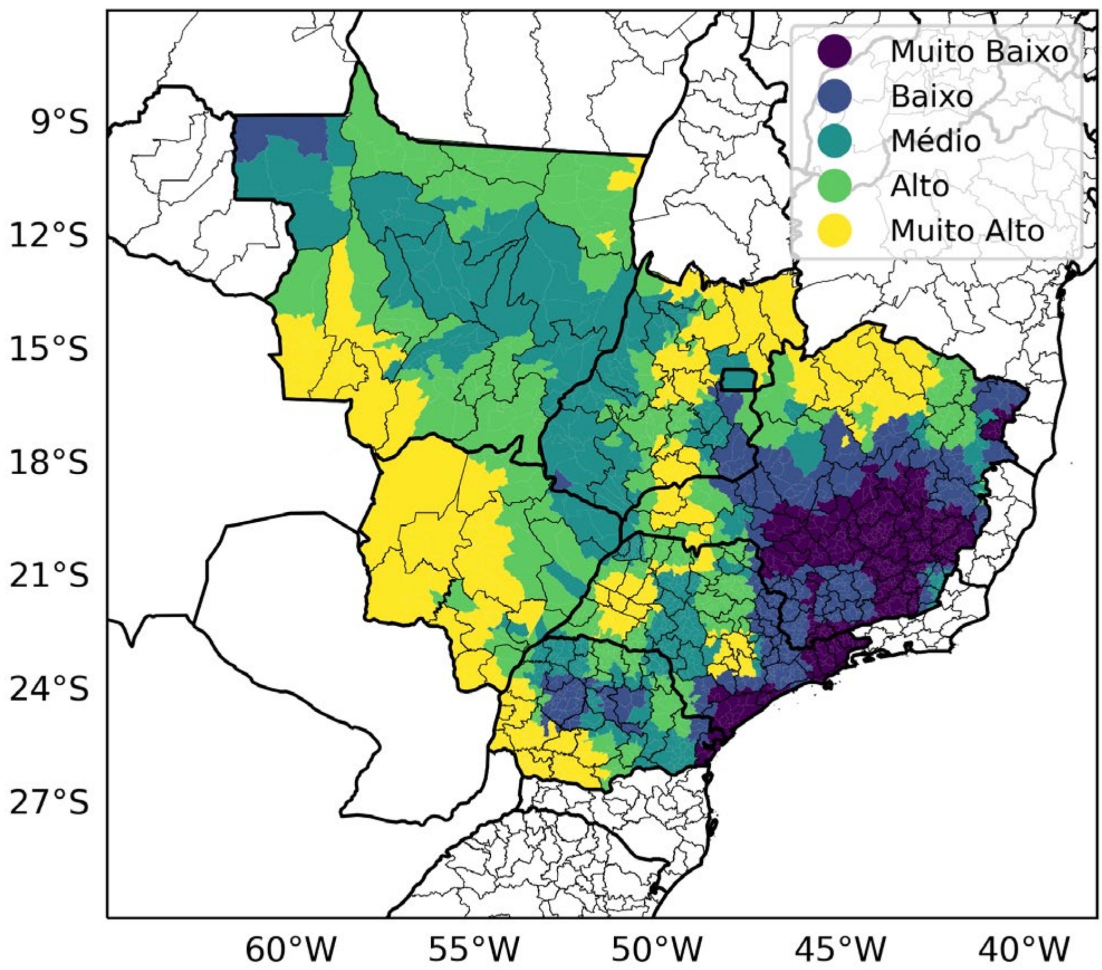
In July, however, a drier period is expected, with slightly above-average rainfall returning in August. Some areas, such as western and northern Paraná, experienced below-average rainfall and high temperatures at the start of planting, which may impact final productivity. Therefore, extra attention is crucial in this final stage of the cycle to minimise potential losses.

The composite risk map for the second-crop corn harvest (figure 16) combines consolidated meteorological data from the beginning of the season with forecasts for the June–August 2025 period. It reveals distinct spatial risk patterns in the main producing states.

Areas in northern and midwestern Mato Grosso, parts of Goiás, midwestern Mato Grosso do Sul, northern Minas Gerais, midwestern São Paulo, and southwestern Paraná stand out with high (light green) to very high (yellow) risk, mainly due to rainfall shortages and high temperatures.

In contrast, south-central Minas Gerais and the eastern strip of São Paulo show low to very low risk (shades of purple and blue), indicating more favourable harvest conditions. This distribution reinforces the importance of regionally focused climate monitoring for effective agricultural risk management in second-crop corn production.

Figure 16 - Composite risk map for second-crop corn harvest – June to August 2025
(Source: MeteoAI, MIA Climate)



Wheat cultivation plays a highly relevant role in Brazil, both economically and in terms of food security. It is the main winter cereal grown in the country and the second most produced in the world.

Although Brazil still relies on imports to meet domestic demand, states such as Rio Grande do Sul, Paraná, and Santa Catarina stand out as the main producers. Additionally, states in the Southeast, Midwest, and Northeast regions — such as São Paulo, Mato Grosso do Sul, Goiás, Minas Gerais, and Bahia — have been expanding their share in national production.

To meet domestic consumption, Brazil imported 505 thousand tons of wheat in April 2025. Among the supplying countries, Argentina accounted for 52.68% of the total, followed by Uruguay (36.5%) and Paraguay (10.75%) (Conab, 2025). It is also worth noting that wheat plays a fundamental role in crop rotation, contributing to soil conservation and the control of pests and disease-important factors for agricultural sustainability.

The 2025 wheat crop is in its early development stage, with production estimated at 8.3 million tons, a 4.6% increase compared to the previous season. Despite an 11.7% reduction in cultivated area, the projected average yield is 3,058 kg/ha, representing a significant 18.6% increase.

This increase in productivity is the main factor driving projected growth in total production. However, it is important to note that these figures are still preliminary and may be adjusted throughout the season, especially since states with significant weight in national production, such as Rio Grande do Sul and Santa Catarina, are still in the planning and planting phases. Meanwhile, Paraná, the country's second-largest producer, has indicated a reduction in the area allocated to wheat cultivation.

Rain, frost, and intense cold hit agricultural areas of Brazil at the end of June

Southern Brazil recorded significant rainfall accumulations between June 15 and 25, 2025. According to INMET, several areas in northern Rio Grande do Sul, Santa Catarina, and Paraná received between 80 mm and 100 mm of rain, with locally higher amounts.

In Novo Hamburgo (RS), Civil Defense reported around 240 mm during this period—twice the historical average. In Rio Pardo (RS), totals exceeded 250 mm in just 48 hours, reflecting the intensity of an extratropical cyclone and its associated cold front that impacted the region.

Subsequently, between June 23 and 25, the third cold wave of the year (and the first of the winter) caused sharp temperature drops across much of the country. The passage of an intense polar air mass resulted in temperatures 5 to 8 °C below the climatological average in the South, Southeast, and Centre-West regions, with light to severe frosts in corn, wheat, and coffee-producing areas.

Record-low temperatures put crops at risk

In the early hours of June 25, intense cold affected several regions of Brazil, with highlights including negative or near-zero minimum temperatures. In Santa Catarina, the city of Urupema recorded -8.0 °C, the lowest temperature in the country.

In Paraná, General Carneiro registered -7.8 °C, with widespread frost in the southern part of the state. In Rio Grande do Sul, Vacaria reached -3.6 °C. Several locations in the South recorded lows below -3 °C, indicating strong and widespread frosts.

In São Paulo, the lowest temperature in the state was recorded in Parelheiros, a district in the capital, with -0.7 °C. In the São Paulo metropolitan region, Campos do Jordão stood out, with thermometers marking 0.5 °C. In Minas Gerais, minimum temperatures remained above zero but dropped close to 3 °C in higher-altitude areas such as Machado and Varginha.

Figure 17 - Summary of extreme minimum temperatures on June 25, 2025 and their sources (Source: Epagri, Ciram, INMET, Simepar, CGE, Defesa Civil)

Region/city	Minimum temperature (in °C)	Source
Urupema (SC)	–8.03	Epagri/Ciram
São Joaquim (SC)	–7.67	Epagri/Ciram
General Carneiro (PR)	–7.8	INMET/Simepar
Vacaria / Serafina Corrêa (RS)	–3.6	INMET
Guarapuava (PR)	–6.9	Simepar
São Paulo – Parelheiros (SP)	–0.7	CGE
Campos do Jordão (SP)	-0.5	Defesa Civil

Impacts on the field

According to INMET, frost alerts were issued at the beginning of winter, with forecasted temperatures between 0 °C and 3 °C in the South and Southeast regions.

Meanwhile, Cocamar Agroindustrial Cooperative reported that weather stations in Paraná recorded temperatures near or below zero in several cities, including Sertanópolis, Apucarana, and Maringá.

These conditions highlight real risks for second-crop corn and wheat fields, which may suffer significant damage due to the low temperatures.

Given this scenario, it is essential for the agricultural sector to remain highly vigilant throughout the 2025 winter, especially regarding sensitive crops such as corn, wheat, and coffee, which are more vulnerable to frost and extreme cold.

North Atlantic hurricane season in 2025

The 2024 North Atlantic hurricane season was quite intense, as discussed in the 3rd and 4th editions of this report. For the 2025 season, is there a forecast or outlook already? Before answering, it is essential to understand a few key concepts.

The formation of tropical cyclones requires specific meteorological conditions. Additionally, the naming of these systems varies by region: in the North Atlantic and Northeast Pacific, they are called hurricanes; in the Northwest Pacific, they are known as typhoons; and in areas such as the Indian Ocean and South Pacific, they are referred to as tropical cyclones.

Among the main factors that favour their formation are high sea surface temperatures, elevated humidity in the lower levels of the atmosphere, and low vertical wind shear.

The system also intensifies through feedback mechanisms, such as the release of latent heat during water vapour condensation—an essential process for maintaining its strength.

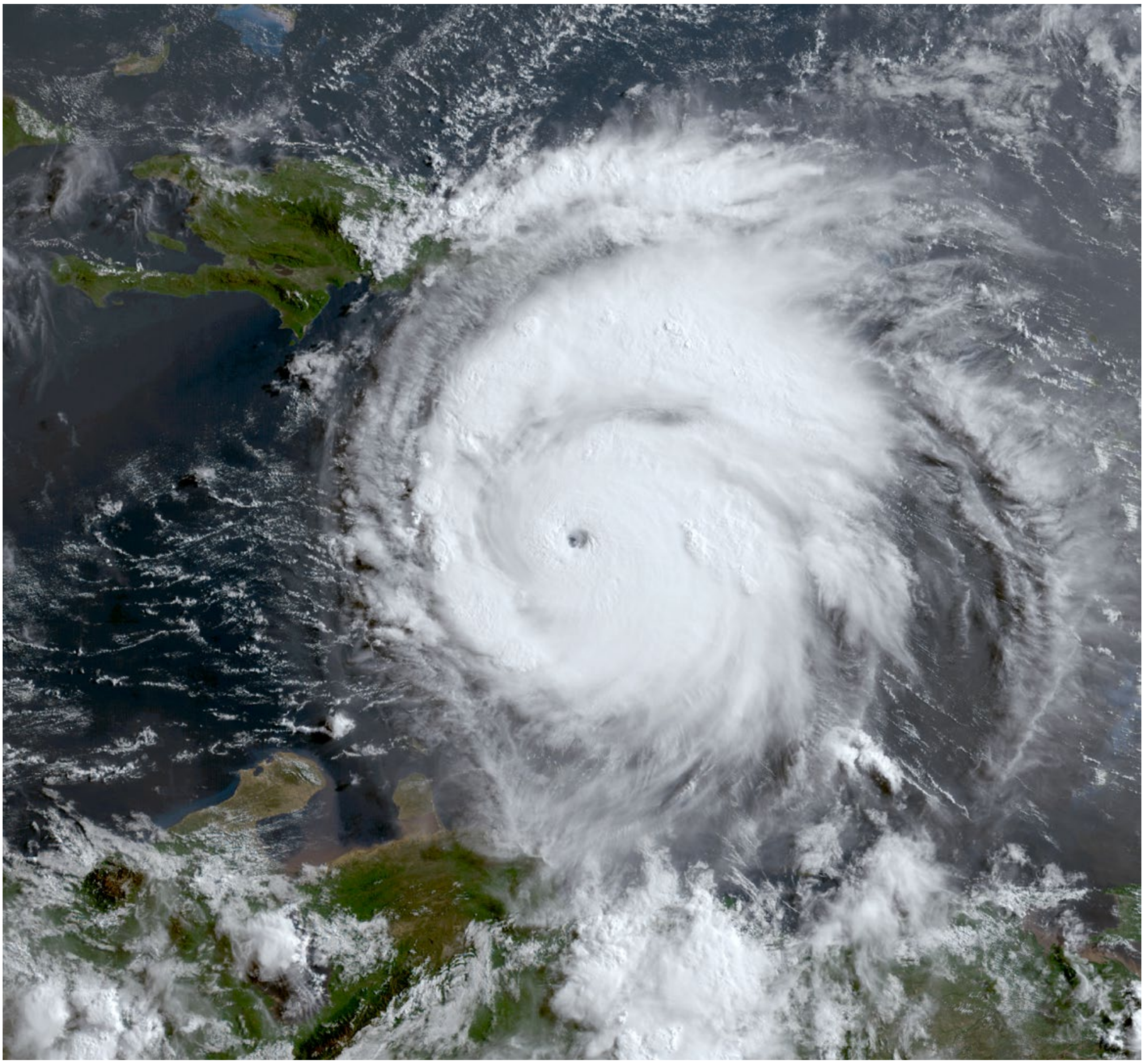
When a low-pressure system, known for causing rain or storms, reaches wind speeds of 61.2 km/h (38 mph) or higher, it is classified as a tropical depression. At this stage, cloud bands become more organised, and convection near the system's centre intensifies.

As the system strengthens and its structure consolidates, it evolves into a tropical cyclone (or hurricane/typhoon) once it reaches wind speeds of at least 118.8 km/h (74 mph). At this stage, the system exhibits a symmetrical organisation and has very intense convection around the centre.

A striking example was Hurricane Beryl, which on July 2, 2024, historically early in the season, became the first Atlantic hurricane to reach Category 5 status. Its rapid intensification upon entering the Caribbean Sea caused catastrophic damage across several islands, with widespread destruction of infrastructure.

Beryl's case highlights how the combination of extremely warm ocean waters, high humidity, and low wind shear can critically accelerate the development of tropical cyclones, reinforcing the importance of monitoring these factors to forecast the intensity of such phenomena.

Figure 18 - GOES-16 satellite image (visible channel) of Hurricane Beryl over the Caribbean Sea at 12:30 UTC on July 2, 2024 (Source: NASA, NOAA)



The North Atlantic hurricane season runs from June 1 to November 30. For 2025, several international institutions are forecasting scenarios ranging from near-average to above-average climatological activity for the formation of these events (figure 19).

Notably, Colorado State University (CSU), the National Oceanic and Atmospheric Administration (NOAA), and The Weather Company (TWC) are all projecting above-average activity, driven primarily by anomalous warming of Tropical Atlantic waters—a factor that favours both the development and intensification of tropical systems (figure 19).

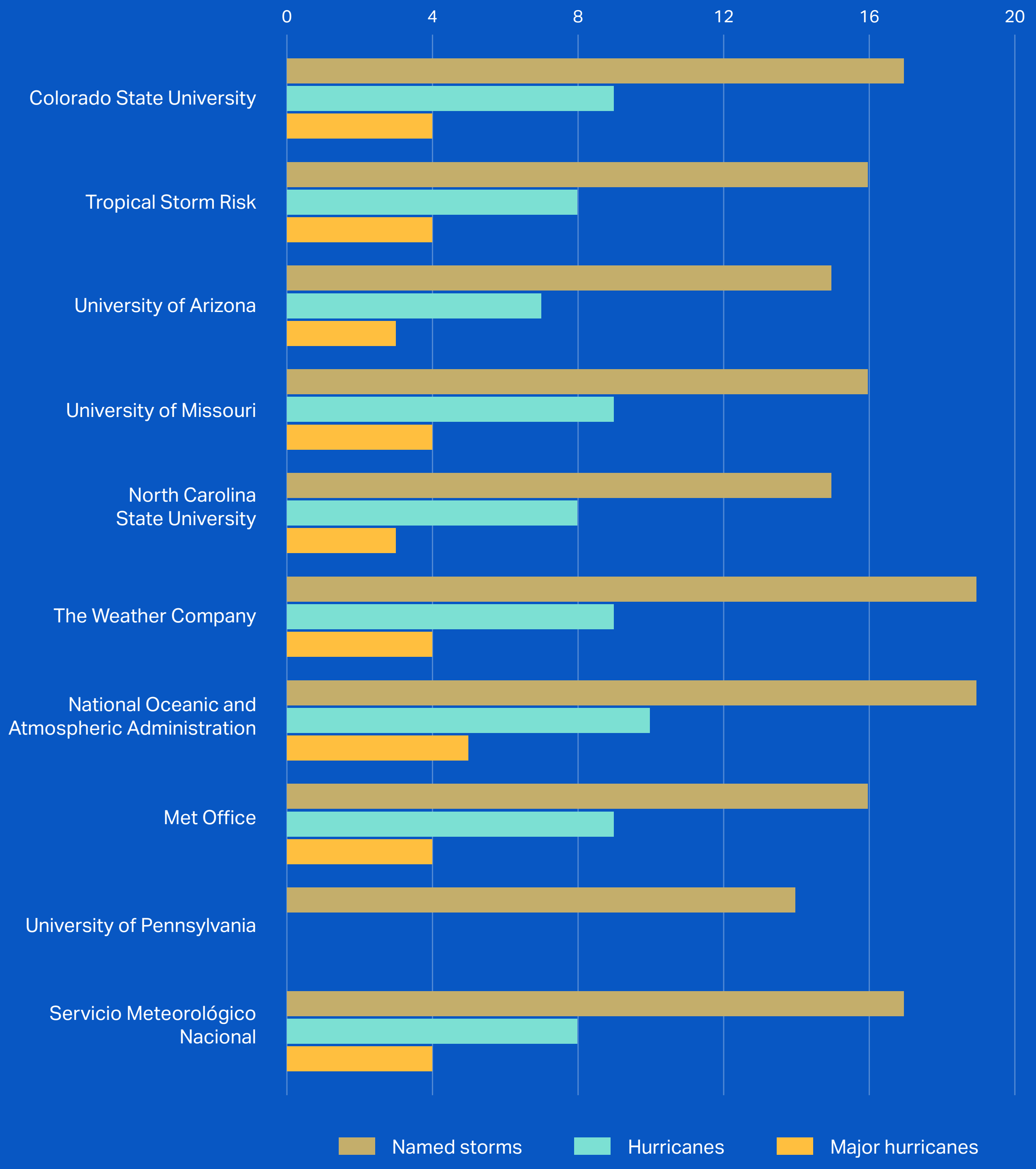
According to the Pre-Season Hurricane Outlook for 2025 report, prepared by the Catastrophe Analytics R&D team at Howden Re and based on data from 1950 to 2024, years classified as "neutral" under ENSO conditions often behave like weak La Niña years.

In such cases, changes in wind direction or speed with altitude and more favourable atmospheric conditions are observed in the main hurricane development region of the Atlantic. While ENSO neutrality may contribute to a more active season, the report emphasises that this does not necessarily imply greater damage.

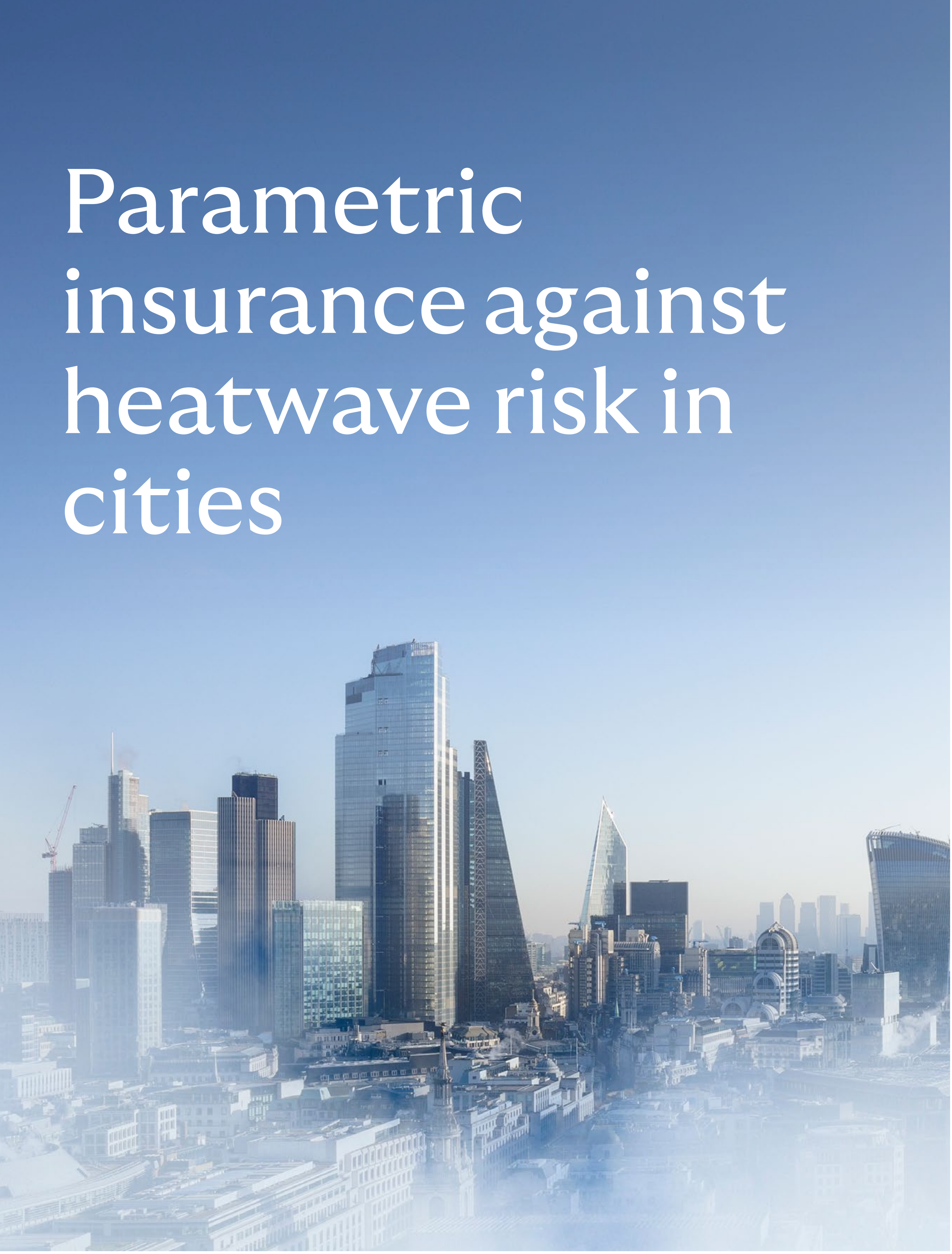
The impact depends heavily on cyclone trajectories, the areas affected, and the level of preparedness in exposed regions. The expectation of increased activity is also linked to the potential transition to La Niña during the peak of the season, between August and October, which tends to further reduce wind shear and favour more intense events.

> "A more active season doesn't necessarily imply greater damage.

Figure 19 - Forecast of the maximum number of tropical storms, hurricanes, and major hurricanes for the 2025 season, according to different international institutions (Source: Howden)



Parametric insurance against heatwave risk in cities



Heatwave protection in Brazil based on UTCI: an innovative solution to mitigate thermal stress, energy consumption, and climate impacts in cities.

The intensification of heatwaves in Brazil has demanded adaptive solutions to protect urban populations. Thermal stress parametric insurance, based on the Universal Thermal Climate Index (UTCI), offers a fast and objective response to risks associated with extreme temperatures, with automatic payouts linked to climate thresholds.

Since the 4th edition of this report, UTCI calculations have been improved and expanded to include all capitals in Brazil's Southeast and South regions, using meteorological data from INMET stations.

The new analysis reveals a significant increase in the number of days with UTCI > 32°C, especially in São Paulo, Rio de Janeiro, and Belo Horizonte — indicating a scenario of high and very high heat stress with growing frequency and intensity between 2015 and 2025.

Figure 20 presents the distribution of Daily Maximum UTCI in the cities of Rio de Janeiro and Porto Alegre from January 2015 to February 2025, highlighting the thermal stress to which the populations of these capitals have been exposed.

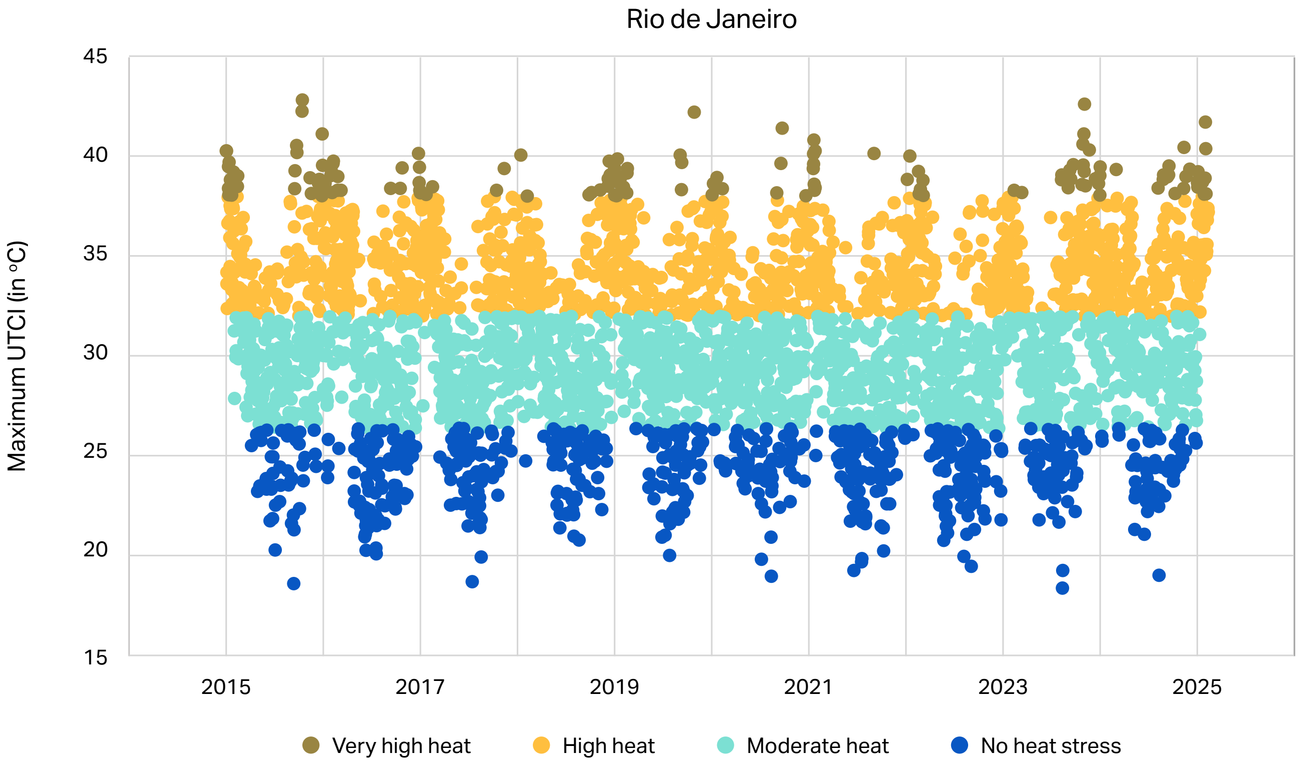
The analysis focuses on two Brazilian regions with distinct climatic characteristics: the Southeast, represented by Rio de Janeiro, and the South, by Porto Alegre — both showing the highest UTCI extremes over the analysed period.

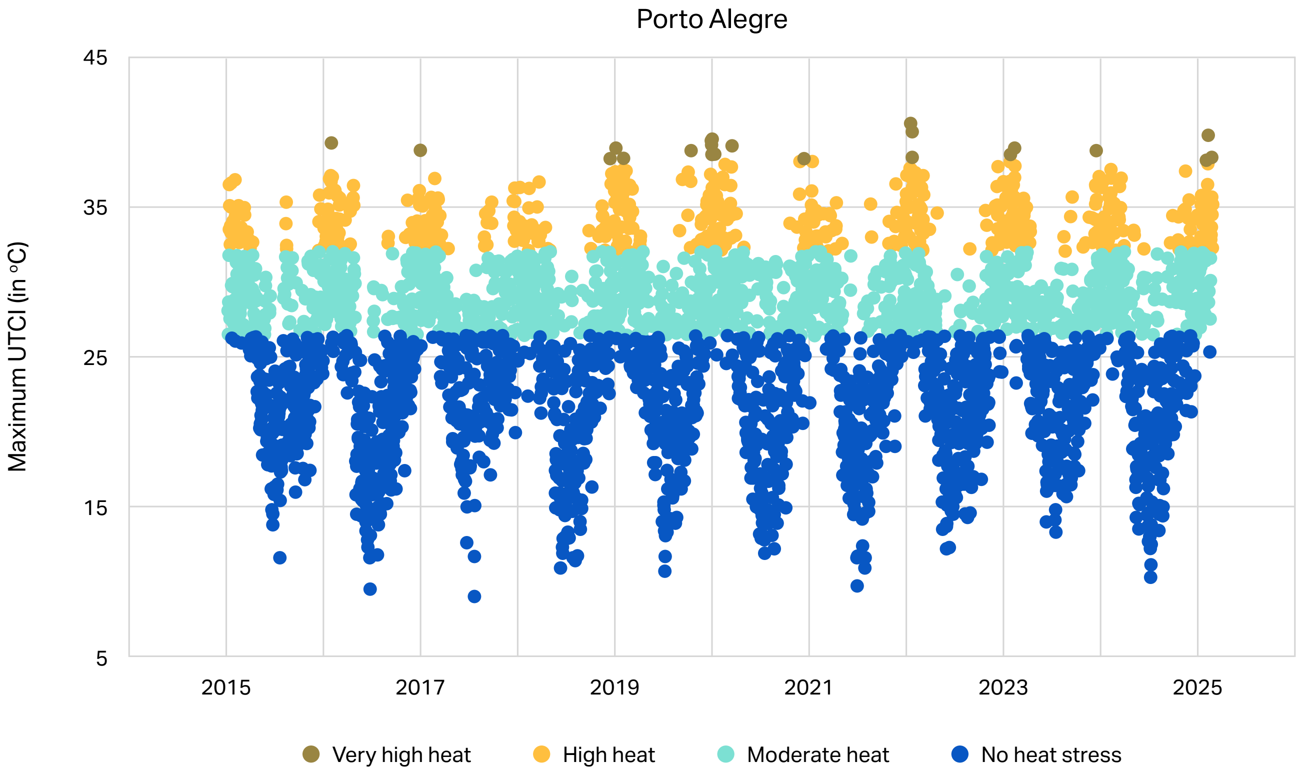
Rio de Janeiro shows a high frequency of days with high and very high heat, with UTCI values often exceeding 38°C, posing a serious health risk, especially for vulnerable populations. Porto Alegre, although located in a milder climate region, also experiences isolated critical events of severe thermal stress.

In summary, Brazil's Southeast region shows high exposure and greater risk of thermal-related losses, with Rio de Janeiro standing out for its more frequent and intense peaks.

The South region shows moderate exposure, with occasional extreme events observed in Porto Alegre. This assessment is essential for planning public health and urban policies adapted to the climatic realities of each region.

Figure 20 - Thermal stress (UTCI) in Rio de Janeiro and Porto Alegre from January 1, 2015 to February 28, 2025 (Source: Howden, INMET)





The parametric insurance model is an effective tool in the face of climate change, promoting financial resilience and social protection in urban areas.

By incorporating UTCI as the main metric, it enables rapid and scalable responses to extreme events such as heatwaves.

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A word from our partners

Brazilian sustainable taxonomy: structure, objectives, and perspectives

The Climate Bonds Initiative (CBI) is an international, not-for-profit organisation focused on mobilising global capital for climate action. They work to develop the green bond market and drive investment into low-carbon and climate-resilient projects.

CBI achieves this through developing the Climate Bonds Standard and Certification Scheme, engaging with policymakers, and providing market intelligence.

In recent years, the concept of a green taxonomy—or more broadly, a sustainable taxonomy—has become a central tool in the international debate on sustainable finance.

It is a technical and regulatory instrument designed to classify economic activities, assets, projects, or practices as sustainable based on scientific, objective, and verifiable criteria.

By establishing clear parameters, taxonomies help enhance legal certainty, promote market transparency, and mitigate greenwashing risks, thereby strengthening the credibility and integrity of sustainable finance.

It is important to distinguish between the terms "green" and "sustainable," which are often used in this context. Green activities are those that generate significant climate or environmental benefits, particularly in terms of climate change mitigation and adaptation.

The term “sustainable,” however, has a broader scope, also encompassing positive social impacts such as the promotion of decent work, reduction of inequalities, and improvement of quality of life.

The use of the term “taxonomy” originates from biological sciences, where it refers to structured classification systems based on characteristics and evolutionary relationships.

In sustainable finance, the concept has been adapted to refer to a technical, coherent, and hierarchical classification of economic activities aimed at guiding public and private investment flows more effectively, transparently, and in alignment with climate and sustainable development commitments over different time horizons.

The Climate Bonds Initiative, a UK-based international organisation dedicated to mobilising capital for climate action, was one of the pioneers in applying this concept to the financial sector.

In addition to introducing the term “taxonomy” in this context, the Climate Bonds Initiative developed a global taxonomy based on scientific evidence and aligned with the Paris Agreement, which has served as a technical foundation for various national and regional initiatives around the world.

In Brazil, the challenge of ecological transition has become even more urgent in light of increasingly frequent extreme climate events, such as prolonged droughts, floods, and record-breaking heatwaves.

As a strategic response, the federal government launched the Ecological Transformation Plan , aimed at promoting a new development model based on sustainability, social justice, and productive innovation.

Within this context, the Brazilian Sustainable Taxonomy (BST) represents a key instrument for directing investments in line with the country’s environmental and social commitments.

The development of the BST began with the publication of the Plano de Ação in December 2023, followed by the start of technical discussions in March 2025. The selection of activities and the development of technical criteria were based on a methodology inspired by international experiences but adapted to the Brazilian context.

Both the criteria and the methodology underwent two public consultation processes between late 2024 and early 2025. Currently, the criteria are in the final stages of discussion, with publication expected in August 2025.

The BST introduces several innovations compared to other national taxonomies. One of the main distinctions is the incorporation of economic and social objectives, which justifies the use of the term “sustainable.” So far, only Mexico’s taxonomy adopts a similar approach, and even then, with a more limited scope than that proposed by the BST.

The priority environmental and climate objectives in this first development phase are:

- Climate change mitigation
- Climate change adaptation
- Conservation, management, and sustainable use of forests

The economic and social objectives include:

- Reduction of socioeconomic inequalities, with attention to racial and gender disparities
- Reduction of regional and territorial inequalities across the country

Another highlight of the BST is the high level of detail in the technical criteria for sectors traditionally underrepresented in other taxonomies, such as extractive industries (with a focus on mining) and agriculture.

Finally, once properly regulated and implemented, the BST is expected to help direct capital flows toward activities, assets, and projects aligned with the transition to a sustainable economy.

The taxonomy should also reduce reputational risks for investors, enhance their ability to identify consistent investment opportunities, and foster the development of project portfolios by companies and developers.

To know more, access www.climatebonds.net.

[i] Climate Bonds Initiative | Mobilizing debt capital markets for climate change solutions

[ii] Available at: Climate Bonds Taxonomy | Climate Bonds Initiative

[iii] Available at: cartilha-novo-brasil

[iv] Plano de Ação — Ministério da Fazenda

"The Sustainable Brazilian Taxonomy, by incorporating criteria focused to the adaptation of Climate Change, becomes a catalytic instrument for Investments that consider both the physical and financial impacts of imminent climate risks. Adaptability and Resilience are priorities for Climate Bonds, which recently issued its own dedicated taxonomy.

Leonardo Gava
Brazil Country Manager
Climate Bonds Initiative

Definitions

Terms

Negative anomaly: when the analysed variable is lower than the historical average for that period

Positive anomaly: when the analysed variable is higher than the historical average for that period

Anticyclone: area of high atmospheric pressure

Wind shear: variation in wind speed with altitude in the atmosphere

Climatology: historical average used for comparison (1990–2023)

Easterly Wave Disturbances (DOLs): tropical atmospheric systems that propagate from east to west, associated with instabilities in the trade winds, potentially causing intense rainfall, especially in Brazil's North and Northeast regions

ENSO: El Niño–Southern Oscillation

LLJ (Low-Level Jets): narrow bands of strong winds in the lower atmosphere

Teleconnections: large-scale climate patterns that connect distant regions through anomalies in atmospheric circulation, influencing weather and climate systems across different time scales

SST: Sea Surface Temperature

ITCZ: Intertropical Convergence Zone

Trough: in meteorology, refers to an elongated area of low atmospheric pressure, often associated with instabilities and adverse conditions. In the context of parametric insurance, the term may also indicate the lowest point of a variable curve (such as losses, productivity, or precipitation), representing the moment of greatest severity within a cycle.

Drought criteria

Mild: entering drought: short-term dry spells reducing planting, crop, or pasture growth. Exiting drought: some prolonged water deficits, pastures or crops not fully recovered.

Moderate: some damage to crops, pastures; low stream, reservoir, or well levels; some developing or imminent water shortages; voluntary water use restrictions requested.

Severe: likely crop or pasture losses; common water shortages; water restrictions imposed.

Extreme: major crop/pasture losses; widespread water shortages or restrictions.

Exceptional: exceptional and widespread crop/pasture losses; water shortages in reservoirs, streams, and wells, creating emergencies.

Heatwave criteria: a heatwave is considered when the temperature is at least 5°C above the monthly climatological average for at least 3 consecutive days.

Thermal stress: an adverse physiological condition resulting from prolonged exposure to extreme temperatures, whether excessive heat or intense cold, which can compromise health, well-being, and the body's functional capacity.

UTCI (Universal Thermal Climate Index): a biometeorological indicator that assesses thermal stress as perceived by the human body. It is calculated from atmospheric variables such as air temperature, relative humidity, wind speed, and solar radiation, providing a unified estimate of thermal load on the body.

MERGE-INPE: a climate dataset developed by Brazil's National Institute for Space Research (INPE), which combines meteorological station observations with satellite-based precipitation estimates. The name "MERGE" reflects the merging of diverse sources, offering a continuous grid of daily precipitation data over Brazil with high spatial resolution (typically 0.25° x 0.25°). It is widely used in hydrological, agricultural, and climate monitoring studies for providing more comprehensive coverage than observational data alone.

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