State of the Climate in Latin America and the Caribbean

2024

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

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Cover illustration by Anderson Cristiano Hendgen:
Yucumã Falls in Turvo State Park, located in Derrubadas, Rio Grande do Sul, Brazil

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We need your feedback

This year, the WMO team has launched a process to gather feedback on the *State of the Climate* reports and areas for improvement. Once you have finished reading the publication, we ask that you kindly give us your feedback by responding to this short survey. Your input is highly appreciated.

Key messages

The mean temperature in Latin America and the Caribbean in 2024 was +0.90 °C above the 1991–2020 average, making 2024 the warmest or second warmest year on record, depending on the dataset used.

With the disappearance of Humboldt, its last remaining glacier, the Bolivarian Republic of Venezuela became the second country in the world to lose all its glaciers.

El Niño conditions in the first half of the year contributed to widespread drought across Amazonia and the Pantanal. Later in 2024, the Negro River in Manaus reached a record low and the Paraguay River in Asunción reached its lowest level in 60 years.

Hurricane *Beryl* was the strongest hurricane on record to make landfall on Grenada and its dependencies and caused devastation across the Caribbean.

Wildfires in the Amazon and Pantanal regions, central Chile, Mexico and Belize were fuelled by drought and extreme heatwaves, breaking records in many countries. In Chile, wildfires resulted in over 130 deaths, making these fires the country's worst disaster since the 2010 earthquake.

Floods triggered by heavy rainfall in Rio Grande do Sul became Brazil's worst climate-related disaster, with economic losses to the agricultural sector of approximately 8.5 billion Brazilian reais. While timely warnings and evacuations helped mitigate the impacts of the flooding, there were more than 180 fatalities highlighting the need to improve the understanding of disaster risks among the authorities and the public.

Climate variability and change, and extreme weather events, are driving acute food insecurity across Latin America and the Caribbean, with droughts, floods, hurricanes and extreme temperatures severely impacting agricultural production, rural livelihoods and food supply chains, underscoring the urgent need for resilience strategies, early action and strengthened food systems.

In 2024, renewable energy in Latin America and the Caribbean was nearly 69% of the region's energy mix. WMO is enhancing the capacity of National Meteorological and Hydrological Services to support renewable energy development and integration through artificial intelligence-based wind forecasting, solar and wind atlases and climate services, in collaboration with national and regional partners.

In 2024, weather and climate impacts cascaded from the Andes to the Amazon, from crowded cities to coastal communities, causing major economic and environmental disruptions. Drought and extreme heat fuelled devastating wildfires. Exceptional rainfall triggered unprecedented flooding, and we saw the earliest Category 5 hurricane on record. But there is also hope. Early warnings and climate services from National Meteorological and Hydrological Services are saving lives and increasing resilience throughout Latin America and the Caribbean. The work of the WMO community and all our partners is more important than ever to meet challenges and seize opportunities.

(Prof. Celeste Saulo)
Secretary-General

Global climate context

The global annual mean near-surface temperature in 2024 was 1.55 °C [1.42 °C to 1.68 °C] above the 1850–1900 pre-industrial average and 1.19 °C [1.15 °C to 1.24 °C] above the 1961–1990 baseline. The global mean temperature in 2024 was the highest on record for the period 1850–2024 according to all six datasets that WMO uses to monitor global mean temperature,[1] beating the previous record of 1.45 °C [1.32 °C to 1.57 °C] set in 2023. Each of the years from 2015 to 2024 was one of the 10 warmest years on record.

Atmospheric concentrations of the three major greenhouse gases reached new record observed highs in 2023, the latest year for which consolidated global figures are available, with levels of carbon dioxide (CO_2) at 420.0 ± 0.1 parts per million (ppm), methane (CH_4) at 1 934 ± 2 parts per billion (ppb) and nitrous oxide (N_2O) at 336.9 ± 0.1 ppb – respectively 151%, 265% and 125% of pre-industrial (before 1750) levels (Figure 1). Real-time data from specific locations, including Mauna Loa[2] (Hawaii, United States of America) and Kennaook/Cape Grim[3] (Tasmania, Australia) indicate that levels of CO_2, CH_4 and N_2O continued to increase in 2024.

The rate of ocean warming over the past two decades (2005–2024) was more than twice that observed over the period 1960–2005, and the ocean heat content in 2024 was the highest on record. Ocean warming and accelerated loss of ice mass from the ice sheets contributed to the rise of the global mean sea level by 4.7 mm per year between 2015 and 2024, reaching a new record observed high in 2024. The ocean is a sink for CO_2. Over the past decade, it absorbed about one quarter of the annual emissions of anthropogenic CO_2 into the atmosphere.[4] CO_2 reacts with seawater and alters its carbonate chemistry, resulting in a decrease in pH, a process known as "ocean acidification".

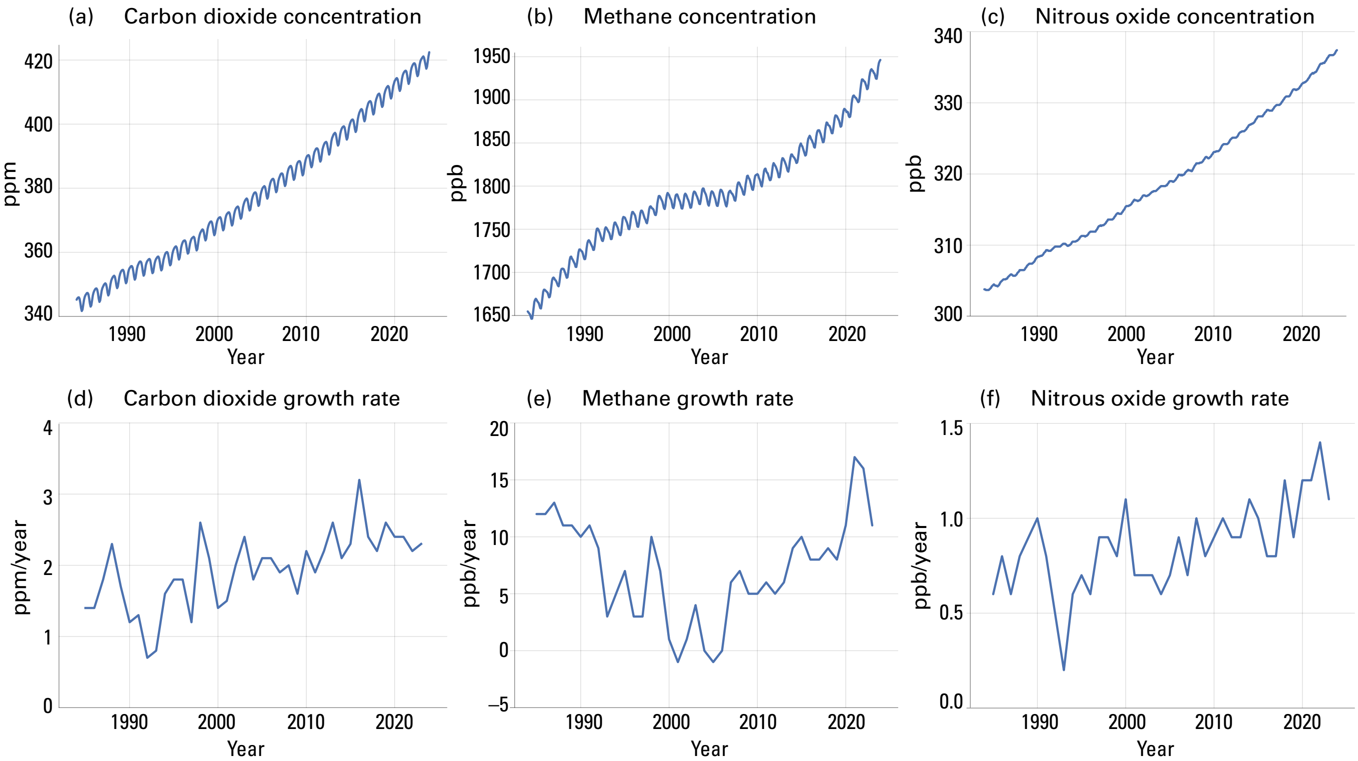


Figure 1: Top row: Monthly globally averaged mole fraction (measure of atmospheric concentration), from 1984 to 2023, of (a) CO_2 in parts per million, (b) CH_4 in parts per billion and (c) N_2O in parts per billion. Bottom row: Growth rates representing increases in successive annual means of mole fractions for (d) CO_2 in parts per million per year, (e) CH_4 in parts per billion per year and (f) N_2O in parts per billion per year.

Regional climate

The following sections analyse key climate indicators in Latin America and the Caribbean (LAC). Some of the indicators are described in terms of anomalies, or departures from a reference period. Where possible, the most recent WMO climatological standard normal, 1991–2020, is used as a reference period for consistent reporting. Exceptions to the use of this reference period are explicitly noted.

TEMPERATURE

Variations in surface temperature have a large impact on natural systems and human beings. The 2024 mean temperature in the LAC region was the highest, or second highest (after 2023), on record, +0.90 °C above the 1991–2020 average (see the subregional assessments shown in Table 1 and Figure 2).

Table 1. 2024 temperature ranking (1900–2024) and anomalies for LAC (°C, difference from the 1991–2020 and 1961–1990 averages) including uncertainties

Subregion/region	*Temperature ranking*	*Anomaly (°C) relative to:*	
		1991–2020	*1961–1990*
Mexico	Warmest or second warmest	+1.09 [1.01–1.19]	+1.79 [1.45–2.10]
Central America	Warmest	+0.96 [0.77–1.09]	+1.44 [1.26–1.63]
Caribbean	Warmest	+0.97 [0.80–1.09]	+1.46 [1.07–1.69]
South America	Warmest or second warmest	+0.87 [0.72–0.99]	+1.43 [1.21–1.60]
LAC	Warmest or second warmest	+0.90 [0.76–1.00]	+1.47 [1.27–1.63]

Source: Data are from the six datasets used in this assessment: Berkeley Earth, ERA5, GISTEMP, HadCRUT5, JRA-3Q and NOAAGlobalTemp v6. Five datasets were used in the assessment relative to 1961–1990.

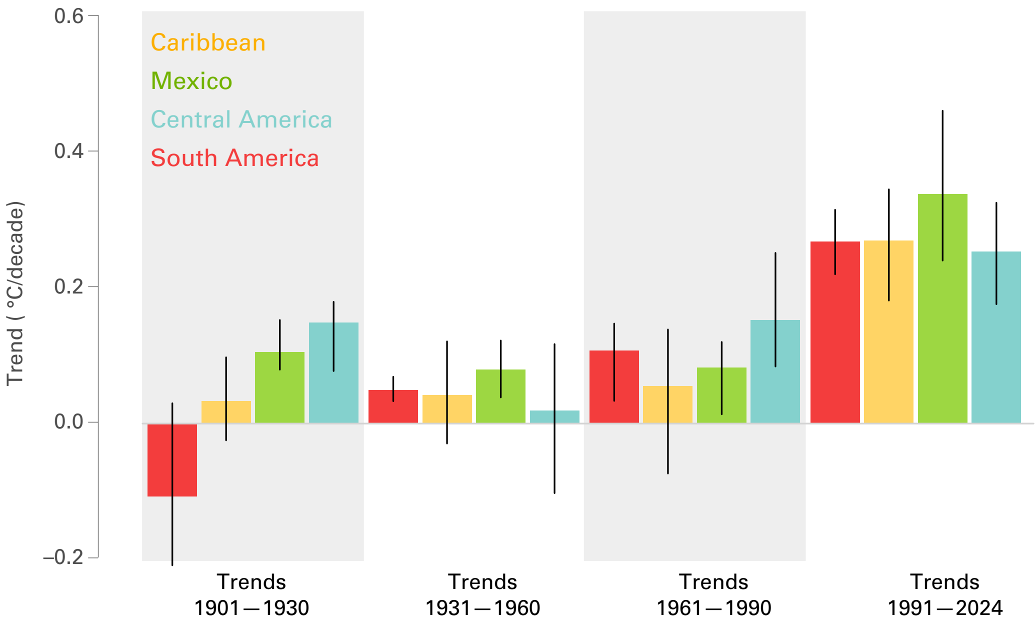


Figure 2. Temperature trends for the Caribbean, Mexico, Central America and South America subregions. The coloured bars show the average trend calculated over each period for the six datasets: Berkeley Earth, ERA5, GISTEMP, HadCRUT5, JRA-3Q and NOAAGlobalTemp v6. The black vertical lines indicate the ranges of the six estimates.

Figure 3 shows positive anomalies of +1 °C to +3 °C in central and eastern Mexico, Central America and across the Caribbean region. Above-normal temperatures of approximately +2 °C to +3 °C were observed in some locations in northern South America, western Amazonia, the southern Andes of Peru, the Plurinational State of Bolivia, Paraguay and parts of eastern Brazil.

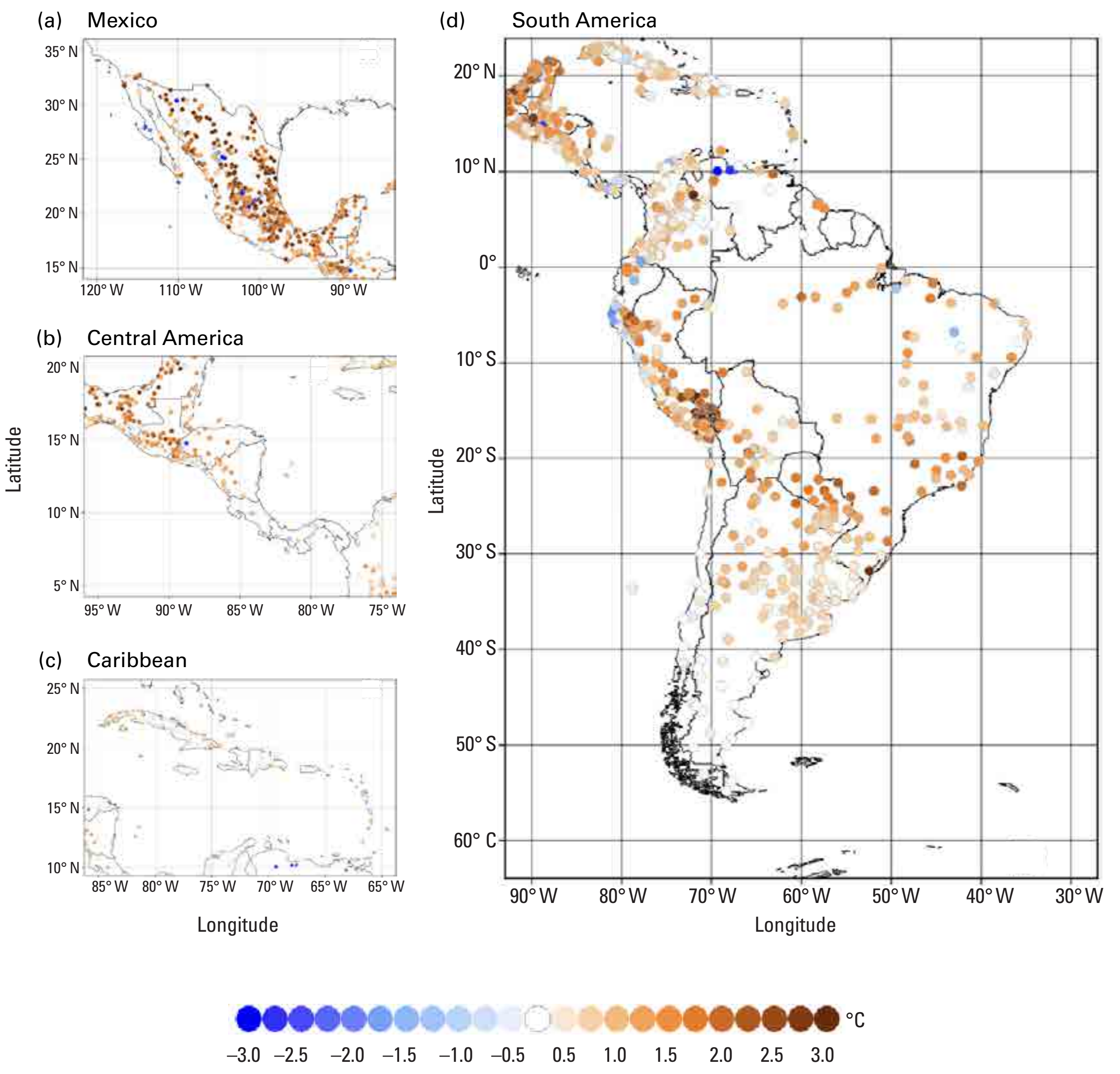


Figure 3. In situ mean air temperature (2 m) anomalies for 2024 (relative to 1991–2020) for (a) Mexico, (b) Central America, (c) the Caribbean and (d) South America, in °C. The colour scale is shown at the bottom of the figure.

Source: International Research Centre on El Niño (CIIFEN), from data from Latin American and Caribbean National Meteorological and Hydrological Services (NMHSs).

PRECIPITATION

Precipitation provides water for drinking, domestic uses, agriculture, industry and hydropower. Precipitation variations also drive droughts and floods. Annual rainfall anomalies from observational stations for 2024 are shown in Figure 4. Rainfall was below normal in most of central and north-west Mexico and Baja California, with negative anomalies ranging from around 20% to 50%. Cuba also experienced below-normal rainfall. Positive rainfall anomalies of between 20% and 40% were recorded in eastern Mexico and the Yucatán Peninsula. Rainfall was generally 20% to 30% above normal in Guatemala and El Salvador and between 10% and 30% above normal in Costa Rica, Honduras and Nicaragua. In the Caribbean, above-normal rainfall was recorded in parts of Jamaica and Haiti (+20%).

In South America, below-normal rainfall was recorded in northern Peru, Ecuador (about 20% to 30% below normal), the central and south-western Amazonia and Pantanal regions (30% to 40% below normal), the Plurinational State of Bolivia, Paraguay, the western part of the Bolivarian Republic of Venezuela, southern Uruguay and parts eastern Argentina (20% to 40% below normal). Positive rainfall anomalies were observed in south-eastern South America, parts of eastern Brazil and Patagonia (20% to 30% above normal) and northern Argentina and Chile (10% to 20% above normal). Central Chile experienced its first above-average rainfall year in a long time. However, the extra rainfall was not enough to alleviate the drought problem in the region which began around 2014.

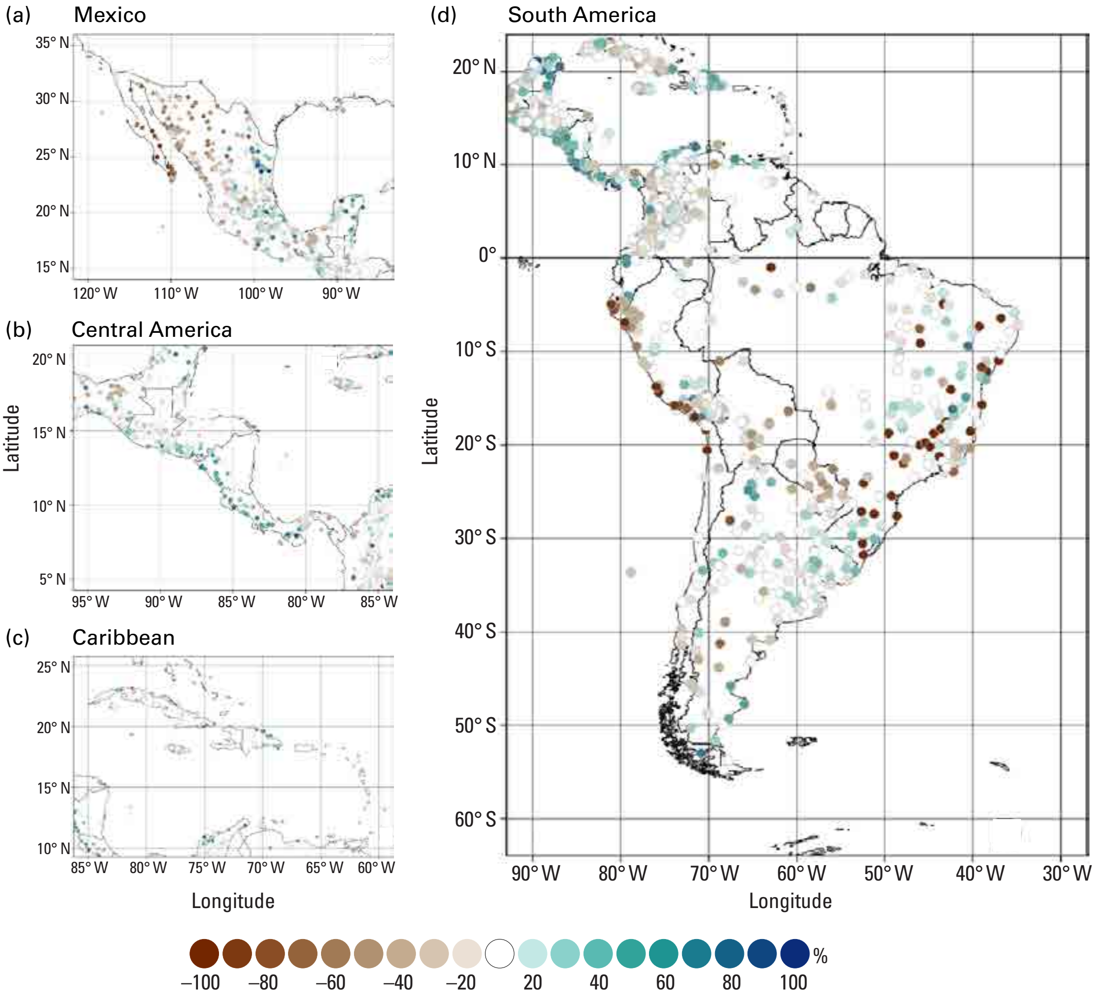


Figure 4. In situ rainfall anomalies for 2024 (percentage relative to the 1991–2020 reference period) in (a) Mexico, (b) Central America, (c) the Caribbean and (d) South America. The colour scale is shown at the bottom of the figure.

Source: CIIFEN, from data from Latin American and Caribbean NMHSs

CRYOSPHERE

GLACIERS

The melting of glaciers affects sea level, regional water cycles and the occurrence of local hazards, such as glacial lake outburst floods (GLOFs). In South America, glaciers are crucial water sources for millions of people, so their accelerated retreat is a cause for concern. The International Cryosphere Climate Initiative (ICCI) State of the Cryosphere Report 2024[5] and the Working Group on Snow and Ice of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Intergovernmental Hydrological Programme for Latin America and the Caribbean noted the following key glacier developments in the LAC region for 2024:

- The Bolivarian Republic of Venezuela lost its final glacier, Humboldt, joining Slovenia as the first two countries to lose all their glaciers in modern times;
- The Conejeras Glacier, nestled within the Sierra Nevada, Colombia, and the Martial South Glacier, in the Cordon Martial, Ushuaia, Argentina, were declared extinct in 2024;
- Data for 2024 from 5 500 glaciers across the Andes show that the mountains have lost 25% of their ice coverage since the end of the nineteenth century and that their tropical glaciers are melting 10 times faster than the cumulative global average;
- Data from July 2024 show fluctuations in Peruvian Andes meltwater that are directly linked to changes in global biodiversity;
- Severe ice losses were also observed in lower and mid-latitude glaciers, and others outside the polar regions, such as in the southern Andes and Patagonia, where the thinning of large glacier tongues is accelerating calving processes, leading to a more rapid retreat of their fronts;
- The eight Andean glaciers cited in the latest glacier mass balance data report by the World Glacier Monitoring Service (WGMS)[6] recorded negative balances averaging –1.68 m water equivalent (m w.e.) for the 2023–2024 hydrological cycle. This is a more significant loss than the global negative mass balance average of –1.35 m w.e. reported for the 141 glaciers worldwide included in the list for the same cycle.

OCEANS

SEA-SURFACE TEMPERATURE

Variations in sea-surface temperature (SST) alter the transfer of energy, momentum and gases between the ocean and the atmosphere. In January 2024, above-average SSTs persisted across the equatorial Pacific Ocean, with the largest anomalies observed in the central and east-central Pacific. Below-average equatorial SSTs were observed in small regions of the eastern Pacific Ocean in May, signalling the end of El Niño. El Niño–Southern Oscillation (ENSO)-neutral conditions began June and continued through September, with near-average SSTs observed across most of the equatorial Pacific. Neutral to weak La Niña conditions emerged in December 2024 and were reflected in below-average SSTs across the central and east-central equatorial Pacific.

SEA LEVEL

Sea level rises in response to ocean warming (via thermal expansion) and the melting of glaciers, ice caps and ice sheets, thereby affecting the lives and livelihoods of coastal communities and low-lying island nations. Figure 5 and Table 2 illustrate altimetry-based regional sea-level trends from January 1993 to November 2024 in the South America, Central America and Caribbean regions. Figure 5 highlights regional variability in the patterns of sea-level trend, with higher rates of sea-level rise observed along the Atlantic side compared to the Pacific side of the region.

Sea-level rise rates for 1993–2024 have been computed for three different areas for the Mexico, Central America and the Caribbean subregion and for the South America subregion, as shown in Figure 5. Table 2 gives the mean sea-level trends for each area, along with the coastal trends, which average sea-level data from the coast to 50 km offshore. Along the Pacific side of Central America, the rate of sea-level rise was lower (around 2.0 ± 0.3 mm/year) than the global mean rise (3.4 ± 0.3 mm/year). In contrast, the mean rate of rise along the Atlantic side was significantly higher, around 4.0 mm/year.

Similarly, along the Pacific side of South America, the rate of sea-level rise was significantly lower (around 2.2 ± 0.3 mm/year) than the global mean rise.

Table 2. Regional rates of sea-level rise computed for the period January 1993 to November 2024 after averaging the gridded C3S altimetry data in bands 50 km wide along the coasts for the three areas in each map in Figure 5

Subregion	*Zone number (see Figure 5)*	*Area*	*Box-average sea-level trend (mm/year)*	*Sea-level trend averaged over 0-50 km from the coast (mm/year)*
Mexico, Central America and the Caribbean	1	Central America Pacific	2.0 ± 0.3	2.0 ± 0.35
	2	Subtropical North Atlantic	3.93 ± 0.3	4.0 ± 0.35
	3	Tropical North Atlantic and the Caribbean	3.30 ± 0.3	3.45 ± 0.35
South America	1	South America tropical North Atlantic	3.49 ± 0.3	3.62 ± 0.35
	2	South Atlantic	3.63 ± 0.3	2.93 ± 0.35
	3	South America Pacific	2.22 ± 0.3	2.26 ± 0.35

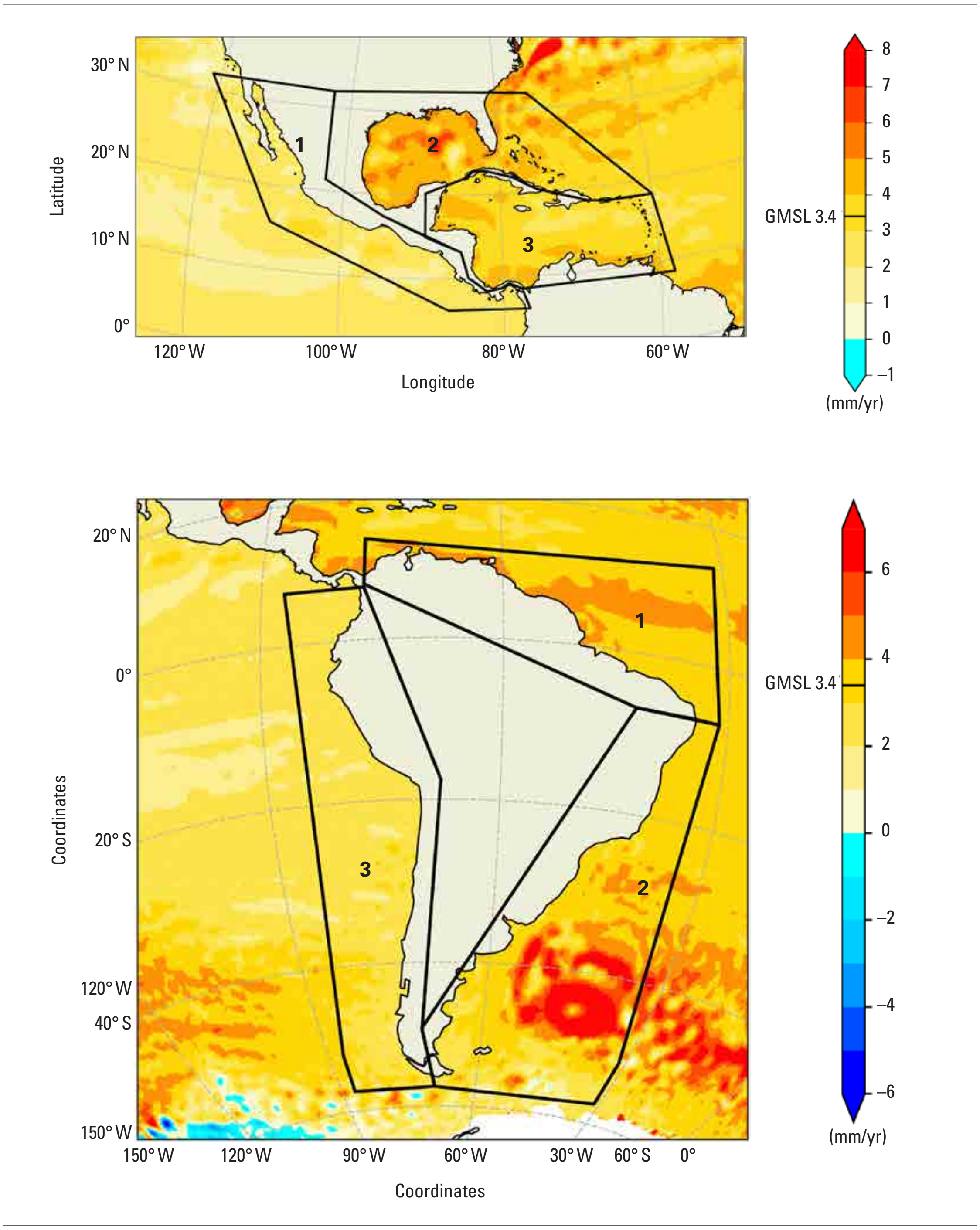


Figure 5. Spatial trend patterns in sea level observed by altimeter satellites between January 1993 and November 2024. The global mean sea-level trend of 3.4 mm/year is included. The numbered boxes indicate areas where the gridded altimetry data have been averaged to compute sea-level time series and associated trends (see Table 2).

Source: The data are based on the Copernicus Climate Change Service (C3S) gridded sea-level product (https://cds.climate.copernicus.eu/datasets/satellite-sea-level-global?tab=overview/; resolution 0.25°).

Extreme events

Figures 6a and 6b highlight some of the key extreme weather and climate-related events that affected the LAC region in 2024. More details and additional events are provided in the text below.

Key extreme events in LAC in 2024

The events shown in the map below were primarily reported by WMO Members and do not represent all events across the region. More details can be found in the 2024 Extreme Events Dashboard.

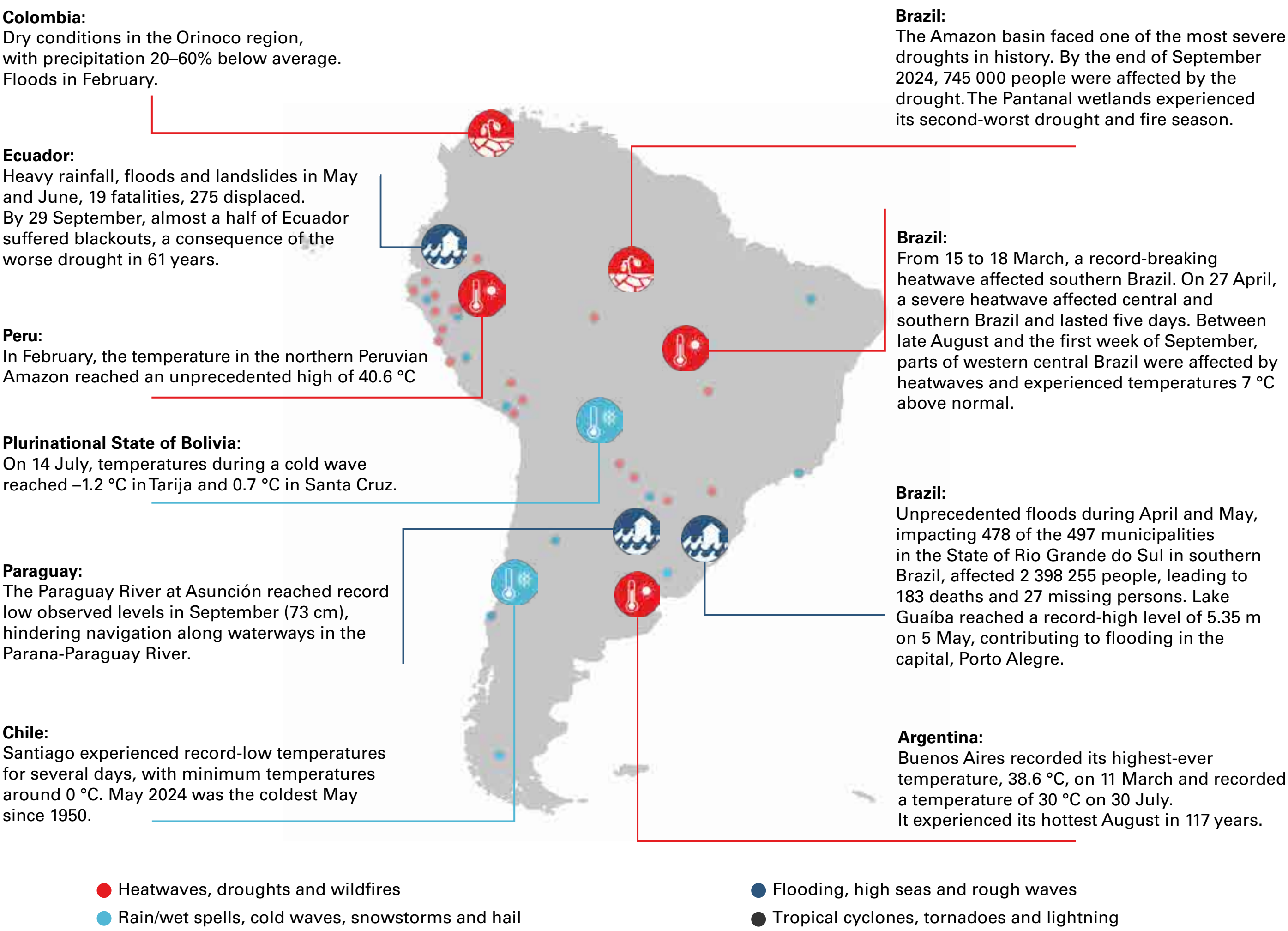


Figure 6a. Key extreme weather and climate events affecting South America in 2024
Sources: Latin American and Caribbean NMHSs

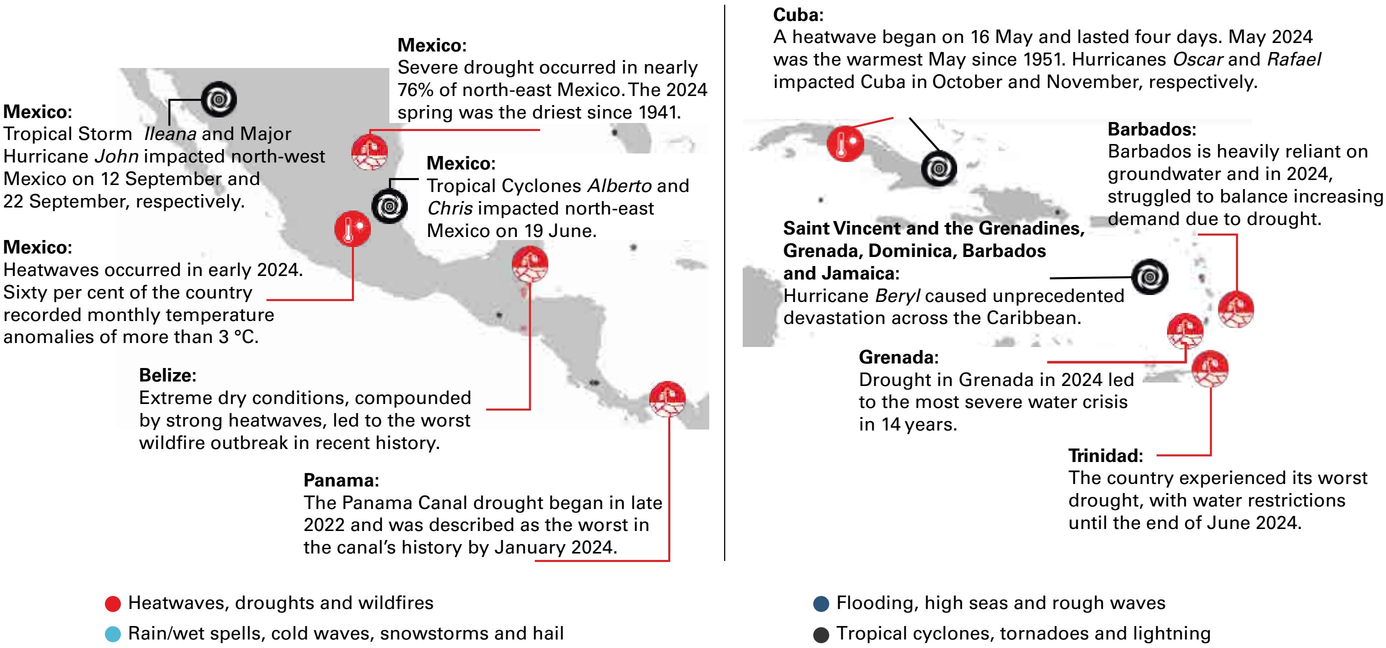


Figure 6b. Key extreme weather and climate events affecting Mexico, Central America and the Caribbean in 2024

Sources: Latin American and Caribbean NMHSs

TROPICAL CYCLONES

The 2024 Atlantic hurricane season had an above-average number of storms, with 18 named storms (compared to an average of 14 named storms for 1991–2020).[7] Of these, nine storms affected land areas in the LAC region, including four tropical storms (*Alberto*, *Chris*, *Nadine* and *Sara*), four hurricanes (*Debby*, *Francine*, *Ernesto* and *Oscar*) and four major hurricanes (*Beryl*, *Helene*, *Milton* and *Rafael*). Major Hurricane *Milton* in October brought heavy rainfall and flooding over the Yucatán, leading to evacuations, and left 12 000 people without electric power. In the eastern Pacific, the hurricane season was slightly less active than normal, with 12 named storms (compared to an average of 15 named storms for 1991–2020). Three of these were major hurricanes and seven were tropical storms. Of these storms, Tropical Storm *Ileana* and Major Hurricane *John* affected Mexico. In July, Major Hurricane *Beryl* was the earliest Atlantic basin Category 5 hurricane on record and became the strongest hurricane on record to make landfall on Grenada and its dependencies. It also strongly impacted islands in the south-eastern Caribbean.

HEAVY PRECIPITATION, FLOODS AND LANDSLIDES

In 2024, various LAC countries were affected by heavy rainfall that resulted in floods, flash floods and landslides, with fatalities and enormous economic losses. Some of the rainfall events were consequences of tropical storms or cold fronts. In Cuba, heavy rainfall and heavy hailstorms affected the western region, in particular, La Habana, Artemisa and Mayabeque Provinces, on 23 March, causing floods, landslides and a number of related incidents that resulted in population evacuation and damage.[8] On 21–23 February, flooding along the Acre River in the western Amazon region caused widespread damage and displacement in riverside communities in Peru, Brazil and the Plurinational State of Bolivia. In Cobija, in the Pando Department of the Plurinational State of Bolivia, the Acre River reached 15.83 m. Broad areas of the state of Acre in Brazil were also affected by flooding during late February. The city of Mimoso do Sul in the state of Espírito Santo, Brazil, registered rainfall accumulations varying from 300 to 600 mm in 48 hours during 22–23 March, with 20 fatalities reported due to flooding and flash floods.[9] Heavy rain and flood events in May 2024 in the state of Rio Grande do Sul caused fatalities and significant damages to the regional economy (see Early warning services for disaster risk reduction: An example from CEMADEN in Brazil).

DROUGHT

Areas affected by severe to exceptional drought from January to October (Figure 7) include most of north-western Mexico and the Yucatán Peninsula, parts of Central America and the Caribbean, the Amazon and Pantanal regions, central and northern South America, western

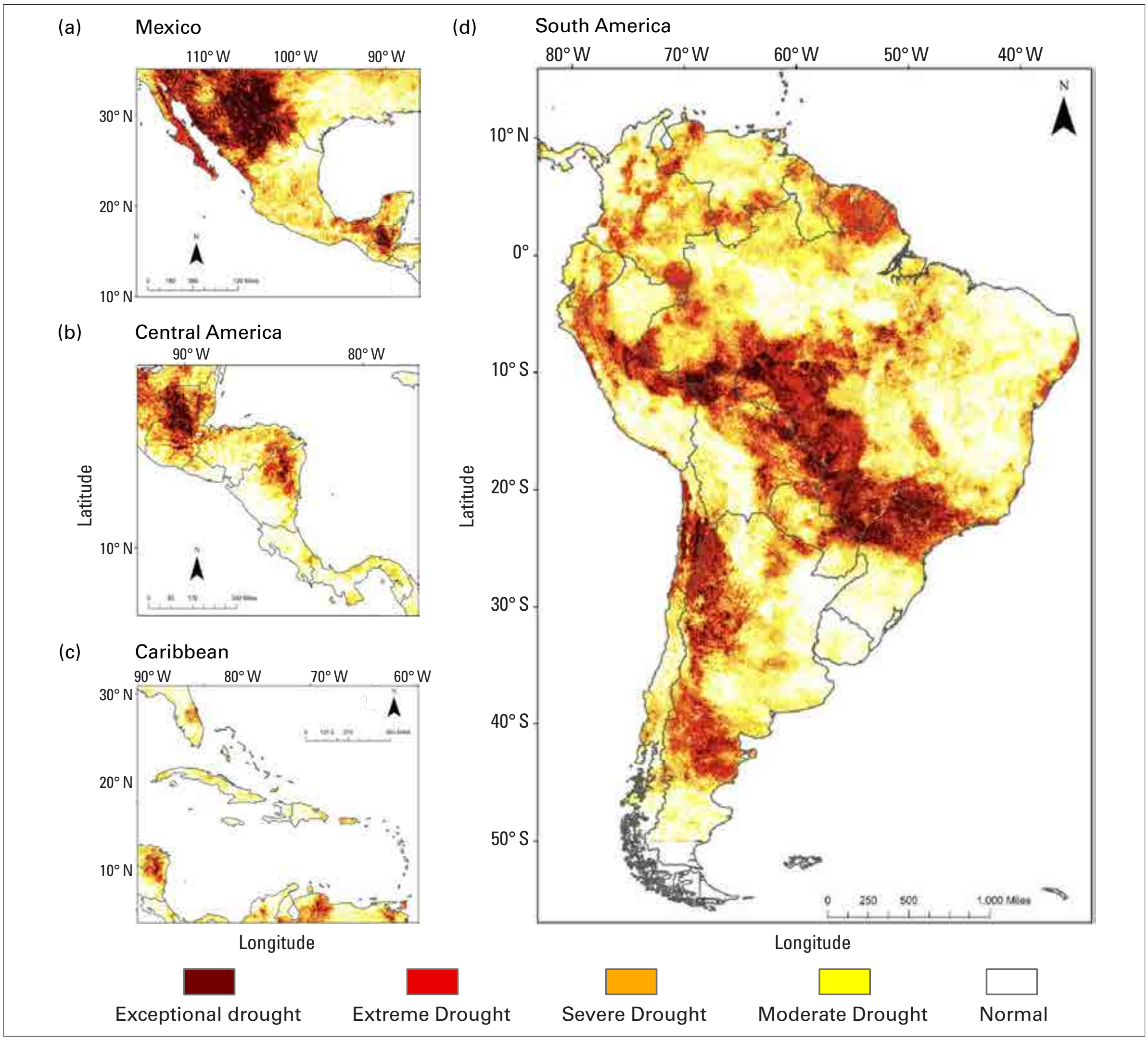


Figure 7. Integrated Drought Index (IDI)[a] for January–October 2024 in Mexico, Central America, the Caribbean and South America. The colour scale shows the intensity of the drought.

Source: National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN)

[a] Integrated Drought Index (IDI)– Cunha, A. P. M. A.; Zeri, M.; Deusdará Leal, K. et al. Extreme Drought Events over Brazil from 2011 to 2019. *Atmosphere* **2019**, *10* (11), 642. https://doi.org/10.3390/atmos10110642.

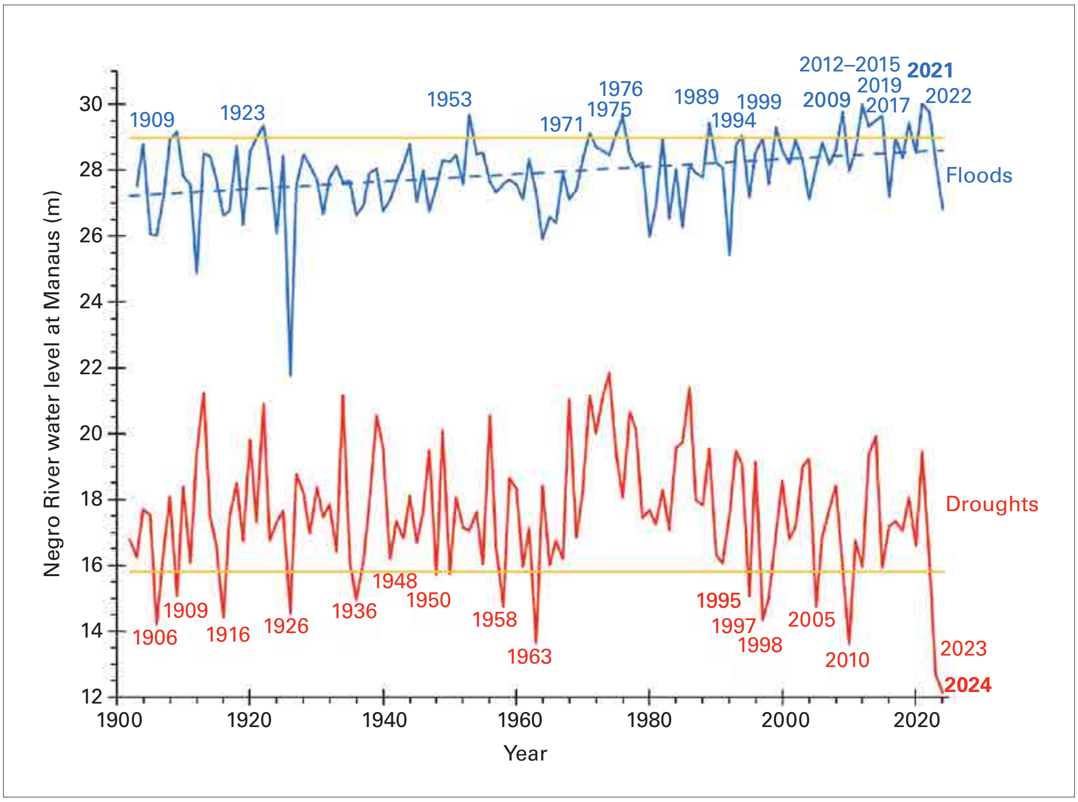


Figure 8. Maximum (blue lines) and minimum (red lines) levels of the Negro River at the Port of Manaus from 1902 to November 2024. The blue and red numbers indicate record floods and droughts, respectively. The orange lines represent the higher (29.0 m) and lower (15.8 m) thresholds to define floods and droughts, respectively. The values are in metres.

Source: J. Schongart, National Institute for Amazonian Research (INPA)

Argentina, and northern and central Chile. The level of the Negro River at Manaus fell to 12.11 m on 10 October, the lowest level in the 112-year record (Figure 8). The Paraguay River at the Pantanal reached its lowest level ever measured, according to the Brazilian Geological Survey (SGB), 62 cm below the reference level. The previous minimum, recorded in 1964, was 61 cm below the reference level.

HEATWAVES

Three heatwaves affected Mexico between April and June (Figure 6b). The maximum temperature in Mexico City reached a new record of 34.7 °C on 25 May.[10] On 5 June, the Mexican Health Ministry reported 1 937 heat-related cases and 90 deaths due to heat strokes and dehydration during these heatwaves.[11] In Cuba, three heatwaves were observed in April, May and July. April 2024 was the warmest April since 1951, and between 16 and 20 April, 35 new temperature records were observed.[12] As shown in Figure 6a, heatwaves also affected central South America, and on 22 September, Palmas and Cuiabá recorded new records of 41.6 °C and 43.1 °C, respectively.[13] Other heatwave episodes were observed in the Amazon region of Peru and in Argentina, where a temperature of 45.7 °C was recorded in Santiago del Estero on 3 February.

WILDFIRES

In South America, there was an increase in wildfire activity in 2024, primarily driven by the 2023–2024 extreme drought and hot conditions that were widespread and unprecedented around the Plurinational State of Bolivia and the Amazonia and Pantanal regions. At the beginning of 2024, fast-moving deadly fires ripped through central and southern Chile, resulting in the deaths of more than 130 people in the coastal towns of the country. The Government of Chile declared that these fires caused the country's worst natural disaster since the 2010 Chile earthquake. In the Plurinational State of Bolivia, wildfires burned over 15 million hectares, making the 2024 fire season that country's worst fire season on record. Hot, dry and windy conditions led to devastating wildfires in June 2024 over the Pantanal. While the peak of the fire season usually occurs in August and September, June 2024 was exceptional, with an estimated 423 000 hectares burned, a significantly larger area than the previous June maximum of 26 725 hectares in 2020 and far exceeding the monthly average of about 8 300 hectares. The burned area of the Amazon rainforest, approximately 15 million hectares, was the largest recorded in a single year since 2012. The burned areas of the Cerrado savannah, approximately 15 million hectares, and the Pantanal wetlands, approximately 2.6 million hectares, were the second largest recorded in a single year for each region, following 2012, for the Cerrado, and following 2020, for the Panatal.[14]

COLD WAVES, HAIL AND SNOW

On 22 March, in Cuba, the provinces of Artemisa and La Habana were affected by an unprecedented hailstorm with 66 km/h winds and lightning.[15] The Argentinian National Meteorological Service (SMN)[16] confirmed that Malargüe and Tandil recorded temperatures of –8.8 °C and –8.5 °C, respectively, on 9 July, and very low temperatures were recorded in Patagonia in July. All of these observations marked record-low temperatures in the almost 90-year history of the stations.[17] Southern Brazil faced extreme cold waves that intensified at the end of June, bringing sub-zero temperatures to several cities in the highlands of the state of Santa Catarina (in Bagé, the temperature reached –5.9 °C, in Urupema, –7.2 °C and in São Joaquim, –6.7 °C).[18]

MAJOR CLIMATE DRIVERS

There are many modes of natural variability in the climate system, often referred to as climate patterns or climate modes, which affect weather and climate at timescales ranging from days to months, or even decades. The Pacific and Atlantic Oceans surround the LAC region, and the climate variability in the region is primarily influenced by the prevailing SSTs and associated large-scale atmosphere–ocean coupling phenomena, such as ENSO and SST anomalies in the tropical and South Atlantic. During April–May 2024, below-average equatorial SSTs emerged in small regions of the eastern Pacific Ocean, indicating the end of El Niño. ENSO-neutral conditions occurred in June and continued through September, with near-average SSTs observed across most of the equatorial Pacific. Signs of a weak La Niña emerged towards the end of the year.[19] The 2024 El Niño event was associated with higher air temperatures and precipitation deficits over Mexico, Guatemala, El Salvador and the Peruvian–Bolivian Altiplano, Pantanal and Amazon regions and increased rainfall in parts of south-eastern South America. It also supported the prolongation of a pre-existing drought over much of central South America, which, together with higher temperatures and heatwaves, led to extremely low river levels and high fire danger in most of the region during the southern hemisphere spring.

Climate-related impacts and risks

Climate-related impacts in the LAC region are associated with hazardous extreme events and a complex scenario of increased exposure and vulnerability. The El Niño event in the first half of 2024 contributed to these impacts. As in previous years, this complex scenario was further complicated by high and rising food prices, increasing poverty, high income inequality, and increasing levels of hunger, political instability and health and food insecurity.

AGRICULTURE AND FOOD SECURITY

Agriculture is a cornerstone sector for the socioeconomic development of the LAC region. Actionable climate services are essential for building resilience to climate variability and change. While data services are widely available for the agriculture and food security sector, gaps in tailored products, sub-seasonal to inter-annual prediction, and projections at the national and local levels could undermine adaptation efforts. Investing in these areas is an opportunity and a necessity for the region's sustainable development. Enhanced climate services have the potential to bolster agricultural productivity, help ensure food security and fortify energy systems against disruptions. The LAC region can unlock innovation, drive growth and secure a resilient future by addressing these critical gaps.

An overview of the state of climate services in the LAC region can be accessed here: https://wmo.int/publication-series/state-of-climate-latin-america-and-caribbean-2024.

Throughout 2024, weather extremes, economic shocks, and conflict/insecurity were the main drivers of acute food insecurity across the region, where conditions remained critical. In 2023, 197 million people experienced high levels of acute food insecurity across nine countries.[20] Integrated Food Security Phase Classification (IPC) analyses in 2024 projected worsening conditions in the tri-national border of Rio Lempa,[21] as well as in Honduras[22] and Haiti,[23] where nearly half of the population (5.4 million people) is in IPC Phase 3 (crisis conditions) or higher. The increasing frequency and intensity of droughts, floods and heatwaves, and the increasing intensity of hurricanes, demonstrate the growing risks for agriculture and food security in the region. The losses of crops and livestock and the interruption of supply chains have significantly affected the availability of food, income and the stability of rural livelihoods. Given this panorama, it is crucial to implement agricultural resilience strategies, anticipate actions, strengthen food systems and prioritize mitigation actions in the face of climate change.

The impacts of climate anomalies on agriculture in LAC can be summarized as follows:

- In Honduras, anomalously high temperatures increased the incidence of plagues and illnesses, generating greater costs for farmers with limited investment capacity.[24] The impact of Tropical Storm *Sara* in November caused significant losses in agriculture and livestock and damage to production infrastructure, affecting corn, frijol and rice crops, among others.

- In Guatemala, 56% of producers reported insufficient or scarce water for irrigation due to irregular rainfall associated with El Niño, while 60% of staple grain producers delayed their planting dates. Additionally, 45% of agricultural households experienced a reduction in income compared to the previous year, and 10% had at least one member migrate due to livelihood loss or insufficiency. The departments most affected by drought were El Progreso (78%), Baja Verapaz (76%), Jutiapa (73%) and Jalapa (70%).[25]

- In El Salvador and Nicaragua, initial droughts followed by intense rains affected the maize areas in the Dry Corridor.[26] In El Salvador, these climatic conditions altered maize production in 2024, with a late onset of May floods and excessive precipitation later in the year that caused floods and landslides in specific regions.[27]

- In Haiti, the number of people experiencing acute food insecurity increased due to climate impacts in combination with violence and economic instability. 48% of the population faced acute food insecurity (IPC Phase 3+),[28] and floods affected 116 602 people in the south of the country and caused important losses in the agricultural and livestock sectors in several southern municipalities.[29] 69% of producers experienced difficulties, especially lack of water.[30] During 2024, the hurricane season in the tropical Atlantic was more active than normal.[31]

- In Cuba, Hurricanes *Oscar* and *Rafael* damaged more than 40 000 hectares of crops, such as cassava plantations, affecting the food supply of 2 million people in Havana.[32] In the Dominican Republic, heavy rains and floods associated with these hurricanes put at risk the agricultural livelihoods of 15 000 people in rural areas.

- In Saint Vincent and the Grenadines, Hurricane *Beryl* caused damage estimated at 700 million United States dollars (US$), severely impacting the forestry, fisheries and agricultural sectors and affecting more than 13 000 farmers and fishers.

- In Colombia, 42% of agricultural producers reported lack of rain or water for irrigation as the main climate impact, affecting crops, dairy production and rural livelihoods.[33] The drought, worsened by El Niño, impacted fishing communities and reduced incomes for 63.4% of surveyed households in rural areas linked to the agricultural sector.[34] Wildfires affected 125 000 hectares of grasslands in the Orinoco region, damaging pasturelands used for livestock.[35]

- Prolonged droughts affected several crops in Ecuador, and milk production fell by 20%.[36]

- In Brazil, floods in the state of Rio Grande do Sul generated losses estimated at 8.5 billion Brazilian reais (R$) in the agricultural sector; soybeans were the most affected crop, representing between 15% and 16% of the agricultural area for harvest in the state. In farming, the losses amounted to R$ 1.2 billion, with 600 000 hectares of pastures seriously damaged.[37]

- In Argentina, the drought conditions experienced in the central region in the spring of 2024 impacted the sowing dates of summer crops, and winter crop yield losses were expected due to rain deficit during the critical period. More than 300 000 hectares of crops and more than four million heads of cattle were at risk.[38]

- The El Niño event affected marine fisheries in 11 of the 19 Food and Agriculture Organization of the United Nations (FAO) Major Fishing Areas . The impacts differed across geographical areas, target species and types of fishing or aquaculture and were both negative and positive. For example, the 2023 El Niño conditions diminished the habitat and food availability of Peruvian anchoveta, leading to a 50% reduction in landings compared with 2022.[39]

- Unprecedented flooding in May 2024 in Brazil severely affected the fishing sector in Rio Grande do Sul. Record-breaking rainfall raised river and lagoon levels, particularly impacting Patos Lagoon, Brazil's largest coastal lagoon and a critical area for biodiversity and fisheries. Small-scale fishers around Patos Lagoon were severely affected by the floods. Boats, equipment and fishing grounds were destroyed, halting fishing activities. Patos Lagoon supplies 30% of Brazil's pink shrimp, and the floods caused the operations of supply chains and markets nationwide to be disrupted.

WMO WEATHER, CLIMATE AND HYDROLOGICAL SERVICES FOR ENERGY IN LATIN AMERICA AND THE CARIBBEAN

Renewable energy generation in LAC reached nearly 69% of the region's energy mix in 2024, with renewable energies such as solar and wind experiencing a remarkable 30% increase in capacity and generation compared to 2023.[40] To advance the expansion and optimization of renewable energy use across LAC, WMO is supporting its Members by enhancing the capacity of NMHSs to develop science-based operational products and services in collaboration with academia, the private sector and energy stakeholders. In 2024, an artificial intelligence (AI)-based short-term wind speed forecasting product for wind power plants was co-developed in collaboration with the National Meteorological Institute of Costa Rica (IMN) and the Costa Rican Electricity Institute (ICE).[41] In Chile, an evaporation rate estimation model for large water bodies with floating solar panels was co-developed in collaboration with the Meteorological Directorate of Chile (DMC), the Ministry of Energy and Diego Portales University.[42] Both countries were also supported in their efforts to develop high-resolution national atlases for wind (Costa Rica) and solar energy (Chile), utilizing reanalysis, observational and climate projection data to support long-term energy planning. A technical webinar organized with the World Bank showcased these results and approaches.[43] Additionally, an operational, modular climate service toolkit for energy is being developed for Colombia, Chile and Ecuador under the Enhancing Adaptive Capacity of Andean Communities through Climate Services (ENANDES+) project and is being tailored for Cuba under funding from the Climate Risk and Early Warning Systems (CREWS) initiative.[44] Looking ahead, additional tools and demonstration products are planned for development and scaling to other countries within the region, leveraging regional projects such as ENANDES+ to address the needs of WMO Members. This will be achieved in collaboration with the regional office and regional partners, such as the Latin American Energy Organization (OLADE), with which WMO signed a memorandum of understanding in 2024.

EARLY WARNING SERVICES FOR DISASTER RISK REDUCTION: AN EXAMPLE FROM CEMADEN IN BRAZIL

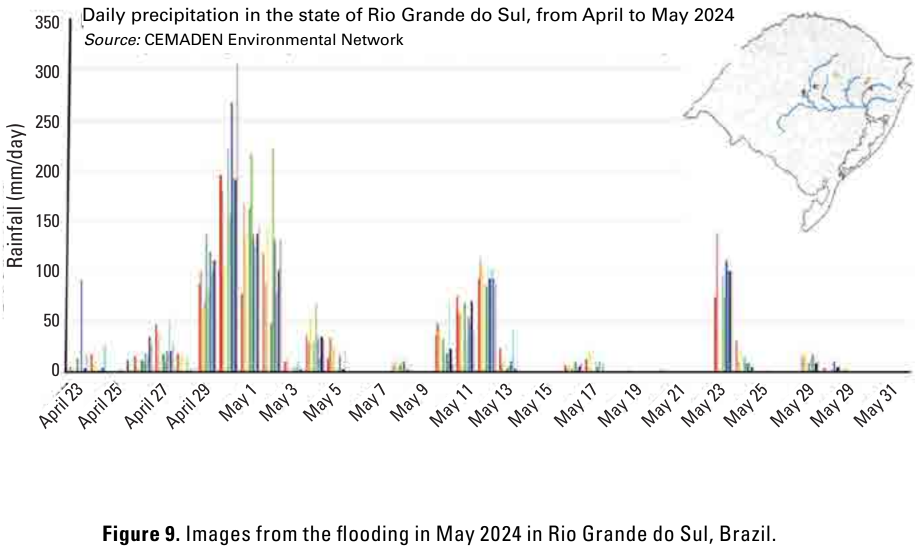
Multi-hazard Early Warning Systems (MHEWS) in the LAC region have evolved significantly over recent decades. However, these systems vary widely between countries, and in some cases, within individual countries. In Brazil, the National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN)[45] monitors natural threats in risk areas in Brazilian municipalities that are susceptible to geo-hydro-meteorological disasters. CEMADEN also carries out research and develops technological innovations to enhance its early warning system, focusing on disaster risk reduction.

The unprecedented floods in April–May 2024 in the state of Rio Grande do Sul affected over 90% of the state. These floods displaced hundreds of thousands people and were associated with 183 deaths. Various studies discuss the meteorological and hydrological aspects of the intense rainfall.[46, 47, 48] The flood event in Porto Alegre was triggered by heavy rainfall over the Guaíba Lake basin, with accumulations surpassing 500 mm in five days, causing the water level of Guaíba Lake to reach a record high of 5.35 m on 5 May. This was considerably higher than the previous record of 4.76 m, set on 2 May 1941. The extreme nature of this event contributed to significant flooding in vulnerable areas of the Porto Alegre metropolitan region and nearby municipalities (Figure 9). The timeline of the events related to this disaster clearly shows that rainfall forecasts and high-risk flood alerts were issued two days before the major flood in Porto Alegre (Figure 10).

Populations living in vulnerable and exposed areas were warned and evacuated on time. However, the number of fatalities was still high. There is a need to increase the understanding of disaster risks by the authorities and the general public. It is also essential to improve weather forecasting and early warning systems to protect populations in areas at risk of being impacted by disasters caused by climate extremes, and thus save lives. Ultimately, this case highlights the growing risk caused by extremes, especially to vulnerable populations, as well as the danger caused by inappropriate territorial management, urban planning and governance at the federal, state and local levels.

City of Porto Alegre, flooded
Credit: O Estado de SãoPaulo

Floods in the city of Canoas
Credit: REUTERS/Amanda Perobell



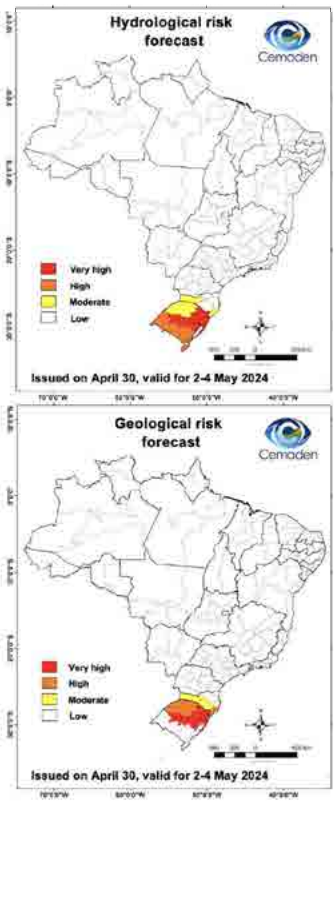
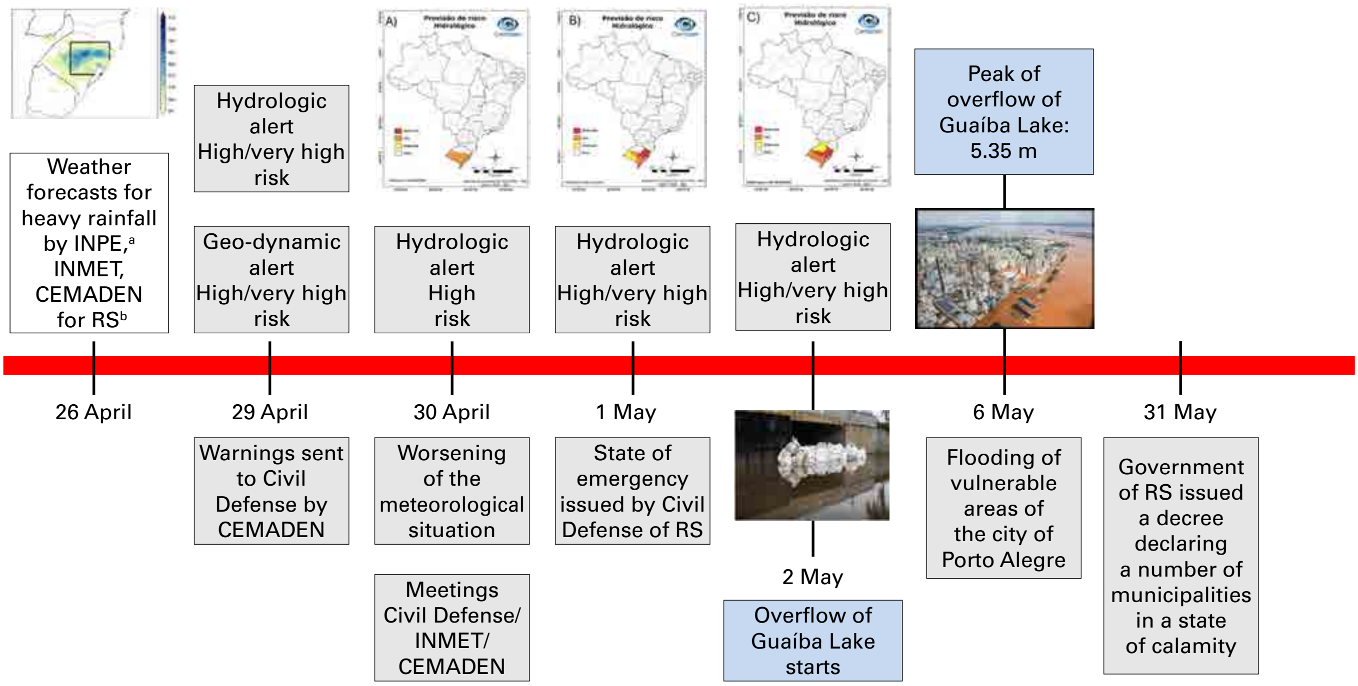


Figure 9. Images from the flooding in May 2024 in Rio Grande do Sul, Brazil.
Top: Photos of flooding in the cities of Porto Alegre and Canoas; bottom: Daily rainfall in stations in the Guaíba Lake basin, in the state of Rio Grande do Sul; each colour represents an individual station; right: Hydrological and geological forecasts issued by CEMADEN on 30 April for 2–4 May; the colours at the lower left of each panel represent the level of alert.

Source: CEMADEN



[a] INPE – National Institute for Space Research
[b] RS – Rio Grande do Sul

Figure 10. Timeline of actions determined in technical meetings, the issuance of risk alerts and the occurrence of disasters between 26 April and 31 May 2024 in Rio Grande do Sul, Brazil.

Datasets and methods

A description of the data and methods used for this report can be accessed here:

https://wmo.int/publication-series/state-of-climate-latin-america-and-caribbean-2024.

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Endnotes

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