State of the Climate

Update for COP30

This update has been prepared to inform discussions at COP30 with authoritative, up-to-date information on the state of the global climate.

WORLD
METEOROLOGICAL
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Key messages

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Greenhouse gases

Atmospheric concentrations of CO_2, CH_4 and N_2O reached record observed levels in 2024 and continue to rise in 2025.

Global mean near-surface temperature

Mean near-surface temperature in January–August 2025 was 1.42 °C ± 0.12 °C above the pre-industrial average. The calendar year 2025 is on track to be the second or third warmest year on record, behind 2024.

Ocean heat content

Ocean heat content reached the highest level on record in 2024, with preliminary 2025 data showing continued warming.

Sea-level rise

The long-term rate of global mean sea-level rise has increased since the start of the satellite record in 1993. Natural climate variability may have led to a small drop in global mean sea level in 2025 to date compared to 2024.

Glacier mass balance

In the hydrological year 2023/2024, glaciers lost an observed record 1.3 metres water equivalent of ice.

Sea-ice extent

Arctic sea-ice extent in March 2025 was the lowest annual maximum in the satellite record. Antarctic sea-ice extent has remained well below average throughout 2025 to date.

Extremes

Weather- and climate-related extreme events to August 2025 had cascading impacts on lives, livelihoods and food systems, and contributed to displacement across multiple regions, undermining sustainable development.

Renewables

Climate-related drivers are shaping renewable energy supply and demand. Anticipating these influences is critical to building reliable and flexible clean energy systems.

Climate services

National Meteorological and Hydrological Services have a growing role in climate action as Nationally Determined Contributions are increasingly recognizing the importance of climate services and early warning services.

Early Warnings for All

Since 2015, the number of countries reporting multi-hazard early warning systems (MHEWSs) has more than doubled – from 56 to 119 in 2024 – yet 40% of countries still lack MHEWSs, and urgent action is needed to close these remaining gaps.

Introduction

This update on the current state of the global climate has been prepared to inform discussions at the thirtieth Conference of the Parties to the United Nations Framework Convention on Climate Change (COP30) with authoritative, up-to-date information. The update combines consolidated data for the year 2024 with preliminary data for 2025 to date where available. While some indicators, such as global temperature and sea-level rise, can be monitored in near-real time, others – such as greenhouse gas concentrations, glacier mass balance and river discharge – are only available through the end of 2024 due to the time required for collection, quality control and verification. Together, these complementary datasets provide a robust picture of ongoing climate change.

The information presented here draws on WMO reports and contributions from partner institutions. All data are from authoritative sources, which are listed on the final page of this update to ensure transparency and traceability.

This update is intended to be used as:

- A science-based reference to anchor COP negotiations in authoritative evidence.
- A communication tool to highlight key climate indicators and their relevance to support policymaking.
- A bridge to more detailed reports, where the underlying datasets and analyses can be explored further.

The message is simple: 2025 is on track to be the second or third warmest year on record, and the last 11 years, including 2025, will individually have been the 11 warmest years on record. We are not on track to meet the goals of the Paris Agreement. Other climate indicators continue to sound alarm bells, and more extreme weather had major global impacts on economies and all aspects of sustainable development.

There is good news: renewable energy is expanding. Climate action plans are increasingly informed by science-based climate services. Early warnings are reaching more people in more places and saving more lives.

This report is based on contributions from WMO Members and partners – proof of the strong collaboration and data exchange which have been hallmarks of WMO throughout its 75-year history as we transform science into action for the global good.

Celeste Saulo,
WMO Secretary General

Greenhouse gas concentrations reached record observed levels in 2024

Real-time data indicate that they continue to rise in 2025.

Concentrations of the three key greenhouse gases in the atmosphere – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – reached record-high observed levels in 2024, the most recent year for which there are global consolidated figures. Measurements to date from individual locations, such as Mauna Loa and Kennaook/Cape Grim, suggest that concentrations of the three key greenhouse gases will be higher again in 2025.

The atmospheric concentration of CO_2 has increased from around 278 parts per million (ppm) in 1750 to 423.9 ppm in 2024, an increase of 53%. The average CO_2 growth rate during the past decade was 2.57 ppm per year. The increase in concentration from 2023 to 2024 was 3.5 ppm, a record increase in the recent observational history. Emissions from fossil fuels have been the largest source of human emissions since the 1950s. Global averaged CH_4 concentrations increased from 729 parts per billion (ppb) in 1750 to 1 942 ppb in 2024, which represents an increase of 166%. N_2O concentrations increased from 270 ppb in 1750 to 338.0 ppb in 2024, which represents a 25% increase.

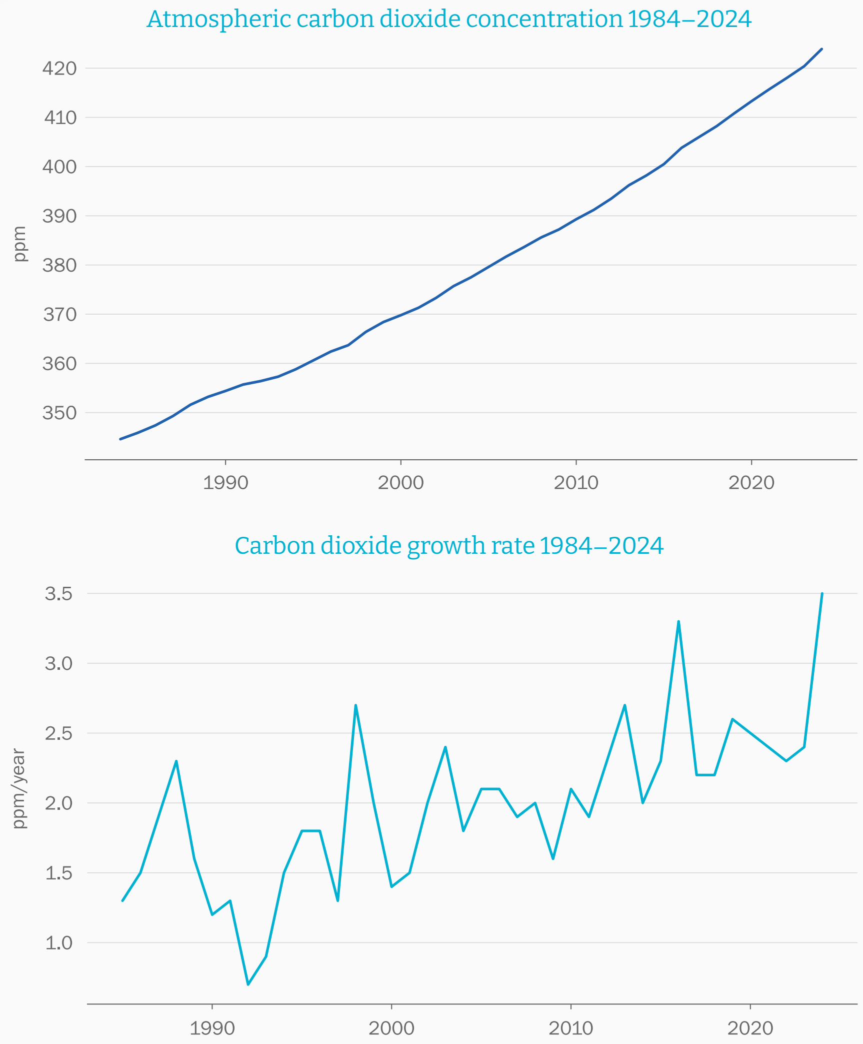
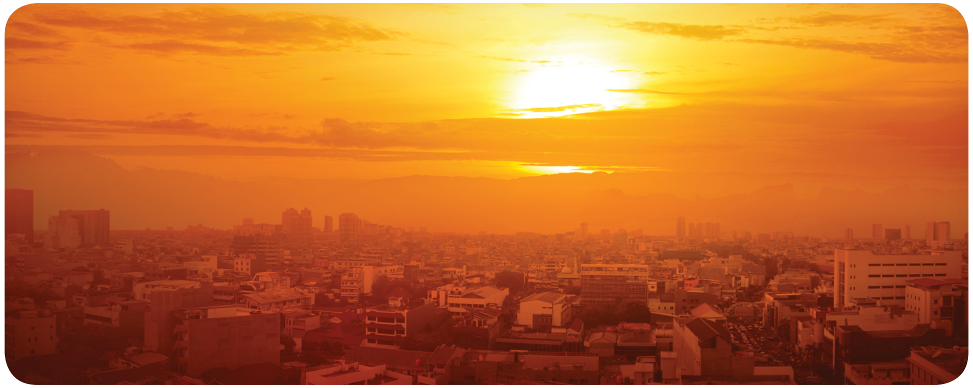


Figure 1. Annual mean globally averaged atmospheric mole fraction of carbon dioxide (top) from 1984 to 2024 in parts per million (ppm) and annual growth rate (bottom).

January–August 2025 was 1.42 °C ± 0.12 °C above the pre-industrial average

The year 2025 is on track to be among the three warmest years on record.



Global mean near-surface temperature averaged from January to August 2025 has dropped slightly from the record high for the year 2024, consistent with the shift from El Niño conditions – which boosted global temperatures during 2023 and 2024 – to neutral conditions at the start of 2025. The average for January to August 2025 was 1.42 °C ± 0.12 °C above the pre-industrial average.

The 26-month period from June 2023 to August 2025 saw only one month (February 2025) with a global mean monthly average temperature that was distinguishably cooler than the same month from 2022 or before. At present, 2025 will likely be the second or third warmest year on record, and cooler than 2024. The past 11 years, 2015 to 2025, will individually have been the eleven warmest years in the 176-year observational record, with the past three years being the three warmest years on record.

The high global temperatures in the past three years relative to the preceding two years are related to the transition from a prolonged La Niña that lasted from 2020 to early 2023, but reductions in aerosols and other factors likely also played a role in the warming.

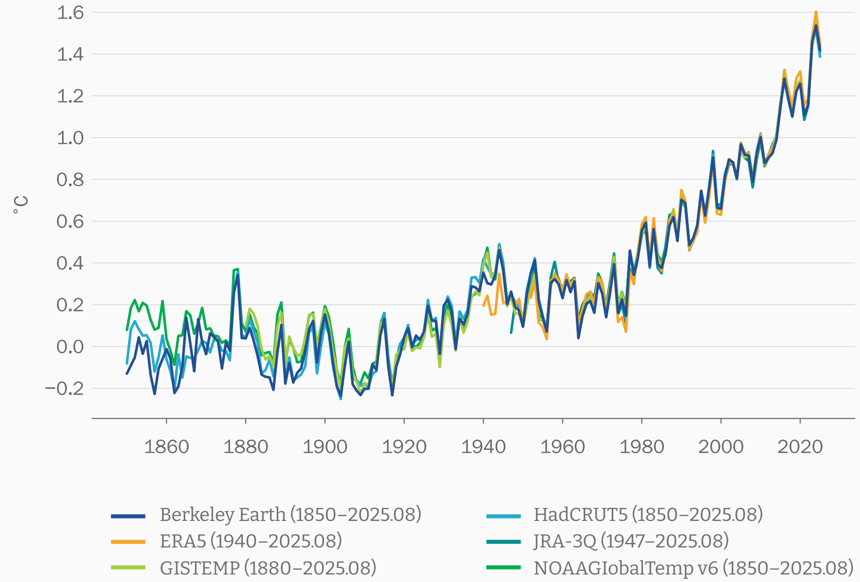


Figure 2. Annual global mean temperature anomalies (relative to 1850–1900) from 1850 to 2025 from six datasets. The 2025 average is based on data from January to August.

Ocean heat content in 2024 was the highest on record

Preliminary data show 2025 has continued at comparable levels.

Did you know?

Over three billion people depend on marine and coastal resources for their livelihoods.

Ocean heat content in 2024 was the highest on record, exceeding the 2023 value by 16 ± 8 zetajoules (ZJ). Preliminary data from the early months of 2025 indicate that ocean heat content has continued to rise.

Ocean warming rates show a particularly strong increase over the past two decades. The average rate of warming was 0.6 ± 0.1 W m^{-2} from 1971 to 2024 and 1.0 ± 0.1 W m^{-2} from 2005 to 2024.

The observed ocean warming indicates that the Earth is currently out of energy balance. The rate of warming reveals how rapidly the Earth system is trapping surplus energy in the form of heat. Over 90% of that energy goes into warming the ocean.

Ocean warming has far-reaching consequences, including the degradation of marine ecosystems, loss of biodiversity, and a weakening of the ocean's role as a carbon sink. It intensifies tropical and subtropical storms, accelerates sea-ice loss in the polar regions, and – together with melting land ice – drives sea-level rise. This warming is projected to continue, representing a change that is irreversible on centennial to millennial timescales.

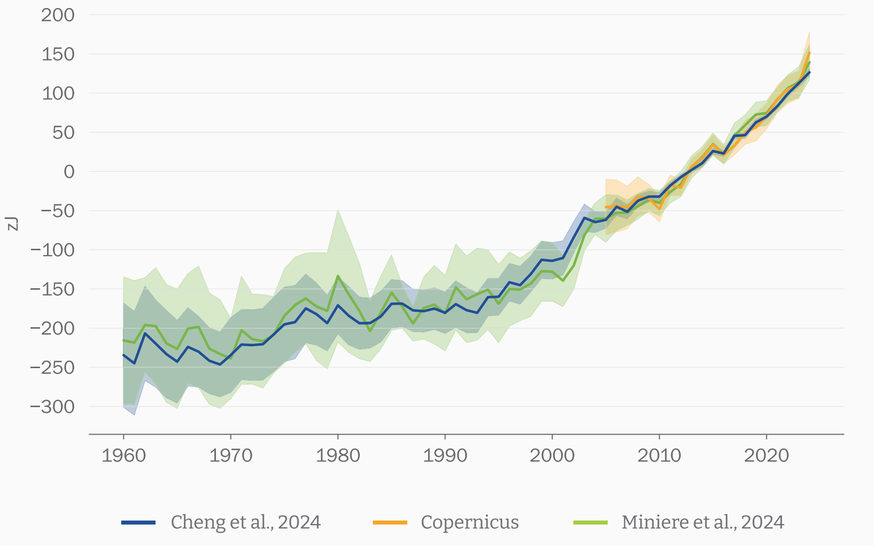


Figure 3. Annual global ocean heat content down to 2 000 m depth for the period 1960–2024, in zettajoules (10^{21} J). The shaded area indicates the 2-sigma uncertainty range on each estimate.

The long-term rate of sea-level rise has increased

Natural variability may have led to a small drop in 2025 to date compared to 2024.

Did you know?

Nearly 11% of the global population, around 900 million people, live on low-lying coasts directly exposed to coastal hazards.

The year 2024 set a new record for annual global mean sea level as measured by satellites. Preliminary 2025 data show that the global mean sea level started the year at a level similar to that in 2024 but has since dropped slightly. This is likely a temporary behaviour related to the internal climate variability superimposed on the long-term positive trend. As in 2011, extensive flooding in the Australian interior concurrent with La Niña conditions may have contributed to the temporary drop in sea level.

The long-term rate of sea-level rise has increased since the start of the satellite record, increasing from 2.1 mm yr^{-1} between 1993 and 2002 to 4.1 mm yr^{-1} between 2016 and 2025. This reflects the combined influence of ocean warming and thermal expansion, together with the melting of glaciers and ice sheets. These individual contributions can be assessed by comparing observed sea-level rise with independently measured drivers such as changes to upper-ocean heat content and glacier melt. This assessment enables the tracing of sea-level changes to their underlying causes. Since 2016, observed sea-level rise has outpaced the sum of known contributions, though recent studies indicate that including deep ocean warming largely explains this gap.

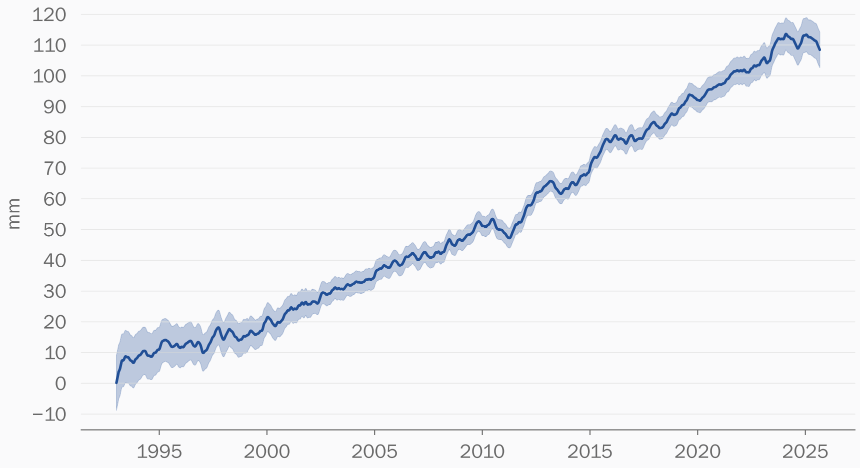


Figure 4. Seasonal global mean sea level change from 1993 shown for 1993–September 2025. The seasonal cycle has been removed from the data. The shaded area indicates the uncertainty.

In the hydrological year 2023/2024, glaciers lost an observed record 1.3 metres water equivalent of ice

The hydrological year 2023/2024 was the third consecutive year that all monitored glaciated regions around the world recorded net mass loss.

For the hydrological year 2023/2024 (October 2023–September 2024), data from a set of reference glaciers monitored by the World Glacier Monitoring Service indicate a global annual mass balance of −1.3 m of water equivalent, or 450 gigatonnes. This is equivalent to 1.2 mm of global mean sea-level rise and nominally the largest loss of ice on record back to 1950. It was driven by an extremely negative balance in both Central Europe and the Southern Andes, and more than double the average annual loss rates of the late twentieth century.

2024 was the third consecutive year that all 19 of the monitored glaciated regions around the world recorded net mass loss. In the Latin America and Caribbean region, Venezuela lost its final glacier, Humboldt, joining Slovenia as the first two countries to lose all their glaciers in modern times. In Africa, the last remaining glaciers, including those on Mount Kilimanjaro, are now on the verge of disappearing, while in the South-west Pacific, glaciers on Puncak Jaya in Indonesia are almost completely lost. These regional findings underscore the retreat of the cryosphere and have far-reaching implications for both local water resources and global sea-level rise.

Did you know?

Between 2002 and 2021, global glacier mass loss contributed approximately 20% to global sea-level rise.

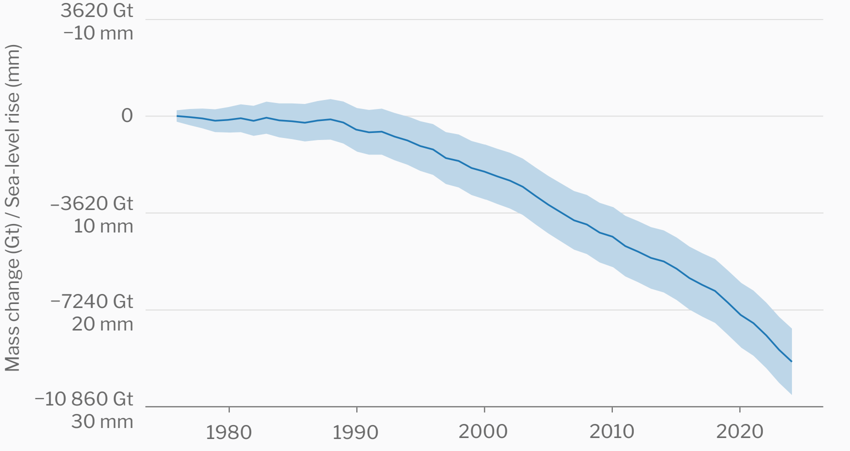


Figure 5. Cumulative global glacier mass change estimates and related contributions to sea-level rise since 1975. Cumulative mass changes in Gt (1 Gt = 10^{12} kg) and global sea-level equivalents in mm sea-level rise are shown with related uncertainties at 95% confidence intervals.

Source: World Glacier Monitoring Service

The annual maximum Arctic sea-ice extent was the lowest on record in the satellite era

Antarctic and Arctic sea-ice extent continued to be below average in 2025.

Arctic sea-ice extent reached its annual maximum of 13.8 million km^2 around 19 March 2025, the lowest maximum extent in the satellite record. Arctic sea-ice extent reached its annual minimum of 4.6 million km^2 around 6 September 2025.

Antarctic sea-ice extent reached its annual minimum of 2.1 million km^2 around 24 February 2025, the third lowest extent in the satellite record (1978–2025), the lowest being in 2023. The annual maximum Antarctic sea-ice extent of 17.9 million km^2 was reached around 16 September 2025. The 2025 maximum extent is the third lowest in the satellite record, the lowest being in 2023.

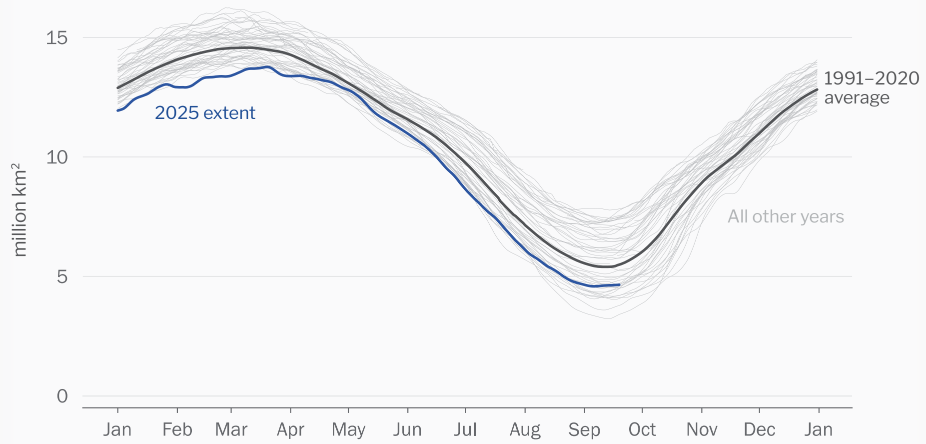


Figure 6. Daily Arctic sea-ice extents in 2025 compared to the average and historical records since 1978

Source: JAXA

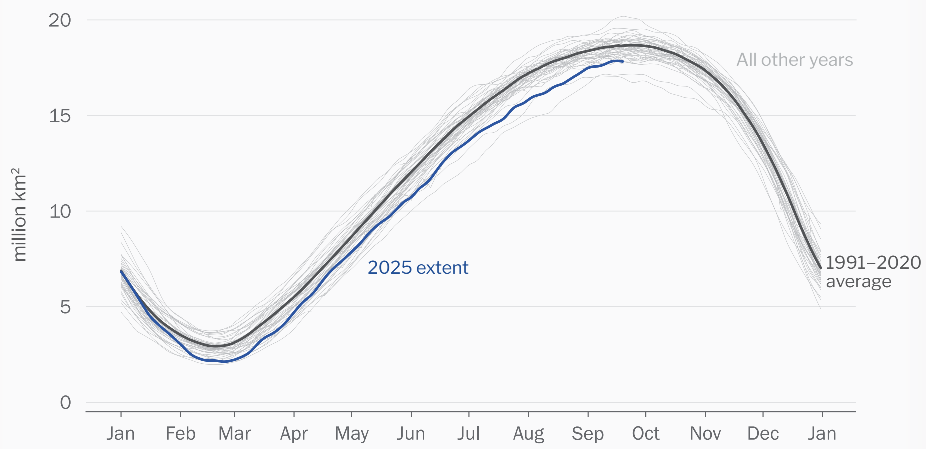


Figure 7. Daily Antarctic sea-ice extents in 2025 compared to the average and historical records since 1978

Source: JAXA

Precipitation varied around the world from January to August 2025

Multi-year dry conditions persisted across central South America, while anomalously high precipitation affected much of Asia.

Unusually low precipitation was recorded in large parts of Canada, the Middle East, South-west Asia, parts of Central Africa, and South-east and North-west Europe. Low precipitation was also recorded in parts of the Himalayas, central and southern Australia, the northern Caribbean islands, and many of the islands in the Pacific. Dry conditions persisted in central South America, lasting since 2023.

Unusually high precipitation totals were recorded in northern Asia, South and South-east Asia and the Maritime Continent, northern South America, north-western North America, parts of Eastern Europe, the western Mediterranean region, some locations in Southern and West Africa, and in parts of the Sahel region.

While annual average differences provide a global distribution pattern, extreme precipitation events are usually recorded at daily-to-monthly timescales. They are associated with heavy rain events that increase the risk of floods. Some of these extreme precipitation events are depicted on the map in the Extreme events section below. Precipitation anomalies also directly influence river discharge, groundwater and soil moisture, described below.

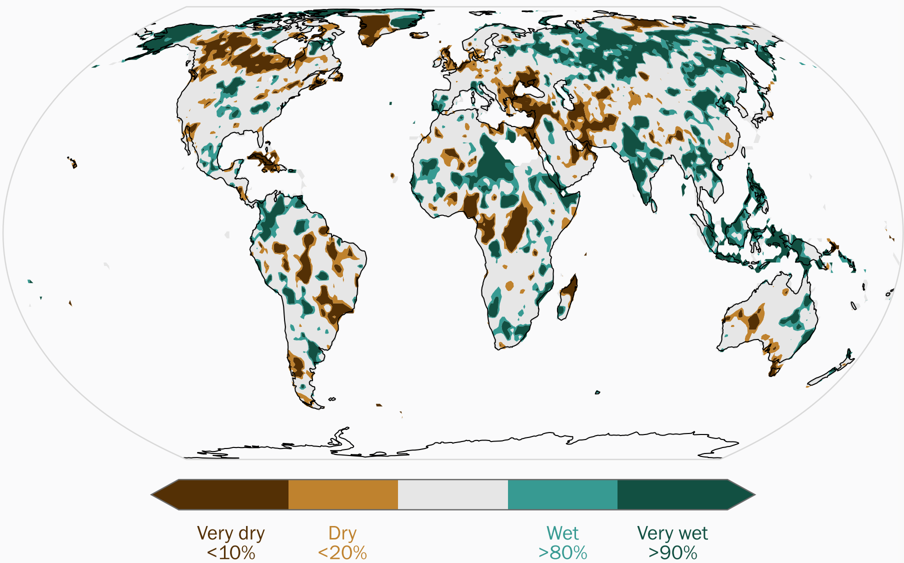
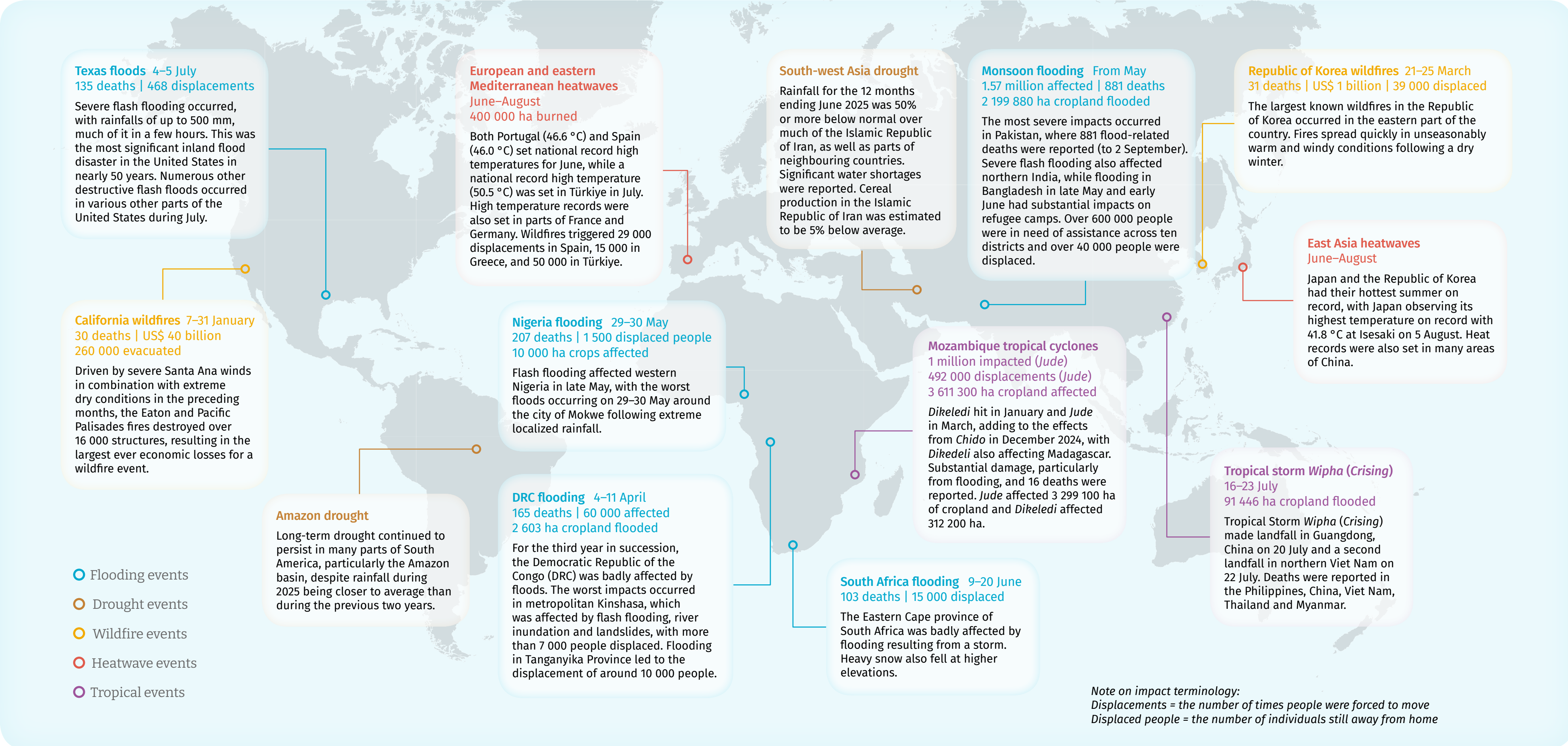


Figure 8. Annual precipitation from January to August 2025 expressed as percentiles of the 1991–2020 distribution. Brown areas are unusually dry. Green areas are unusually wet.

Source: Global Precipitation Climatology Centre

Extreme weather and climate-related events to August 2025 had major global impacts

The compounding impacts of these events have damaged cropland, eroded livelihoods and deepened poverty, and contributed to displacement across multiple regions.



Texas floods 4–5 July
135 deaths | 468 displacements

Severe flash flooding occurred, with rainfalls of up to 500 mm, much of it in a few hours. This was the most significant inland flood disaster in the United States in nearly 50 years. Numerous other destructive flash floods occurred in various other parts of the United States during July.

California wildfires 7–31 January
30 deaths | US$ 40 billion
260 000 evacuated

Driven by severe Santa Ana winds in combination with extreme dry conditions in the preceding months, the Eaton and Pacific Palisades fires destroyed over 16 000 structures, resulting in the largest ever economic losses for a wildfire event.

Amazon drought

Long-term drought continued to persist in many parts of South America, particularly the Amazon basin, despite rainfall during 2025 being closer to average than during the previous two years.

European and eastern Mediterranean heatwaves
June–August
400 000 ha burned

Both Portugal (46.6 °C) and Spain (46.0 °C) set national record high temperatures for June, while a national record high temperature (50.5 °C) was set in Türkiye in July. High temperature records were also set in parts of France and Germany. Wildfires triggered 29 000 displacements in Spain, 15 000 in Greece, and 50 000 in Türkiye.

Nigeria flooding 29–30 May
207 deaths | 1 500 displaced people
10 000 ha crops affected

Flash flooding affected western Nigeria in late May, with the worst floods occurring on 29–30 May around the city of Mokwe following extreme localized rainfall.

DRC flooding 4–11 April
165 deaths | 60 000 affected
2 603 ha cropland flooded

For the third year in succession, the Democratic Republic of the Congo (DRC) was badly affected by floods. The worst impacts occurred in metropolitan Kinshasa, which was affected by flash flooding, river inundation and landslides, with more than 7 000 people displaced. Flooding in Tanganyika Province led to the displacement of around 10 000 people.

South-west Asia drought

Rainfall for the 12 months ending June 2025 was 50% or more below normal over much of the Islamic Republic of Iran, as well as parts of neighbouring countries. Significant water shortages were reported. Cereal production in the Islamic Republic of Iran was estimated to be 5% below average.

Monsoon flooding From May
1.57 million affected | 881 deaths
2 199 880 ha cropland flooded

The most severe impacts occurred in Pakistan, where 881 flood-related deaths were reported (to 2 September). Severe flash flooding also affected northern India, while flooding in Bangladesh in late May and early June had substantial impacts on refugee camps. Over 600 000 people were in need of assistance across ten districts and over 40 000 people were displaced.

Mozambique tropical cyclones
1 million impacted (*Jude*)
492 000 displacements (*Jude*)
3 611 300 ha cropland affected

Dikeledi hit in January and *Jude* in March, adding to the effects from *Chido* in December 2024, with *Dikedeli* also affecting Madagascar. Substantial damage, particularly from flooding, and 16 deaths were reported. *Jude* affected 3 299 100 ha of cropland and *Dikeledi* affected 312 200 ha.

South Africa flooding 9–20 June
103 deaths | 15 000 displaced

The Eastern Cape province of South Africa was badly affected by flooding resulting from a storm. Heavy snow also fell at higher elevations.

Republic of Korea wildfires 21–25 March
31 deaths | US$ 1 billion | 39 000 displaced

The largest known wildfires in the Republic of Korea occurred in the eastern part of the country. Fires spread quickly in unseasonably warm and windy conditions following a dry winter.

East Asia heatwaves
June–August

Japan and the Republic of Korea had their hottest summer on record, with Japan observing its highest temperature on record with 41.8 °C at Isesaki on 5 August. Heat records were also set in many areas of China.

Tropical storm *Wipha* (*Crising*)
16–23 July
91 446 ha cropland flooded

Tropical Storm *Wipha* (*Crising*) made landfall in Guangdong, China on 20 July and a second landfall in northern Viet Nam on 22 July. Deaths were reported in the Philippines, China, Viet Nam, Thailand and Myanmar.

Note on impact terminology:
Displacements = the number of times people were forced to move
Displaced people = the number of individuals still away from home

Global river discharge anomalies continued in 2024

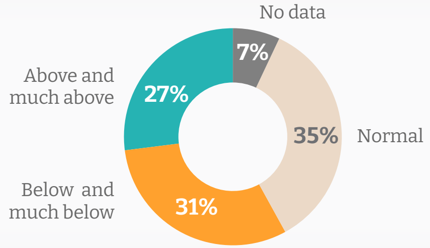
About 60% of catchments recorded above- or below-normal flows, marking the sixth consecutive year of widespread disruption in the global water cycle.

River discharge is one of the key indicators of the global water cycle, reflecting precipitation and temperature anomalies. In 2024 – the latest year for which consolidated data are available – only about one-third of the global catchment area was within normal discharge ranges compared to the 1991–2020 baseline. This is continuing a six-year pattern of disruption, reflecting either too much or too little water.

Much-below-normal discharge persisted across South America, affecting the Amazon, São Francisco, La Plata and Orinoco basins, and across North Africa, with implications for hydropower production (see the Renewable energy section). Northern basins in North America, including the Mackenzie and Fraser, also remained below normal, while the Mississippi basin returned closer to average after the extended drought of 2022–2023. In Oceania, most of Australia recorded normal to below-normal discharge apart from the north (which had wetter conditions), and New Zealand showed a north–south contrast, with the North Island drier and the South Island wetter.

By contrast, much-above-normal flows and flooding occurred in Central and Northern Europe, including the Danube basin, and in West Africa, where the Senegal, Niger and Volta basins recorded surpluses. Several Asian basins also experienced high flows, including the Ganges and upper Indus, while snowmelt drove major flooding in the Balkhash, Ural and Ob basins of Kazakhstan and the Russian Federation.

World river discharge conditions in 2024



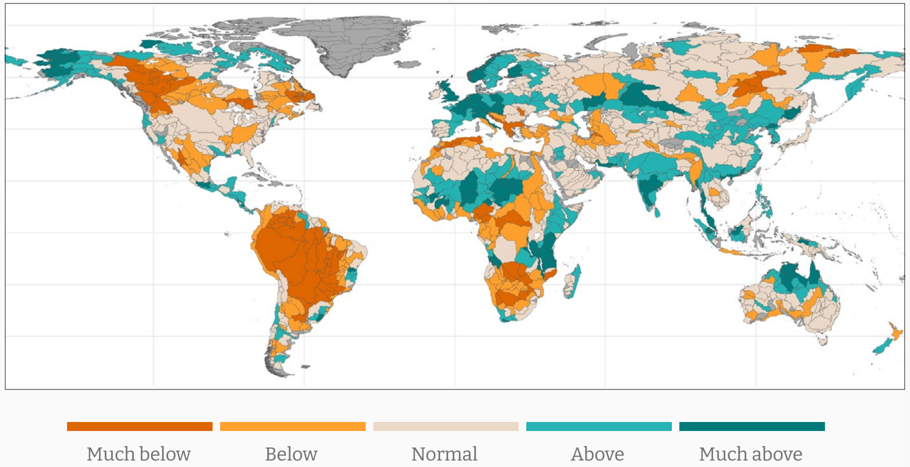


Figure 9. River discharge anomalies in 2024 calculated from 12 global hydrological models and expressed as percentiles relative to the 1991–2020 reference period. Percentiles are defined as much below normal (≤10th percentile), below normal (10th–25th), normal (25th–75th), above normal (75th–90th), and much above normal (≥90th percentile).

Reservoir inflows, soil moisture and groundwater also reflected these discharge anomalies, with deficits across South America and Southern Africa, and surpluses in Europe, Asia and the Greater Horn of Africa.

Climate variability continued to impact renewable energy production

As global renewable energy capacity expands, integrating climate data and science is essential across the sector's value chain – from generation to transmission, distribution and dispatch. Climate-informed energy indicators make it possible to estimate impacts at every stage of this chain.

Did you know?

Global renewable power capacity reached 4 448 GW in 2024 – a 15% increase from 2023, the strongest annual growth on record.

Renewable energy is a key component of climate change mitigation, and production and demand are closely tied to climate variability. Year-to-year changes in temperature, wind, precipitation and cloud cover can directly influence both the generation of renewable power and the demand for energy.

In 2024, major climate drivers affected energy supply and demand across the globe. For example, ongoing dry conditions across South America (see Precipitation/river discharge section above) suppressed hydropower output, while high temperatures elevated electricity demand for cooling. In South Asia, below-normal wind and solar photovoltaic (PV) power production coincided with higher-than-average energy demand, highlighting potential stress on the energy sector. In Southern Africa, the strong El Niño event and above-average winds led to positive anomalies in wind and solar resources – up by 3.4% and 1.5%, respectively. These gains translated into additional power for around 120 000 households (based on the region's currently low installed solar and wind capacities).

Globally, the record heat of 2024 drove energy demand to 4% above the 1991–2020 baseline. This anomaly far exceeded demand in previous years and varied significantly across regions, with demand in Central and Southern Africa nearly 30% above average.

These findings reinforce the need for climate-informed energy planning and operations. As renewable capacity expands globally, accounting for the influence of large-scale climate patterns is essential to build energy systems that are resilient and flexible in a changing climate.

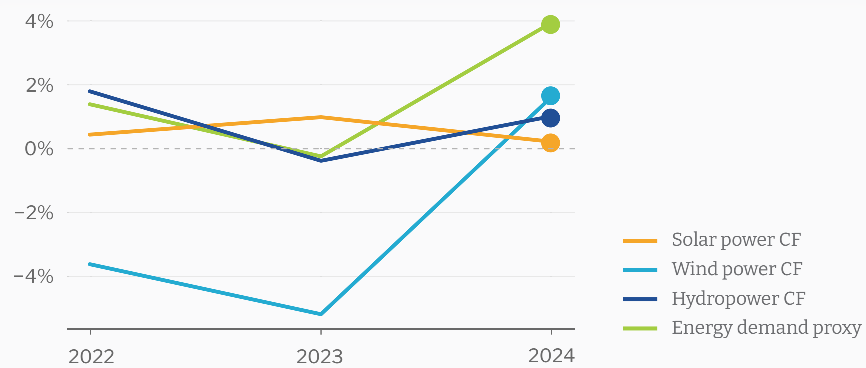


Figure 10. Global annual averages of anomalies for four key energy indicators – wind power, solar PV, hydropower potential and energy demand – expressed as percentage deviations relative to the 1991–2020 climatological reference period for 2022–2024. Note: CF = capacity factor.

National Meteorological and Hydrological Services have a growing role to support climate action

Nationally Determined Contributions (NDCs) are increasingly recognizing the importance of climate services and early warning systems.

Climate services and early warning systems are emerging as indispensable components of updated NDCs (NDC 3.0), translating global climate commitments into real progress on the ground. According to the UNFCCC 2024 NDC Synthesis Report, 92% of Parties with adaptation components in their NDCs emphasized the need for enhanced climate data, observation systems and climate research. Of the NDC 3.0s submitted so far, 26 of 36 explicitly reference climate services and 25 reference early warning systems, underscoring their centrality to national policy planning.

National Meteorological and Hydrological Services (NMHSs) are central to ensuring that NDCs are science-based and actionable. In Mozambique, for instance, tools such as the Climate Information Platform and Climpact enabled the National Institute of Meteorology to produce detailed climate risk profiles that now inform both adaptation and mitigation priorities. This analysis also underpinned Mozambique's Early Warnings for All National Roadmap, soon to be embedded in NDC 3.0, strengthening anticipatory planning across sectors including health, food security and disaster risk reduction.

Encouragingly, NMHS climate service capacity is expanding. According to the WMO's *Checklist for Climate Services Implementation*, approximately 65% of NMHSs are now operating at an essential to advanced level – notable progress compared to five years ago when it was approximately 35%. This trajectory is expected to continue, with essential to advanced-level service provision expected to exceed 90% by 2027. Strengthening this capacity is vital for meeting NDC commitments and the Global Goal on Adaptation (GGA), and for ensuring climate services effectively support early warning systems and climate-sensitive sectors, but it will require sustained support from the global community.

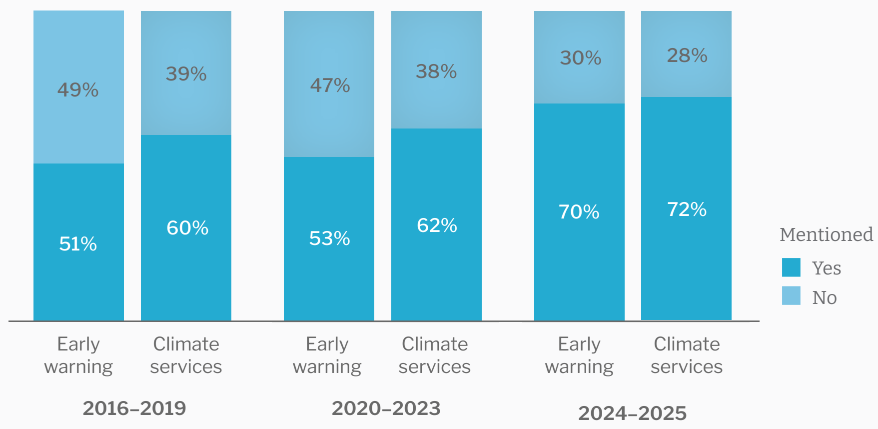


Figure 11. Percentage of NDCs referencing climate services and early warning systems across submission rounds (based on total NDCs submitted)

Early warning systems are expanding with stronger observations and forecasting

The global reach of multi-hazard early warning systems continues to expand, though disparities remain across components. Global cooperation in forecasting and data sharing has been key to this progress.

Effective multi-hazard early warning systems (MHEWSs) are more crucial than ever. Significant advances have been made toward the United Nations Secretary-General's Early Warnings for All (EW4All) initiative, which aims for universal MHEWS coverage by 2027. Since 2015, the number of countries reporting MHEWSs has more than doubled – from 56 to 119 in 2024 – yet 40% of countries still lack MHEWSs. Progress is particularly notable among least developed countries (LDCs) and small island developing States (SIDSs), where reported coverage increased by about 5% in the past year alone.

Effective MHEWSs are built on four pillars: (1) risk knowledge, (2) forecasting, (3) communication and dissemination, and (4) preparedness and response. While dissemination and preparedness are comparatively strong, significant gaps persist in risk knowledge and forecasting capacities, underscoring the need to strengthen the technical foundation of early warning systems.

Observations form the backbone of hazard monitoring and forecasting, improving model performance, extending lead times and enabling more accurate warnings. Since 2019, the number of surface stations sharing observation data has grown by about 20%, while daily observations and reports per station have increased by 60%. LDCs have tripled the number of compliant stations in the past two years, though no country has yet achieved full compliance with WMO network standards.

Forecasting capacity has also advanced substantially through the WMO Integrated Processing and Prediction System (WIPPS). Its global network of over 150 designated centres ensures that all NMHSs can access state-of-the-art forecast products, regardless of their own modelling capacity. Three-quarters of WMO Members now use WIPPS outputs, bridging capability gaps and strengthening forecasting capacity across the global early warning network.

Continued investment in connectivity, data access and technical skills at the national level is essential to close remaining observation and forecasting gaps. With the EW4All initiative nearing its end, urgent action is needed to ensure no country is left behind.

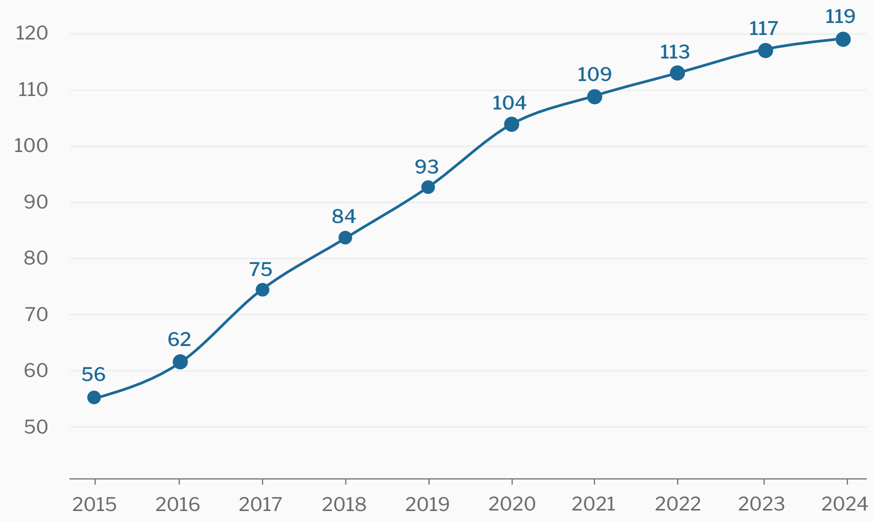


Figure 12. Cumulative number of countries reporting existence of MHEWSs globally

Source: Sendai Framework Monitor, data as of March 2025

Acknowledgements and data sources

Atmospheric indicators
Authors: John Kennedy (WMO expert), Oksana Tarasova (WMO)
Data sources: Greenhouse Gas Bulletin and six datasets (ERA5, GISTEMP, HadCRUT5, JRA-3Q, NOAAGlobalTemp v6, Berkley Earth)

Cryosphere
Authors: Peter Siegmund (Royal Netherlands Meteorological Institute (KNMI))
Sources: World Glacier Monitoring Service (WGMS) and JAXA

Ocean
Authors: Blair Trewin (BOM), John Kennedy (WMO), Anny Cazenave (LEGOS), Lancelot Leclercq (Laboratory of Space Geophysical and Oceanographic Studies (LEGOS)), Karina von Schuckmann (Mercator Ocean)
Sources: Cheng et al., 2024; Copernicus; Miniere et al., 2023; AVISO CNES

Precipitation
Authors: Markus Ziese (Global Precipitation Climatology Centre, Deutscher Wetterdienst (GPCC-DWD))
Source: Global Precipitation Climatology Centre

River discharge
Authors: Sulagna Mishra (WMO), Stefan Uhlenbrook (WMO)
Source: *State of Global Water Resources 2024* provides a standardized, authoritative overview of the global water cycle based on the latest observational datasets and global hydrological modelling systems.

Extreme events
Authors: Blair Trewin (BOM), Jana Birner (UNHCR), Esmé Okeeffe (United Nations High Commissioner for Refugees (UNHCR)), Elisabeth du Parc (International Organization for Migration (IOM)), Giancarlo Pini (World Food Programme (WFP))
Data sources: EM-DAT, Internal Displacement Monitoring Centre, Advanced Disaster Analysis and Mapping (ADAM). For a full list of sources, please consult the extreme events supplement.

Renewable energy
Authors: Roberta Boscolo (WMO), Alberto Troccoli (World Energy & Meteorology Council (WEMC))
Sources: WMO and IRENA review of climate-driven global renewable energy potential and energy demand (third edition in preparation). This annual report examines four key indicators – wind, solar, hydropower and energy demand – relative to the 1991–2020 climate reference period.

Climate services
Authors: Veronica Grasso (WMO), Nakiete Msemo (WMO), Ilaria Gallo (WMO)
Sources: The UNFCCC *2024 NDC Synthesis Report* synthesizes information from the 168 latest available NDCs, representing 195 Parties to the Paris Agreement, including the 153 new or updated NDCs communicated by 180 Parties. A Checklist for Climate Services Implementation data is available via the Climate Services Dashboard.

Early Warnings for All
Authors: Assia Alexieva (WMO), Anais Bellalouna (WMO), Daniela Cuellar Vargas (WMO)
Sources: *The Early Warnings for All in Focus: Hazard Monitoring and Forecasting* report is entirely focused on Pillar 2 and captures WMO's programmatic work, including multiple case studies from projects, and data from Rapid Assessments Country Hydromet Diagnostics and the recent Data Collection Campaign.

The Sendai Framework Monitor is an online tool that captures progress data self-reported (by member States) against a set of 38 Sendai Framework indicators towards the seven Sendai Framework global targets.

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