WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

# GLOBAL SEASONAL CLIMATE UPDATE

## TARGET SEASON: September-October-November 2023

**Issued: 26 August 2023**

## Summary

During May-July 2023, the Pacific Niño sea-surface temperature (SST) index in the eastern Pacific (Niño 1+2) was much above-normal and the other three indices in the central Pacific were also positive. The observed SST conditions in the equatorial Pacific were characterized by a weak El Niño state. The Indian Ocean Dipole (IOD) was near normal. The North Tropical Atlantic (NTA) and the South Tropical Atlantic (STA) SST indices were also positive and reflected widespread warmth in the tropical Atlantic north of the equator.

Above-normal sea-surface temperature anomalies in the Niño 3.4 and Niño 3 regions are predicted to amplify during the September-November (SON) 2023 season, indicating the development of moderate to strong El Niño conditions. Farther west in the Niño 4 region, the sea-surface temperature anomaly is also predicted to be above-normal. The Indian Ocean Dipole (IOD) index is also predicted to be above-normal in SON 2023. In the equatorial Atlantic, SSTs are predicted to be above-normal in both the northern (NTA) and the southern (STA) areas during the season.

Consistent with the anticipated development of an El Niño in the equatorial central and eastern Pacific, together with the prediction of above-normal sea-surface temperatures over much of the global oceans, there is widespread prediction of above-normal temperatures over almost all land areas. Positive temperature anomalies are expected over almost the entire Northern Hemisphere except for a maritime area off the south-west coast of North America that extends into the central Pacific at about 20° N. The largest increase in probabilities for above-normal temperatures in the Northern Hemisphere is predicted generally south of about 40° N, and also over parts of Central and East Asia, north-eastern parts of North America. Elsewhere in the Northern Hemisphere, including Europe, Greenland, Asia north of about 45° N, and in North America north of about 30° N, the probabilities for above-normal temperature are moderately increased. There are also enhanced probabilities for above-normal temperatures over most of the Southern Hemisphere, except for the areas bordering the eastern tropical Indian Ocean, and southeast Pacific between 120 and 70° W where probabilities for below-normal temperature is enhanced. Over most other Southern Hemisphere land areas north of about 30° S, the probabilities for above-normal temperature are strongly increased. However, over Australia, New Zealand, and over the central and eastern Pacific Ocean islands south of about 20° S the probabilities for above-normal temperatures are only weakly increased. There is no clear signal over South America south of about 35° extending to the southern tip of the continent.

Predictions for rainfall are similar to some of the canonical rainfall impacts of El Niño, which is expected to strengthen in SON 2023. Probabilities for above-normal rainfall are enhanced over a narrow band along and just north of the equator from 150° E extending across the equator to the west coast of South America. Across most of the Pacific Ocean south of about 30° N, and immediately to the north of the wet band, rainfall is predicted to be below-normal. South of the equator and east of the Maritime continent, an area of strong enhancement in below-normal rainfall extends into the Indian Ocean to about 60° E and is consistent with the prediction for the positive phase of the IOD. This area of below-normal rainfall extends southeast towards the western coast of Australia, where it further extends eastward towards Tasmania. East of the Maritime continent, an area of below-normal rainfall extends towards the southeast to the Date Line where it curves southwestward towards the southeast coast of Australia. The probability for below-normal rainfall is also weakly enhanced over much of Australia, and in the middle of the Indian subcontinent. The probability for above-normal rainfall is enhanced in Southeast Asia and extends westward along the Indian Ocean north of the equator towards the eastern coast of Africa and into the Greater Horn of Africa. There is a weak enhancement in the probability of above-normal rainfall over most of western and northern Africa, the Arabian Peninsula, central and northern Asia, parts of eastern Asia, and northern Caribbean. Over North America, a weak enhancement in the probability of above-normal rainfall is predicted over the northwest while the probability for below-normal rainfall is enhanced in the southwest. The probability for below-normal rainfall is enhanced across much of the northern part of South America north of about 25° S, southern parts of Central America and the southern Caribbean. The probability for above-normal rainfall is enhanced in South America below 30° S, however, over the extreme southern tip of the continent the probability for below-normal rainfall is enhanced and extends westward along 55° S to about 120° W.

**Surface Air Temperature, SON 2023** **Precipitation, SON 2023**

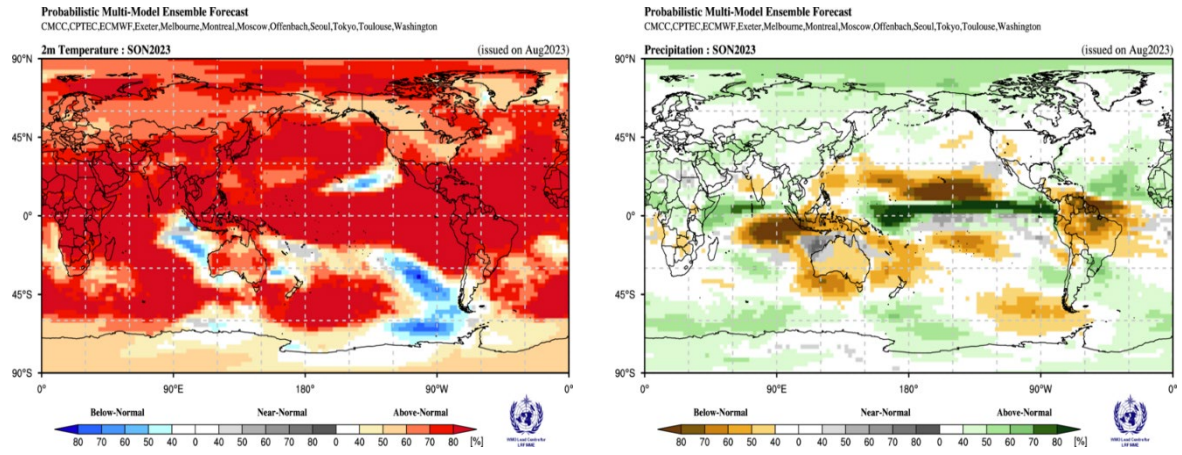



Figure 1. Probabilistic forecasts of surface air temperature and precipitation for the season September-November 2023. The tercile category with the highest forecast probability is indicated by shaded areas. The most likely category for below-normal, above-normal, and near-normal is depicted in blue, red, and grey shadings respectively for temperature, and orange, green and grey shadings respectively for precipitation. White areas indicate equal chances for all categories in both cases. The baseline period is 1993–2009.

# 1. Observations: May-July 2023

In the following sections, observed temperature and precipitation patterns for the previous season are discussed. For more detailed information about regional and local climate anomalies, the reader is referred to the concerned WMO Regional Climate Centres (RCCs) or RCC Networks, listed in Section 5.

## 1.1 Large-scale sea-surface temperature (SST) indices

During May-July 2023, the Pacific Niño sea-surface temperature (SST) index in the eastern Pacific (Niño 1+2) was much above-normal and the other three indices in the central Pacific were also positive. The observed SST conditions in the equatorial Pacific were characterized by a weak El Niño state. The Indian Ocean Dipole (IOD) was near normal. The North Tropical Atlantic (NTA) and the South Tropical Atlantic (STA) SST indices were also positive and reflected widespread warmth in the tropical Atlantic north of the equator.

| Month | Niño 1+2 | Niño 3 | Niño 4 | Niño 3.4 | IOD | NTA | STA |
|---|---|---|---|---|---|---|---|
| May 2023 | 2.0 | 0.9 | 0.3 | 0.5 | 0.0 | 0.8 | 0.6 |
| June 2023 | 2.6 | 1.2 | 0.6 | 0.9 | -0.1 | 1.3 | 0.3 |
| July 2023 | 3.2 | 1.6 | 0.7 | 1.1 | 0.1 | 1.3 | 0.3 |
| May - July 2023 | 2.6 | 1.2 | 0.6 | 0.8 | 0.0 | 1.2 | 0.4 |

Table 1. Large-scale oceanic indices (°C). Anomalies are with respect to the 1991–2020 average. (*Source:* U.S. Climate Prediction Center)

### 1.2 Observed temperature

Over land areas, temperature anomalies for May-July 2023 were generally above normal with small regions of below-normal conditions interspersed in between (Figure 2, top). In the northern hemisphere, positive land-temperature anomalies occurred almost over the entire North America, with the exception being a narrow belt of normal to below-normal along 35° N stretching across the continent and also over the extreme northwest. Above average temperature anomalies also occurred over the northern regions of Central America, the Caribbean, southern and western Europe, coastal regions of western Africa, a north-south band along 50° E extending across Asia, and the eastern parts of East Asia extending into southeast Asia. Negative temperature anomalies were observed over Greenland, and regions of eastern Europe extending into western Asia. In the Southern Hemisphere, positive temperature anomalies dominated and were observed over South America, Africa, New Zealand, and the southern regions of the Maritime Continent. Negative temperature anomalies were observed over most of Australia and Madagascar.

Over the oceans, in the equatorial eastern Pacific extending all the way to the western coastal regions of South America, extending further north along the coast of Central America and south along the coast of South America, above-normal temperature anomalies occurred. These temperature anomalies reflected El Niño conditions. In the extratropical southern Pacific Ocean along 60° S and between 180°-60° W, below average temperatures were observed. SST anomalies in the Pacific north of 30° N and in the southern Pacific along 45° S were positive. A band of positive SST anomalies also extended from the Maritime continent towards the southern coast of South America. SSTs in the Indian Ocean were near average. SSTs in the western Caribbean and over almost the entire Atlantic Ocean and Mediterranean were above-normal.

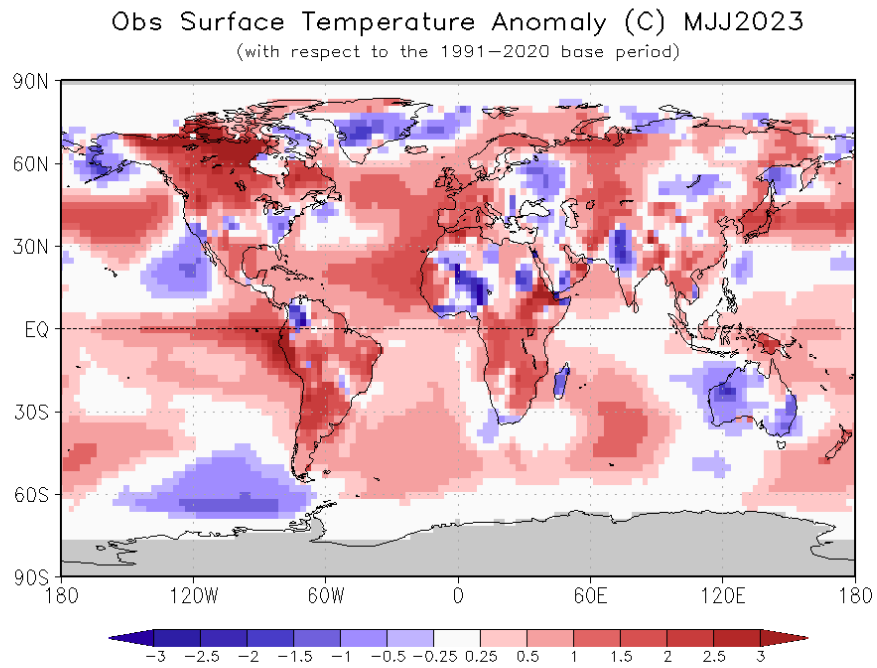
Warm extremes (exceeding all seasonal mean temperatures observed during 1991–2020), occurred over a few patchy land regions – in the far north and a band along 50°N over North America, equatorial Africa which in the eastern regions extended north and south, western regions of South America below the equator (Figure 3, bottom panel). Warm extremes also occurred over oceanic regions, notably over the eastern Atlantic extending from the coastal regions from north-western Africa into the coastal regions of western Europe. A region of warm extreme also occurred in the southern Indian Ocean between 60°-90° E. A region of cold extreme was observed over the interior region of western Africa.

### 1.2 Observed precipitation

For May-July 2023, the precipitation anomalies in the equatorial Pacific were starting to reflect El Niño conditions with a narrow band of above-normal anomalies extending throughout the equatorial eastern Pacific and a broader region in the western Pacific (Figure 3, top panel). To the north of this equatorial band of above-normal anomalies, starting near the Date Line a band of below-normal precipitation anomalies extended eastward towards Central America. South of the equator, also starting near the date line, a band of below-normal precipitation anomalies extended south-eastward to the western coast of South America. Below-normal precipitation anomalies dominated the Indian Ocean. Positive precipitation anomalies occurred in the north equatorial Atlantic. Coastal regions of western and eastern Australia were dominated by below-normal precipitation anomalies.

Over land, negative precipitation anomalies dominated in Central America and extended into the northern regions of South America. A band of below-normal precipitation anomalies extended along 50°N over North America into the northern Atlantic. Below-normal precipitation anomalies were also observed over Greenland, northern Europe, central Asia, and coastal regions of western and eastern Australia. Above-normal precipitation anomalies occurred in northern equatorial Africa, eastern coastal regions of Africa extending into the southernmost region, southern Europe, and the Indian subcontinent.

Small patchy regions of wet extremes (exceeding all seasonal mean rainfall observed during 1991-2020) were scattered over different land regions that include Africa, the Indian subcontinent, northern Caribbean, and southern Japan (Figure 3, bottom panel). A region of dry extreme was located over North America along 50°N.



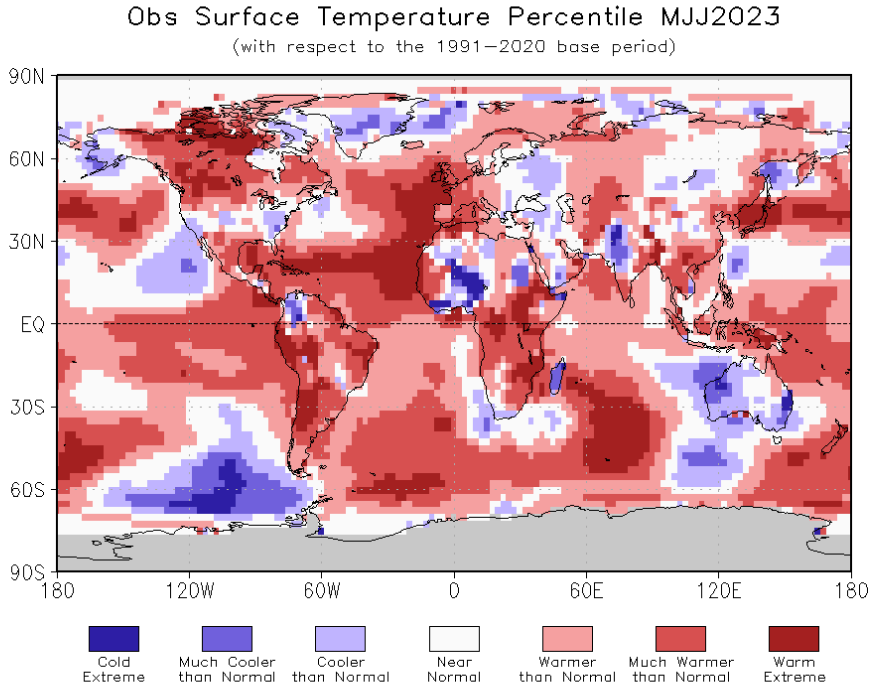
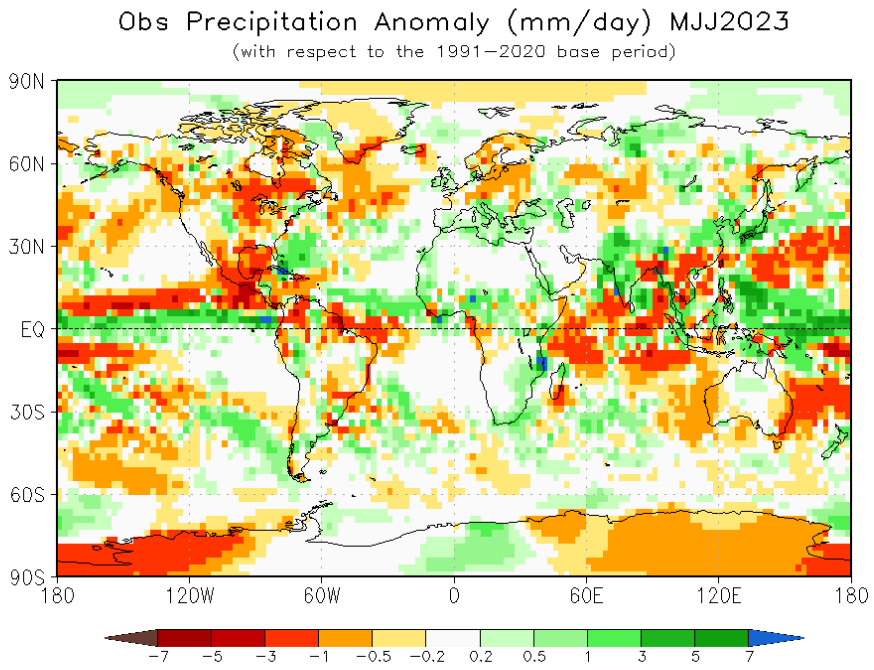




Figure 2. Observed May-July 2023 near-surface temperature anomalies relative to 1991–2020 (top). The *Cooler than Normal, Near Normal, and Warmer than Normal* shadings on the percentile map (bottom) indicate that seasonal mean anomalies were in the bottom, middle, and upper tercile of the 1991–2020 distribution, respectively. Regions with anomalies in the lowest and highest decile (or 10%) of the distribution are marked as *Much Cooler than Normal* and *Much Warmer than Normal*, respectively. The *Cold Extreme* and *Warm Extreme* shadings indicate that the anomalies exceeded the coldest and warmest temperature values of the 1991–2020 period for the season. Grey shading indicates areas where observational analysis was not available. (*Source:* U.S. Climate Prediction Center).



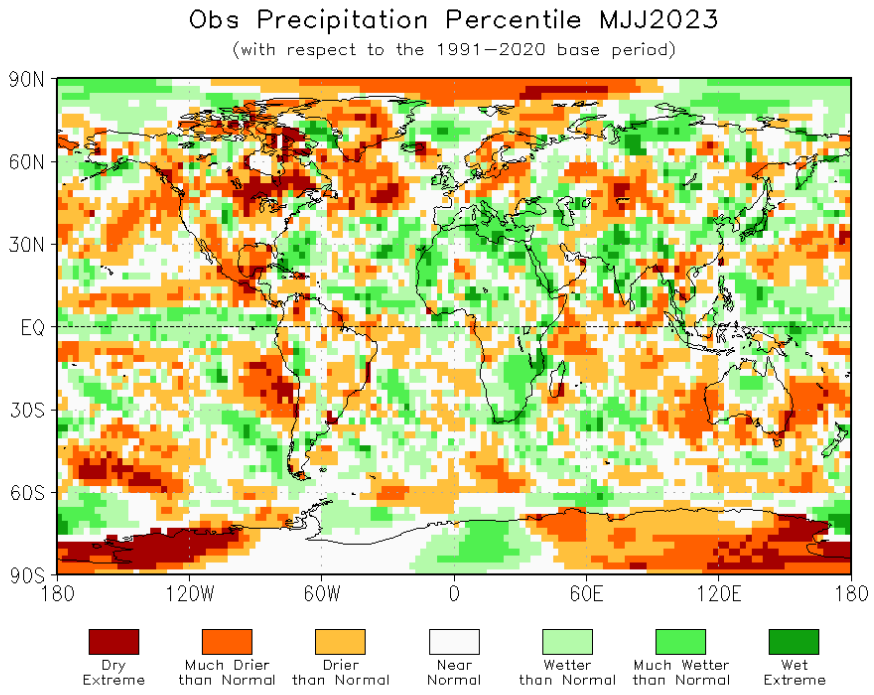




Figure 3. Observed precipitation anomalies for May-July 2023, relative to 1991–2020 base period (top). The *Drier than Normal*, *Near Normal and Wetter than Normal* shadings on the percentile map (bottom) indicate that seasonal mean anomalies were in the bottom, middle, and upper tercile of the 1991–2020 distribution, respectively. Regions with anomalies in the lowest and highest decile (or 10%) of the distribution are marked as *Much Drier than Normal* and *Much Wetter than Normal*, respectively. The *Dry Extreme* and *Wet Extreme* shadings indicate that the anomalies exceeded the driest and wettest values of the 1991–2020 period for the season.
(*Source:* U.S. Climate Prediction Center).

# 2. Potential evolution of the state of the climate over the next three months (September - November 2023 )

## 2.1 Large-scale SST-based indices, September - November (SON) 2023

| Month | Nino 1+2 | Nino 3 | Nino 4 | Nino3.4 | IOD | NTA | STA |
|---|---|---|---|---|---|---|---|
| **September 2023** | 2.8±0.4 | 2.1±0.3 | 1.2±0.2 | 1.7±0.3 | 1.0±0.2 | 1.1±0.2 | 0.4±0.2 |
| **October 2023** | 2.4±0.5 | 2.2±0.3 | 1.4±0.2 | 1.9±0.3 | 1.1±0.2 | 1.0±0.1 | 0.4±0.2 |
| **November 2023** | 2.2±0.5 | 2.3±0.3 | 1.5±0.3 | 2.1±0.3 | 0.9±0.3 | 1.0±0.1 | 0.5±0.2 |
| **September – November 2023** | 2.6±0.5 | 2.2±0.3 | 1.3±0.2 | 1.8±0.3 | 1.0±0.2 | 1.0±0.1 | 0.4±0.2 |

Table 2: Multi-model forecasts for oceanic indices (°C), with standard deviation. Values are the equal-member-weighting average of those derived, using each GPC model's own hindcast climate mean, from the GPCs supplying SST forecasts (GPC Beijing, CMCC, ECMWF, Exeter, Melbourne, Montreal, Offenbach, Seoul, Tokyo, Toulouse, Washington). The standard deviation is calculated on all ensemble members. The latitude/longitude bounds of the regions are given in the supplementary information section.

Observed sea-surface temperatures in the central tropical Pacific were characterized by a weak El Niño state during May-July 2023. Above-normal sea-surface temperature anomalies in the Niño 3.4 and Niño 3 regions are predicted to amplify during the September-November (SON) 2023 season, indicating the development of moderate to strong El Niño conditions. Farther west in the Niño 4 region, the sea-surface temperature anomaly is also predicted to be above-normal. The Indian Ocean Dipole (IOD) index is also predicted to be above-normal in SON 2023. In the equatorial Atlantic, SSTs are predicted to be above-normal in both the northern (NTA) and the southern (STA) areas during the season.

## 2.2 Predicted temperature, September - November 2023

For information on the construction of the multi-model forecast maps, refer to the supplementary information section. (Note: Maps indicating forecast consistency among GPC models are available in the supplementary information[1]).

[1] File with supplementary information can be downloaded from https://ftp.cpc.ncep.noaa.gov/mingyue/GSCUWMO/Forecasts/GSCU_SON2023_supplementary_info_LC-LRFMME.docx

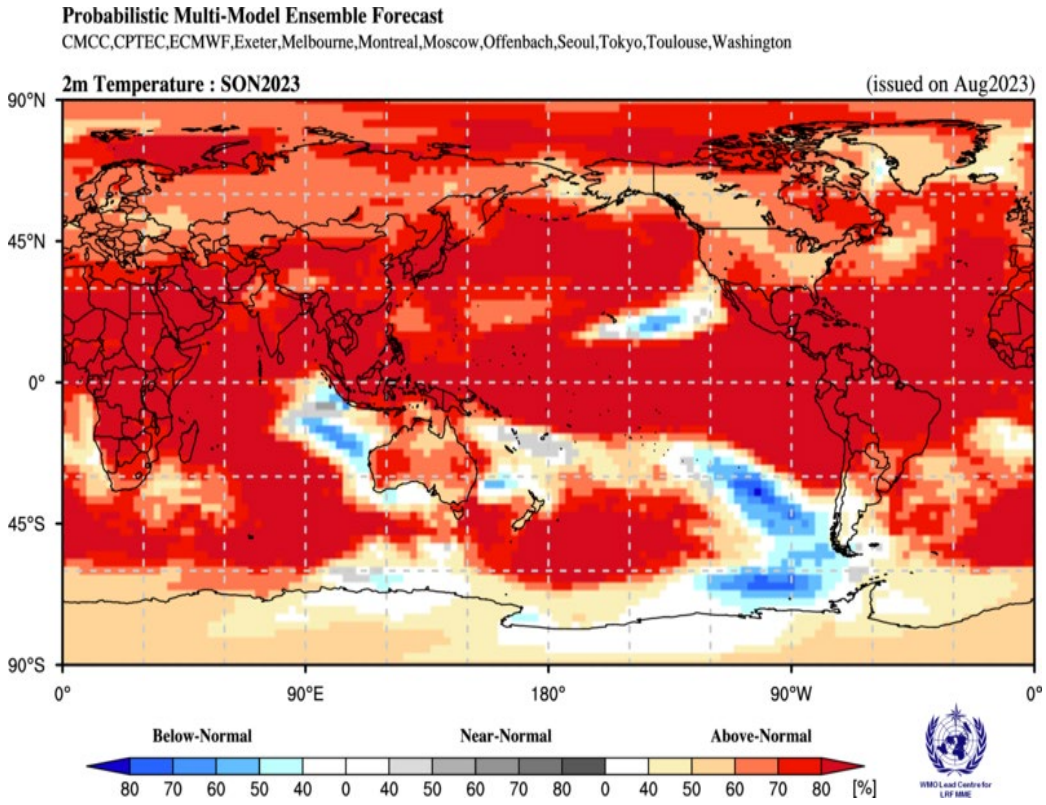



Figure 4. Probabilistic forecasts of surface air temperature for September-November 2023. The tercile category with the highest forecast probability is indicated by shaded areas. The most likely category for below-normal, above-normal, and near-normal is depicted in blue, red, and grey shadings, respectively. White areas indicate equal chances for all categories in both cases. The baseline period is 1993–2009. Figure is generated by The WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble.

Consistent with the anticipated development of an El Niño in the equatorial central and eastern Pacific, together with the prediction of above-normal sea-surface temperatures over much of the global oceans, there is widespread prediction of above-normal temperatures over almost all land areas. Positive temperature anomalies are expected over almost the entire Northern Hemisphere except for a maritime area off the south-west coast of North America that extends into the central Pacific at about 20° N. The largest increase in probabilities for above-normal temperatures in the Northern Hemisphere is predicted generally south of about 40° N, and also over parts of Central and East Asia, north-eastern parts of North America. Elsewhere in the Northern Hemisphere, including Europe, Greenland, Asia north of about 45° N, and in North America north of about 30° N, the probabilities for above-normal temperature are moderately increased. There are also enhanced probabilities for above-normal temperatures over most of the Southern Hemisphere, except for the areas bordering the eastern tropical Indian Ocean, and southeast Pacific between 120 and 70° W where probabilities for below-normal temperature is enhanced. Over most other Southern Hemisphere land areas north of about 30° S, the probabilities for above-normal temperature are strongly increased. However, over Australia, New Zealand, and over the central and eastern Pacific Ocean islands south of about 20° S the probabilities for above-normal temperatures are only weakly increased. There is no clear signal over South America south of about 35° extending to the southern tip of the continent.

RA I (Africa): Enhanced probabilities of above-normal temperatures are indicated over all of mainland Africa and Madagascar. The probability increases are strong everywhere except along a small area of the west coast of Southern Africa extending towards the southernmost tip of Africa. Throughout the continent, model consistency is moderate to strong.

RA II (Asia): Enhanced probabilities for above-normal temperatures are indicated over all mainland Asia. Probabilities for above-normal temperatures are high almost everywhere south of about 40° N but are strongest over central inland Asia at about 90° E, and over the Arabian Peninsula. Over these regions model consistency is moderate to strong. North of 50° N above-normal temperatures is still the most likely outcome, but with the exception of far northern regions, probabilities are weaker than they are further south, and model consistency is moderate.

RA III (South America): Strongly enhanced probabilities for above-normal temperatures are indicated over South America north of about 25º S and extending south to about 30º S along the west coast. Model consistency is high over most of this region. In between 25º S and 35º S there is moderate increase in the probability for above-normal temperature. South of 35ºS and extending to the southern tip of the continent there is no clear signal.

RA IV (North America, Central America, and the Caribbean): There are enhanced probabilities for above-normal temperatures over all of North America. The probabilities for above-normal temperatures are strongest over Central America and the Caribbean but also over the northeast of the continent. Model consistency is moderate to strong virtually everywhere. Along parts of the southwest coast of North America extending into the Pacific Ocean, there are weak probabilities of below-normal temperature that are consistent with an area of predicted negative sea-surface temperature anomalies. However, model consistency is only moderate to strong over the oceans.

RA V (Southwest Pacific): Strongly enhanced probabilities for above-normal temperatures are predicted across the whole of the Pacific Ocean within about 10 to 15º latitude of the equator. Further south, there are patches where probabilities for above-normal temperature are also strongly increased, including a large area extending from south of Australia, around New Zealand to about 120º W. Model consistency is moderate to high over most of these regions. In between 15 and 30º S and extending from the eastern coast of Australia to about 120º W probabilities for above-normal temperature are weakly enhanced. Over Australia, above-normal temperatures are indicated everywhere with higher probabilities in the middle of the continent, and model consistency is moderate to strong. North of the equator, above-normal temperatures are predicted almost everywhere except for an area of predicted below-normal temperatures extending from about 160º W towards North America. Model consistency is moderate in this cold area. In the Indian Ocean, east of the Maritime Continent, consistent with the prediction for the positive phase of the IOD, probabilities for below-normal temperature are enhanced.

RA VI (Europe): The probabilities for above-normal temperatures are increased over all of Europe with stronger probabilities located in the extreme southwest, and also over the extreme north. The model-to-model consistency is moderate to high.

## 2.3 Predicted precipitation, September - November 2023

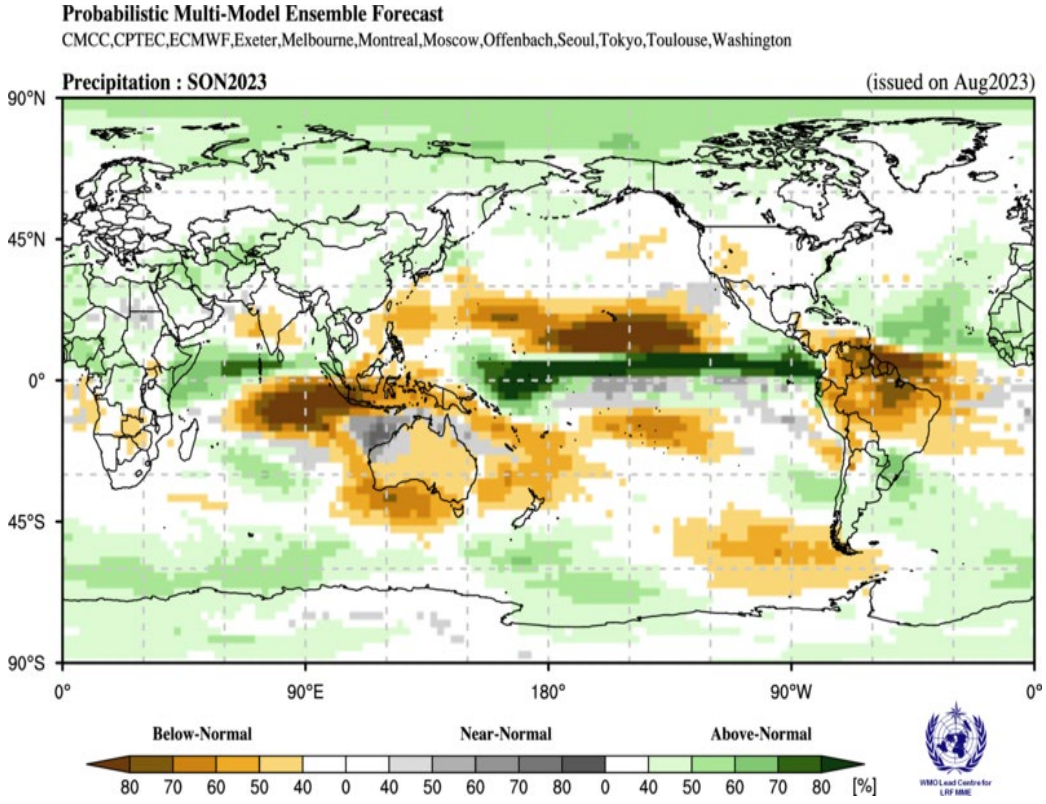


Figure 5. Probabilistic forecasts of precipitation for the season for September-November 2023. The tercile category with the highest forecast probability is indicated by shaded areas. The most likely category for below-normal, above-normal, and near-normal is depicted in orange, green and grey shadings, respectively. White areas indicate equal chances for all categories in both cases. The baseline period is 1993–2009. Figure is generated by The WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble.

Predictions for rainfall are similar to some of the canonical rainfall impacts of El Niño, which is expected to strengthen in SON 2023. Probabilities for above-normal rainfall are enhanced over a narrow band along and just north of the equator from 150º E extending across the equator to the west coast of South America. Across most of the Pacific Ocean south of about 30º N, and immediately to the north of the wet band, rainfall is predicted to be below-normal. South of the equator and east of the Maritime Continent, an area of strong enhancement in below-normal rainfall extends into the Indian Ocean to about 60º E and is consistent with the prediction for the positive phase of the IOD. This area of below-normal rainfall extends southeast towards the western coast of Australia, where it further extends eastward towards Tasmania. East of the Maritime Continent, an area of below-normal rainfall extends towards the southeast to the Date Line where it curves southwestward towards the southeast coast of Australia. The probability for below-normal rainfall is also weakly enhanced over much of Australia, and in the middle of the Indian subcontinent. The probability for above-normal rainfall is enhanced in Southeast Asia and extends westward along the Indian Ocean north of the equator towards the eastern coast of Africa and into the Greater Horn of Africa. There is a weak enhancement in the probability of above-normal rainfall over most of western and northern Africa, the Arabian Peninsula, central and northern Asia, parts of eastern Asia, and northern Caribbean. Over North America, a weak enhancement in the probability of above-normal rainfall is predicted over the northwest while the probability for below-normal rainfall is enhanced in the southwest. The probability for below-normal rainfall is enhanced across much of the northern part of South America north of about 25º S, southern parts of Central America and the southern Caribbean. The probability for above-normal rainfall is enhanced in South America below 30º S, however, over the extreme southern tip of the continent the probability for below-normal rainfall is enhanced and extends westward along 55º S to about 120º W.

RA I (Africa): Enhanced probabilities for above-normal precipitation are predicted over parts of eastern Africa including the Greater Horn of Africa and model consistency is moderate. Over much of Africa west of about 25º E and north of the equator to 15º N there are weak to moderate increases in the probability of above-normal rainfall, with weak to moderate consistency. Around 30º N an area with enhanced probability for above-normal rainfall extends in towards the east and covers most of the north coast of Africa. There are areas with enhanced probability for below-normal rainfall in the vicinity of the Gulf of Guinea and in interior Africa around 20º S but the model consistency is low.

RA II (Asia): Regions with a weak enhancement in probability for above-normal rainfall cover wide areas of Asia that include the Arabian Peninsula extending to Central Asia and western parts of East Asia. This region of enhancement in the probability for above-normal rainfall also extends northeastward to cover the entire northern Asia. Over Southeast Asia and the eastern parts of East Asia there is a weak enhancement in the probability for above normal rainfall. The only region with an enhancement in the probability for below-normal rainfall is along 15º N in the Indian subcontinent. Throughout Asia, with the exception of northern regions where model consistency is stronger, model consistency is moderate.

RA III (South America): Over South America, there is a moderate enhancement in the probability for below-normal rainfall above 20º S. Further, the probability of below-normal rainfall gets stronger towards the north. The model-to-model consistency follows the same pattern with an increase in consistency moving from south to north. Along the west coast of South America, a region with an increase in the probability for below-normal rainfall extends south to 30º S. The probability for above-normal rainfall is enhanced below 30º S, particularly on the eastern side of the continent. However, over the extreme southern tip of the continent the probability for below-normal rainfall is enhanced and extends westward along 55º S to about 120º W. The model consistency over these regions is moderate to high.

RA IV (North America, Central America, and the Caribbean): There is a weak enhancement in the probability for below-normal rainfall in the southern regions of Central America extending into the southern Caribbean. A small region with an increase in probability of below-normal rainfall is also located in southwest North America. In all these regions model consistency is low to moderate. A region with an enhancement in the probability of above-normal rainfall is located in the northwest region of North America and model consistency is moderate.

RA V (Southwest Pacific): Probabilities for above-normal rainfall are strongly enhanced over a narrow area extending along the equator from about 150° E to the coast of South America. Model consistency is moderate to high. Located also at 150° E a southward branch extends to about the dateline. Some of the islands in the Southwest Pacific are located in this branch. Immediately to the north and the south of the equatorial wet band are areas centered at about 150° W, where probabilities for below-normal rainfall are predicted to be moderately to strongly increased. The increases in probabilities are stronger in the north Pacific where the dry area extends to almost 30° N and spans almost the full width of the Pacific Ocean. Model consistency is strong. Below the equator and east of the Maritime continent, an area of strong enhancement in below-normal rainfall (and strong model consistency) extends into the Indian Ocean to about 60° E and is consistent with the prediction for the positive phase of the IOD. This area of below-normal rainfall extends southeast towards the western coast of Australia, where it extends eastward towards Tasmania. East of the Maritime continent, an area of below-normal rainfall extends towards the southeast to the date line where it curves southwestward towards the southeast coast of Australia. The probability for below-normal rainfall is also weakly enhanced over much of Australia and model consistency is moderate to high.

RA VI (Europe): Most of Europe has little to no signal, but there are weak indications of enhanced probability of above-normal precipitation in northern Europe, and model consistency is low for southern Europe.

## 3. Latest updates for monitoring and prediction information

Each month, the latest updates for the real-time monitoring and seasonal mean predictions included in GSCU can be found at:

Monitoring:

https://ftp.cpc.ncep.noaa.gov/mingyue/GSCUWMO/

Predictions:

www.wmolc.org/board/downloadExt?fn=WMOLC_T2M.png

http://www.wmolc.org/board/downloadExt?fn=WMOLC_PREC.png

## 4. How to use the Global Seasonal Climate Update

The GSCU is intended as guidance for RCCs, Regional Climate Outlook Forums (RCOFs) and National Meteorological and Hydrological Services (NMHSs). It does not constitute an official forecast for any region or nation. Seasonal outlooks for any region or nation should be obtained from the relevant RCCs (see below for contact details) or NMHS.

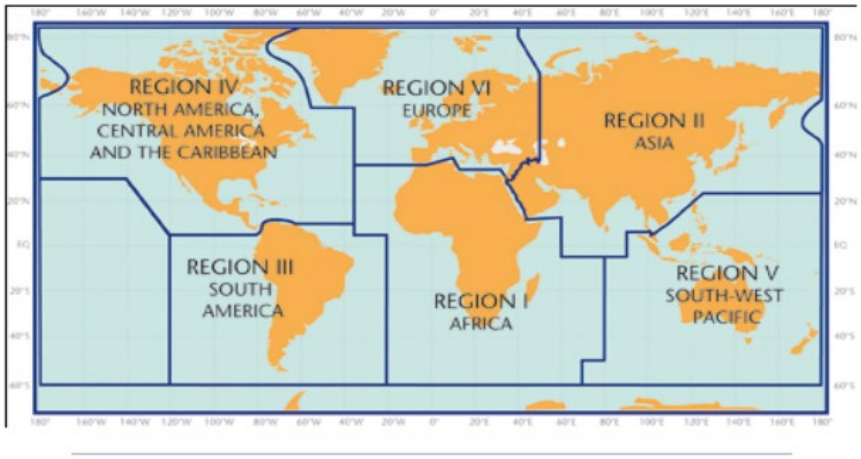
Figure 4 shows the spatial pattern of seasonal mean surface air temperature forecast probabilities. Probabilities are calculated for the average temperature for the season being in the highest third (above-normal or warm), middle third (normal) or lowest third (below-normal or cold) ranges of the baseline record (1993-2009) at each location. Colour code is indicated only for the category that has the highest probability of occurrence. For example, for regions highlighted in red, the most likely forecast category for seasonal mean surface air temperature to occur is warmer than normal. Similarly, the blue colour highlights regions where the seasonal mean surface air temperature forecast indicates the colder than normal category as most likely, while grey colour highlights regions where the seasonal mean temperature forecast indicates the near normal category as most likely. Deeper shades of respective colours highlight increasing probability for the seasonal mean temperature to be in the indicated category. White areas indicate equal chances for all categories.

A particular colour does not assure that the seasonal mean temperature is "certain" to be observed in the most likely forecast category that is shown, but rather its probability of being in that category. As a consequence, the observed seasonal mean temperatures have a non-negligible probability to be observed in a category different from the category indicated on the map as most likely. Users need to take the probabilistic nature of seasonal forecasts into account when making decisions. It should also be noted that the absolute values for the surface air temperature corresponding to the definitions of the above normal (warm), normal or below normal (cold) categories depend on the climatology (historical information) at the location, and therefore, is location dependent.

The interpretation of the probabilities for the rainfall forecast (Figure 5) is the same as that for the seasonal mean surface air temperature except that green and brown colours indicate whether the forecasted seasonal mean precipitation is most likely to be in the wet or dry category. As for surface temperature, grey colour highlights regions where the seasonal mean rainfall forecast indicates the near normal category as the most likely.

The skill of seasonal forecasts is substantially lower than that of weather timescales and skill may vary considerably with region and season. It is important to view the forecast maps together with the skill maps provided in the supplementary material.

For reference, the six WMO Regional Associations domains are depicted in the figure below.




## 5. Designated and developing WMO Regional Climate Centres and Regional Climate Centre Networks

- https://public.wmo.int/en/our-mandate/climate/regional-climate-centres

## 6. Resources

Sources for the graphics used in the GSCU:

- The WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble (LC-LRFMME): http://www.wmolc.org
- WMO portal to the Global Producing Centres for Long-range Forecasts (GPCs-LRF): https://public.wmo.int/en/programmes/global-data-processing-and-forecasting-system/global-producing-centres-of-long-range-forecasts
- WMO portal for Regional Climate Outlook Forums https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products
- International Research Institute for Climate and Society (IRI): https://iri.columbia.edu/
- NOAA Climate Prediction Centre (CPC): http://www.cpc.ncep.noaa.gov

## 7. Acknowledgements

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- WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble (LC-LRFMME), Korea Meteorological Administration, NOAA National Centers for Environmental Prediction
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