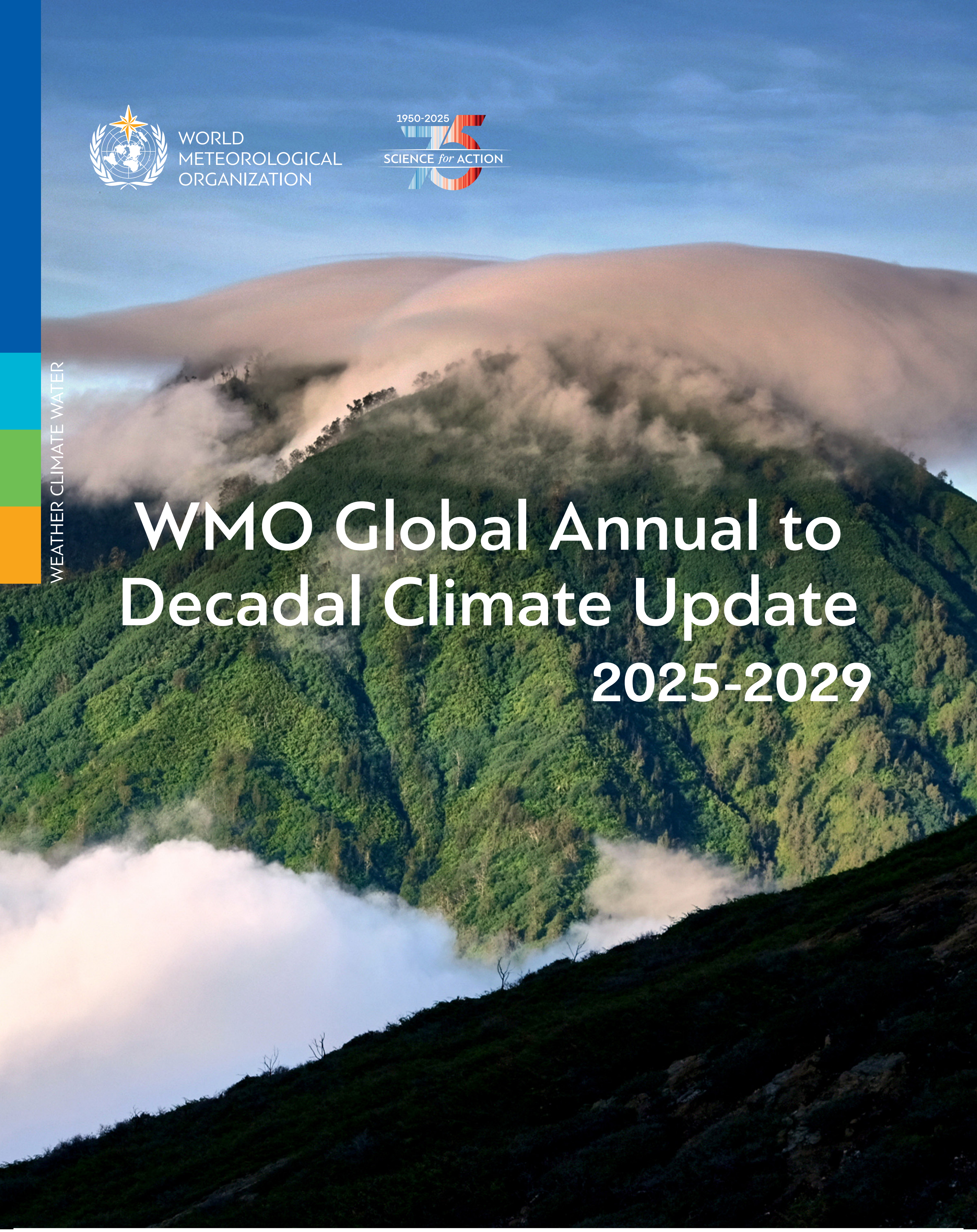

WORLD METEOROLOGICAL ORGANIZATION

1950-2025 SCIENCE for ACTION

WEATHER CLIMATE WATER

WMO Global Annual to Decadal Climate Update 2025-2029

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

CCCMA

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Met Office

WORLD METEOROLOGICAL ORGANIZATION

Global Annual to Decadal Climate Update 2025

Key Messages

The Global Annual to Decadal Climate Update is issued annually by the World Meteorological Organization (WMO). It provides a synthesis of the global annual to decadal predictions produced by the WMO designated Global Producing Centres and other contributing centres. The latest predictions show that:

- Global mean temperatures are likely to continue at or near record levels in the five-year period 2025-2029. The annually averaged global mean near-surface temperature for each year between 2025 and 2029 is predicted to be between 1.2°C and 1.9°C higher than the average over the years 1850-1900.
- It is likely (86% chance) that global mean near-surface temperature will exceed 1.5°C above the 1850-1900 average levels for at least one year between 2025 and 2029. It is also likely (70% chance) that the 2025-2029 five-year mean will exceed 1.5°C above the 1850-1900 average.
- It is likely (80% chance) that at least one year between 2025 and 2029 will be warmer than the warmest year on record (currently 2024) and although exceptionally unlikely, there is now also a chance (1%) of at least one year exceeding 2°C of warming in the next five years.
- Long-term warming (averaged over decades) remains below 1.5°C.
- The five-year average temperature in the Niño 3.4 region relative to the whole tropics indicates mixed or mainly neutral ENSO conditions in this period.
- The average Arctic temperature anomaly over the next five extended winters (November to March), relative to the recent climatological normal (the average of the years 1991-2020), is predicted to be 2.4°C, more than three and a half times as large as the anomaly in global mean temperature.
- Predictions of Arctic sea-ice for March 2025-2029 suggest further reductions in sea-ice concentration in the Barents Sea, Bering Sea, and Sea of Okhotsk.
- Predicted precipitation patterns for May-September 2025-2029, relative to the 1991-2020 average, suggest anomalously wet conditions in the Sahel, northern Europe, Alaska and northern Siberia, and anomalously dry conditions for this season over the Amazon.
- Recent years, apart from 2023, in the South Asian region have been anomalously wet and the forecast suggests this will continue for the 2025-2029 period. This may not be the case for all individual seasons in this period.

Observed Climate of the Last Five Years

This section provides a brief summary of the observed climate of the last five years to give context for the predictions shown later in this report. Please refer to the WMO State of the Global Climate report for a more complete discussion. Figure 1 shows the global patterns of surface air temperature, sea-level pressure and precipitation anomalies over the last year (2024) and the last five-year (2020-2024) period with respect to the most recent climatological normal, the average over the years 1991-2020.

Last year, 2024, was the warmest year on record, with the globally averaged near-surface temperature estimated at 1.55 °C ± 0.13 °C above the 1850–1900 baseline. Near-surface temperatures in 2024 were warmer than the long-term average almost everywhere over land with particularly large warm anomalies in the tropics, North America, North Africa, Europe and parts of Asia.

Over 2020-2024, positive anomalies were widespread, except over the eastern tropical Pacific and parts of South America, Australia and India. These were greatest at high latitudes in the Northern Hemisphere, especially the Arctic, and generally larger over land than ocean, apart from in the North Pacific. This period had La Niña conditions in three consecutive years.

Sea-level pressure in 2024 and in the last five years was anomalously low over Antarctica. The Aleutian Low for 2020-2024 was anomalously weak, consistent with the extended La Niña conditions that prevailed.

Precipitation patterns in 2024 show that parts of central and southern Africa and South America were particularly dry. During 2020-2024, parts of Asia and the African Sahel were wetter than average, and southern Africa, western Australia, central and southern South America, southwestern Europe and parts of North America were drier than average.

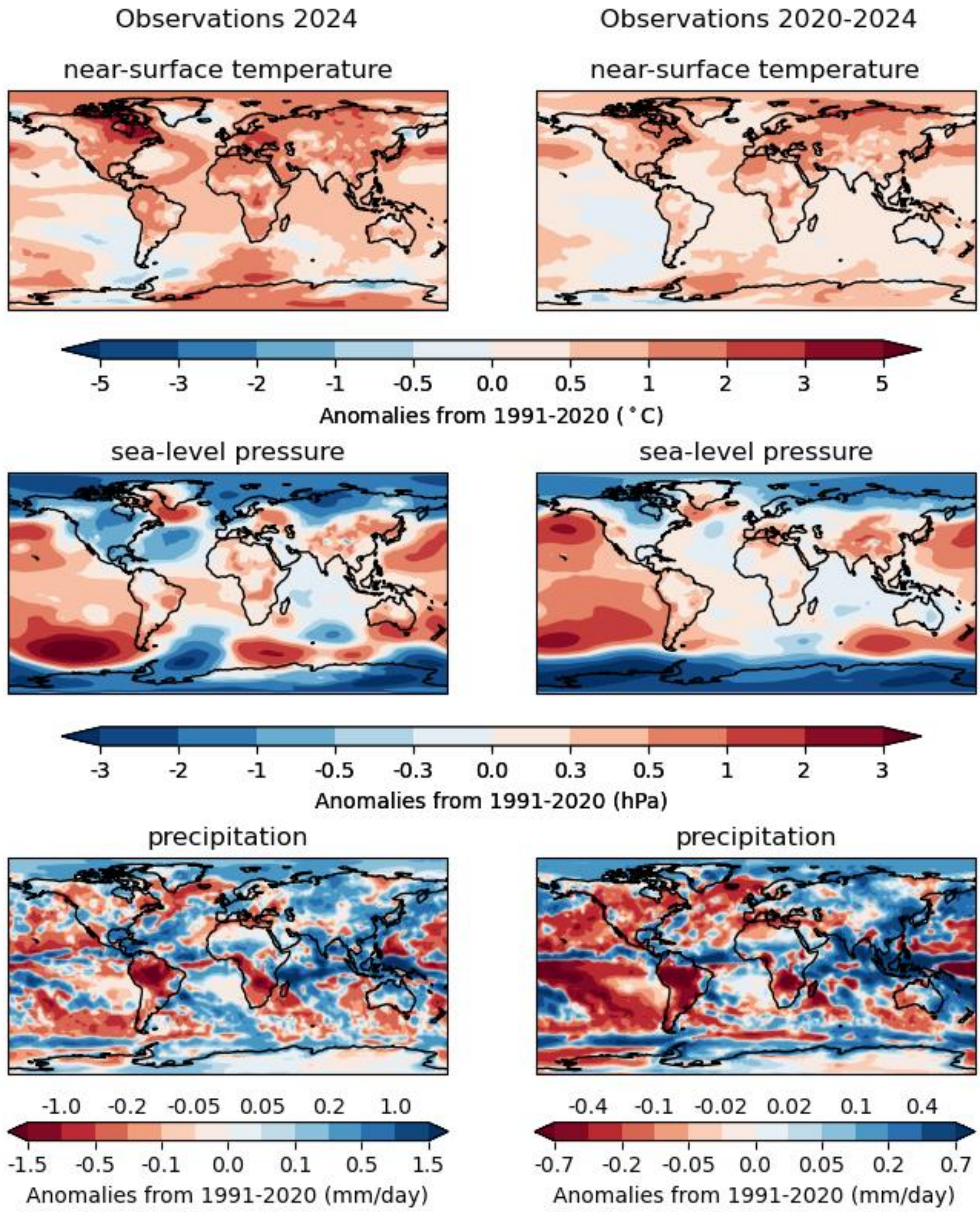

Figure 1: Observed annual mean near-surface temperature (°C, top), pressure (hPa, middle) and precipitation (mm/day, bottom) anomalies relative to 1991-2020. *The left column shows the year 2024, the right column refers to the average of the five-year period 2020-2024. Near-surface temperature is ERA5 2m temperature from ECMWF (Bell et al, 2021). Mean sea-level pressure is also from ERA5. Precipitation is from GPCP (Adler et al, 2003, updated).*

To highlight summer and winter differences, Figure 2 shows average anomalies over the last five years for two extended seasons, May to September and November to March. Both seasons had generally higher temperatures than the 1991-2020 average, apart from the tropical eastern Pacific, and South Pacific. Western North America was anomalously cold in November to March.

The sea-level pressure anomalies seen in the five-year mean in Figure 1 over Antarctica and the Aleutian Low were largest in November to March. Precipitation patterns show that East Asia and South Asia were wetter than average in May to September, but this hides large inter-annual variability in the monsoons. The African Sahel also shows wet anomalies for this season. Western Australia and most of South America were drier than average over the five years in both seasons.

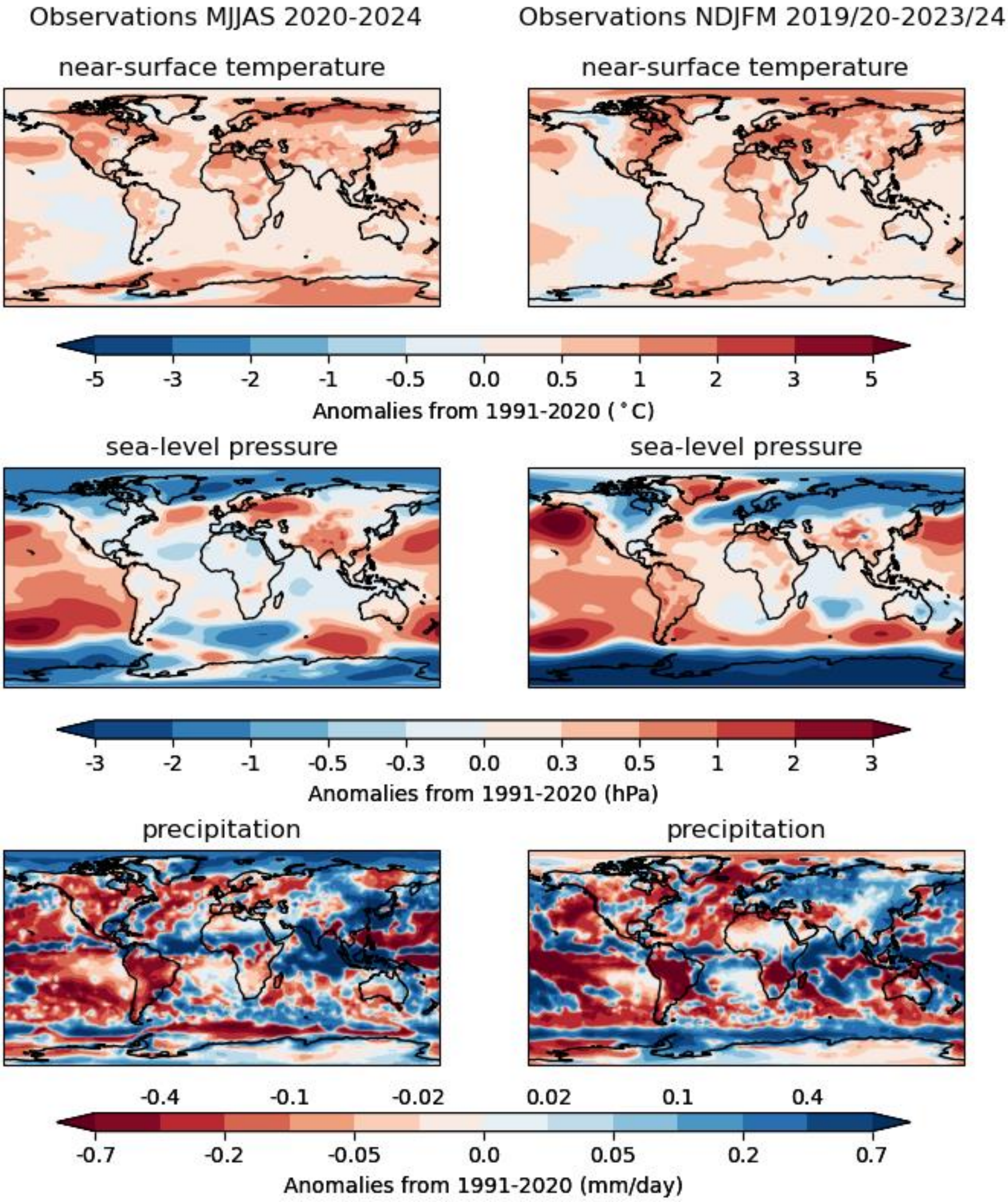

Figure 2: Observed five-year seasonal mean near-surface temperature (°C, top), pressure (hPa, middle) and precipitation (mm/day, bottom) anomalies relative to 1991-2020. *The left column shows anomalies for May to September averaged over 2020-2024, the right column shows anomalies for November to March averaged over 2019/2020-2023/2024. Observational datasets are the same as those in Figure 1.*

Annually averaged global (land and sea) mean near-surface temperature has increased since the 1960s (Figure 3). Last year, 2024, broke many records including the warmest year (as did 2023). The WMO State of the Global Climate report notes that each of the last ten years (2015-2024) were individually the warmest ten years on record primarily due to the atmospheric concentration of carbon dioxide being at the highest level in 800,000 years. Atlantic Multidecadal Variability (AMV) anomalies in the last four years are positive since near-surface temperatures in the North Atlantic have been warmer than the rest of the oceans. After a string of three negative (La Niña) December to February seasons, the tropical East Pacific had warm anomalies at the beginning of 2024 (El Niño). In 2025, the anomalies are negative again.

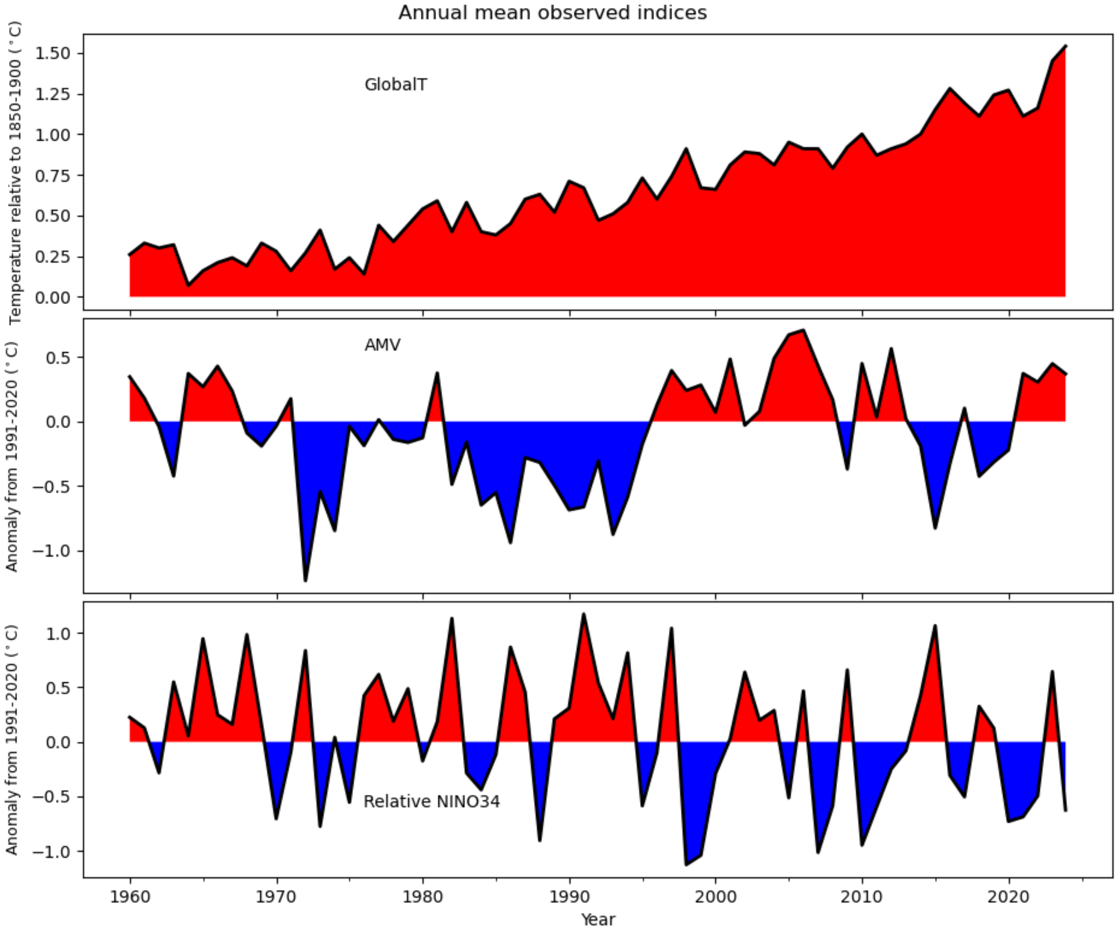

Figure 3: Observed climate indicators. *Global annual mean near-surface temperature anomaly (top), annual mean Atlantic Multidecadal Variability (AMV) defined as the difference between two regions: 45°N-60°N,60°W-0°E minus 45°S-0°S, 30°W-10°E as in Roberts et al, 2013 (middle) and December to February Niño 3.4 defined as the average over 5°S-5°N, 170°W-120°W with the tropical average 20°S-20°N removed as in van Oldenborgh et al, 2021 (bottom). Six datasets are used in the calculation of global near-surface temperature and are the same as in the WMO State of Global Climate 2024 report. Anomalies are with respect to 1850-1900. The other two indices are based on 2m temperature from ERA5 as in Figure 1 and anomalies are relative to the 1991-2020 reference period.*

Predictions from the WMO Lead Centre

Predictions of climate indices and global fields are obtained from multi-model initialised annual-to-decadal climate predictions contributed to the WMO Lead Centre for Annual to Decadal Climate Prediction. For this year's update there are 220 ensemble members from models contributed by 14 different institutes, including four Global Producing Centres: Barcelona Supercomputer Centre, Canadian Centre for Climate Modelling and Analysis, Deutscher Wetterdienst, and the Met Office. Predictions are either started from the conditions on 1 November 2024 or 1 January 2025, depending on the decadal prediction system. Retrospective forecasts, or hindcasts, covering the period 1960-2018 are used to estimate forecast skill. Also shown for the climate indicators are uninitialised historical simulations and projections from the World Climate Research Programme's Coupled Model Intercomparison Project phase 6 (CMIP6). Please consult the "How to Use the Global Annual to Decadal Climate Update" section of this report for information on forecast confidence and see Hermanson et al (2022) for background information.

Predictions of Global Climate Indicators

Annually averaged global temperatures are likely to continue at or near record levels in the five-year period 2025-2029 and stay well above annual mean temperatures seen in the last 60 years (Figure 4). Annually averaged global mean near-surface temperature for each year in this five-year period is predicted to be between 1.2°C and 1.9°C (90% confidence interval) higher than the average for the period 1850-1900[1].

The chance of the annually averaged global near-surface temperature in 2025-2029 exceeding 1.5°C above 1850-1900 levels for at least one year has been increasing with time and is now 86% (brown histogram and right-hand axis in Figure 4). It is likely (70%) that the five-year mean will also exceed this threshold. Note that the 1.5°C level specified in the Paris Agreement refers to long-term level of warming inferred from global temperatures, typically over 20 years. Temporary exceedances of the 1.5°C level are expected to occur with increasing frequency as the underlying rise in global temperature approaches this level. There is now also a non-zero chance (1%) of at least one year exceeding 2°C in 2025-2029.

The chance of at least one year exceeding the warmest year on record, 2024, in the next five years is 80%. The chance of the five-year mean for 2025-2029 being higher than the last five years is 89%. Confidence in forecasts of annually averaged global mean near-surface temperature is high since hindcasts show very high skill in all measures (right-hand panels of Figure 4).

Estimates of the current global warming level for 2024 were presented in the WMO State of the Global Climate 2024 report earlier this year using three approaches, with central estimates ranging from 1.34°C to 1.41°C, and the 90% confidence ranges for human-induced warming spanning 1.1–1.7°C. One of those approaches combines the most recent 10 years of observed historical temperature with climate model projections for the next 10 years to give a 20-year average as the current global warming level. Adopting this approach using the decadal forecasts featured here to replace the projections gives an estimate of 1.44°C above the 1850-1900 average, with a 90% confidence range of 1.22–1.54°C. Several approaches are under consideration by WMO and the international scientific

[1] Forecasts are produced relative to 1991-2020 and then the difference between this period and 1850-1900 derived from observations is added. This difference is most likely 0.88°C, but is uncertain due to the incomplete observational network in the 19th century and could be as low as 0.72°C or as large as 0.99°C.

community to enable more timely reporting of warming in the context of the Paris Agreement. Further details can be found in the WMO State of the Global Climate Report 2024.

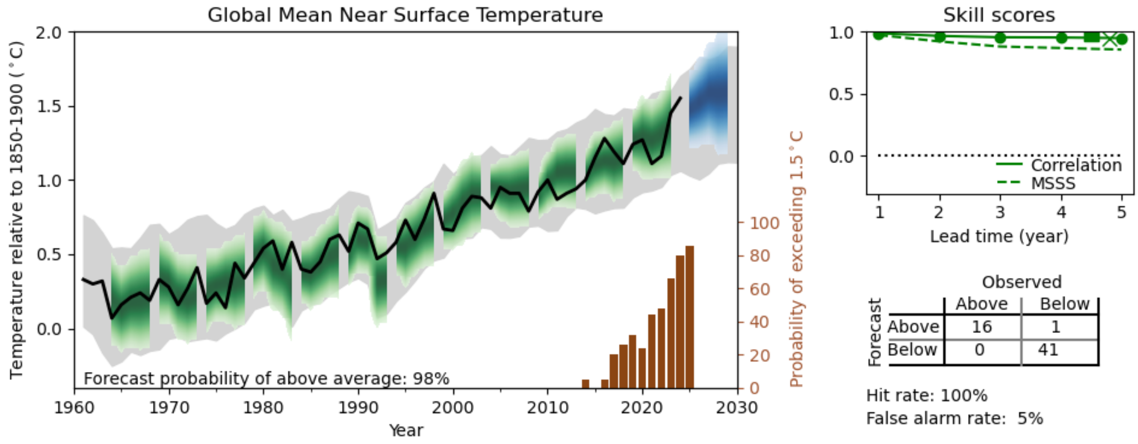

Figure 4: Multi-annual predictions of global mean near-surface temperature relative to 1850-1900. *Annual global mean observations (see Figure 3) in black, forecast in blue, hindcasts in green. The extent of shading indicates the 90% confidence interval, with the intensity of shading indicating the level of likelihood at the indicated anomaly value. The grey shading shows the 90% confidence interval of unininitialised simulations, indicating the degree to which forecasts reduce the uncertainty compared to climate projections. The calibrated probability for above average (compared to 1991-2020) of the five-year-mean forecast is given at the bottom of the main panel. Hindcast skill scores are shown in the upper right panel; the square and the cross show the correlation skill and Mean Square Skill Score (MSSS) for five-year means, respectively. Statistically significant correlation skill (at the 5% confidence level) is indicated by solid circles/square. The contingency table for the prediction of above-average five-year means (compared to 1991-2020) is shown in the bottom right panel. Also inset in the main panel, in brown, referring to the right hand axis, is the probability of global temperature exceeding 1.5°C above 1850-1900 levels for at least one of the five following years, starting with the year indicated. This probability is calculated as in Smith et al (2018) by counting the proportion of ensemble members that predict at least one year above 1.5°C.*

Predictions indicate an 87% calibrated probability (Bett et al, 2022) that Atlantic Multidecadal Variability (AMV) index will be positive on average over the next five years (Figure 5). The hindcasts have medium skill in both measures and a medium hit rate, giving medium confidence in this prediction. The North Atlantic subpolar gyre, the main centre of action of the AMV, has had positive near-surface temperature anomalies in the last five years (Figure 1). Some predictions from the contributing centres indicate a return to cool temperatures in the next five years, but most predict continued warming of the region (individual centre contributions can be seen on the website). Predictions for the Atlantic Meridional Overturning Circulation (AMOC), which is related to AMV and shows an increase, can be found in the Appendix.

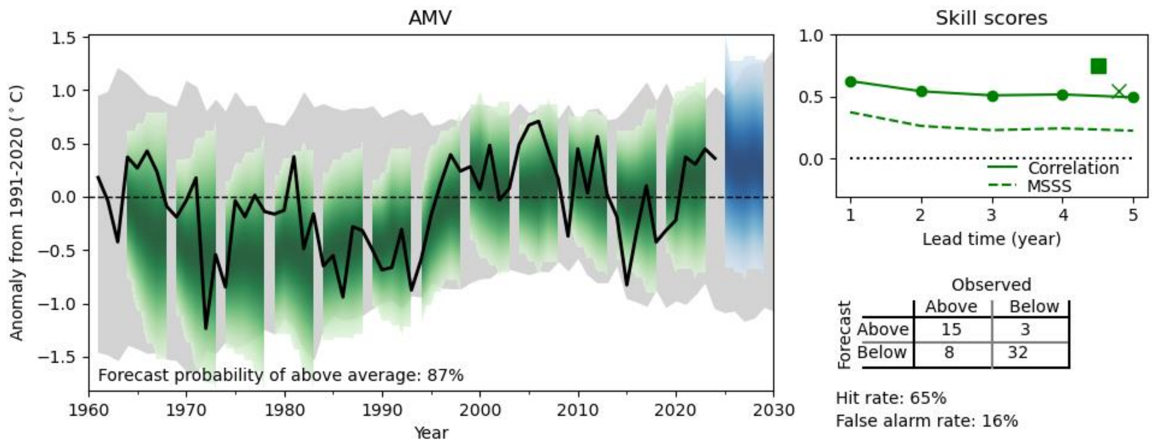

Figure 5: Multi-annual predictions of Atlantic Multidecadal Variability (AMV) relative to its 1991-2020 average, defined as the anomaly difference between two regions: 45°N-60°N, 60°W-0°E minus 45°S-0°S, 30°W-10°E as in Roberts et al (2013). *Annual mean observations (see Figure 3) in black, forecast in blue, hindcasts in green. The extent of shading indicates the 90% confidence interval, with the intensity of shading indicating the level of likelihood at the indicated anomaly value. The grey shading shows the 90% confidence interval of unininitialised simulations, indicating the degree to which forecasts reduce the uncertainty compared to projections. The calibrated probability (as in Bett et al, 2022) for the most likely category (above or below climatology) of the five-year-mean forecast is given at the bottom of the main panel. Hindcast skill scores are shown in the upper right panel; the square and the cross show the correlation skill and Mean Square Skill Score (MSSS) for five-year means, respectively. Statistically significant correlation skill (at the 5% confidence level) is indicated by solid circles/square. The contingency table for the prediction of above/below average five year means is shown in the bottom right panel.*

This year, 2025, started with weak La Niña conditions in the tropical East Pacific. These anomalies are predicted to decline, and the multi-model ensemble-mean temperature anomalies in the Niño 3.4 region are predicted to be near zero for December 2025 – February 2026. There is a large ensemble spread (±0.5 °C) and skill is medium for year 1 (Figure 6). The five-year average temperature in the Niño 3.4 region relative to the whole tropics has a 55% calibrated probability of being above average, indicating little signal for predominance of either El Niño or La Niña in this period. Skill is medium, giving medium confidence in this forecast.

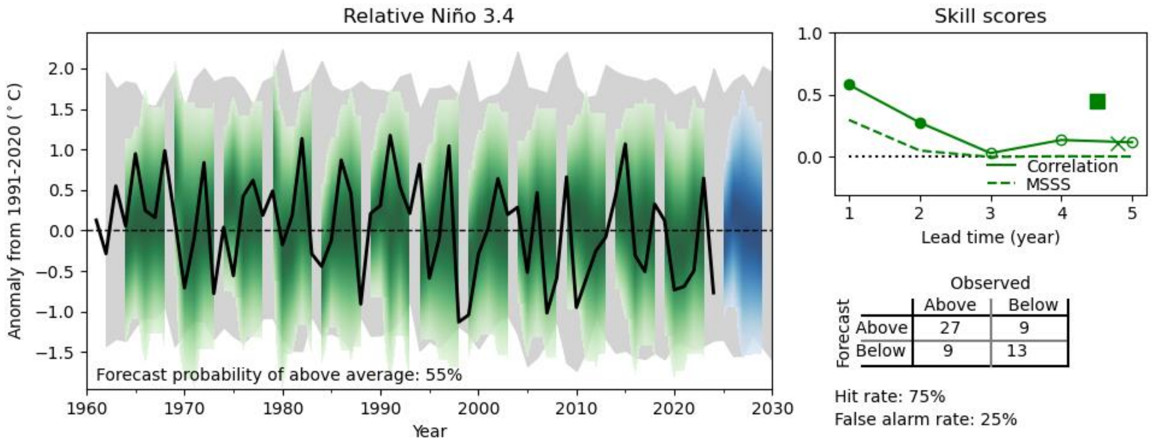

***Figure 6: As Figure 5, but for December-February averaged Niño 3.4 relative to the tropical mean defined as the average over 5°S-5°N, 170°W-120°W with average over 20°S-20°N removed**. This index is suitable for a warming climate (van Oldenborgh et al, 2021).*

Regional Predictions for 2025

Near-surface temperatures in 2025 are predicted to be higher than the 1991-2020 average in almost all regions across the globe, except for parts of the South Pacific and Southern Ocean (Figure 7). The stippled regions in Figure 7 indicate where the different prediction systems disagree on the sign of the anomaly. The regions showing below-average temperatures are stippled, which implies low confidence in whether the forecasts for these regions will be above or below normal. Skill is estimated from hindcasts to be medium or high in most other regions (Figure 8), giving medium to high confidence in the forecast there.

Sea-level pressure forecasts suggest the Aleutian Low will remain weak and anomalous high pressure is likely over the South Pacific. The skill gives medium confidence in this prediction. The pattern of low pressure over Antarctica and high pressure over the southern hemisphere mid-latitudes is consistent with a positive Antarctic Oscillation index (see also Figure 21). The skill for these regions give medium to low confidence.

Predicted precipitation patterns show an increased chance of wetter conditions in the African Sahel due to a northward shifted Intertropical Converge Zone (ITCZ) in the Atlantic, possibly due to the relatively warm North Atlantic. Northern high latitudes are likely to have above average precipitation as expected from climate change. Parts of Australia are likely to be wetter than usual. Correlation skill for precipitation in hindcasts is low despite being significant in these regions, giving low confidence in the forecast.

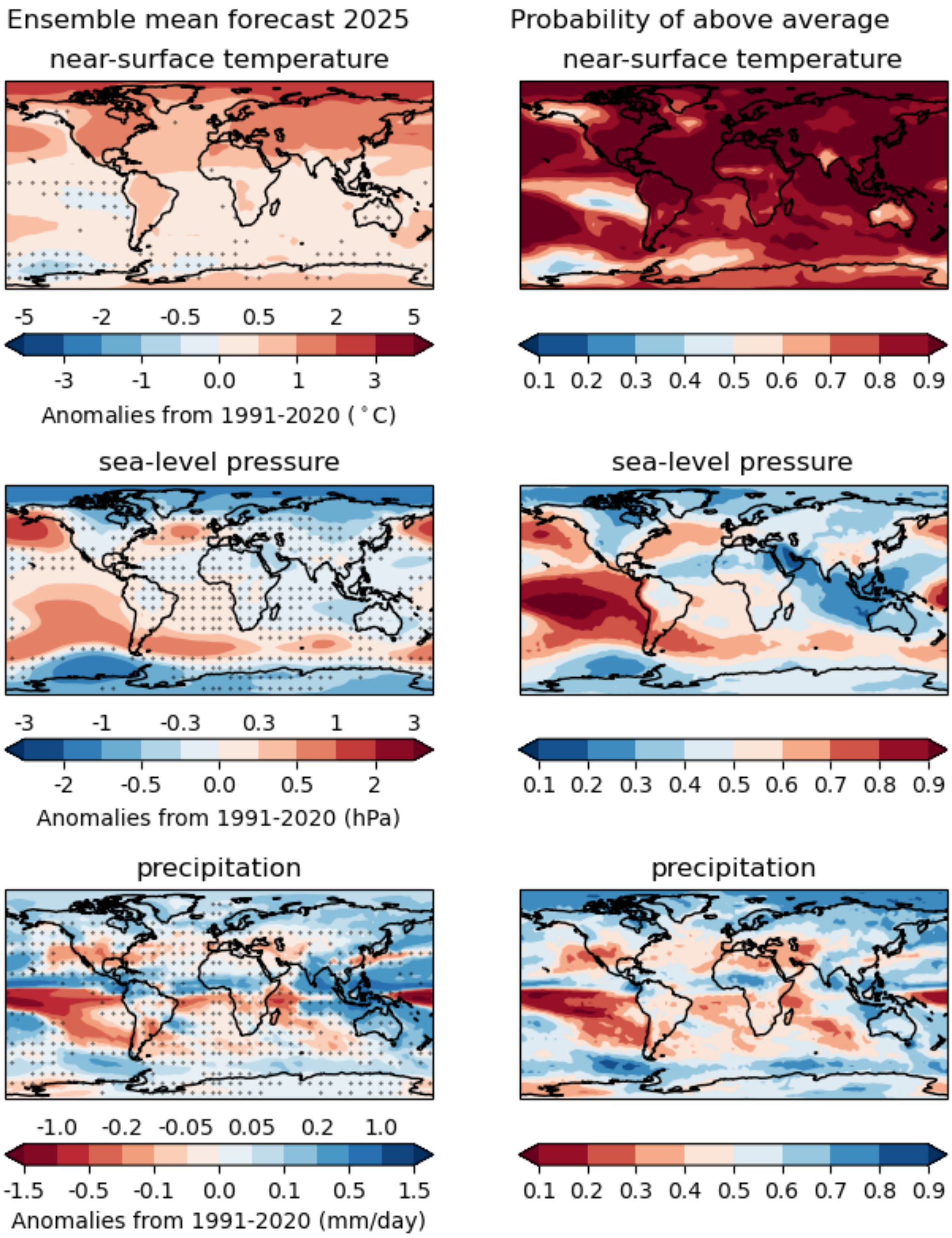

Figure 7: Annual mean anomaly predictions for 2025 relative to 1991-2020. *Ensemble mean (left column) for temperature (top, °C), sea level pressure (middle, hPa), precipitation (bottom, mm/day), stippled where more than 1/3 of models disagree on the sign of the anomaly, and probability of above average (right column). As this is an uncalibrated two-category forecast, the probability for below average is one minus the probability shown in the right column.*

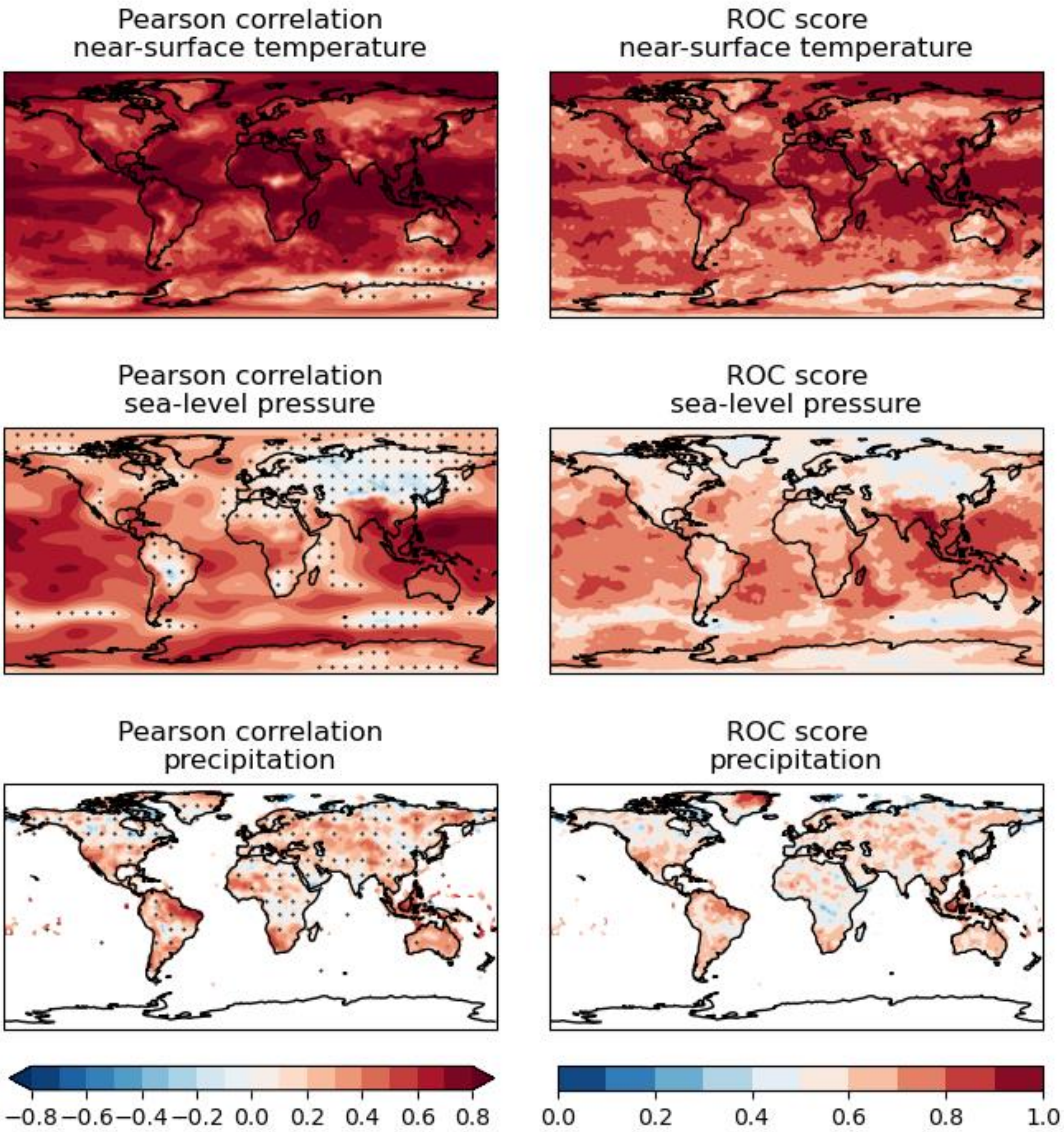

Figure 8: Prediction skill of annual means evaluated using hindcast experiments. *Pearson correlation (left) and ROC score for predictions of above average conditions (right). For correlation stippling shows where skill is insignificant (at the 5% level).*

Regional Predictions for 2025-2029

This section shows predictions for the average of the next five extended seasons for May to September and November to March.

For the May to September average, predicted temperature patterns over the years 2025-2029 show a high probability of temperatures above the 1991-2020 average almost everywhere, with enhanced warming over land in the northern hemisphere (Figure 9). Skill is very high in most regions, giving high confidence in this prediction (Figure 10).

For the same season, sea-level pressure is predicted to be anomalously low over the Mediterranean and surrounding countries. Anomalously high pressure is predicted over the South Pacific and the mid-latitudes of the other oceans in the Southern Hemisphere. There is low to medium skill for most of these regions, giving low to medium confidence. Predictions of precipitation show wet anomalies in the Sahel, northern Europe, Alaska and Siberia, and dry anomalies for this season over the Amazon. Skill gives low to medium confidence.

For the November to March average over the years 2025/26-2029/30 (Figure 11), the predictions show that warm anomalies are likely almost everywhere, with land temperatures showing larger anomalies than those over the ocean. The Arctic (north of 60°N) near-surface temperature anomaly for this season is predicted to be 2.4°C above 1991-2020 average, which is more than three and half times larger than the global mean anomaly. The North Atlantic subpolar gyre, the location of the so-called "warming hole", which has been linked to a reduction in the AMOC and changes to regional winds, is an area where the models disagree on the sign of the anomaly. Skill is high in most regions except for parts of the North Pacific, some areas in Asia, Australia, and the Southern Ocean (Figure 12), giving medium to high confidence.

There will likely be a positive pressure anomaly over the tropical west and central Pacific. In the Arctic, there is a negative pressure anomaly predicted and a positive anomaly in the North Atlantic (though models disagree on the latter region) implying increased likelihood of positive North Atlantic Oscillation (NAO) conditions in this period. The skill over the tropical Pacific gives medium confidence for this prediction, but there is low confidence in the NAO prediction due to lower skill in these regions.

Precipitation predictions favour wetter than average conditions at high latitudes in the northern hemisphere for the next five extended winter seasons (November to March). The pattern of increased precipitation in the tropics and high latitudes compared to the 1991-2020 reference period, and reduced precipitation in the subtropics, particularly in the southern hemisphere, is consistent with expectations of a warming climate. Skill is moderate over large parts of northern Eurasia, Greenland, and the Canadian Arctic Archipelago giving low to medium confidence in the forecast for an increased chance of precipitation in these regions.

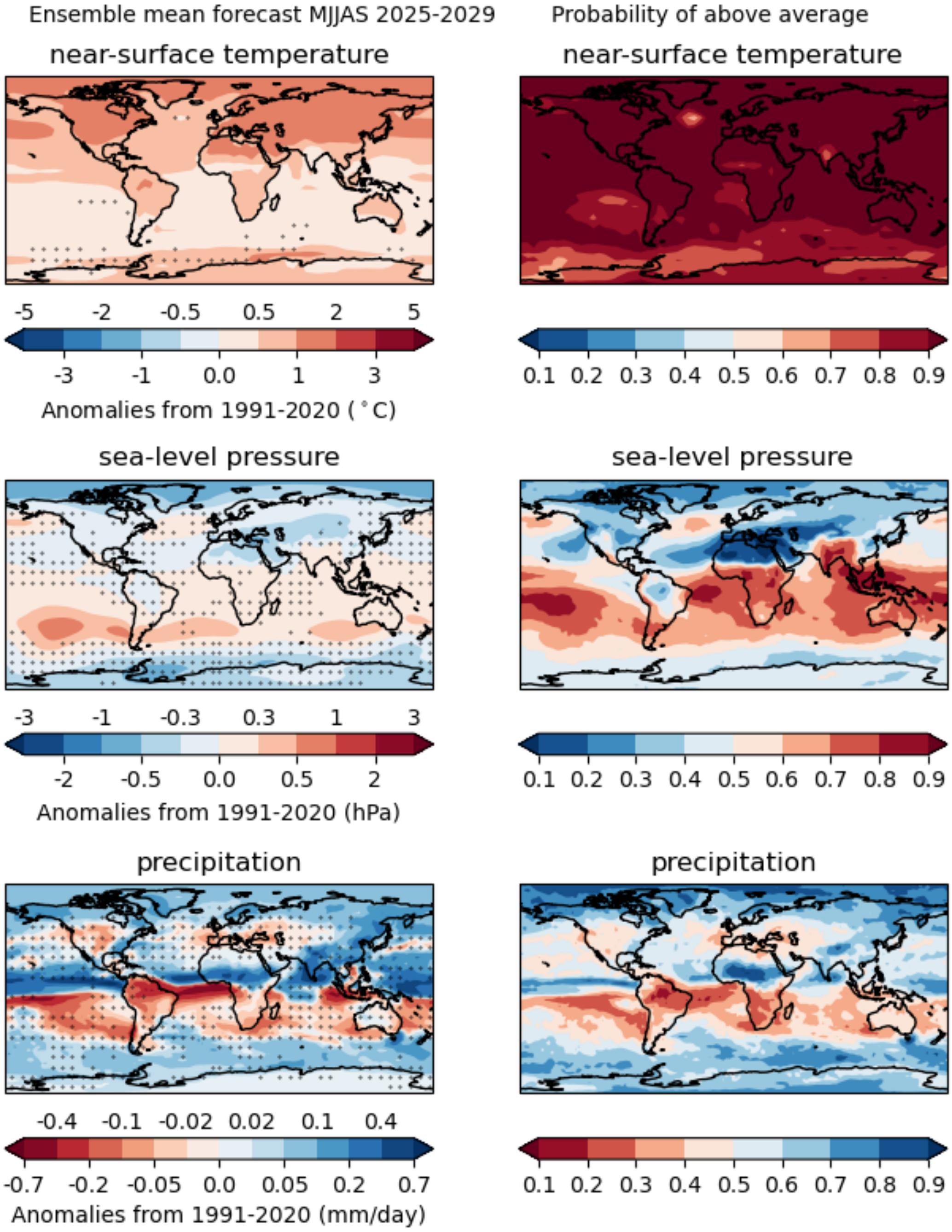

Figure 9: Predictions for 2025-2029 May to September anomalies relative to 1991-2020. *Ensemble mean (left column) for temperature (top, °C), sea level pressure (middle, hPa), precipitation (bottom, mm/day), stippled where more than 1/3 of models disagree on the sign of the anomaly, and probability of above average (right column). As this is an uncalibrated two-category forecast, the probability for below average is one minus the probability shown in the right column.*

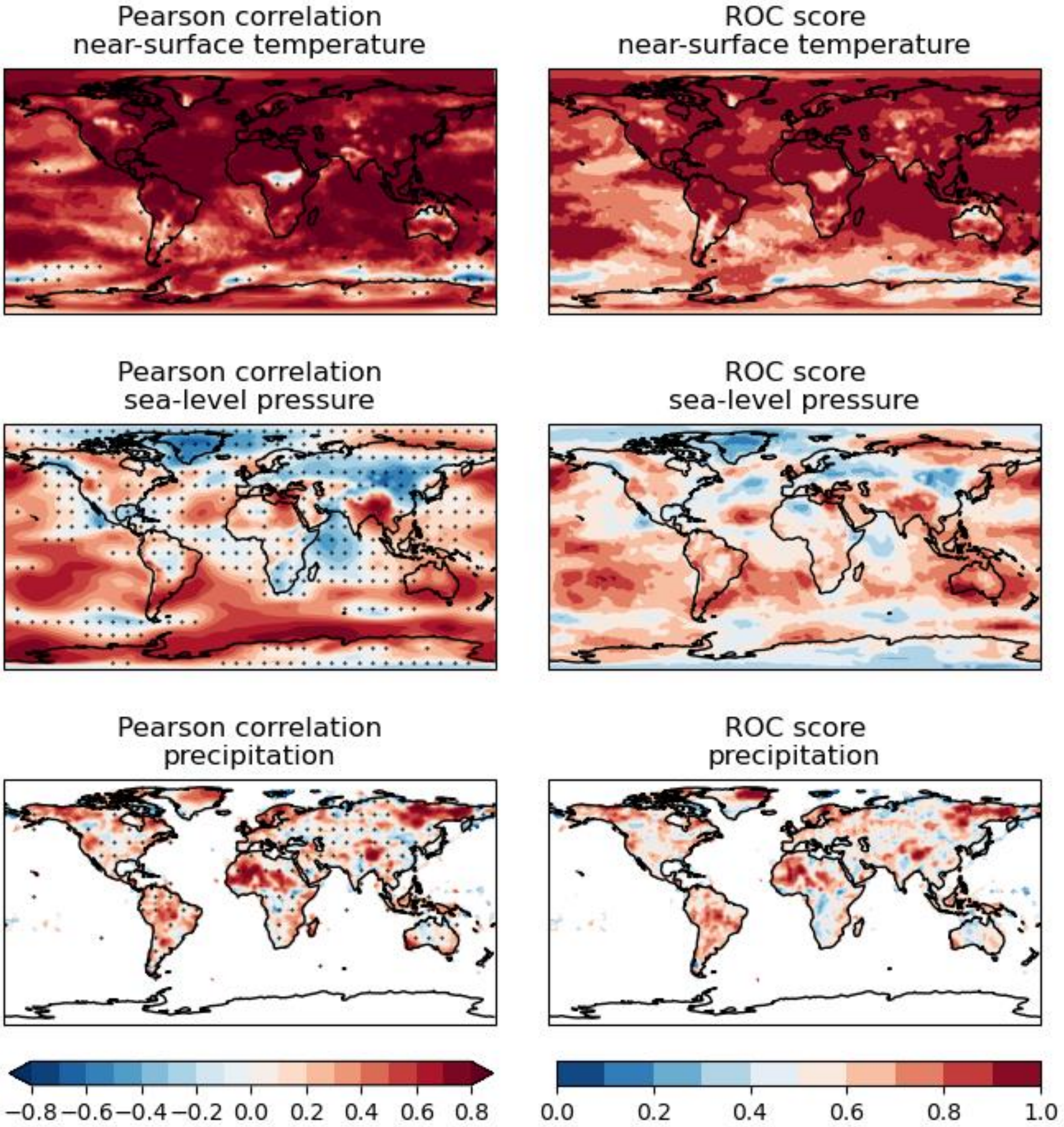

Figure 10: Prediction skill of five-year mean May to September anomalies evaluated using hindcast experiments. *Pearson correlation (left) and ROC score for predictions of above average conditions (right). For correlation stippling shows where skill is not significantly positive (at the 5% level).*

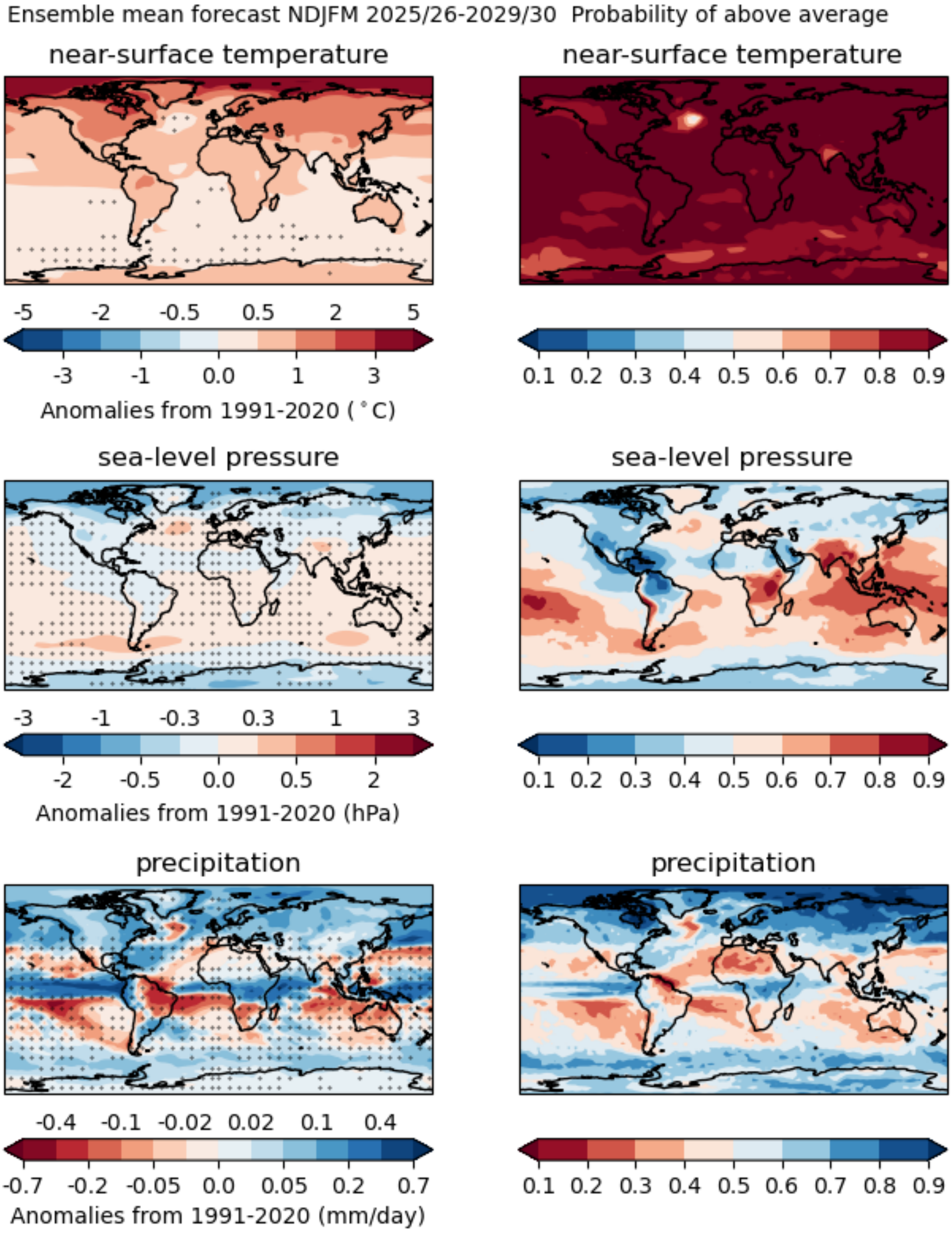

Figure 11: Predictions for 2025/2026-2029/2030 November to March anomalies relative to 1991-2020. *Ensemble mean (left column) for temperature (top, °C), sea level pressure (middle, hPa), precipitation (bottom, mm/day), stippled where more than 1/3 of models disagree on the sign of the anomaly, and probability of above average (right column). As this is an uncalibrated two-category forecast, the probability for below average is one minus the probability shown in the right column.*

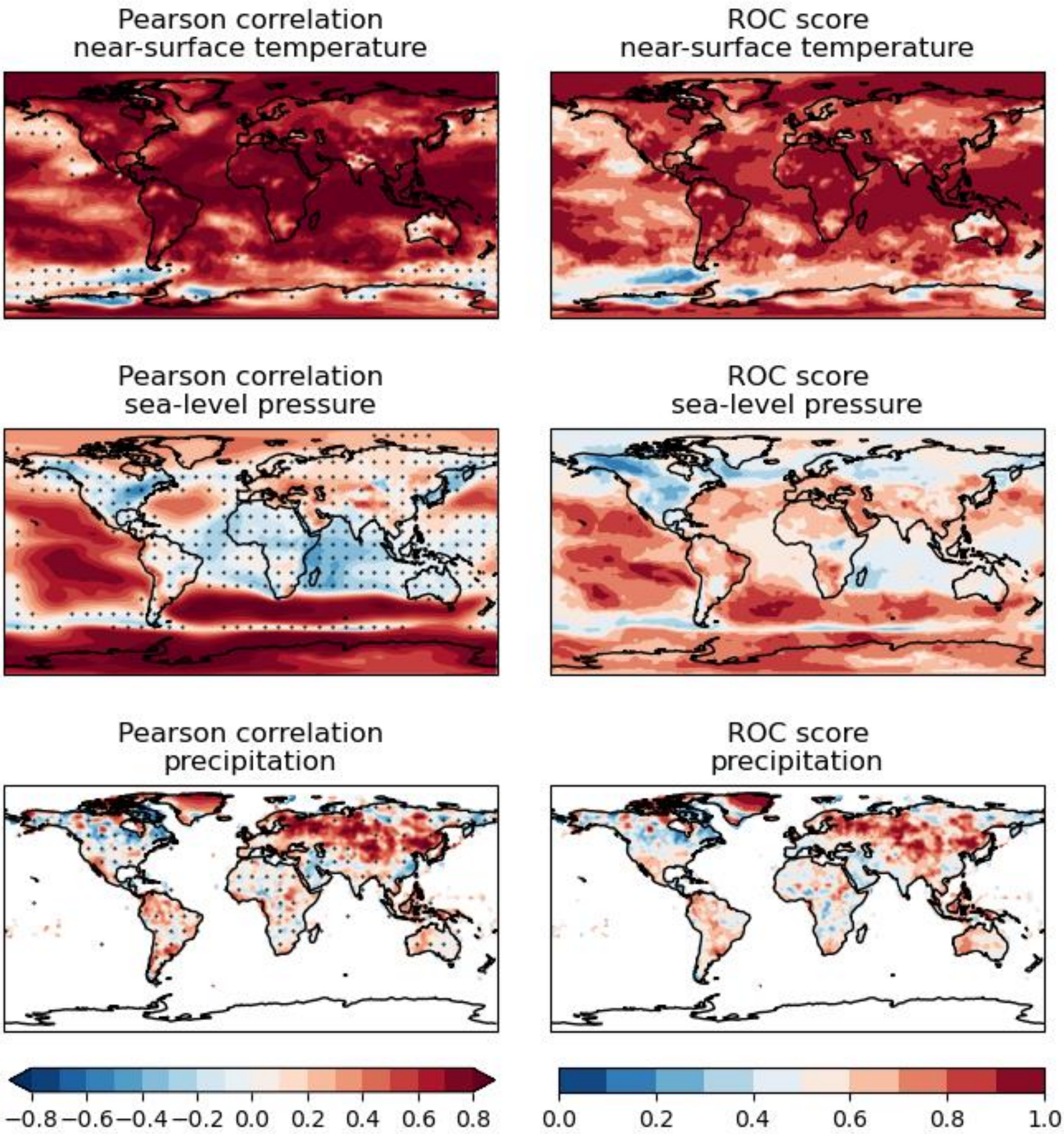

Figure 12: Prediction skill of five-year means November to March anomalies evaluated using hindcast experiments. *Correlation (left) and ROC score for predictions of above average conditions (right). For correlation stippling shows where skill is not significantly positive (at the 5% level).*

Regional Forecast Indices

This section shows an example of a regional forecast index based on notable forecast signals found in the previous section and where there is skill in the multi-model ensemble. The full set of regional forecasts and hindcasts can be found on the website on the "Regional" tab. The regions are based on the WMO Regional Climate Outlook Forums (RCOFs) and Regional Associations. The season used for the indices is the relevant season for that region, usually the wet season or monsoon season.

The Southern Asian (SASCOF) region, considered here as an example to showcase regional forecast indices, has decadal variability in its May to September monsoon season. Recent years, apart from 2023, have been anomalously wet and the forecast suggests this will continue for the 2025-2029 period (Figure 13). The calibrated probability of above average is 82%. Predictions for this region are skilful, but skill is medium, so confidence is medium in this prediction. Note that although the five-year-mean may be positive, this may not be the case for all individual monsoon seasons in this period.

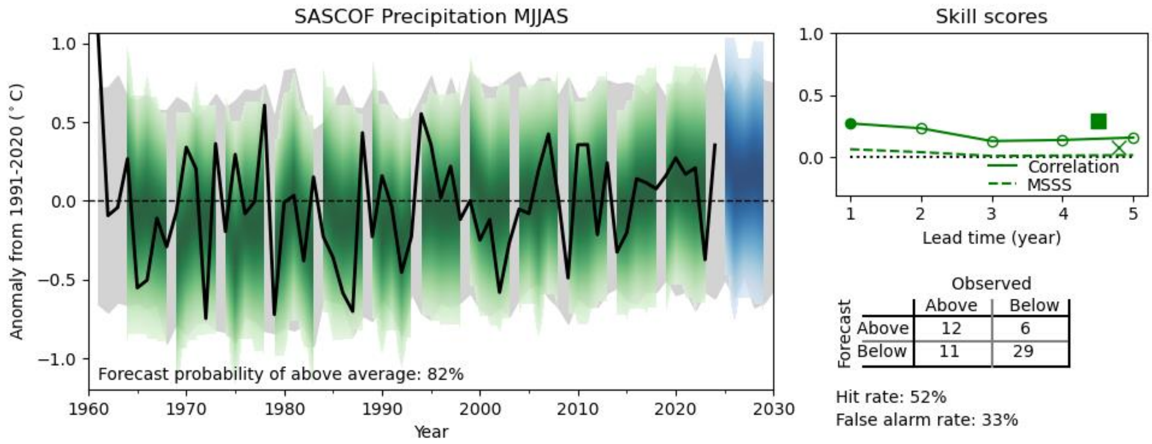

Figure 13: As Figure 5, but for May to September (MJJAS) averaged precipitation over the Southern Asian (SASCOF) region.

Sea ice Forecasts

Sea ice forecasts are challenging for current decadal prediction systems. This can be seen by inspecting the sea-ice concentration maps which are shown (under the "Forecasts" tab) and sea-ice extent timeseries (under the "Timeseries" tab) on the website. Although there is a wide range of mean states and forecast skill, the multi-model ensemble mean is skilful, and these forecasts are issued to stimulate conversations to further improve this aspect of annual-to-decadal predictions.

The sea-ice concentration anomalies (Figure 14) for the Arctic in March (the time of maximum ice extent) show large predicted reductions for 2025-2029 in the Barents Sea, Bering Sea, and Sea of Okhotsk. There is also model agreement for reductions in the Greenland Sea and Labrador Sea. Skill is high in the North Atlantic and medium in the Pacific for these predictions (Figure 15). For Arctic sea ice in September (minimum extent) 2025-2029, large reductions are predicted for all regions that normally have sea-ice at this time of year. There is high skill in predicting anomalies at the sea-ice edge, so there is high confidence for these reductions, except in the Arctic Archipelago where there is low confidence.

For Antarctic September (maximum extent) the predictions show a high probability of below normal sea ice along the climatological sea-ice edge. Correlation skill gives is low-to-medium confidence in this prediction. Many prediction systems have unrealistically low sea ice in Antarctica in March and so there is little agreement on anomalies (stippling), but there is a signal for reductions in the eastern Ross Sea that has increased since last year's forecast. Confidence is medium for this forecast.

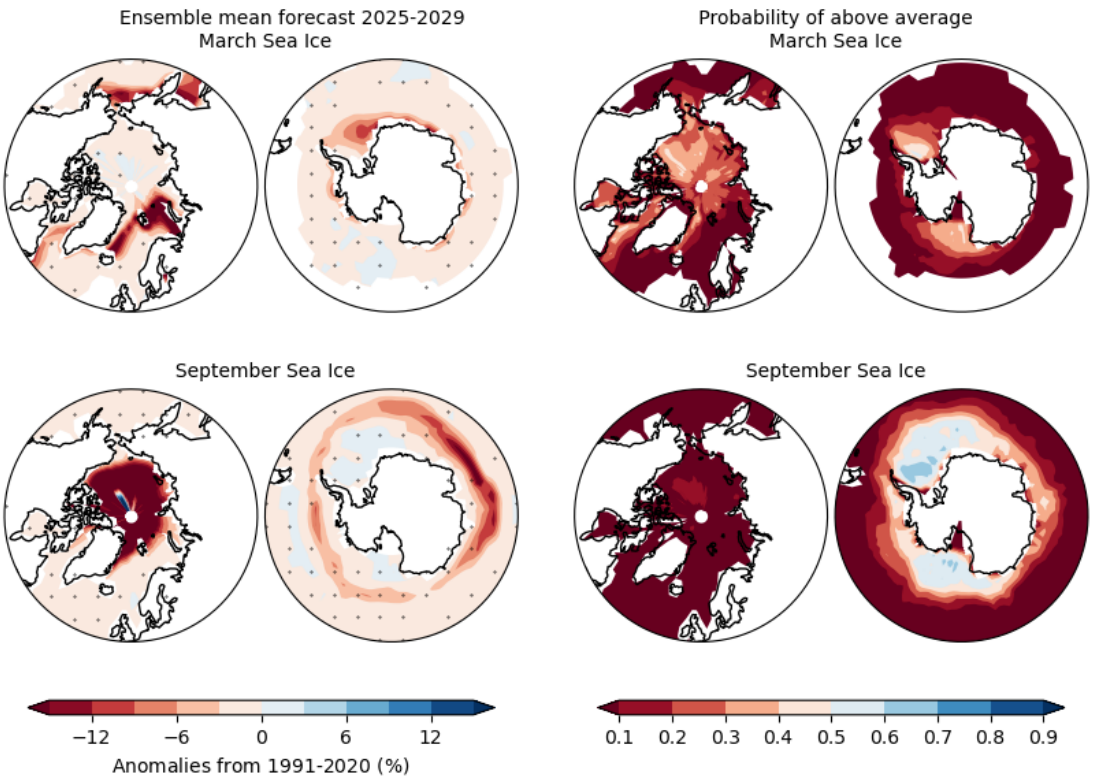

Figure 14: Predictions for 2025-2029 March and September sea-ice concentration anomalies relative to 1991-2020. *Ensemble mean (left column) for March (top, %) and September (bottom, %), stippled where more than 1/3 of models disagree on the sign of the anomaly, and probability of above average (right column). As this is an uncalibrated two-category forecast, the probability for below average is one minus the probability shown in the right column.*

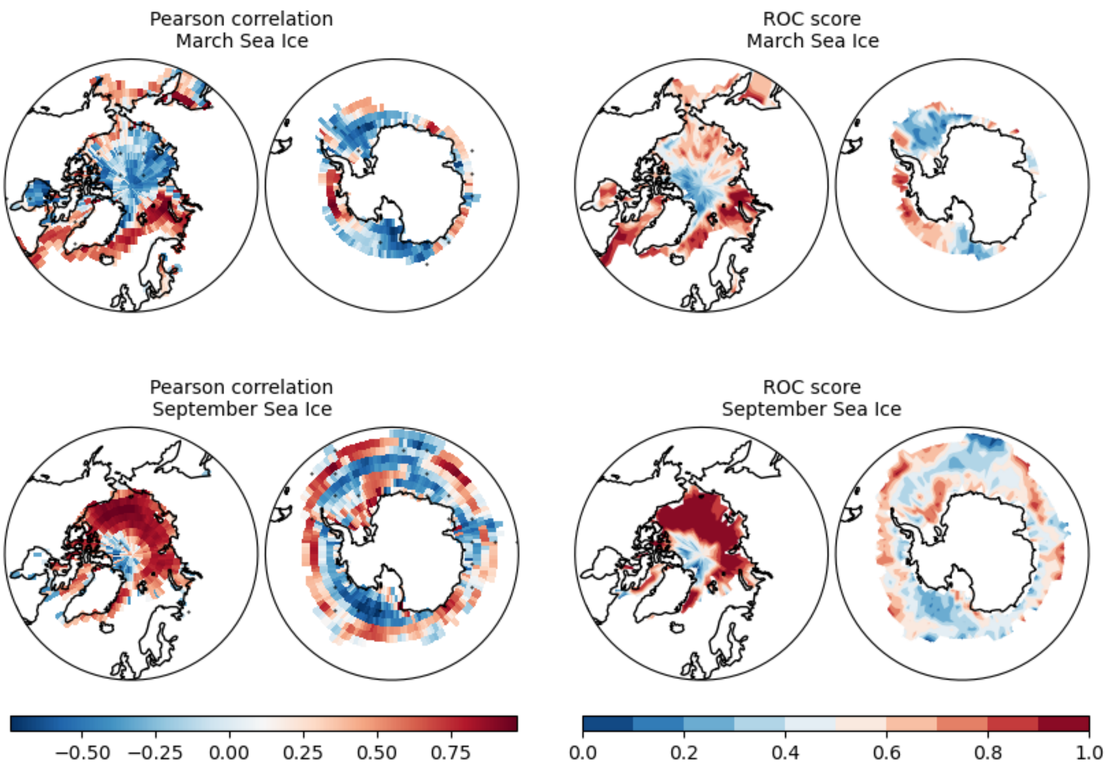

Figure 15: Prediction skill of five-year means of March and September sea-ice anomalies evaluated using hindcast experiments. *Correlation (left) and ROC score for predictions of above average conditions (right). For correlation stippling shows where skill is not significantly positive (at the 5% level).*

Evaluation of Previous Forecasts

This section assesses forecasts that were issued in real time for the most recently completed one- and five-year periods. The forecast for 2024, which was produced using simulations initialised at the end of 2023, is shown in Figure 16. Stippling in the right-hand panels indicates where observations are outside the predicted 90% confidence interval for the multi-model ensemble spread. For near-surface temperatures, the anomalies were underestimated in the multi-model ensemble mean for many regions including the eastern North Atlantic, Eastern Europe, and parts of Africa. Cold anomalies over Iceland, southern Greenland, and eastern South Pacific were captured by the ensemble spread. The spatial correlation (in brackets above the observations) is 0.56 for temperature. This is higher than for other variables.

Sea-level pressure patterns agree reasonably well with the observations (spatial correlation of 0.46) with anomalously low pressure over the Arctic and Antarctic and anomalously high pressure over much of the Pacific and Southern Ocean. However, the predicted anomalies are systematically too small. The ensemble spread does not encompass the largest anomalies in the Southern Ocean.

The ensemble mean predictions of precipitation captured the correct sign of anomalies in many regions (spatial correlation of 0.30), including wetter conditions in central Europe, Asia, and the Sahel, and drier conditions in South America and southern Africa. The confidence interval does not encompass many of the northern hemisphere high latitude wet anomalies and the dry conditions in the Amazon.

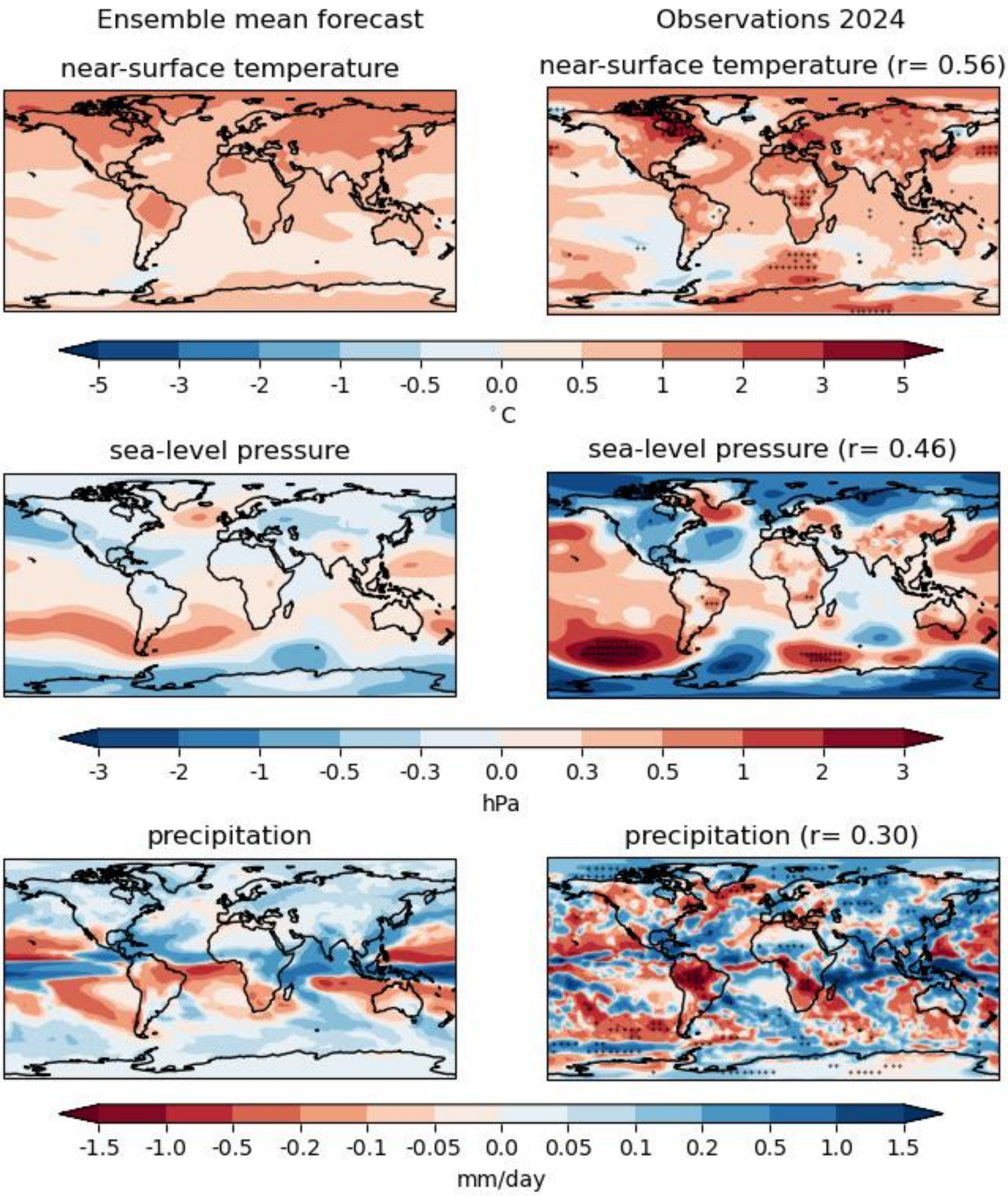

Figure 16: Evaluation of the one-year forecast for 2024 relative to 1991-2020. *Ensemble mean forecast (left) and observed (right) anomalies. Top: temperature (°C); middle: sea level pressure (hPa); bottom: precipitation (mm/day). The spatial Pearson correlation between forecast and observations is shown in brackets above the observations. Stippling shows where the observations fall outside of the 90% range of the multi-model ensemble spread. Observations are from the same sources as in Figure 1.*

Average forecast temperature anomalies for the last five years 2020-2024 (from forecasts initialised at the end of 2019 shown relative to 1981-2010, Figure 17), generally agree well with observations (spatial correlation of 0.80) with warm conditions over the Arctic and Eurasia, and enhanced warming over the land compared to the ocean, especially in the northern hemisphere. Relatively cool conditions in the northern North Atlantic, South Pacific and Southern Ocean were mostly captured within the confidence interval of the ensemble spread.

Sea-level pressure patterns show reasonable agreement with the observations (spatial correlation of 0.70), with lower-than-average pressure over the Arctic and Antarctic and higher than average pressure over most ocean regions. However, as with the one-year prediction evaluated above, the forecast anomalies are often too small and the observations are outside the ensemble spread for regions over the Pacific, Antarctica, and central Asia.

Precipitation patterns over land show reasonable agreement with observations (spatial correlation of 0.34), including wetter than usual conditions across much of Asia, India and sub-Saharan Africa, and drier than usual conditions in southern Africa and in South America. The wet anomalies in East Asia and drier than normal conditions in North America and South America were not within the ensemble spread.

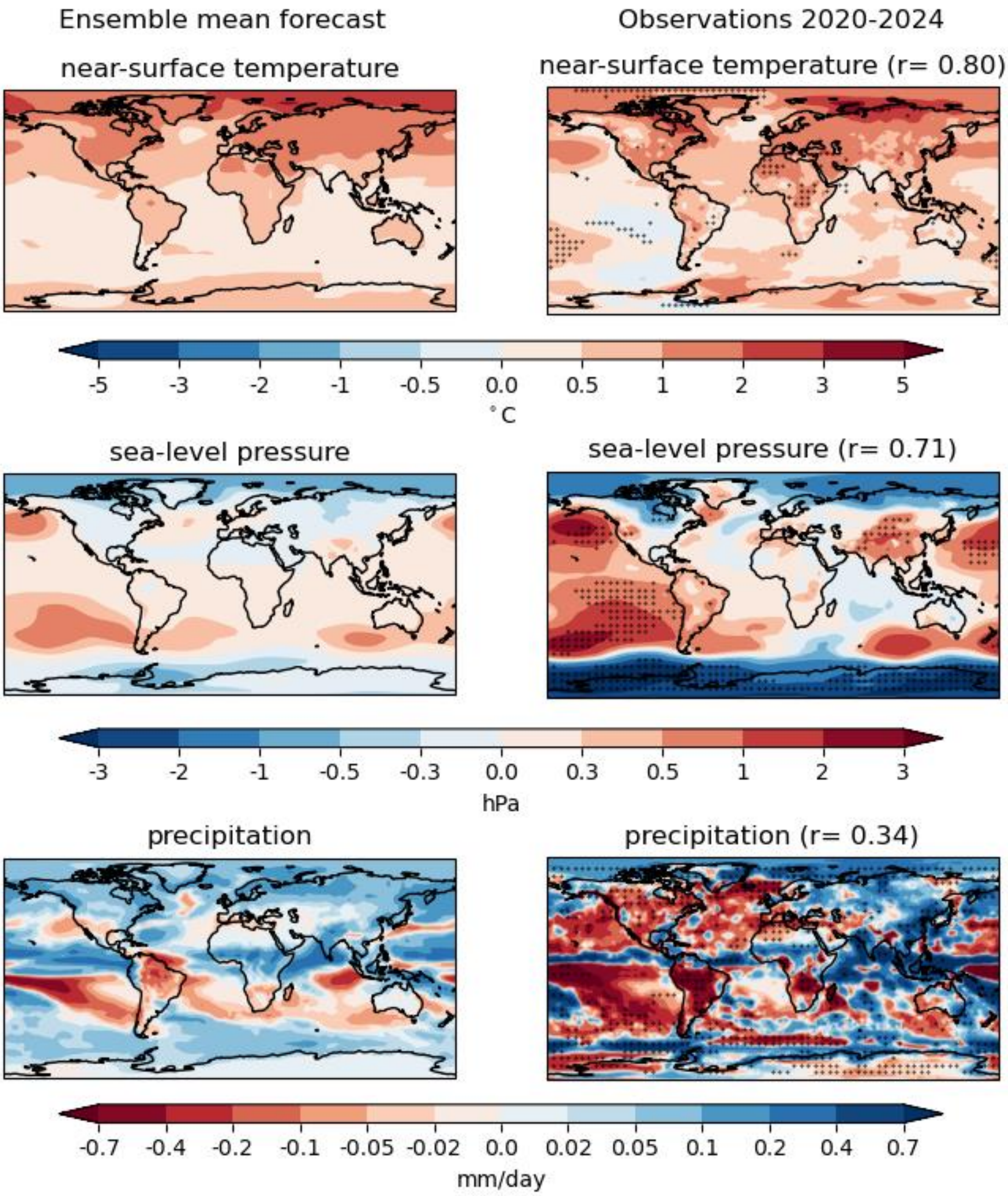

Figure 17: Evaluation of the five-year forecast for 2020-2024 relative to 1981-2010 (this was the forecast climatology at the time of issue). *Ensemble mean forecast (left) and observed (right) anomalies. Top: temperature (°C); middle: sea level pressure (hPa); bottom: precipitation (mm/day). The spatial Pearson correlation between forecast and observations is shown in brackets above the observations. Stippling shows where the observations fall outside of the 90% range of the multi-model ensemble spread. Observations are from the same sources as in Figure 1.*

How to Use the Global Annual to Decadal Climate Update

The forecasts shown here are intended as guidance for Regional Climate Centres (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, but RCCs, RCOFs and NMHSs are encouraged to appropriately interpret and develop value-added forecasts from this Climate Update.

Where the ensemble mean is shown, this only shows the most likely outcome. Other outcomes are possible and may be almost as likely. A major volcanic eruption would change the expected climate, and in this case new forecasts will be made (Sospedra-Alfonso et al, 2024). Signals with small spatial extent are likely unreliable and will likely have lower skill. See Hermanson et al (2022) for more information.

The skill of interannual to decadal forecasts is different to that of weather and seasonal timescales and skill may vary considerably with region and season. It is important to view the forecast maps together with the skill maps provided to evaluate the confidence in a prediction. Skill and therefore the confidence in a forecast is evaluated from hindcasts. Note that skill of predictions from a given initial climate state may differ from average skill estimated over many different cases. Correlation skill is classified into five categories: very low (below 0.2, but still significant), low (between 0.2-0.4), medium (between 0.4-0.6), high (between 0.6-0.8) and very high (0.8 and higher).

Appendix – predictions for other indices

Predictions of Atlantic Meridional Overturning Circulation (AMOC) are important for the climate of countries surrounding the North Atlantic and for global heat transport. The AMOC has been measured at 26°N since 2004. The forecast for 2025 (Figure 18, top row) shows an increased upper ocean overturning cell in the North Atlantic, which is probably wind-driven, a consequence of the meridional pressure gradient predicted for 2025 (Figure 7). Skill cannot be evaluated due to insufficient observations, which only exist for particular locations.

The AMOC prediction for 2025-2029 (Figure 18, bottom row) shows anomalously low values in the ensemble mean below 1000m throughout the Atlantic basin, particularly in the northern hemisphere mid-latitudes. There is large variability in the ensemble (individual models are shown on the WMO Lead Centre for Annual to Decadal Climate Prediction web page, www.wmolc-adcp.org). Confidence is low as there are insufficient observations to evaluate skill.

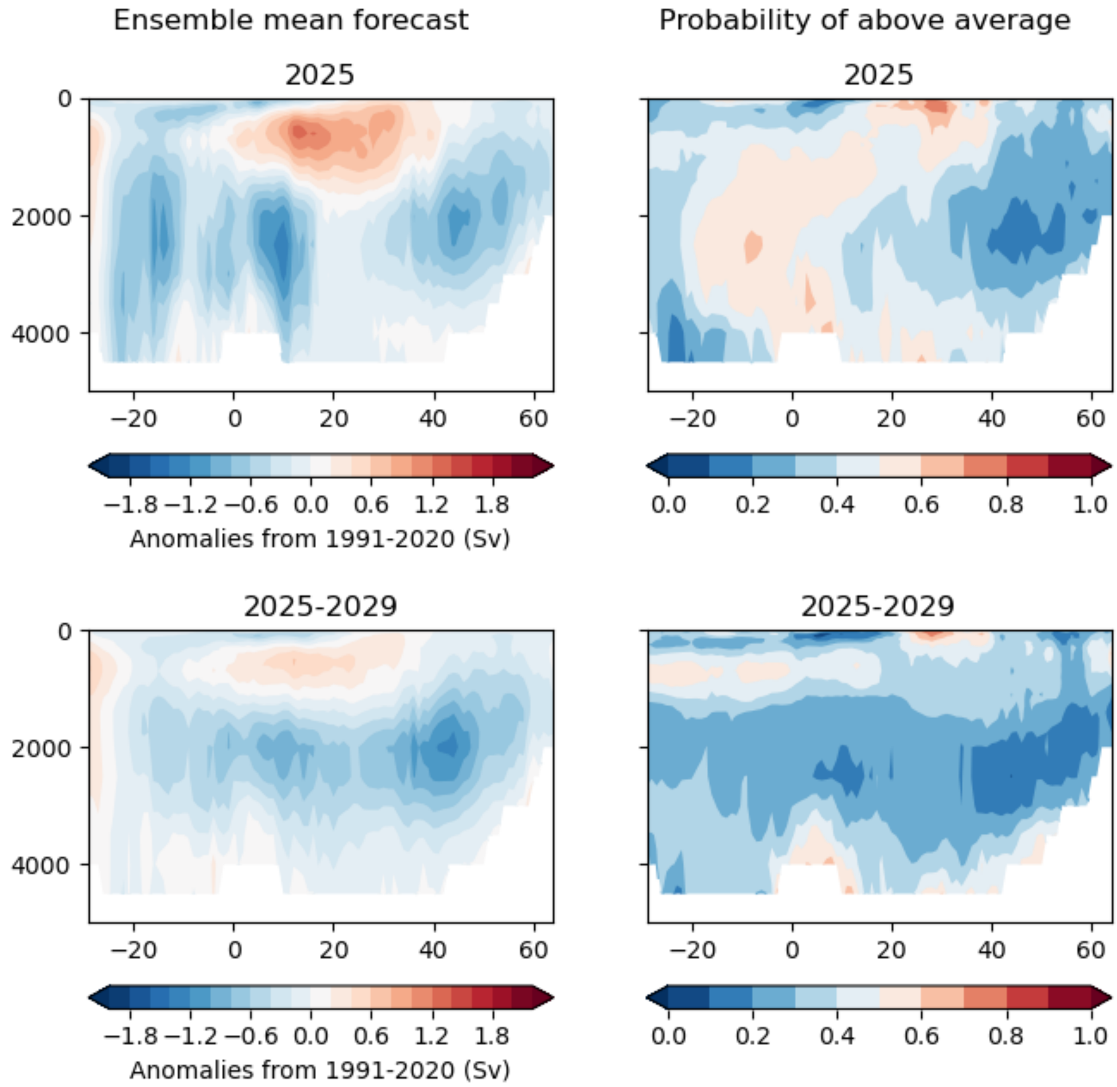

Figure 18: Atlantic Meridional Overturning Circulation (AMOC) forecast for 2025 (first row) and 2025-2029 (second row) relative to 1991-2020. *The left column shows the ensemble mean streamfunction prediction and the right column shows the probability of a stronger than average AMOC. As this is an uncalibrated two-category forecast, the probability for below average is one minus the probability shown in the right column.*

The AMOC close to 30°N is predicted to be near or slightly below recent observed values (Figure 19). After a stable period since the strong decline observed during the 2000s, the AMOC is predicted to decline at a rate similar to climate projections. However, confidence in this forecast is low because there are insufficient past observations to evaluate skill and a recent hindcast (rightmost green plume) predicted a stronger AMOC than was measured.

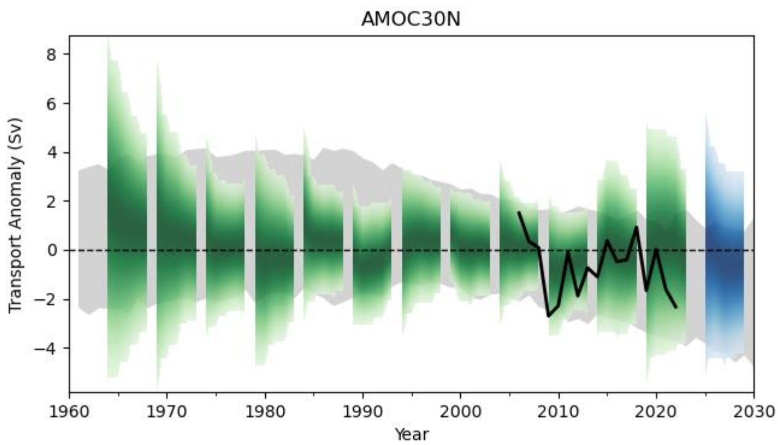

Figure 19: Atlantic Meridional Overturning Circulation close to 30°N and 1100m as in Roberts et al (2013). *RAPID observations (26°N) in black (anomalies relative to its full time series 2005-2021 and then adjusted to 1991-2020 using CMIP6 AMOC) and model forecast in blue.*

A positive phase of Pacific Decadal Variability (PDV) is characterised by warm anomalies in the tropical eastern Pacific and cold anomalies in the central North Pacific. Predictions for the next five years show warming in both these regions and therefore do not show a typical PDV pattern. Nevertheless, the PDV index used here is predicted to be negative during 2025-2029 with an 89% calibrated probability (Figure 20). This is consistent with the trend seen since 1990.

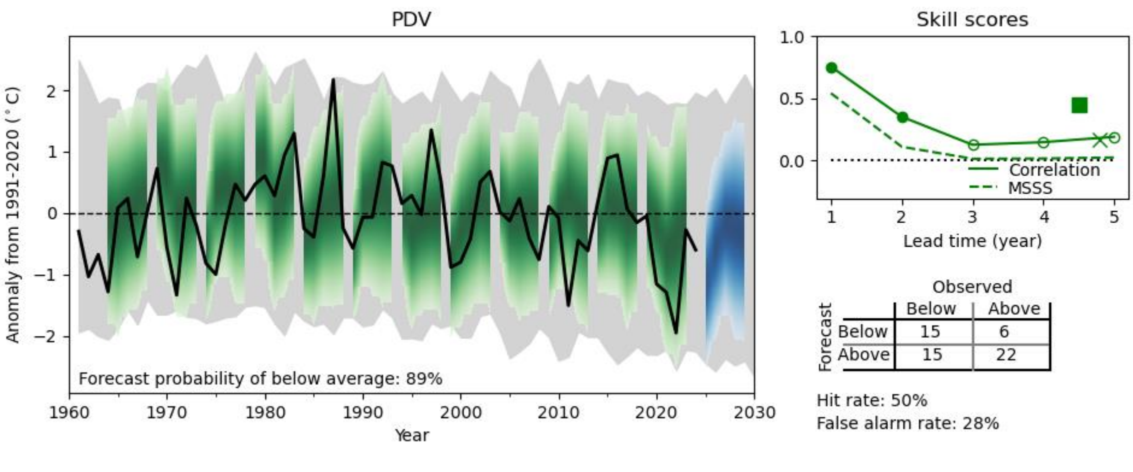

Figure 20: As Figure 5, but for Pacific Decadal Variability (PDV) defined as the difference in SST between the eastern tropical Pacific (10°S-6°N, 110°W-160°W) and the North Pacific (30°N-45°N, 145°W-180°W) as in Dong et al (2014).

The recent strong Antarctic Oscillation (AAO) or Southern Annular Mode (SAM) is predicted to remain above average (Figure 21). The calibrated probability of above average for 2024-2028 is 67%. Although skill is medium for individual years and high for the next five years, the hindcasts (green) underestimate the strengthening in the five years and the forecast (blue) is lower than recent observations leading to less confidence in the prediction.

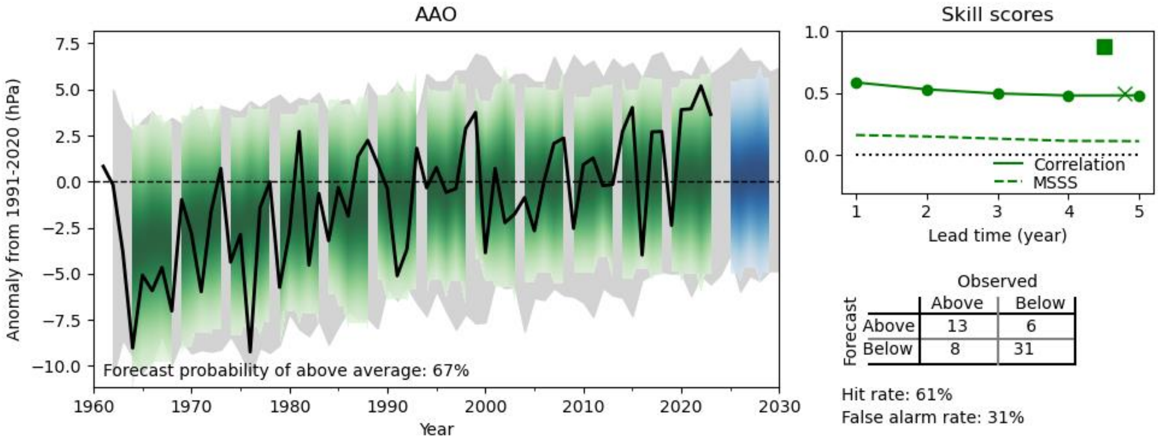

Figure 21: As Figure 5, but for the Antarctic Oscillation (AAO) defined as the difference in November to March mean zonal mean sea-level pressure between 65°S and 40°S as in Gong & Wang (1999).

The Arctic Oscillation has recently been close to neutral due to both high and low pressure in the winter season in the Arctic (Figure 2). Although skill is low, the calibrated probability of above average for the next five years is 77%.

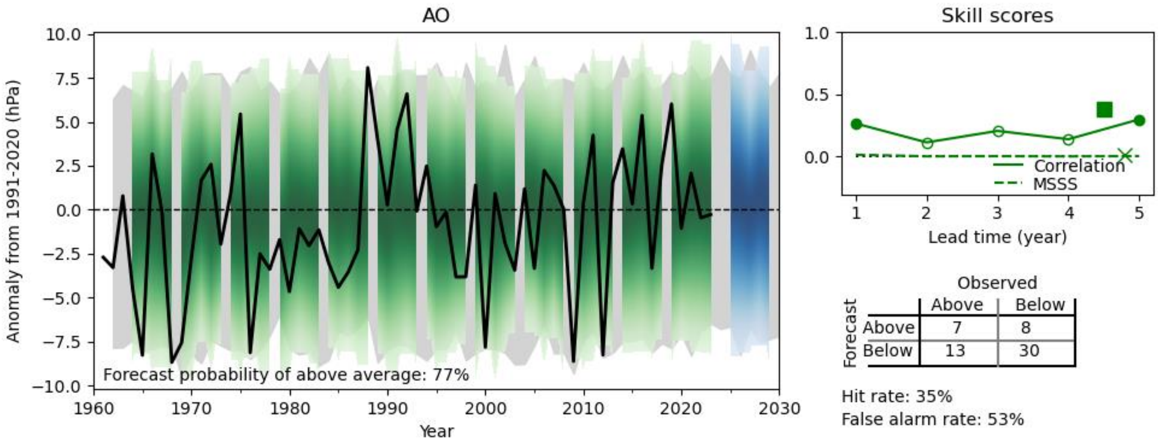

Figure 22: As Figure 5, but for the Arctic Oscillation (AO) defined as the difference in November to March mean zonal mean sea-level pressure between 80°N and 45°N similar to Gong & Wang (1999), but for the Northern Hemisphere.

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