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**SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA
(December 2024 to March 2025)**

Highlights

- The sea surface temperatures are mostly below average in the central and eastern Pacific Ocean. Currently, neutral El Niño-Southern Oscillation (ENSO) conditions are observed over the equatorial Pacific. The probability forecast indicates a highest probability of La Niña conditions during the DJF and JFM seasons.
- Above-average sea surface temperatures (SSTs) are currently seen across most of the Indian Ocean. Currently, neutral Indian Ocean Dipole (IOD) conditions are observed over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue for the next several months.
- The probability forecast for precipitation for DJF season indicate that enhanced probability of above normal precipitation is likely in most parts of south peninsular India, central, northeast and southeast of South Asia, some parts of northwest of South Asia and enhanced probability of below normal precipitation is likely over extreme northwest, north along the plains of Himalayas and west parts of South Asia. The same for DJF season indicates that enhanced probability of above normal precipitation is likely in some parts of northwest, extreme north, central and northeast of South Asia and enhanced probability of below normal precipitation in west, east, southern peninsular region, north along the Himalayan plains and south east of South Asia.
- In December, the country averaged monthly precipitation is likely to be normal to above normal for Bangladesh, Bhutan, India and Myanmar and likely to be below normal for Afghanistan, Maldives, Nepal, Sri Lanka and Pakistan. In January, the country averaged monthly precipitation is likely to be below normal to normal for all countries of South Asia. In February, it is likely to be normal to above normal in all the south Asian countries. In March, the country averaged monthly precipitation is likely to be normal to above normal for all the South Asian countries except Nepal where it is likely to be below normal.
- Temperature probability forecast for DJF and JFM seasons indicate that enhanced probability of above normal temperatures is likely over most parts of South Asia.
- The country averaged monthly temperatures during December, January, February and March are likely to be normal to above normal for all South Asian countries.

DISCLAIMER:

- (1) The long-range forecasts presented here are currently experimental and are produced using techniques that have not been validated.
- (2) The content is only for general information and its use is not intended to address particular requirements.
- (3) The geographical boundaries shown in this report do not necessarily correspond to the political boundaries.

1. Important Global Climate Factors

1.1 Sea Surface Temperatures over the Pacific Ocean

In November 2024, sea surface temperatures (SSTs) were near-to-below average in most of the central and east-central Pacific Ocean. Equatorial SSTs were above average across the western Pacific Ocean and around the Maritime Continent (Fig.1a). Warmer than average SSTs were observed over some parts of the northern extra-tropical Pacific region. Cooler than average SSTs were observed over parts of the south of the extra-tropical Pacific region. Compared to October 2024, negative SST anomalies were seen over western equatorial Pacific Ocean and some region of the central equatorial Pacific Ocean. Positive SST anomalies were seen over east-central and eastern equatorial Pacific Ocean. Cool SST anomalies are observed over the higher latitudes of North Pacific Ocean (Fig.1b). The probability forecast indicates a highest probability of La Niña conditions during the DJF and JFM seasons. (Fig.2)

1.2 Sea Surface Temperatures over Indian Ocean

In November 2024, equatorial SSTs were above average across the most of the Indian Ocean, including Arabian Sea and Bay of Bengal (Fig. 1a). Compared to October 2024, warmer SSTs were observed in the Arabian Sea and north Bay of Bengal, as well as south eastern parts of Indian Ocean. In contrast, cooler SSTs were observed in the southern parts of central equatorial Indian Ocean (Fig. 1b). The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue for the next several months. (Fig.3).

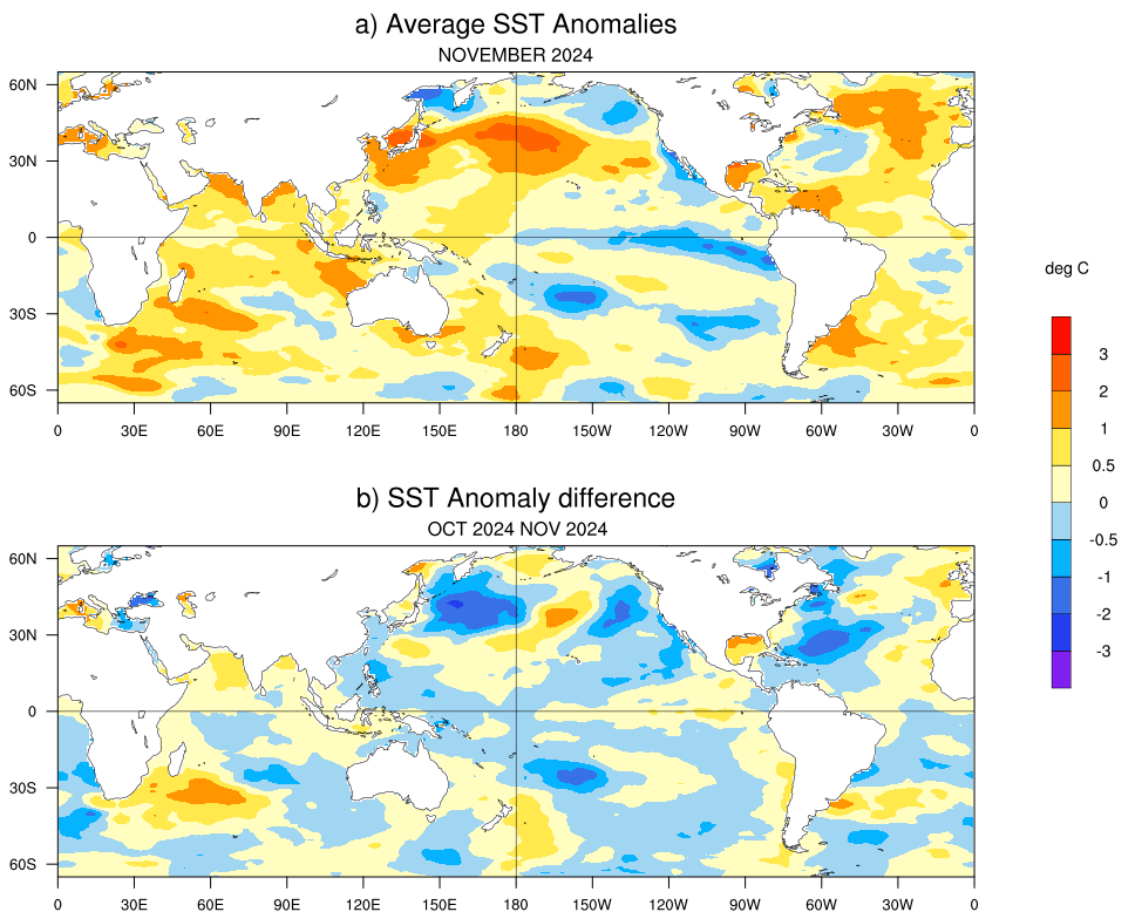


Fig.1: (a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during November 2024 and (b) changes in the SST anomalies ($^{\circ}\text{C}$) from October to November 2024. SSTs are based on the COBE-SST 2, from NOAA, and anomalies are computed with respect to 30-year (1991-2020) long term mean.

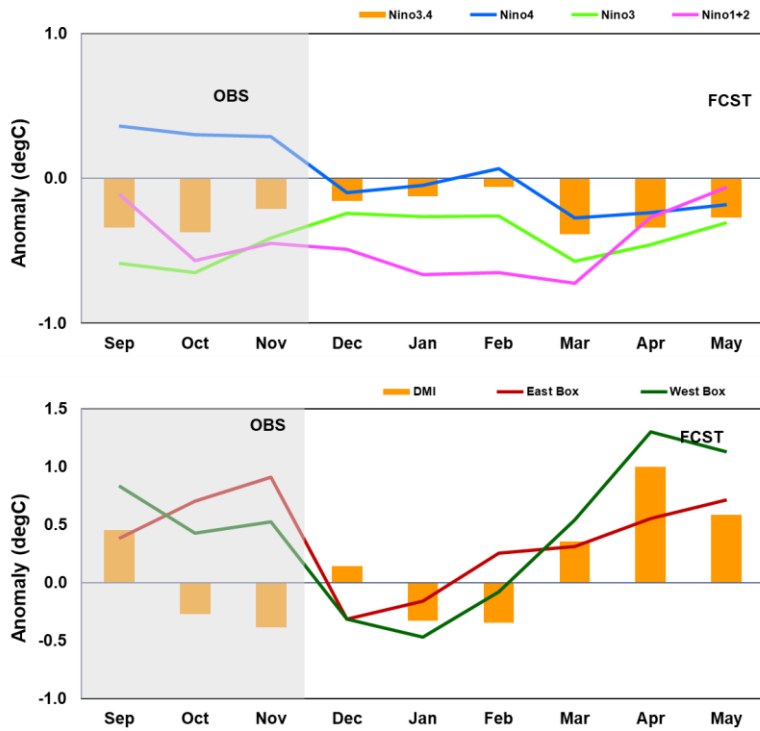


Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

Fig.3: The time series of the monthly area-averaged SST anomaly indices (°C) over west equatorial Indian Ocean (WEI) & east equatorial Indian Ocean (EEI) along with Dipole Mode Index (DMI=WEI-EEI) representing Indian Ocean Dipole (IOD). ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

1.3 Convection (OLR Anomaly) Pattern over the Asia Pacific Region

The Outgoing Longwave Radiation (OLR) anomaly during November 2024 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over most parts of south-central Bay of Bengal, south Indian Ocean, south China Sea and eastern tropical Pacific Ocean. Negative OLR anomalies were also observed over extreme tip of peninsular India, and most parts of Australia. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over north Arabian Sea, western and central Tropical Pacific Ocean. Positive OLR anomalies were also observed over northwest South Asia.

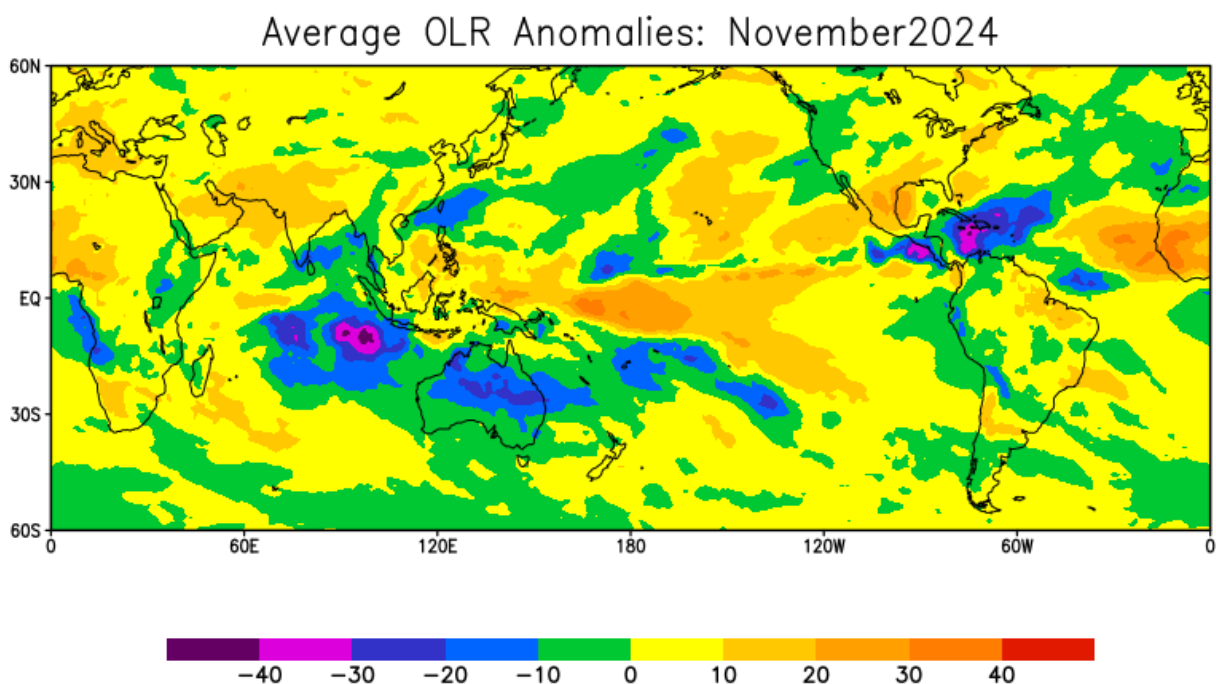


Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m^2) for November 2024 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

During November 2024, the NH snow cover area (34.32 million Sq. km) was less than the 1991-2020 normal by 0.734 million Sq. km (Fig. 5). Eurasian Snow cover area (20.9 million Sq. km) was 0.28 million Sq. km less than the 1991-2020 normal. North America snow cover area of 13.42 million sq. km was less by 0.45 million Sq. Km with respect to 1991-2020 normal.

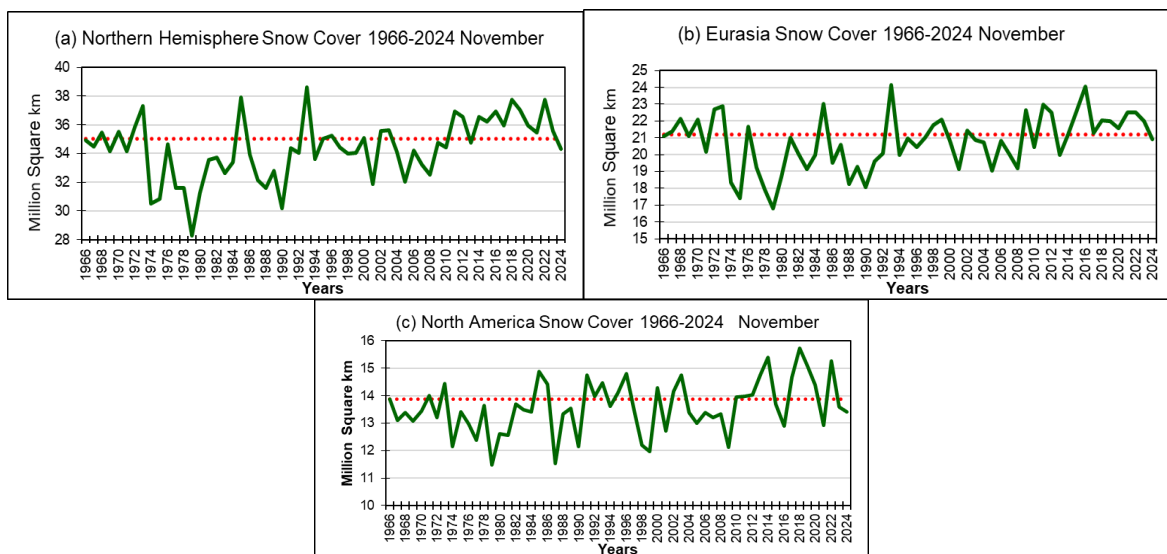


Fig.5. Snow cover area (million Sq. km) for the month of November during the period 1966-2024 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5 Madden Julian Oscillation (MJO)

During the first fortnight of November 2024, MJO moved from phase 8 (Western Hemisphere and Africa) to phase 2 (Indian Ocean) with enhanced strength. It then moved eastwards to phase 4 (Maritime Continent) with enhanced strength in the second fortnight. The MJO phase diagram illustrates the progression of the MJO through different phases, which generally coincide with locations along the equator around the globe.

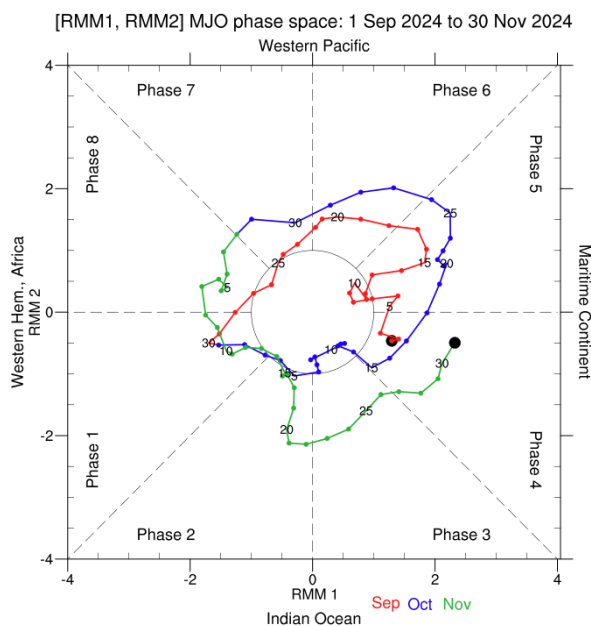


Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period September to November 2024. (Data Source: <http://www.bom.gov.au/climate/mjo/>).

2. Seasonal Outlook for South Asia

The seasonal outlook was prepared based on the forecast from Monsoon Mission Coupled Forecasting System (MMCFS). The model is a fully coupled ocean-atmosphere-land model. The atmospheric component of CFSv2 is Global Forecast System (GFS) with spectral resolution of T382 (approximately 38 km) and 64 hybrid vertical levels and the ocean component is Geophysical Fluid Dynamics Laboratory (GFDL) Flexible Modelling System (FMS) Modular Ocean Model version.

2.1. Precipitation Probability Forecast:

The probability forecasts for precipitation for the seasons December 2024 to February 2025 (DJF) and January to March 2025 (JFM) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the November initial conditions. The probability forecast for precipitation for DJF season indicate that enhanced probability of above normal precipitation is likely in most parts of south peninsular India, central, northeast and southeast of South Asia, some parts of northwest of South Asia and enhanced probability of below normal precipitation is likely over extreme northwest, north along the plains of Himalayas and west parts of South Asia. The same for JFM season indicates that enhanced probability of above normal precipitation is likely in some parts of northwest, extreme north, central and northeast of South Asia and enhanced probability of below normal precipitation in west, east, southern peninsular region, north along the Himalayan plains and south east of South Asia.

MMCFS Rainfall % Probability Forecast: NovIC2024

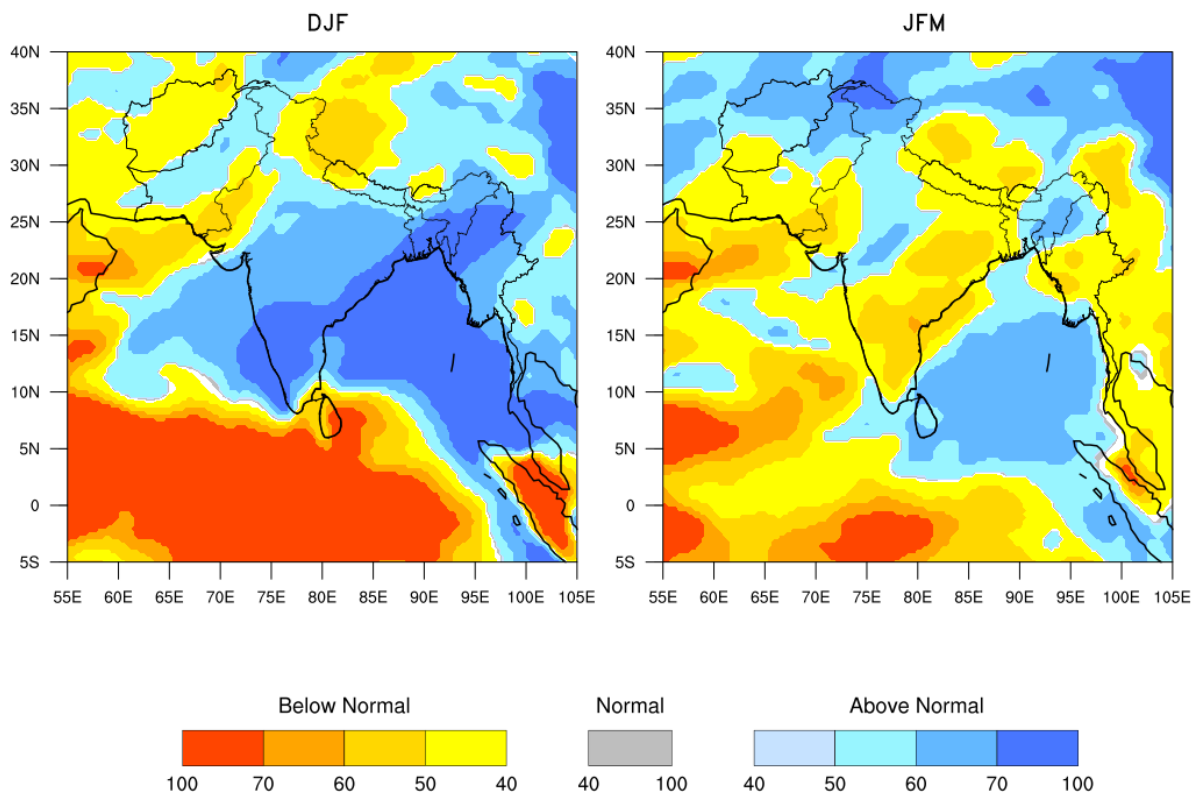


Fig.7: Seasonal probability (%) forecasts of precipitation for (a) DJF 2024-25 (left) and (b) JFM 2025 (right) based on initial conditions of November 2024. The white colour indicates climatological probability.

2.2. Temperature Probability Forecast:

The probability forecasts for temperature for the season December 2024 to February 2025 (DJF) and January to March 2025 (JFM) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the November initial conditions. Temperature probability forecast for DJF and JFM seasons indicate that enhanced probability of above normal temperatures is likely over most parts of South Asia.

MMCFS Temperature % Probability Forecast: Nov IC 2024

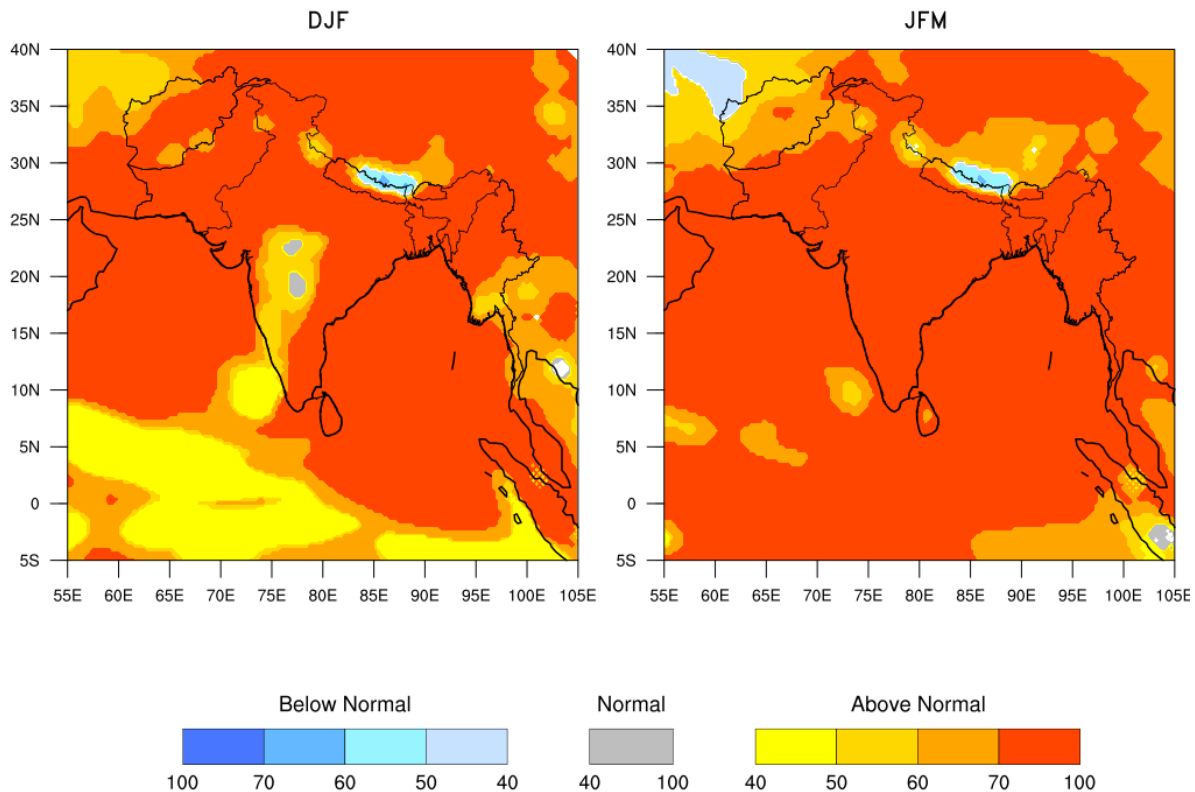


Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) DJF 2024-25 (left) and (b) JFM 2025 (right) based on initial conditions of November 2024. The white colour indicates climatological probability.

3. Forecast Outlook for the Country Averaged Monthly Precipitation and Temperature

The MMCFS model forecast for monthly precipitation and temperature for the next four months (from December 2024 to March 2025) averaged over the 9 south Asian countries viz., Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka were shown in the Figures 9. The monthly rainfall anomaly is expressed as percentage departure from Long Period Model Average (LPMA) and monthly temperature anomaly is expressed in degree Celsius.

In December, the country averaged monthly precipitation is likely to be normal to above normal for Bangladesh, Bhutan, India and Myanmar and likely to be below normal for Afghanistan, Maldives, Nepal, Sri Lanka and Pakistan. In January, the country averaged monthly precipitation is likely to be below normal to normal for all countries of South Asia. In February, it is likely to be normal to above normal in all the south Asian countries. In March, the country averaged monthly precipitation is likely to be normal to above normal for all the South Asian countries except Nepal where it is likely to be below normal.

The country averaged monthly temperatures during December, January, February and March are likely to be normal to above normal for all South Asian countries.

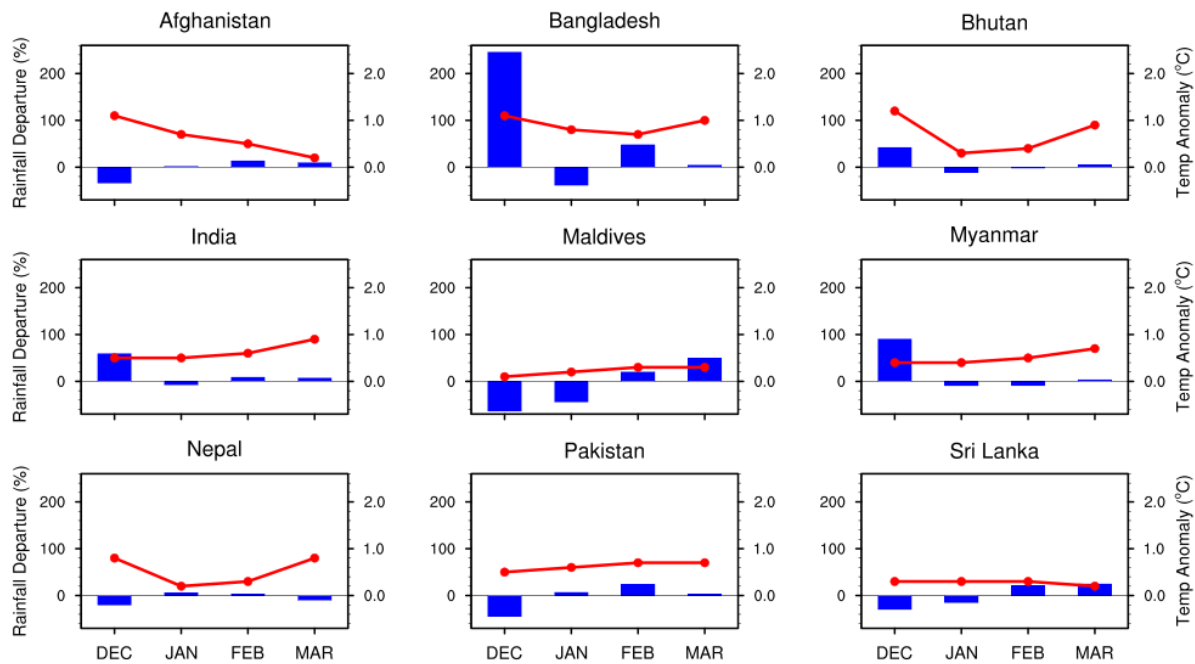


Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during December 2024 to March 2025. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale for Precipitation indicated in blue shaded bars) and the normal range for country averaged monthly temperature is taken -0.25°C to +0.25°C (Right Vertical Axis Scale for Temperature indicated in red coloured lines).