# Earth System Science Organization (ESSO)
# Ministry of Earth Sciences (MoES)
# India Meteorological Department
### WMO Regional Climate Centre
### Pune, India

### SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA
### (July to October 2024)

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**Highlights**

- The sea surface temperatures are colder than normal in the eastern equatorial Pacific Ocean. Currently, El Niño-Southern Oscillation (ENSO) neutral conditions are observed over the equatorial Pacific. The latest Monsoon Mission Climate Forecast System (MMCFS) forecast indicates a higher likelihood of La Niña conditions during second half of monsoon season.

- At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. Most of the Climate models across the globe indicate the neutral IOD conditions likely to continue during the remaining part of the monsoon season. However, the latest MMCFS forecast indicates current neutral IOD conditions are likely to turn to negative IOD conditions by the end of the monsoon season.

- The probability forecast for precipitation for July – September (JAS) and August – October (ASO) indicates that enhanced probability of above normal precipitation is likely in most parts of South Asia except over extreme north and extreme northwest where below normal rainfall is likely to occur.

- In July, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries. In August, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries except Afghanistan and Maldives where it is likely to be below normal. In September and October, it is likely to be normal to above normal for all the South Asian countries except Afghanistan where it is likely to be below normal

- Temperature probability forecast for JAS and ASO seasons indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over some parts of north and central South Asia where probability of below normal temperature is likely.

- The country averaged monthly temperatures during July, August, September and October are likely to be normal to above normal for all South Asian countries.

# 1. Important Global Climate Factors

## 1.1 Sea Surface Temperatures over the Pacific Ocean

During May 2024, below-average equatorial sea surface temperatures (SSTs) emerged in small regions of the eastern Pacific Ocean. However, above-average SSTs prevailed across the rest of the equatorial Pacific (Fig.1a). Warmer than normal SSTs were observed over some parts of northern and southern extra-tropical Pacific region. Cooler than normal SSTs were observed over some parts of the southern extra-tropical Pacific region. As compared to April 2024, negative SST anomalies were seen over central and eastern equatorial Pacific region and positive SST anomalies were seen over the western equatorial Pacific Ocean (Fig.1b). The latest MMCFS forecast indicates that the ENSO-neutral conditions are likely to continue with strong possibility of transition to La Niña conditions around August-October 2024 season. (Fig.2)

## 1.2 Sea Surface Temperatures over Indian Ocean

In May 2024, warmer than normal SSTs were observed over most parts of the Indian Ocean (Fig.1a) including Bay of Bengal and Arabian Sea. As compared to April 2024, cool SSTs were observed over the equatorial Indian Ocean and warm SSTs were observed over the north Bay of Bengal (Fig.1b). The latest MMCFS forecast indicates enhanced probability for neutral IOD conditions to continue. At the same time, the possibility for the emergence of the positive IOD conditions during the monsoon season has reduced significantly. Up to last month, many global models including MMCFS were predicting the development of positive IOD conditions during the monsoon season. (Fig.3).
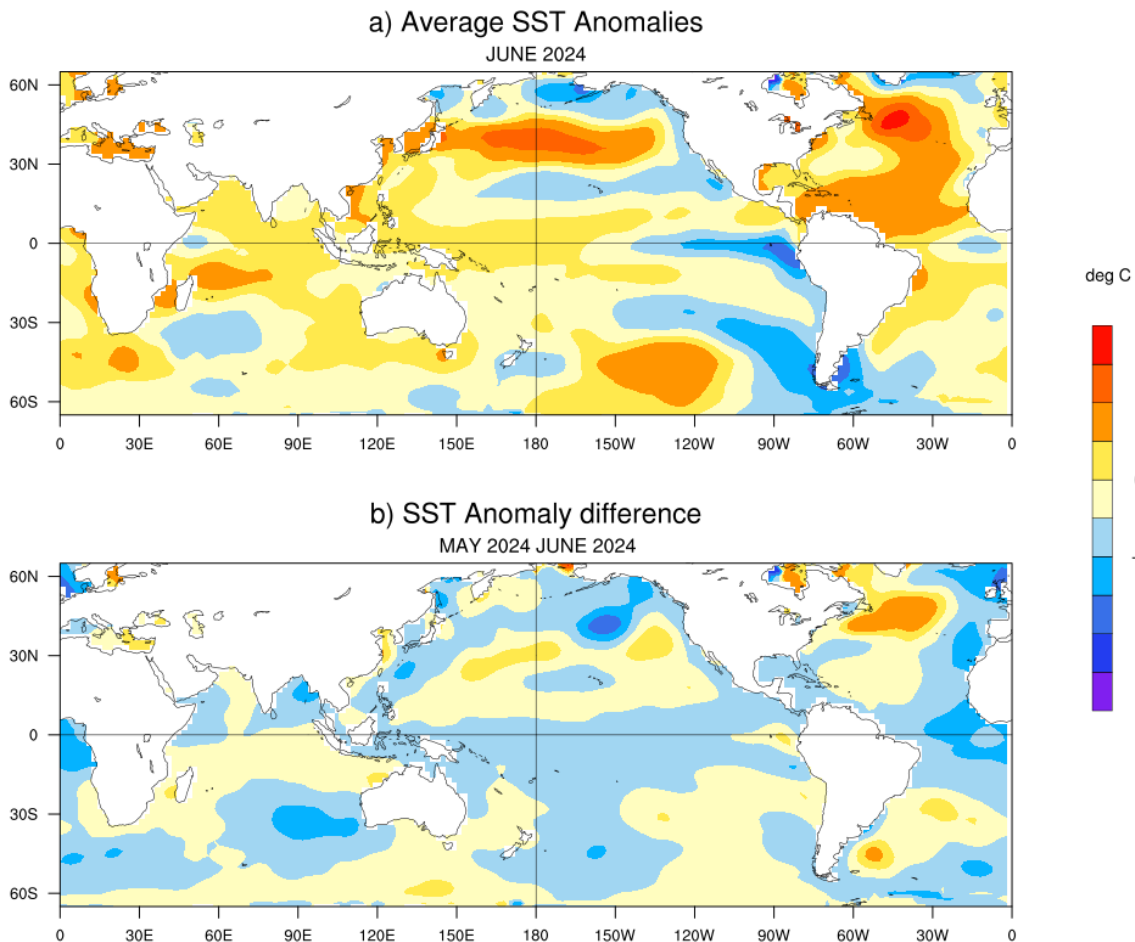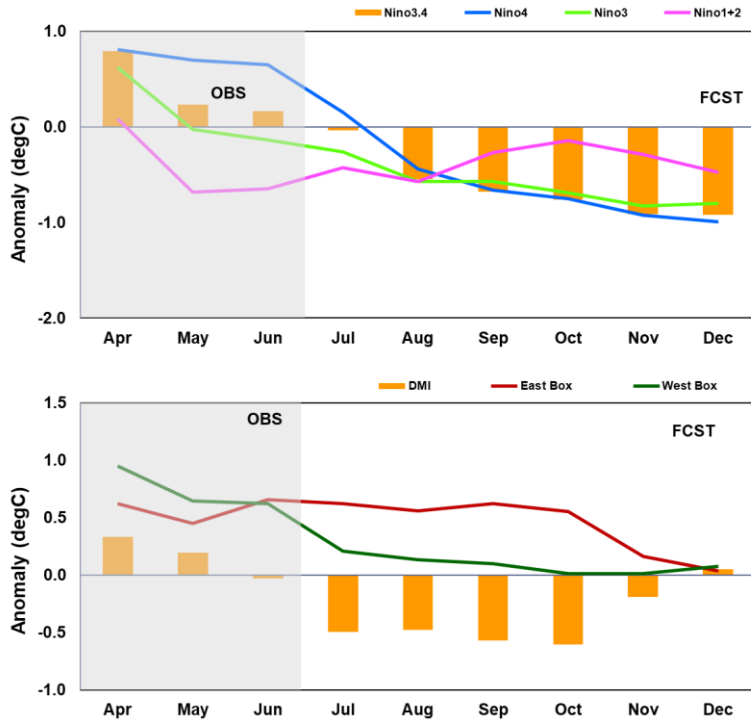


Fig.1(a) Sea surface temperature (SST) anomalies (°C) during June 2024 and (b) changes in the SST anomalies (°C) from May to June 2024. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) long term mean.

**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 June 2024 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over south Bay of Bengal and Central Parts of South Asia. Negative OLR anomalies were also observed over maritime continent, central equatorial Pacific region and parts of central America. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over most parts of Indian Ocean, some parts of east equatorial Pacific Ocean, most parts of Africa and south America.
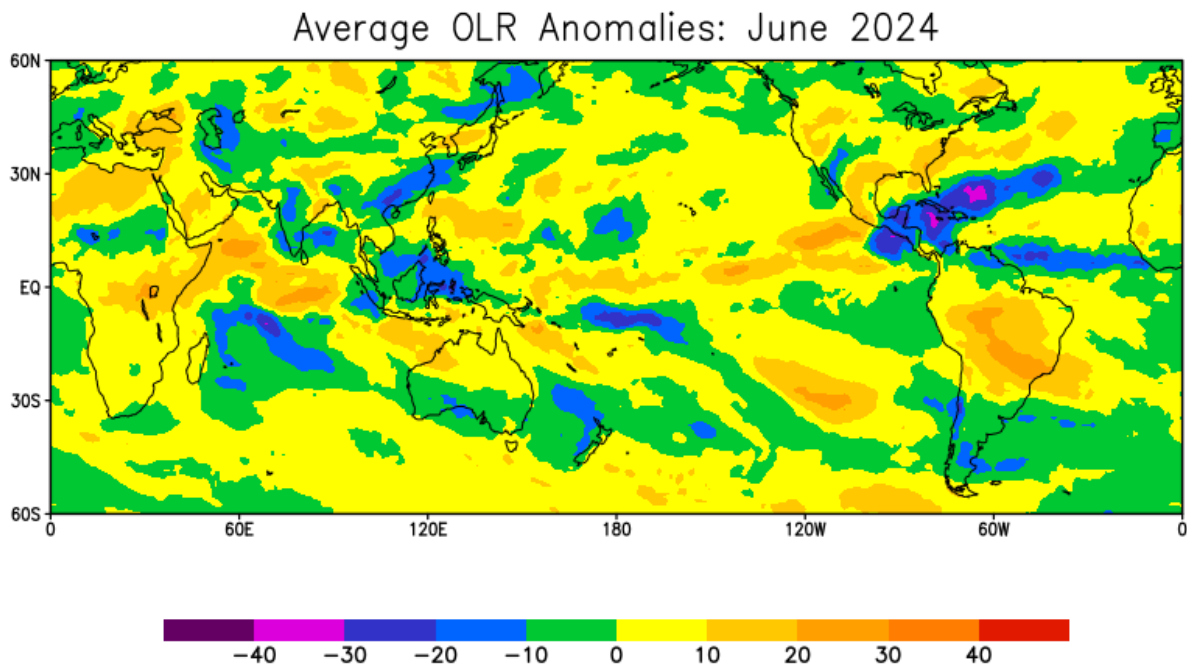


**Fig.4:**  Outgoing Long Wave Radiation (OLR) Anomaly (W/m²) for June 2024
(Data source: NCEP-NOAA)

### 1.4 Snow Cover Area over the Northern Hemisphere (NH)

During June 2024, the NH snow cover area (6.59 million Sq. km) was less than the 1991-2020 normal by 1.54 million Sq. km (Fig. 5). Eurasian Snow cover area (2.04 million Sq. km) was 0.803 million Sq. km less than the 1991-2020 normal. North America snow cover area of 4.53 million sq. km was less by 0.75 million Sq. Km with respect to 1991-2020 normal.
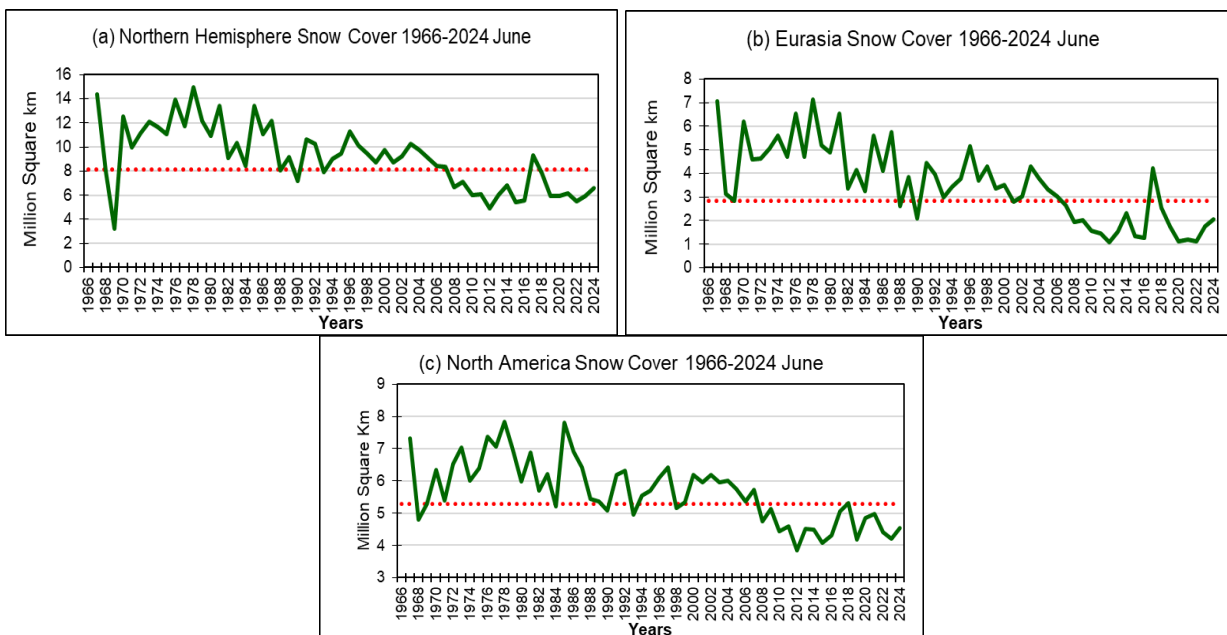


**Fig.5.** Snow cover area (million Sq. km) for the month of June during the period 1966-2024 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

### 1.5. Madden Julian Oscillation (MJO)

During the first three weeks of June 2024, MJO moved eastwards from phase 4 (Maritime Continent) to phase 2 (Indian Ocean) with reduced strength. In the last fortnight it remained in phase 2 (Indian Ocean) with enhanced strength. The MJO phase diagram illustrates the progression of the MJO through different phases, which generally coincide with locations along the equator around the globe.
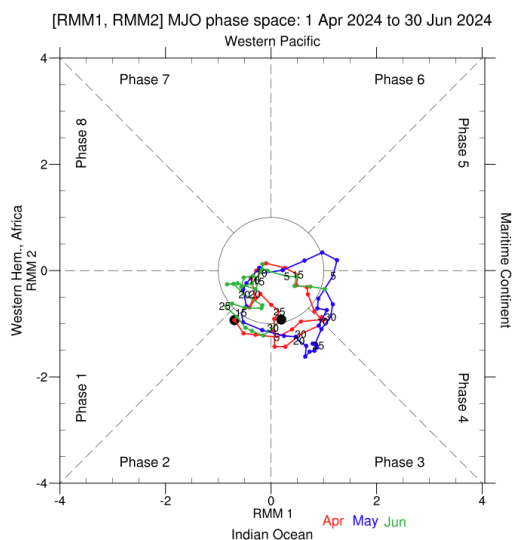


**Fig.6.** RMM phase diagram for Madden Julian Oscillation (MJO) for the period April to June 2024. (Data Source: http://www.bom.gov.au/climate/mjo/).
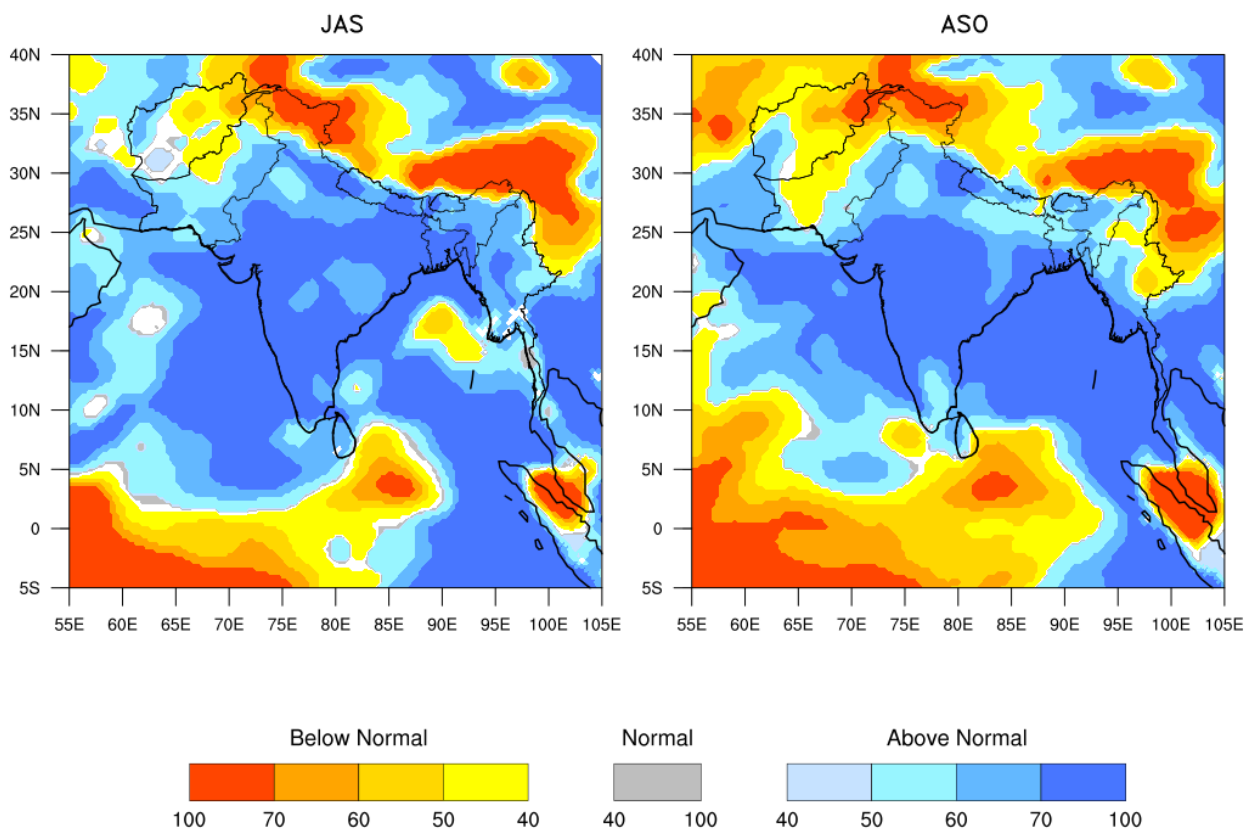
## 2.     Seasonal Outlook for South Asia

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 July to September 2024 (JAS) and August to October 2024 (ASO) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the June initial conditions. The probability forecast for precipitation for JAS and ASO seasons indicates that enhanced probability of above normal precipitation is likely in most parts of South Asia except over extreme north and extreme northwest where below normal rainfall is likely to occur.
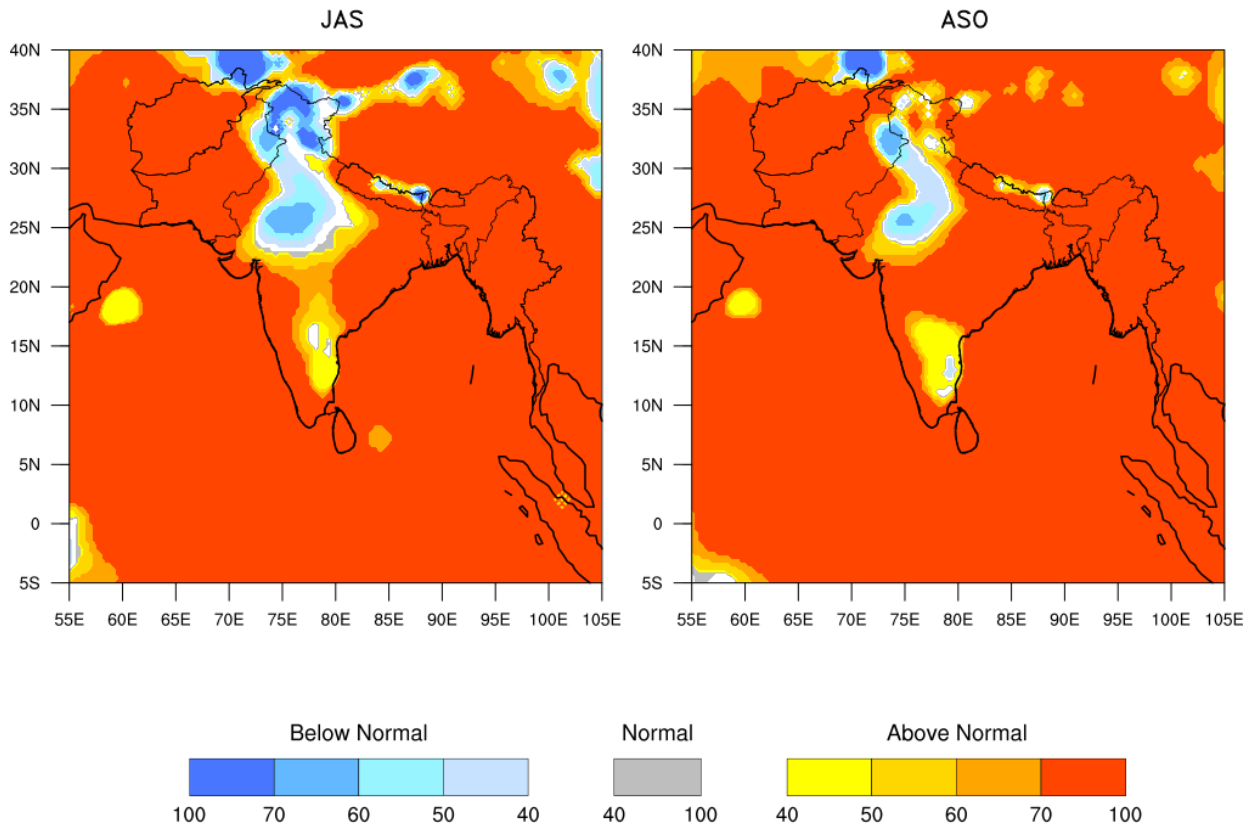


**Fig.7:** Seasonal probability (%) forecasts of precipitation for (a) JAS 2024 (left) and (b) ASO 2024 (right) based on initial conditions of June 2024. The white colour indicates climatological probability.

### 2.2.     Temperature Probability Forecast:

The probability forecasts for temperature for the season July to September 2024 (JAS) and August to October 2024 (ASO) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the June initial conditions. Temperature probability forecast for JAS and ASO seasons indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over some parts of north and central South Asia where probability of below normal temperature is likely.

**Fig. 8:** Probability (%) forecast for the seasonal mean temperature for (a) JAS 2024 (left) and (b) ASO 2024 (right) based on initial conditions of June 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 July to October 2024) 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 July, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries.  In August, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries except Afghanistan and Maldives where it is likely to be below normal.  In September and October, it is likely to be normal to above normal for all the South Asian countries except Afghanistan where it is likely to be below normal.

The country averaged monthly temperatures during July, August, September and October are likely to be normal to above normal for all South Asian countries.
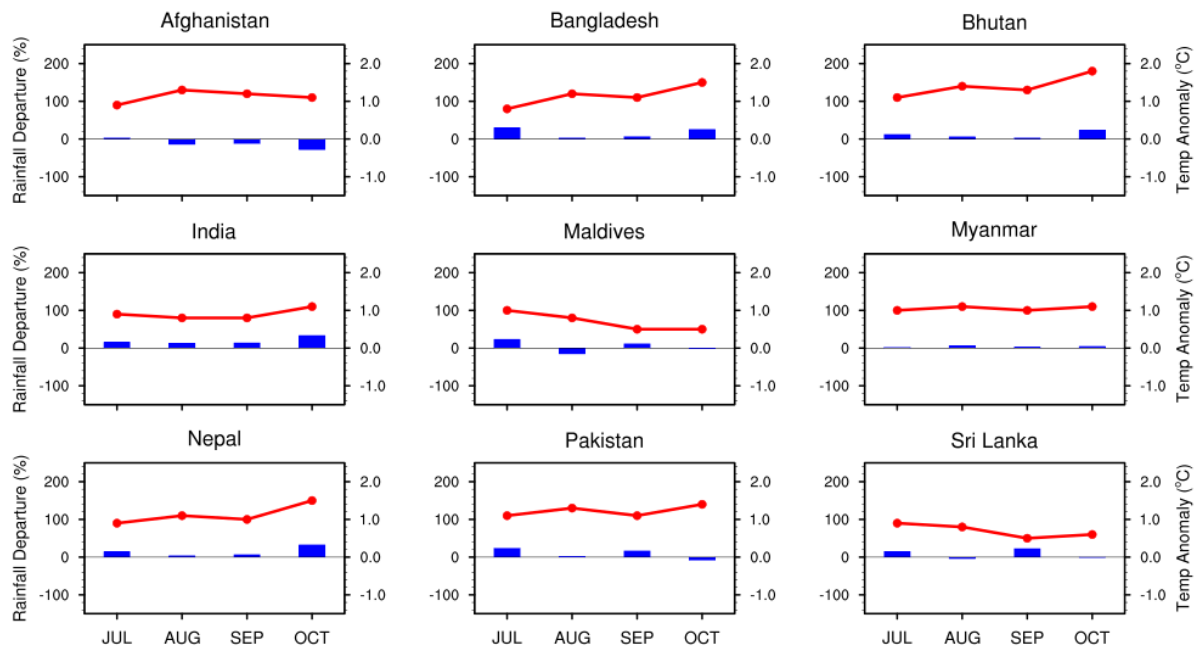
**Fig. 9:** Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during July to October 2024. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale 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).