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SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA

(April to July 2024)

Highlights

- The strength of El Niño conditions weakened since beginning of the year and currently moderate El Niño conditions are prevailing over equatorial Pacific. The latest MMCFS forecast indicates that El Niño conditions are likely to weaken further during the upcoming season and turn to ENSO neutral thereafter. The model also indicates likely development of the La Niña conditions during the monsoon season.
- At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates that the positive IOD conditions are likely to develop during the monsoon season.
- The probability forecast for precipitation for April – June (AMJ) indicates that enhanced probability of above normal precipitation is likely in most parts of northwest, extreme south, some parts of north along the Himalayan plains and north Peninsular India. Extreme north, northeast and south east of South Asia is likely to experience below normal rainfall. The same for May – July (MJJ) indicates that enhanced probability of above normal precipitation is likely in most parts of South Asia except in some parts of extreme north, northwest and southwest regions of South Asia where probability of below normal precipitation is likely.
- In April, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries except Bangladesh, Maldives and Myanmar where it is likely to be below normal. In May, it is likely to be normal to above normal for all the countries except Myanmar where it is likely to be below normal. In June, it is likely to be normal to above normal for all the countries. In July, it is likely to be normal to above normal for all countries except Afghanistan where it is likely to be below normal.
- Temperature probability forecast for AMJ and MJJ season indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over north along the plains of Himalayas where probability of below normal temperature is likely
- The country averaged monthly temperatures during April, May, June and July 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

During the March 2024, warmer than normal sea surface temperatures (SSTs) were observed across the central and east-central Pacific Ocean and the northern extra-tropical Pacific region (Fig.1a). However, cooler than normal SSTs were observed over some parts of Southern Pacific. As compared to February 2024, negative SST anomalies were detected across the majority of the equatorial Pacific region, with the most pronounced differences observed over the eastern most parts of the Pacific Ocean (Fig.1b). The latest MMCFS forecast indicates that El Niño conditions are likely to weaken further during the upcoming season and turn to ENSO neutral thereafter. The model also indicates likely development of the La Niña conditions during the monsoon season. (Fig.2).

1.2 Sea Surface Temperatures over Indian Ocean

In March 2024, warmer than normal SSTs were observed over the Indian Ocean (Fig.1a). As compared to February 2024, cool SSTs were observed over most of the North Indian Ocean including Bay of Bengal and north Arabian Sea (Fig.1b). The latest MMCFS forecast indicates that the positive IOD conditions are likely to develop during the monsoon season. (Fig.3).

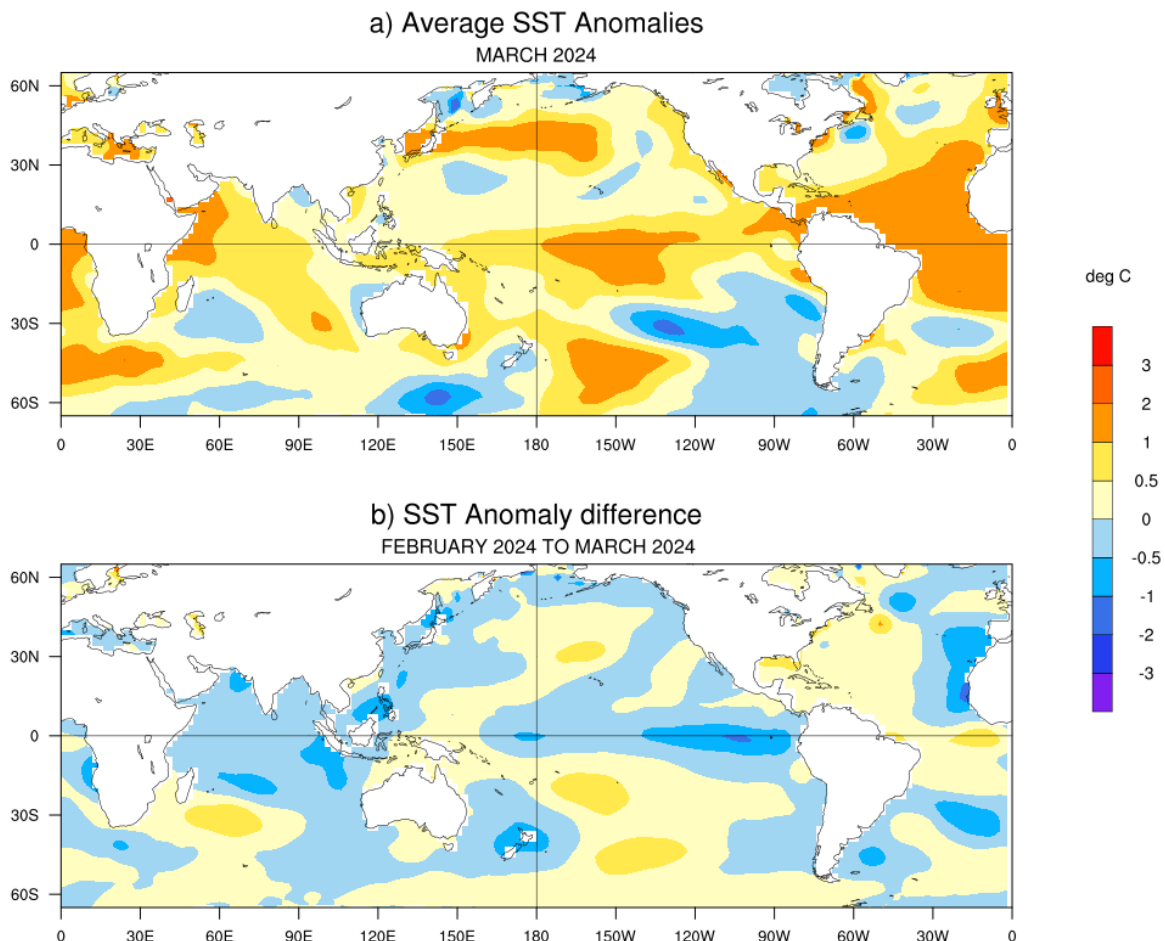


Fig.1(a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during March 2024 and (b) changes in the SST anomalies ($^{\circ}\text{C}$) from February to March 2024. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) long term mean.

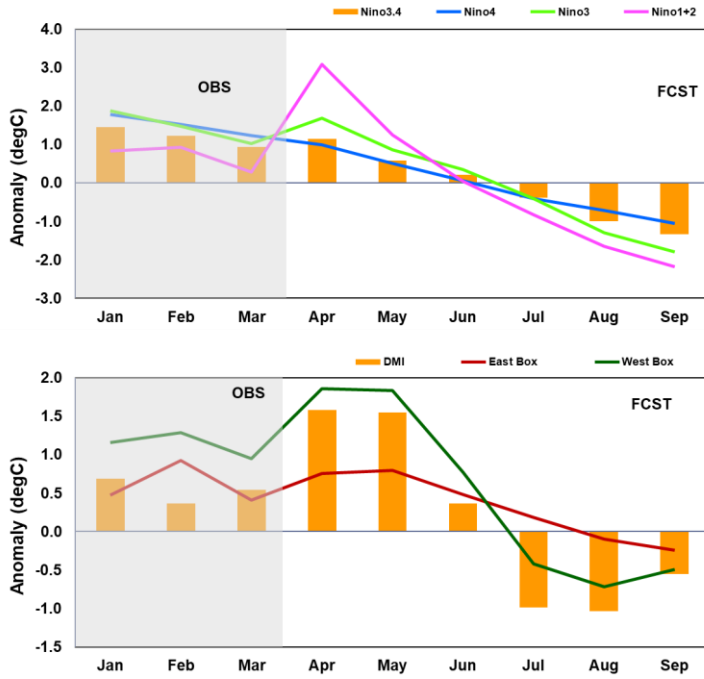


Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 March 2024 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over east Indian Ocean, east central equatorial Pacific Ocean and parts of south Pacific Ocean. Negative OLR anomalies were also observed over most parts of Australia. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over western tropical Pacific Ocean, south Indian Ocean and south-central Pacific Ocean. Positive OLR anomalies were also present in South Peninsular India, some parts of Africa and South America.

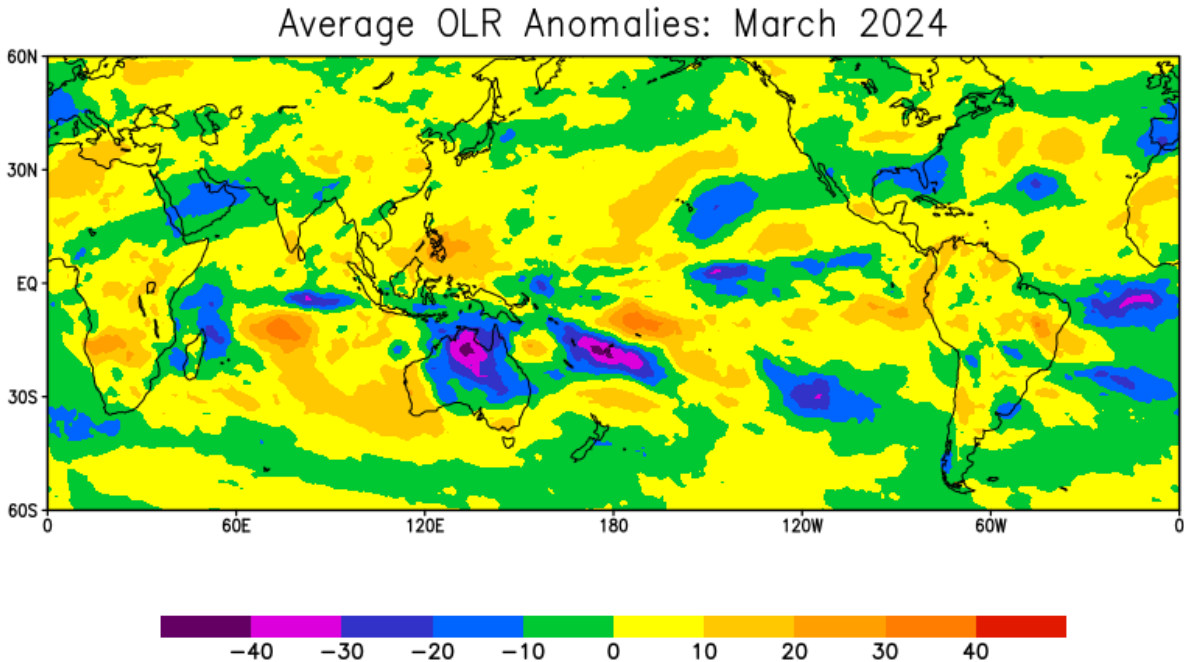


Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m^2) for March 2024 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

During March 2024, the NH snow cover area (38.37 million Sq. km) was less than the 1991-2020 normal by 1.42 million Sq. km (Fig. 5). Eurasian Snow cover area (23.25 million Sq. km) was 0.84 million Sq. km less than the 1991-2020 normal. North America snow cover area of 15.12 million sq. km was less by 0.58 million Sq. Km with respect to 1991-2020 normal.

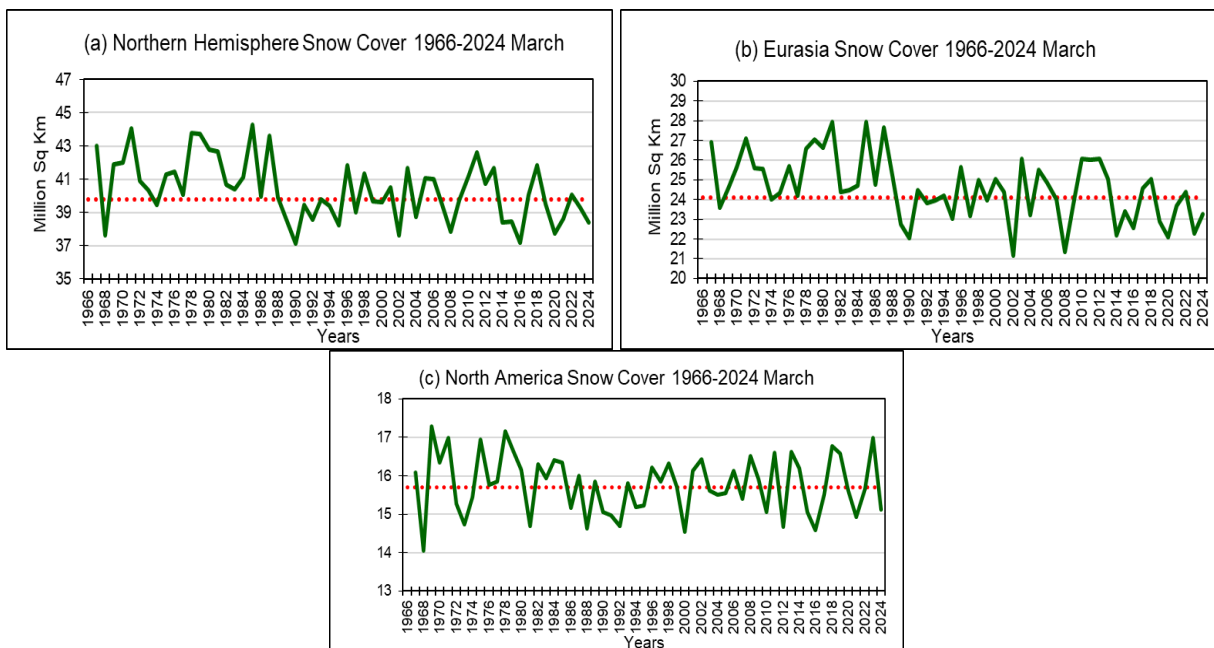


Fig.5. Snow cover area (million Sq. km) for the month of March during the period 1966-2024 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5 Madden Julian Oscillation (MJO)

During the first week of March 2024, MJO was in phase 3 (Indian Ocean). In the second week it moved eastward and moved to phase 5 (Maritime Continent). It further moved eastwards to Phase 7 (Western Pacific) in the third week and entered into phase 1 (Western Hemisphere and Africa) in the fourth week. The MJO had enhanced strength throughout the month. The MJO phase diagram illustrates the progression of the MJO through different phases, which generally coincide with locations along the equator around the globe.

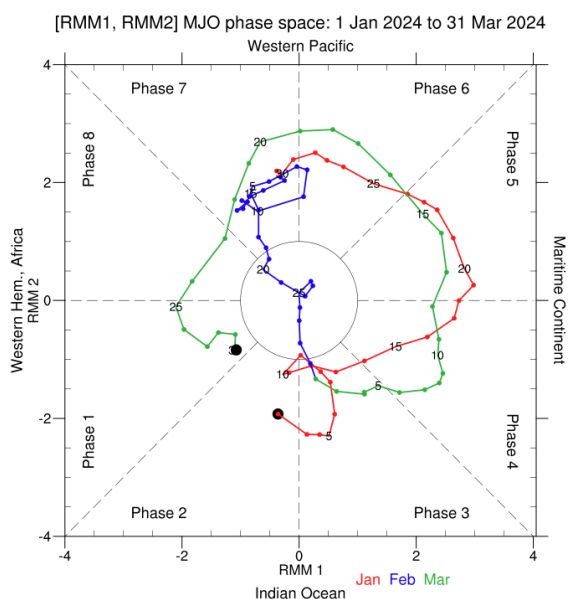


Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period January to March 2024. (Data Source: <http://www.bom.gov.au/climate/mjo/>).

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 April to June 2024 (AMJ) and May to July 2024 (MJJ) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the March initial conditions. The probability forecast for precipitation for AMJ season indicates that enhanced probability of above normal precipitation is likely in most parts of northwest, some parts of north along the Himalayan plains, north Peninsular India and extreme south, Extreme north, northeast and south east of South Asia is likely to experience below normal rainfall. Central regions of South Asia are likely to experience enhanced probability of above normal precipitation. The same for MJJ season indicates that enhanced probability of above normal precipitation is likely in most parts of South Asia except in some parts of extreme north, northwest and southwest regions of South Asia where enhanced probability of below normal precipitation is likely.

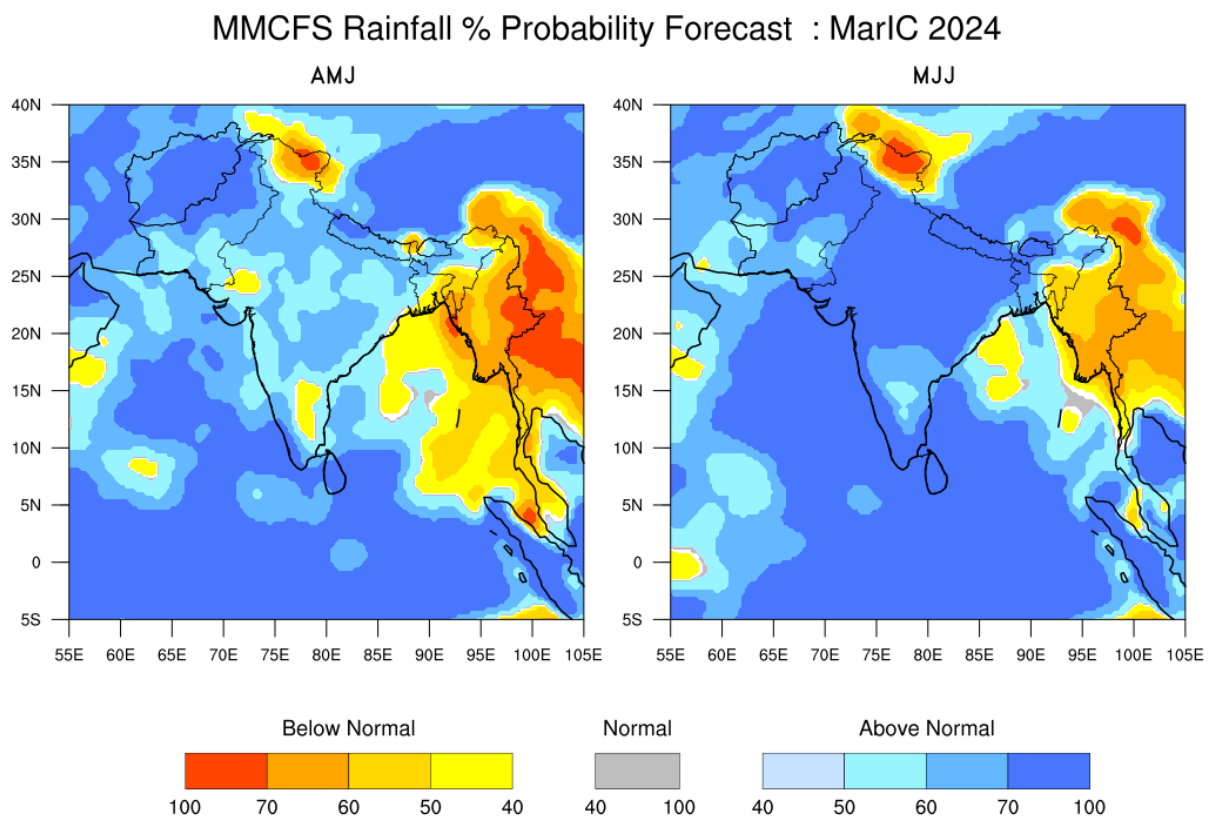


Fig.7: Seasonal probability (%) forecasts of precipitation for (a) AMJ 2024 (left) and (b) MJJ 2024 (right) based on initial conditions of March 2024. The white colour indicates climatological probability.

2.2. Temperature Probability Forecast:

The probability forecasts for temperature for the season April to June 2024 (AMJ) and May to July 2024 (MJJ) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the March initial conditions. Temperature probability forecast for AMJ and MJJ season indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over north along the plains of Himalayas where probability of below normal temperature is likely.

MMCFs Temperature % Probability Forecast : MarIC 2024

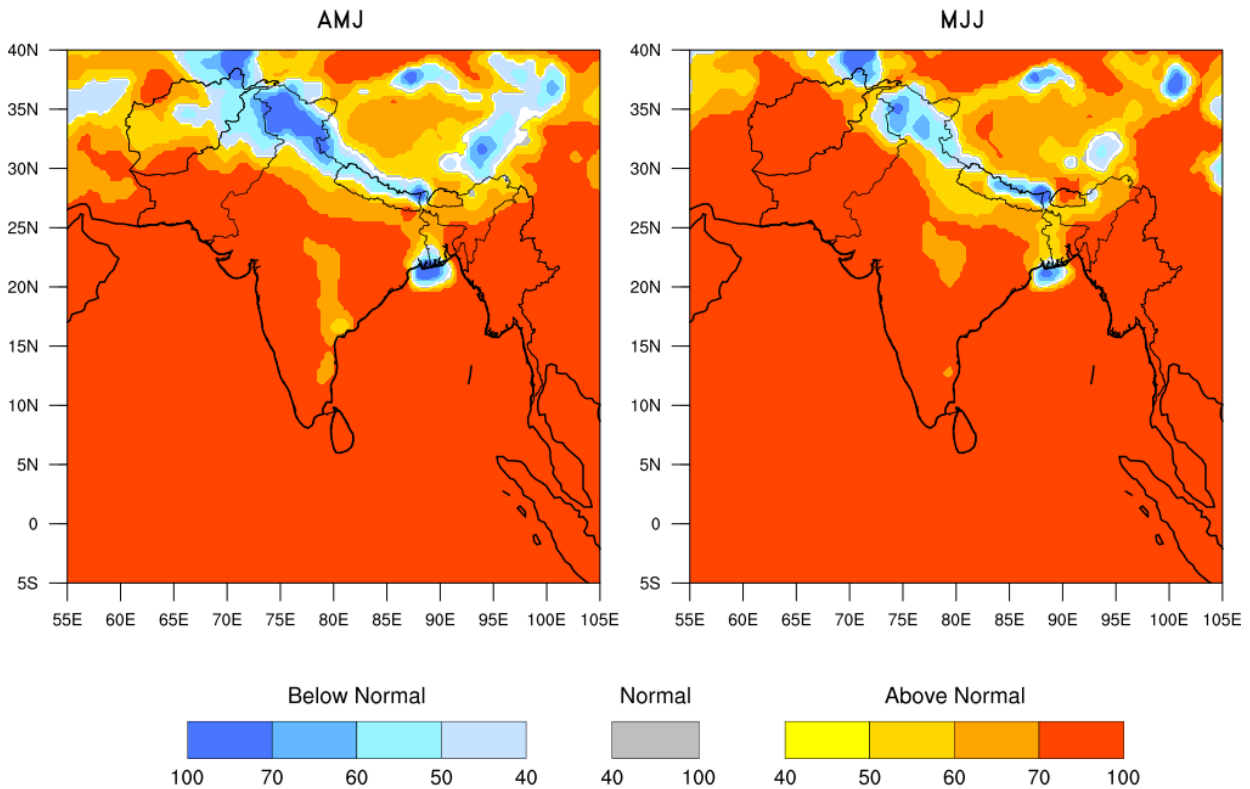


Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) AMJ 2024 (left) and (b) MJJ 2024 (right) based on initial conditions of March 2024. The white colour indicates climatological probability.

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 April to July 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 April, the country averaged monthly precipitation is likely to be normal to above normal for all South Asian countries except Bangladesh, Maldives and Myanmar where it is likely to be below normal. In May, it is likely to be normal to above normal for all the countries except Myanmar where it is likely to be below normal. In June, it is likely to be normal to above normal for all the countries. In July, it is likely to be normal to above normal for all countries except Afghanistan where it is likely to be below normal.

The country averaged monthly temperatures during April, May, June and July are likely to be normal to above normal for all south Asian countries.

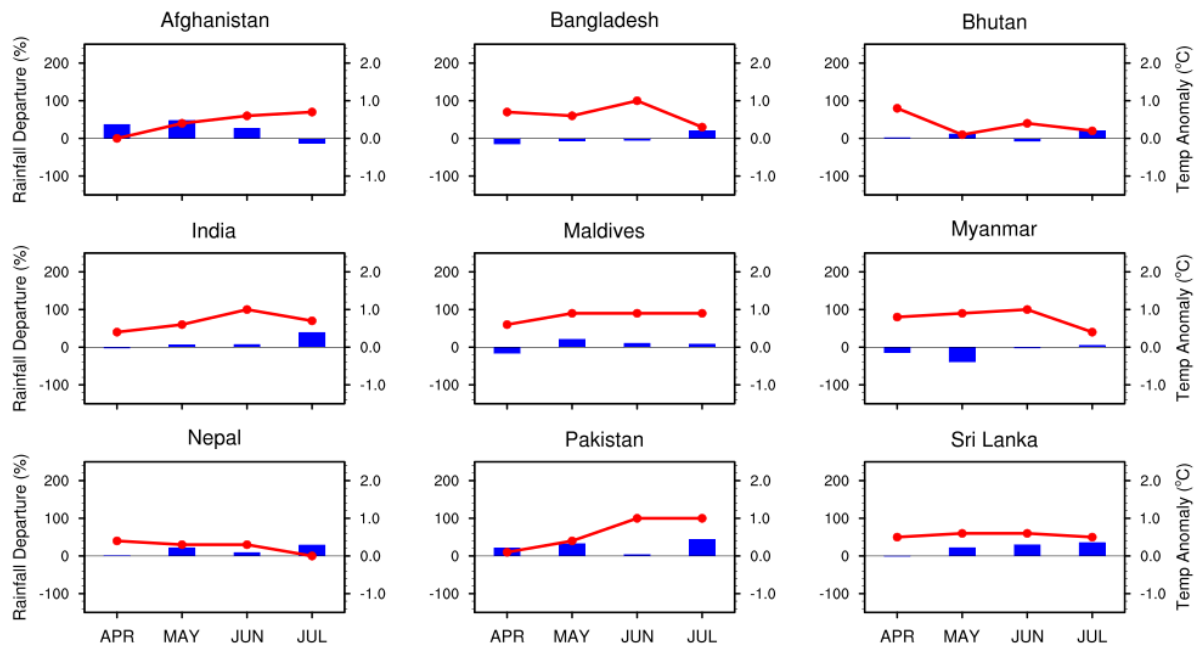


Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during April to July 2024. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale for 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).