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

(March to June 2023)

- The La Niña conditions are prevailing over the equatorial Pacific region, but the strength of the La Niña continue to weaken for the past few months. The latest MMCFS forecast indicates that the ENSO-neutral conditions are expected to start from the next season and the El Niño is likely to develop during the second half of the southwest monsoon season.

- The neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming season, but a positive IOD is likely to develop towards the end of the southwest monsoon season.

- The probability forecast for precipitation for March – May (MAM) and April - June (AMJ) indicates that an enhanced probability of below normal precipitation is likely over South Asia except over some parts of southeast of south Asia where above normal precipitation is likely.

- The country averaged monthly precipitation for March and April 2023 is likely to be normal to below normal for all south Asian countries. In May, the country averaged monthly precipitation is likely to be normal to below normal for all south Asian countries except Myanmar where it is likely to be above normal. In June it is likely to be normal to below normal for all south Asian countries except Maldives and Myanmar where it is likely to be above normal.

- Temperature probability forecast for MAM and AMJ season indicates that enhanced probability of below normal temperatures is likely over most parts of north, northwest, west and west peninsular regions whereas enhanced probability of above normal temperatures are likely over most parts of north along the foothills of Himalayas, east, east central and east peninsular regions of South Asia.

- The country averaged monthly temperatures during March to June is likely to be above normal for all south Asian countries.

1. Important Global Climate Factors

1.1 Sea Surface Temperatures over the Pacific Ocean

During February 2023 cooler than normal SSTs were observed across the central and eastern tropical Pacific Ocean, and warmer than normal SSTs were observed in the far western tropical Pacific Ocean (Fig.1a). Warmer than normal SSTs were also observed over the extra-tropical regions of the north and the South Pacific Ocean. Also, warm SST anomalies were observed over most parts of the western Pacific Ocean. As compared to the last month, warming of SST anomalies were observed over some parts of central and eastern Pacific Ocean (Fig.1b). Cooling of SST anomalies were observed over many parts of the north Pacific Ocean. The La Niña conditions are prevailing over the equatorial Pacific region, but the strength of the La Niña continue to weaken for the past few months. The latest MMCFS forecast indicates that the ENSO-neutral conditions are expected to start from the next season and the El Niño is likely to develop during the second half of the southwest monsoon season.

Sea Surface Temperatures over Indian Ocean

Warm SST anomalies were observed over the north Arabian Sea and north Bay of Bengal (Fig.1a). However, cold SST anomalies were also observed over the equatorial Indian Ocean. As compared to the last month, close to normal with cool SST anomalies were observed over most parts of northern Indian Ocean whereas warm SST anomalies were observed over most parts of southern Indian Ocean (Fig. 1b). The neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming season, but a positive IOD is likely to develop towards the end of the southwest monsoon season

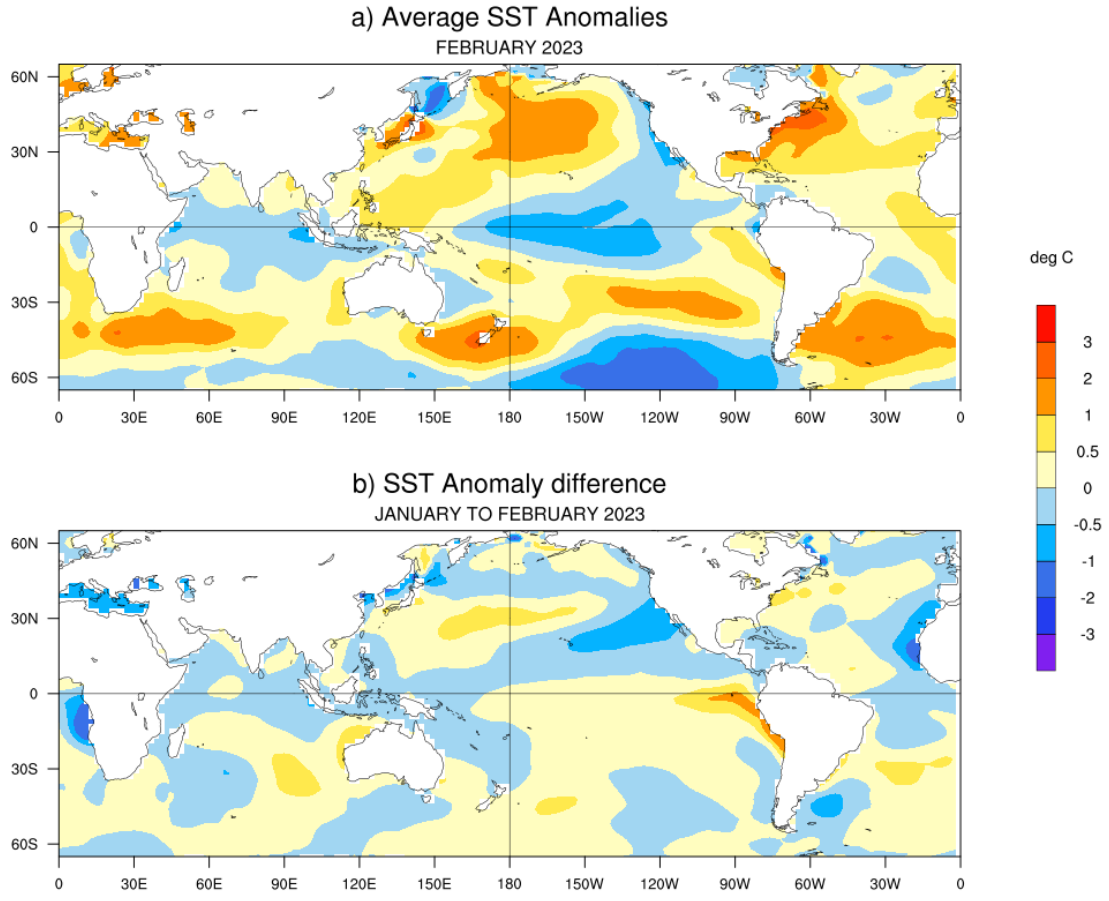

Fig.1: (a) Sea surface temperature (SST) anomalies (ºC) during February 2023 and (b) changes in the SST anomalies (ºC)from January to February 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

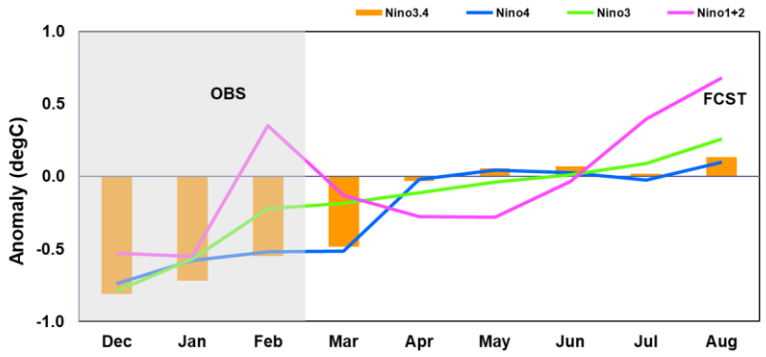

Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

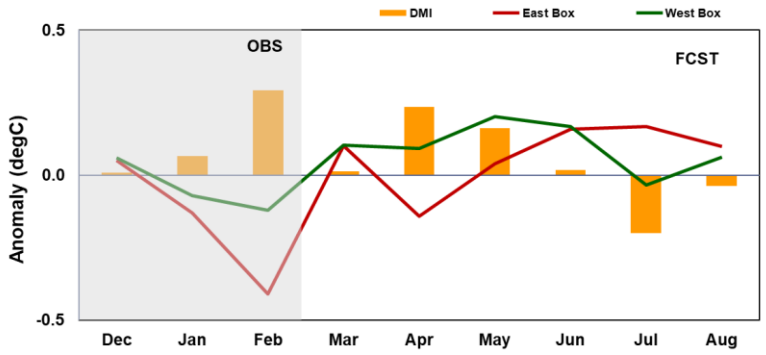

Fig.3: The time series of the monthly area-averaged SST anomaly Indices (°C) over west equatorial Indian Ocean (WEI) & east equatorial Indian Ocean (EEI) along with Dipole Mode Index (DMI=WEI-EEI) representing Indian Ocean Dipole (IOD). ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF 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 of February2023 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over most parts of maritime continent, western equatorial Pacific Ocean, south tropical Pacific Ocean near dateline and east central tropical Pacific Ocean. Negative OLR anomalies were also present in north west Australia and south-east parts of South Africa. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over west equatorial and south Indian Ocean, west and central equatorial Pacific Ocean near dateline, some parts of north and south extra tropical Pacific Ocean, northern parts of India and parts of North and South America.

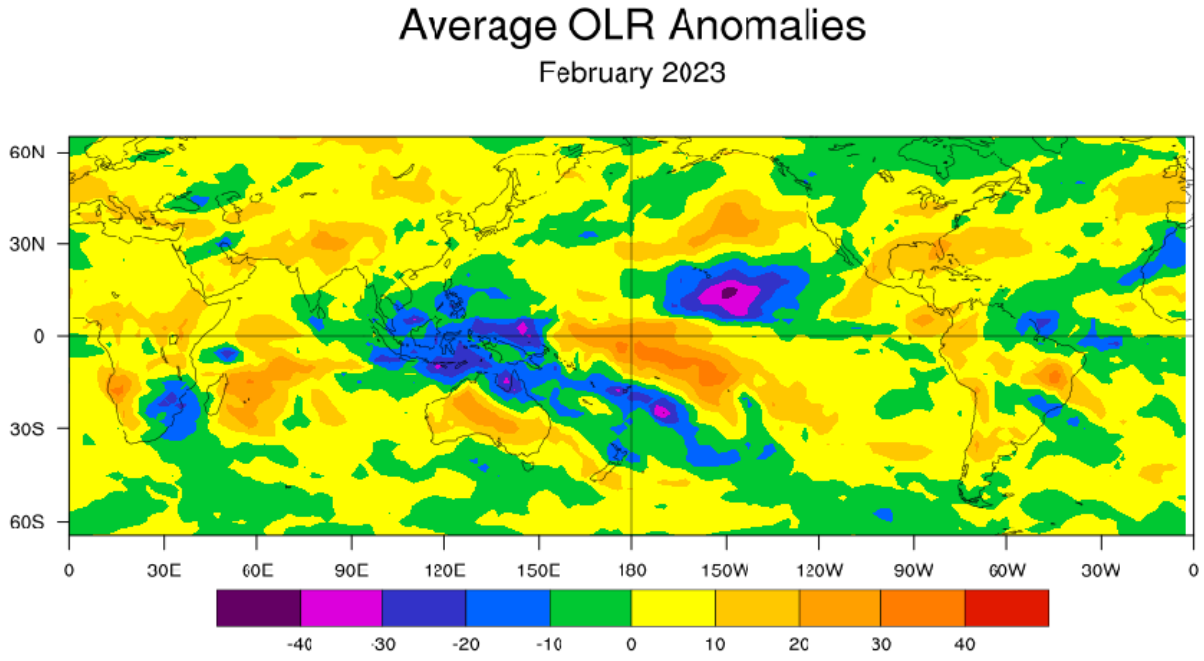

Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m^2) for February 2023 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

During February2023, the NH snow cover area (45.53 million Sq. km) was less than the 1991-2020 normal by0.2million Sq. km (Fig. 5). Eurasian Snow cover area (28.21 million Sq. km) was 0.31million Sq. km less than the 1991-2020 normal. North America snow cover area of 17.32million sq. km was more by0.13 million Sq. Km with respect to 1991-2020 normal.

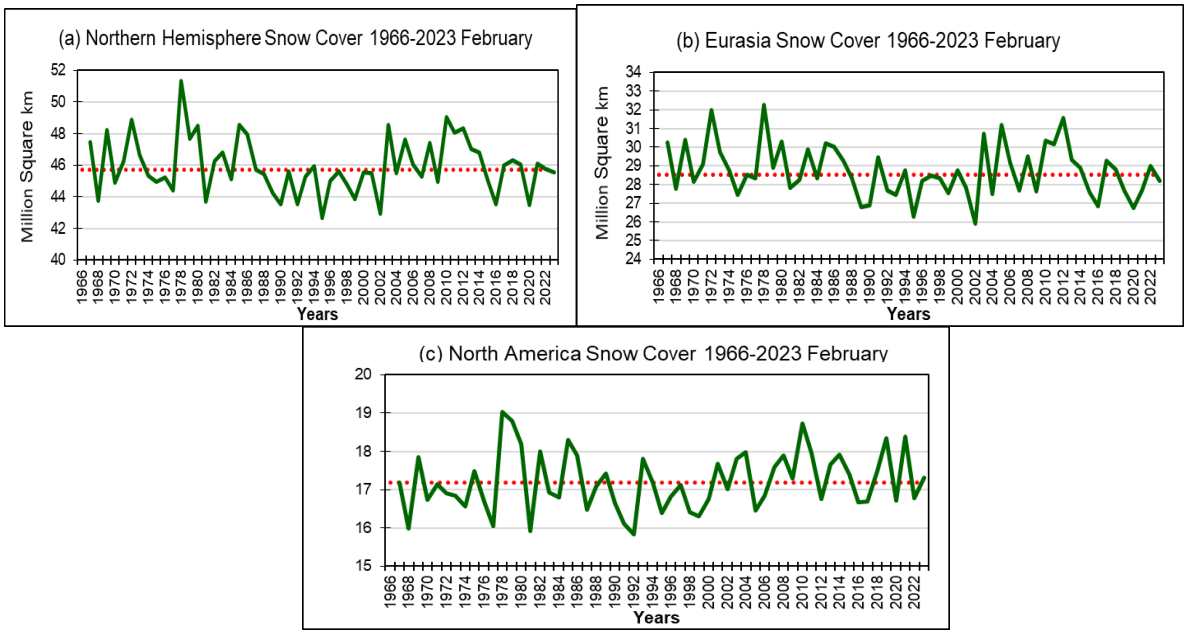

Fig.5. Snow cover area (million Sq. km) for the month of February during the period 1966-2023 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO)

During the first two week of February 2023, the MJO propagated eastwards from phase 3 (Indian Ocean) to phase 4 and 5 (Maritime continent) with increased strength. In the last fortnight it moved eastwards to phase 6 and 7 (Western Pacific) with reduced 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.

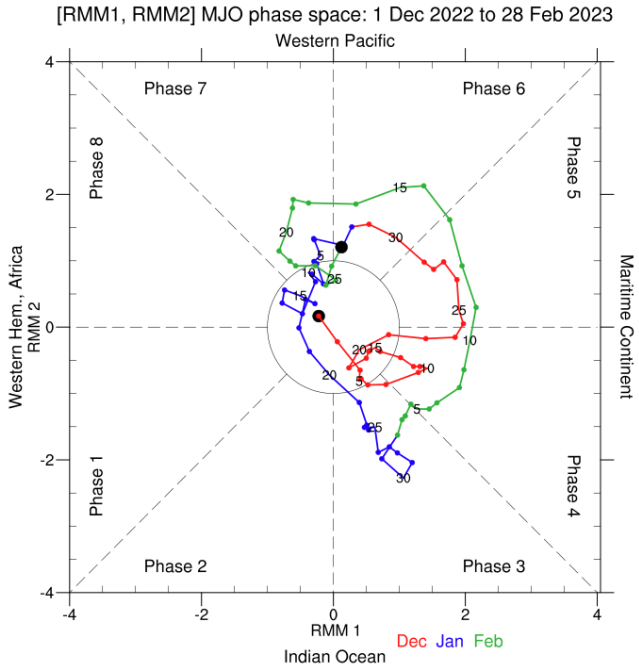

Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period December 2022 to February 2023. (Data Source: http://www.bom.gov.au/climate/mjo/).

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 March to May 2023 (MAM) and April to June 2023 (AMJ) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the February initial conditions. The probability forecast for precipitation for MAM (Fig.7a) and AMJ (Fig. 7b) indicates that enhanced probability of below normal precipitation is likely over most parts of South Asia except over some parts of southeast of south Asia where above normal precipitation is likely.

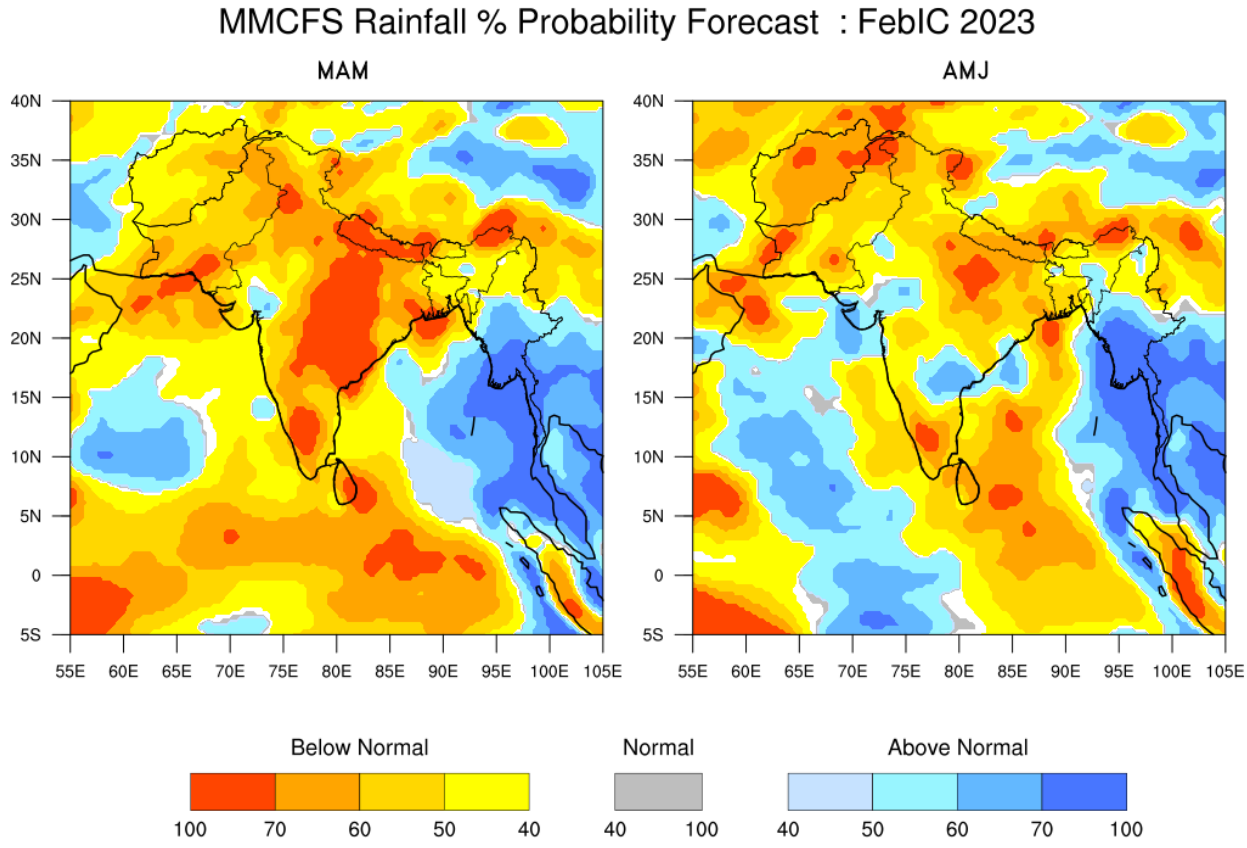

Fig.7: Seasonal probability (%) forecasts of precipitation for (a) MAM 2023(left) and (b) AMJ 2023 (right) based on initial conditions of February2023.The white colour indicates climatological probability.

2.2. Temperature Probability Forecast*:*

The probability forecasts for temperature for the season March to May 2023 (MAM) and April to June 2023 (AMJ) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the February initial conditions. Temperature probability forecast for MAM season (Fig. 8a) and AMJ (Fig. 8b) indicates that enhanced probability of below normal temperatures are likely over most parts of north, northwest, west and west peninsular regions whereas enhanced probability of above normal temperatures are likely over most parts of north along the foothills of Himalayas, east, east central and east peninsular regions of South Asia

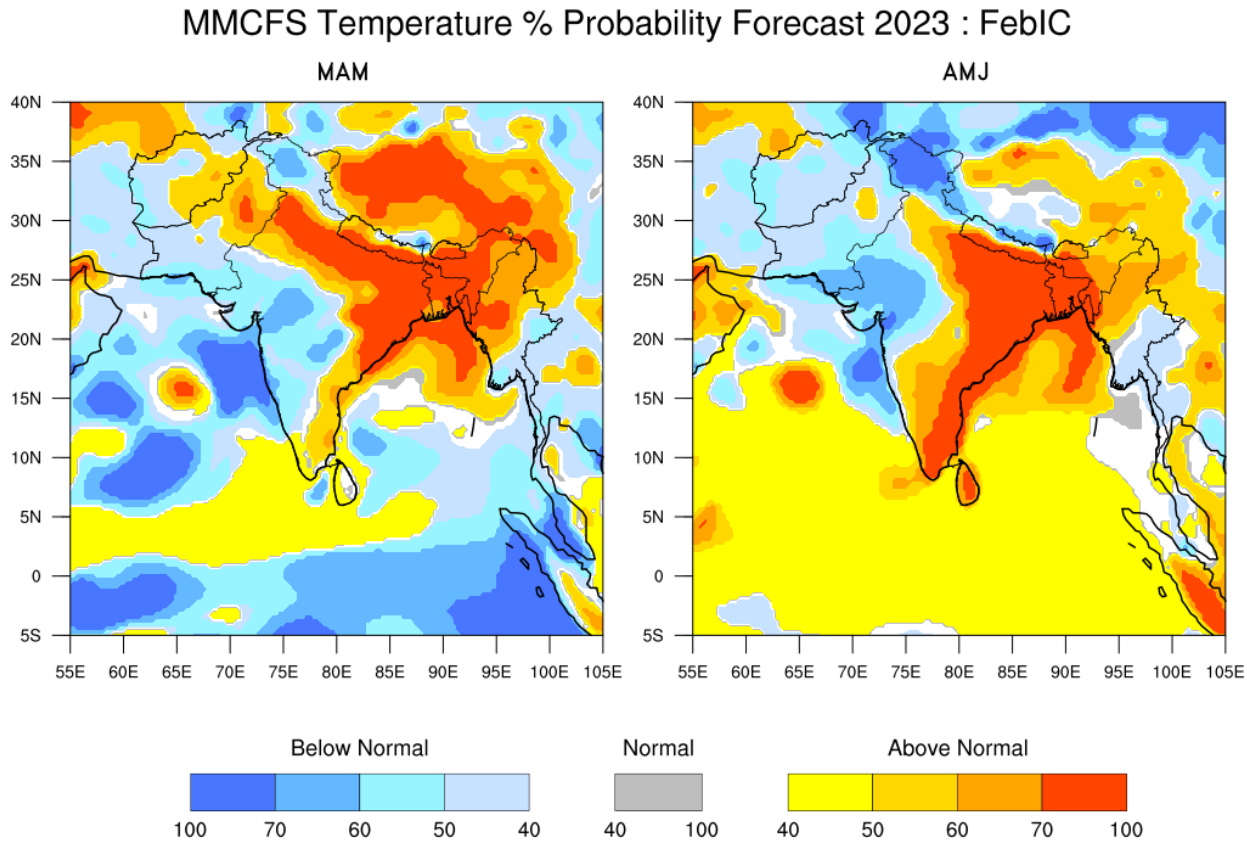

Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) MAM 2023(left) and(b) AMJ 2023(right) based on initial conditions of February2023. The white colour indicates climatological probability.

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 March to June 2023) 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 March and April 2023, the country averaged monthly precipitation is likely to be normal to below normal for all south Asian countries (Fig.9). In May, the country averaged monthly precipitation is likely to be normal to below normal for all south Asian countries except Myanmar where it is likely to be above normal. In June it is likely to be normal to below normal for all south Asian countries except Maldives and Myanmar where it is likely to be above normal.

The country averaged monthly temperatures during March to June is likely to be above normal for all south Asian countries.

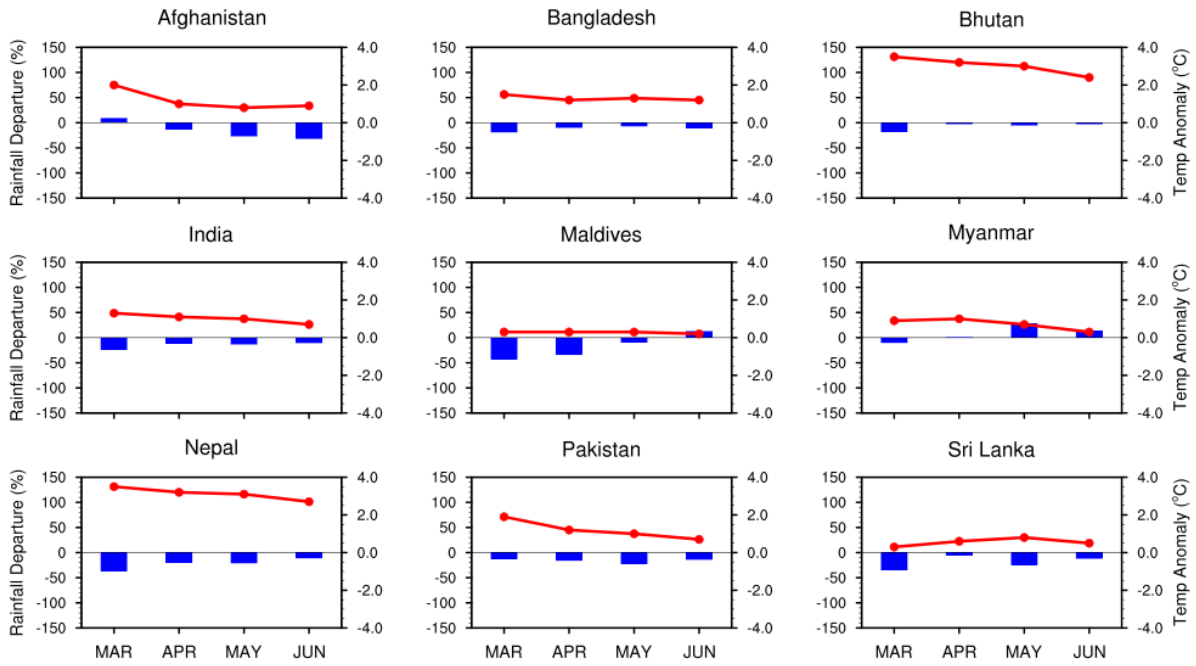

Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during March to June 2023. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale for 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).