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SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA

(February to May 2023)

- The La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates the transition of La Niña to ENSO-neutral conditions during the upcoming season.
- The neutral 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 seasons.
- The probability forecast for precipitation for February – April (FMA) indicates that an enhanced probability of below normal precipitation is likely over most parts of northwest, north along the plains of Himalayas, central and east India and some parts of northeast of South Asia and above normal precipitation is likely over some parts of west, south peninsula and few parts of northeast and southeast of South Asia. The same for March - May (MAM) indicates that enhanced probability for below normal precipitation is likely over most parts of northwest, north along the plains of Himalayas, east and eastern peninsular region of South Asia and above normal precipitation is likely over few parts of northwest and most parts of west, west peninsular region and northeast and southeast of South Asia.
- The country averaged monthly precipitation for February 2023 is likely to be normal to below normal for all south Asian countries except Maldives and Sri Lanka where it is likely to be above normal. In March it is likely to be below normal for all south Asian countries. In April and May, the country averaged monthly precipitation is likely to be normal to above normal for all south Asian countries.
- Temperature probability forecast for FMA season indicates that below normal temperatures are likely over most parts of South Asia except over the east, northeast and southeast of South Asia where above normal temperatures are likely. Temperature probability forecast for MAM season indicates that enhanced probability for below normal temperatures are likely over most parts of South Asia except over few parts of east and southeast of South Asia where above average temperatures are likely.
- The country averaged monthly temperatures during February is likely to be normal to above normal for all south Asian countries except Afghanistan and Sri Lanka where it is likely to be below normal. In March it is likely to be normal to above normal for all the countries except Sri Lanka where it is likely to be below normal. The country averaged monthly temperatures during April is likely to be normal to above normal for all South Asian countries except India, Nepal and Pakistan. It is likely to be normal to below normal for all south Asian countries in the month of May.

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 January 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 northern Pacific Ocean. As compared to the last month, warming of SST anomalies were observed over some parts of equatorial and north Pacific Ocean as well as parts of south Pacific Ocean (Fig.1b). Cooling of SST anomalies are observed over most parts of the north and west Pacific Ocean. The La Niña conditions are prevailing over the equatorial Pacific region. However, the strength of the La Niña has weakened since October 2022. The latest MCMFS forecast indicates the transition of La Niña to ENSO-neutral conditions during the upcoming season.

1.2 Sea Surface Temperatures over Indian Ocean

Normal to warmer than normal SSTs were observed over most parts of Arabian Sea and Bay of Bengal (Fig.1a). Normal to cooler than normal SSTs were also observed over the equatorial Indian Ocean and warm SST anomalies were also observed in some parts of the southwestern Indian Ocean. As compared to the last month, warming of SST anomalies were observed over some parts of western Indian Ocean whereas cooling of SST anomalies was observed over most parts of Arabian Sea and Bay of Bengal (Fig. 1b). The neutral IOD conditions are prevailing over the Indian Ocean. The latest MCMFS forecast indicates that the neutral IOD conditions are likely to continue during the coming seasons

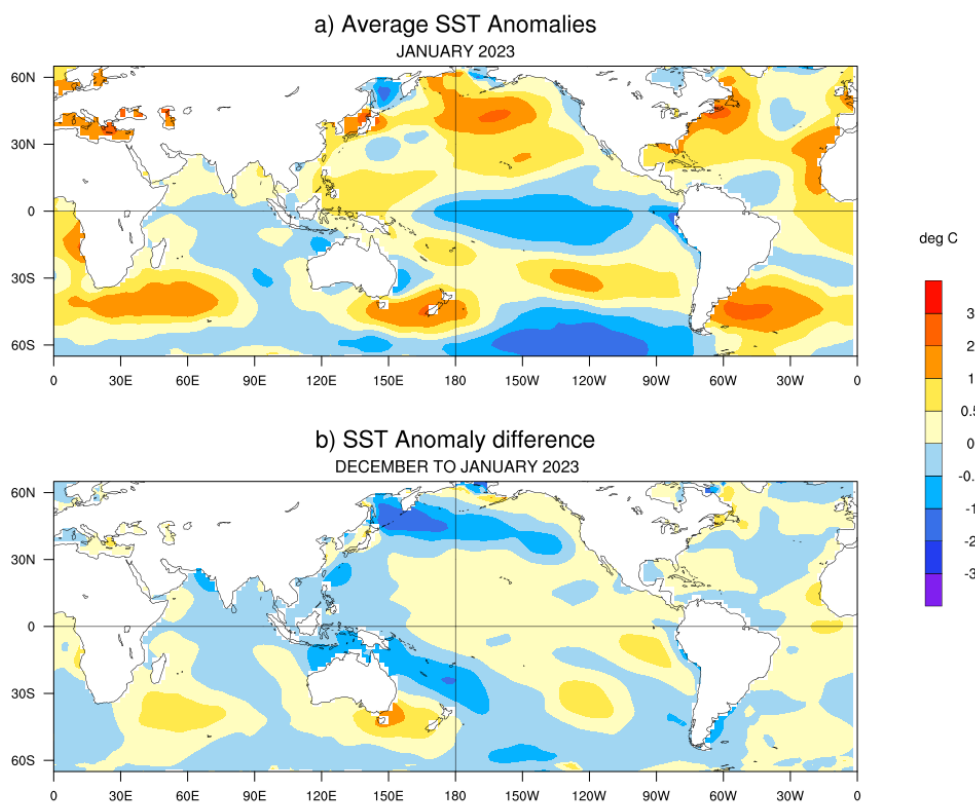


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during January 2023 and (b) changes in the SST anomalies (°C) from December 2022 to January 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

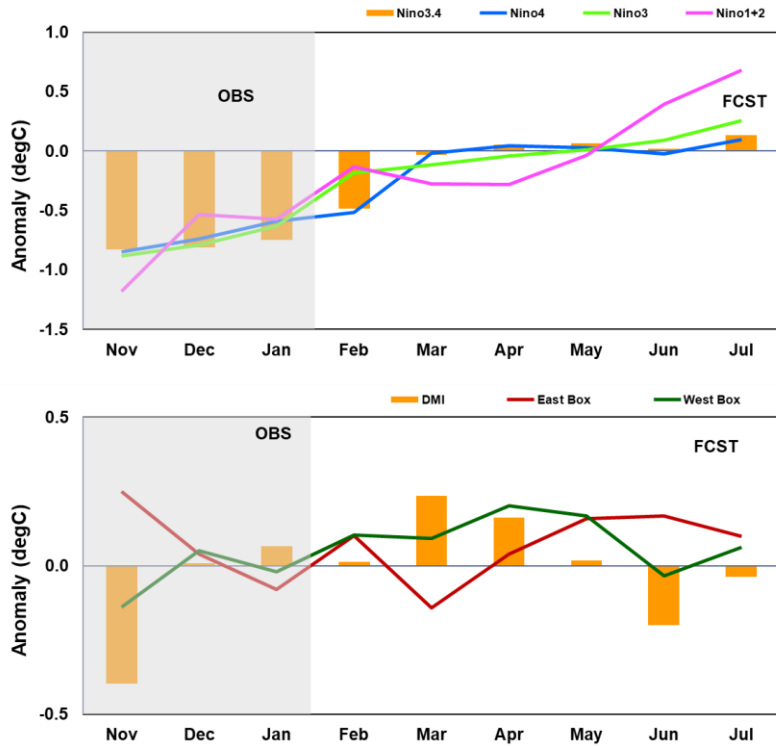


Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 January 2023 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over most parts of south Bay of Bengal, east equatorial Indian Ocean, maritime continent, far western equatorial Pacific Ocean and south China Sea. Negative OLR anomalies were also present in north Australia, southern tropical Pacific Ocean and northern parts of South America. 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 tropical Pacific Ocean and parts of North and South America.

Average OLR Anomalies
January 2023

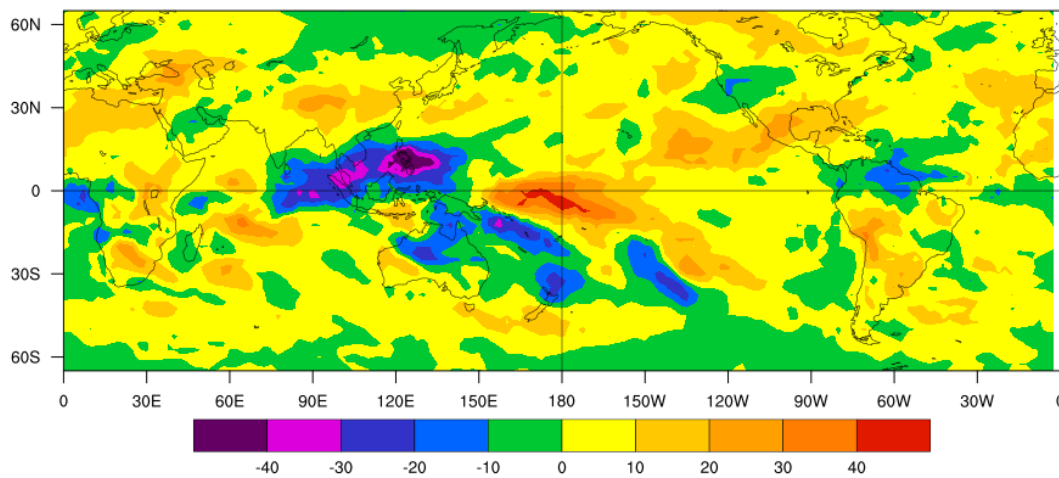


Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m^2) for January 2023 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

During January 2023, the NH snow cover area (46.27 million Sq. km) was less than the 1991-2020 normal by 0.97 million Sq. km (Fig. 5). Eurasian Snow cover area (28.61 million Sq.

km) was 1.04 million Sq. km less than the 1991-2020 normal. North America snow cover area of 17.66 million sq. km was more by 0.07 million Sq. Km with respect to 1991-2020 normal.

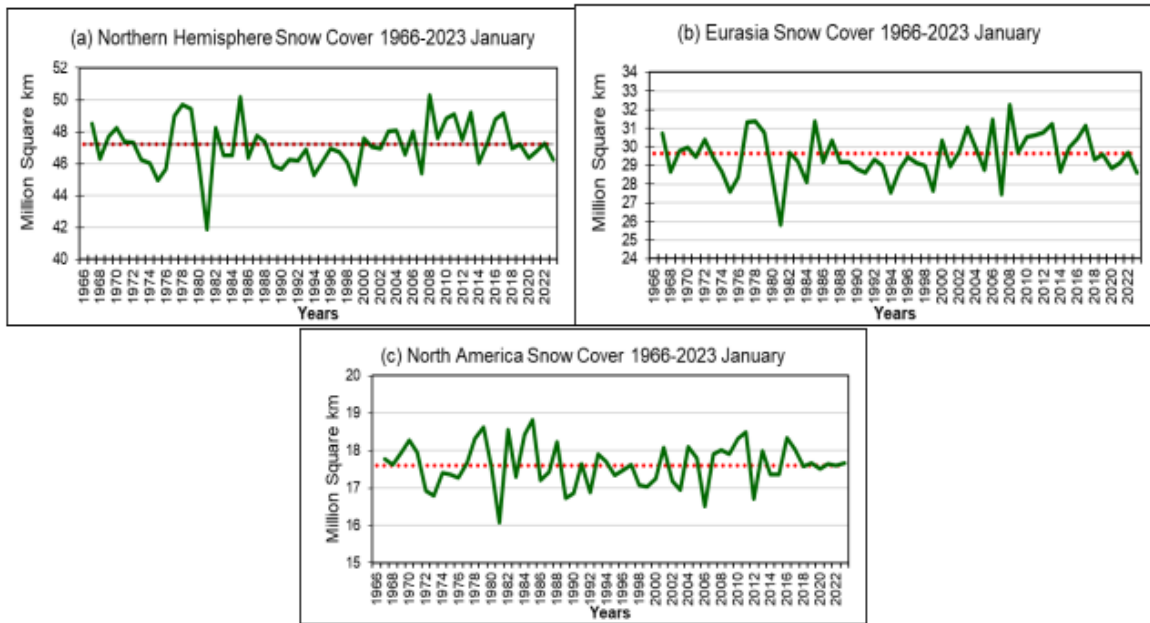


Fig.5. Snow cover area (million Sq. km) for the month of January during the period 1966-2023 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO)

During the first three weeks of January 2023, the MJO propagated eastwards from phase 6 (Western Pacific) to phase 3 (Indian Ocean) with reduced strength. Thereafter, it remained in phase 3 till the end of January 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.

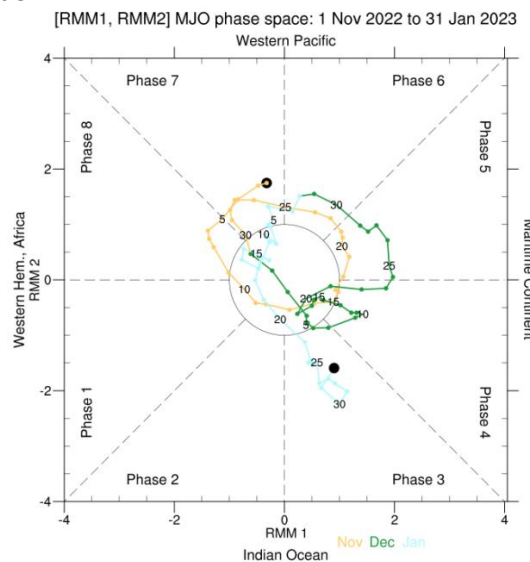


Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period November 2022 to January 2023. (Data Source: <http://www.bom.gov.au/climate/mjo/>).

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

2.1. Precipitation Probability Forecast:

The probability forecasts for precipitation for the seasons February to April 2023 (FMA) and March to May 2023 (MAM) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the January initial conditions. The probability forecast for precipitation for FMA (Fig.7a) indicates that enhanced probability of below normal precipitation is likely over most parts of northwest, north along the plains of Himalayas, central and east India and some parts of northeast of South Asia and above normal precipitation is likely over some parts of west, south peninsula and few parts of northeast and southeast of South Asia. The same for MAM (Fig 7b) indicates that enhanced probability for below normal precipitation is likely over most parts of northwest, north along the plains of Himalayas, east and eastern peninsular region of South Asia and above normal precipitation is likely over few parts of northwest and most parts of west, west peninsular region and northeast and southeast of South Asia.

MMCFS Rainfall % Probability Forecast : JanIC 2023

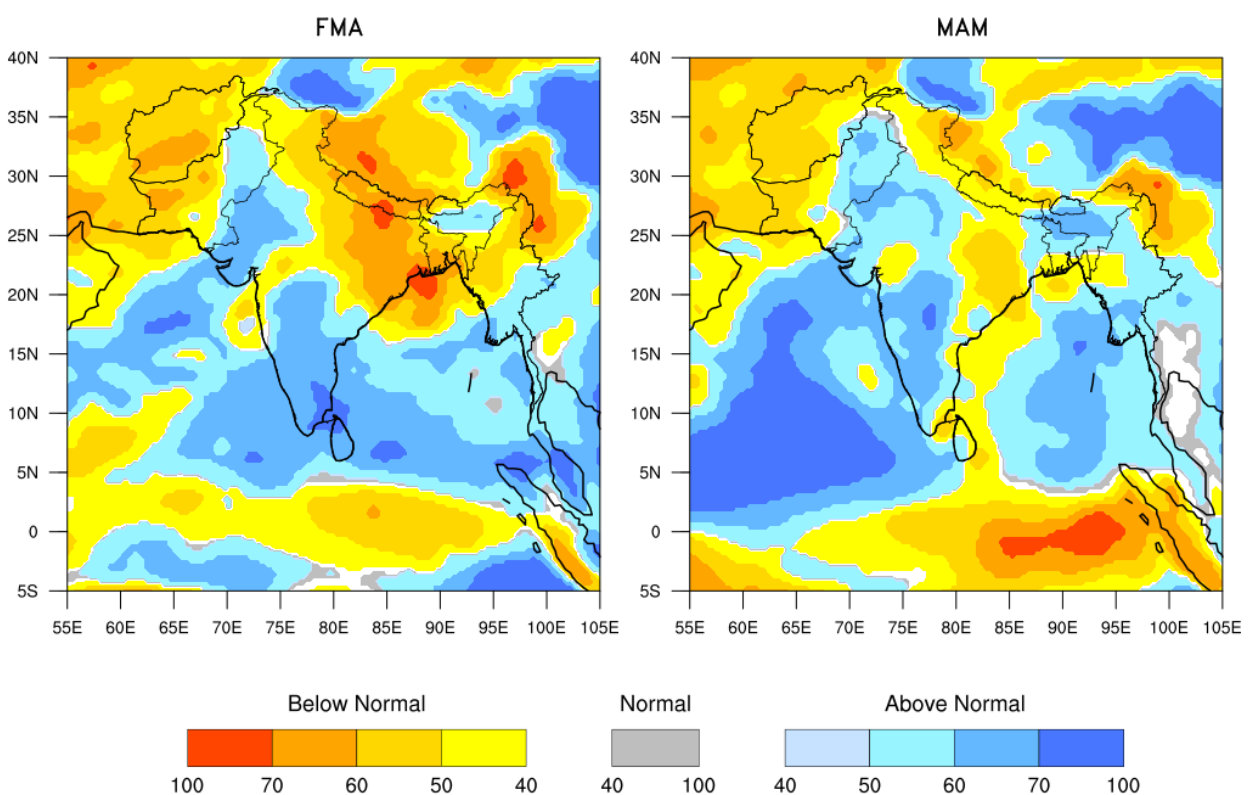


Fig.7: Seasonal probability (%) forecasts of precipitation for (a) FMA 2023 (left) and (b) MAM 2023 (right) based on initial conditions of January 2023. The white colour indicates climatological probability.

2.2. Temperature Probability Forecast:

The probability forecasts for temperature for the season February to April 2023 (FMA) and March to May 2023 (MAM) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the January initial conditions. Temperature probability forecast for FMA season (Fig. 8a) indicates that below normal temperatures are likely over most parts of South Asia except over the east, northeast and southeast of South Asia where above normal temperatures are likely. Temperature probability forecast for MAM season (Fig.8b) indicates that enhanced probability for below normal temperatures are likely over most parts of South Asia except over few parts of east and southeast of South Asia where above average temperatures are likely.

MMCFS Temperature % Probability Forecast 2023 : JanIC

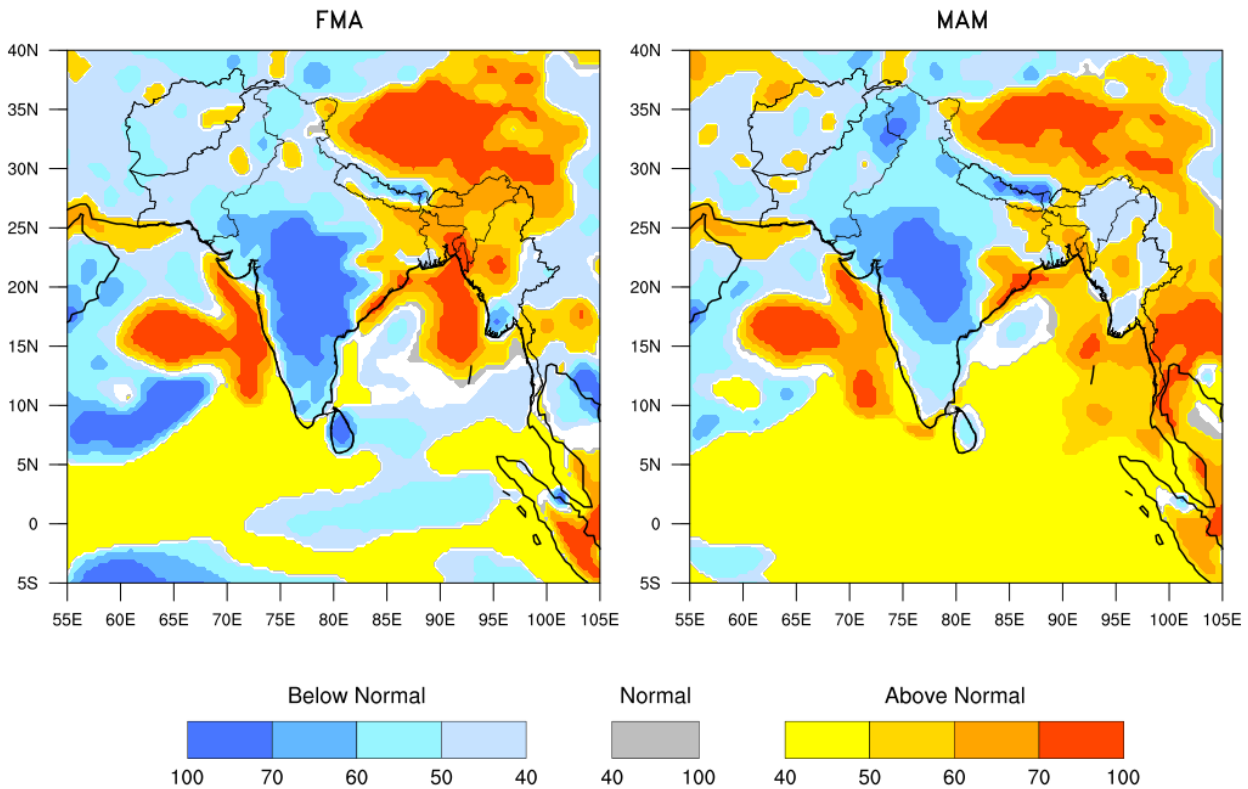


Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) FMA 2023 (left) and (b) MAM2023 (right) based on initial conditions of January 2023. The white colour indicates climatological probability.

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

The country averaged monthly temperatures during February is likely to be normal to above normal for all south Asian countries except Afghanistan and Sri Lanka where it is likely to be below normal. In March it is likely to be normal to above normal for all the countries except Sri Lanka where it is likely to be below normal. The country averaged monthly temperatures during April is likely to be normal to above normal for all South Asian countries except India, Nepal and Pakistan. It is likely to be normal to above normal for all south Asian countries in May except Afghanistan, Nepal and Pakistan where it is likely to be below normal.

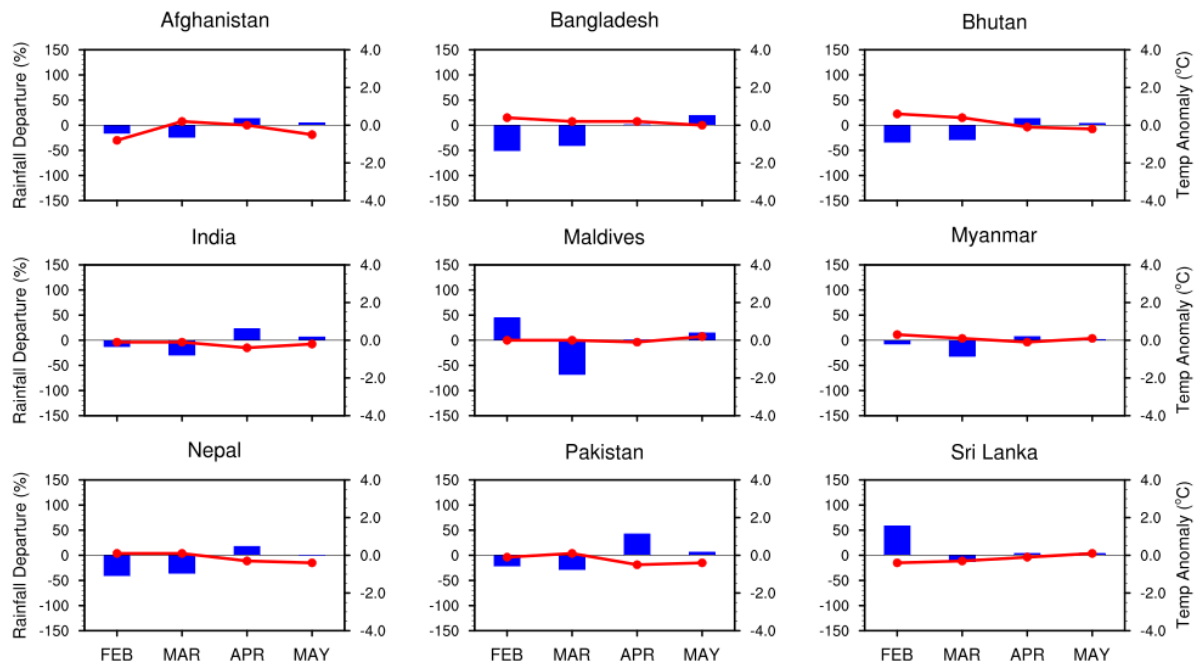


Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly ($^{\circ}\text{C}$) forecast during February to May2023. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale for Precipitation indicated in blue shaded bars) and the normal range for country averaged monthly temperature is taken -0.25°C to $+0.25^{\circ}\text{C}$ (Right Vertical Axis Scale for Temperature indicated in red coloured lines).