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SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA

(January to April 2024)

Highlights

- Currently, strong El Niño conditions are prevailing over equatorial Pacific and the sea surface temperatures (SSTs) are warmer than normal over most of the equatorial Pacific Ocean. The latest MMCFS forecast indicates El Niño conditions are likely to continue during the upcoming season and weaken thereafter.
- Positive Indian Ocean Dipole (IOD) conditions are continuing over the Indian Ocean and the latest MMCFS forecast indicates weakening of positive IOD conditions during the upcoming season.
- The probability forecast for precipitation for January – March (JFM) indicates enhanced probability of above normal precipitation in most parts of South Asia except over few parts of northwest and north along the plains of Himalayas where probability of below normal precipitation is likely and the same for February - March (FMA) season indicates that except for small pockets in northeast and northwest, most of the regions of South Asia is likely to experience enhanced probability of below normal precipitation.
- The country averaged monthly precipitation for the month of January, March and April 2024, is likely to be normal to above normal for all south Asian countries. In February it is likely to be normal to above normal for Afghanistan, Bangladesh, Bhutan and Myanmar and below normal for India, Maldives, Nepal, Pakistan and Sri Lanka.
- Temperature probability forecast for DJF and JFM seasons indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia.
- The country averaged monthly temperatures during January, February, March and April 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 December 2023, warmer than normal SSTs were observed over most of the equatorial and the northern extra-tropical Pacific region (Fig.1a). Cooler than normal SSTs were observed over some parts of southern extra-tropical Pacific regions. Compared to November 2023, cool SST anomalies were observed over the central equatorial Pacific Ocean near the Date Line, eastern and south eastern Pacific Ocean (Fig.1b) and some parts of western Pacific Ocean. The latest MMCFS forecast indicates El Niño conditions are likely to continue during the upcoming season and weaken thereafter (Fig. 2).

1.2 Sea Surface Temperatures over Indian Ocean

In December 2023, warmer than normal SSTs were observed over the western equatorial Indian Ocean (Fig.1a). However, cooler than normal SSTs were observed over some parts of the eastern equatorial Indian Ocean. Compared to November 2023, warmer than normal SSTs were observed over equatorial Indian Ocean whereas colder than normal SSTs were observed over north Arabian Sea and north Bay of Bengal (Fig. 1b). The latest MMCFS forecast indicates weakening of positive IOD conditions during the upcoming season. (Fig.3).

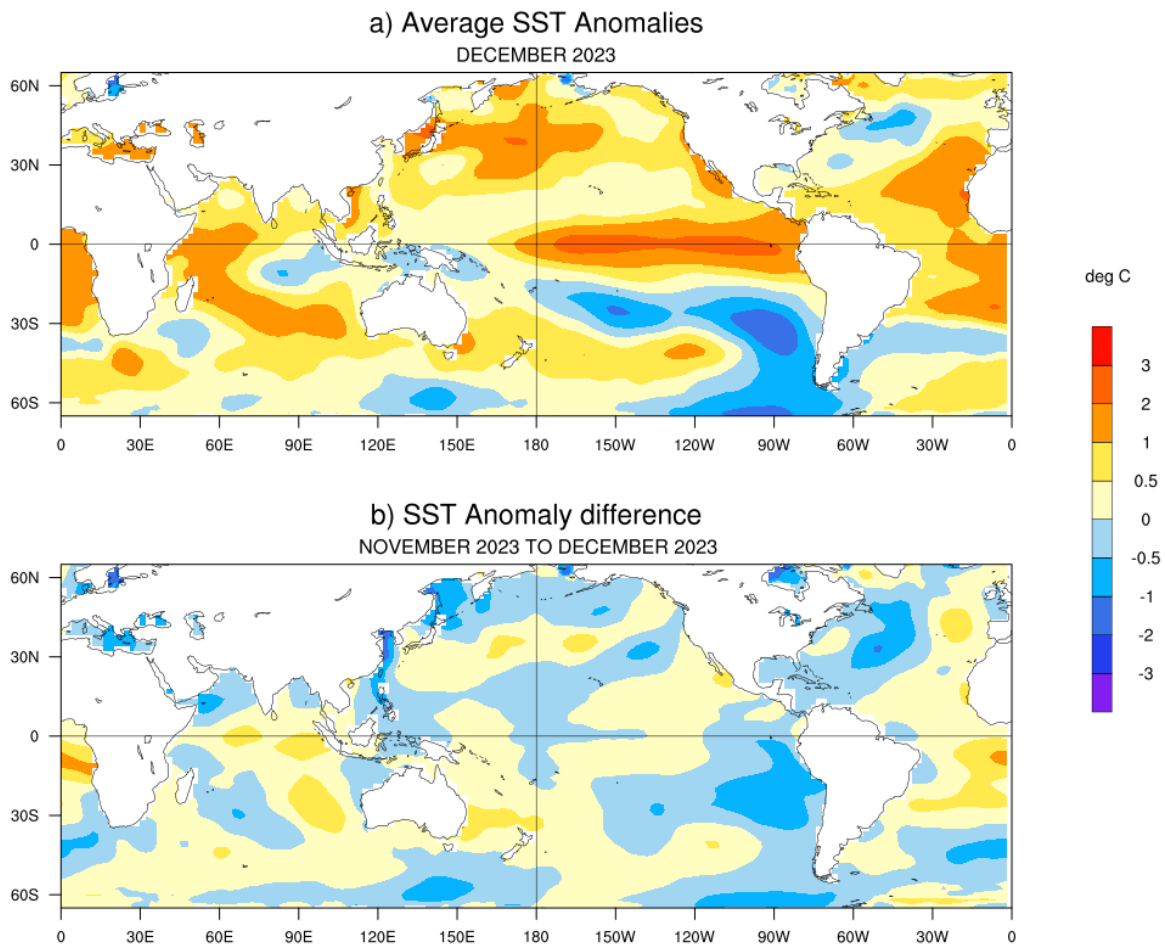


Fig.1(a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during December 2023 and (b) changes in the SST anomalies ($^{\circ}\text{C}$) from November to December 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) long term mean.

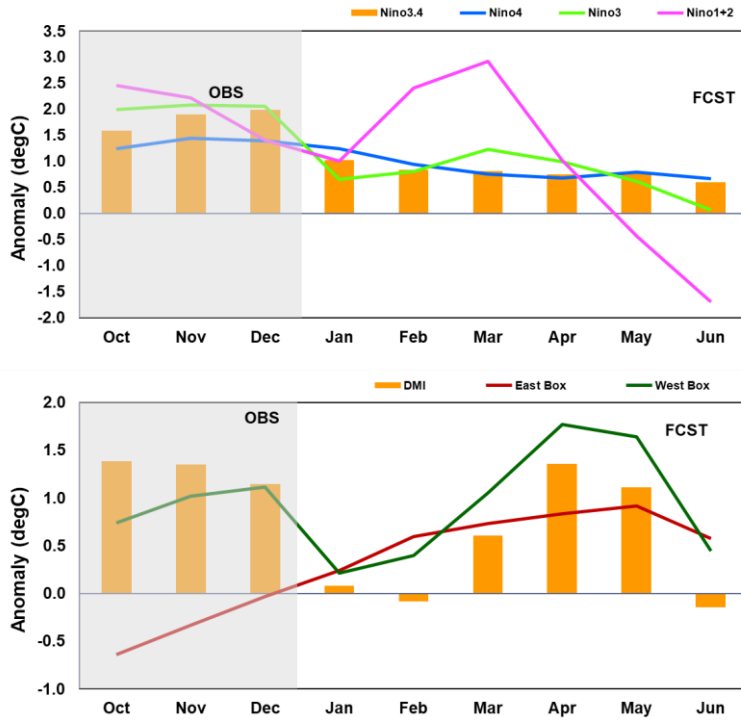


Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 December 2023 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over north Bay of Bengal, western Indian Ocean, central equatorial Pacific Ocean and some parts of east Pacific Ocean. Negative OLR anomalies were also observed over Peninsular India, central and eastern Africa, south east China, northeast Australia, and central America. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over South Indian Ocean, maritime continent, adjoining western Pacific Ocean, north tropical Pacific Ocean and south America.

Average OLR Anomalies: December 2023

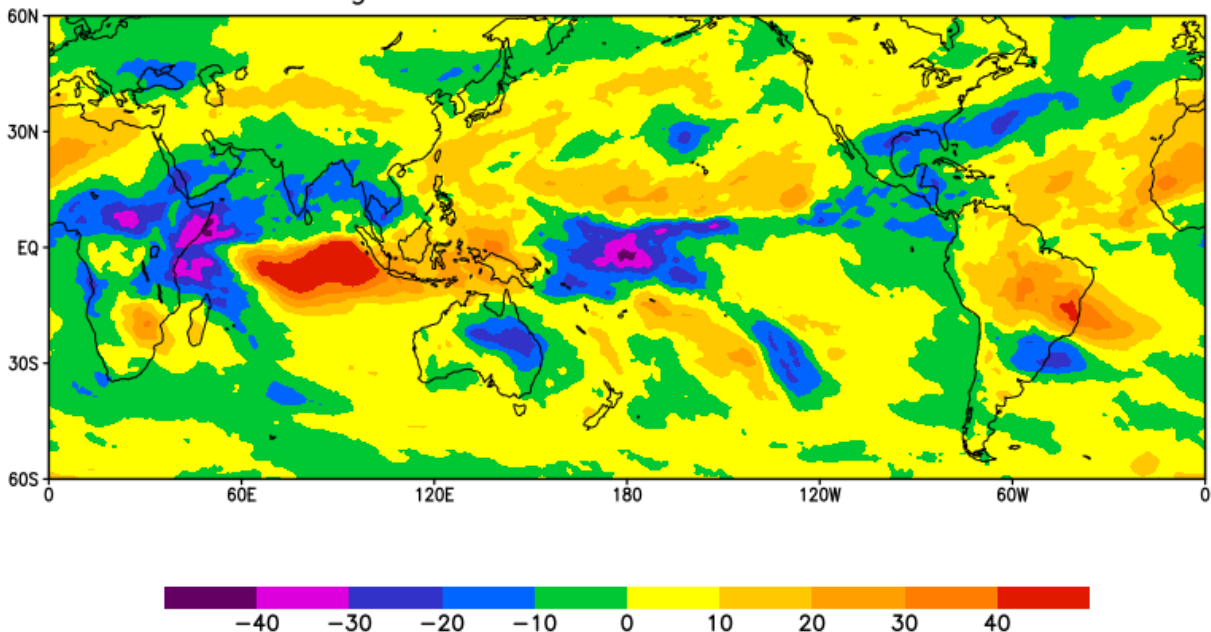


Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m²) for December 2023 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

During December 2023, the NH snow cover area (42.47 million Sq. km) was less than the 1991-2020 normal by 1.8 million Sq. km (Fig. 5). Eurasian Snow cover area (27.53 million Sq. km) was 0.17 million Sq. km more than the 1991-2020 normal. North America snow cover area of 14.94 million sq. km was less by 2.0 million Sq. Km with respect to 1991-2020 normal.

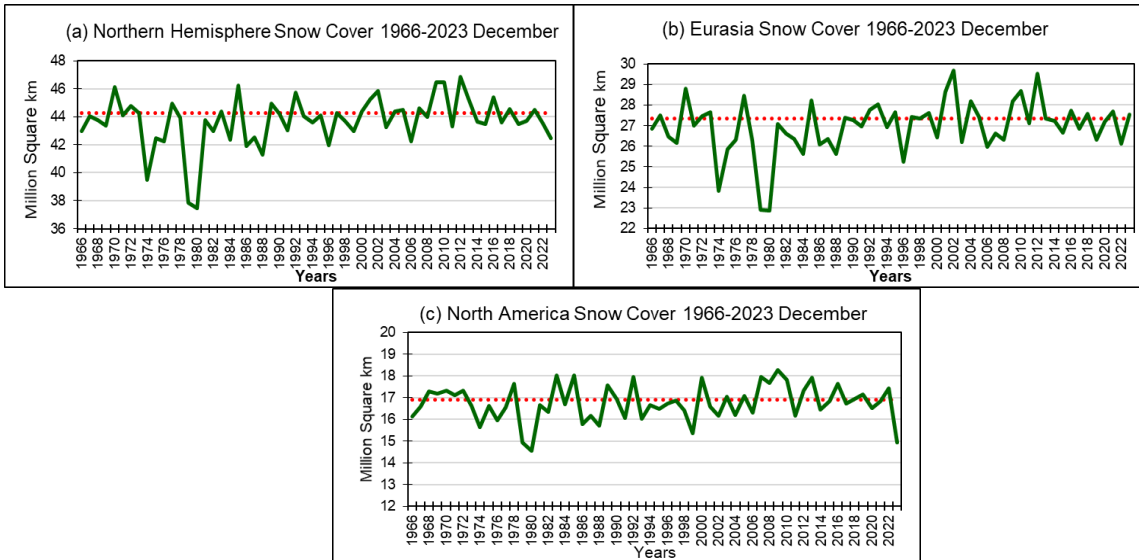


Fig.5. Snow cover area (million Sq. km) for the month of December during the period 1966-2023 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5 Madden Julian Oscillation (MJO)

During the first fortnight of December 2023, MJO propagated eastwards from phase 3 (Indian Ocean) to phase 6 (Western Pacific) with enhanced strength. In the third week it moved to phase 8 (Western hemisphere and Africa) with reduced strength. In the last week it entered into 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.

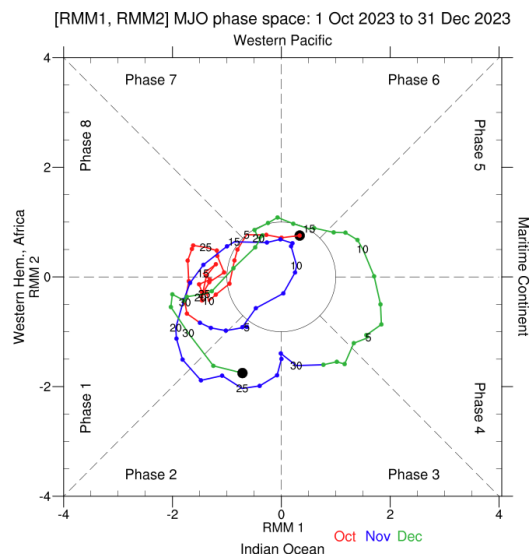


Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period October to December 2023. (Data Source: <http://www.bom.gov.au/climate/mjo/>).

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 January to March 2024 (JFM) and February to April 2024 (FMA) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the December initial conditions. The probability forecast for precipitation for JFM indicates enhanced probability of above normal precipitation in most parts of South Asia except over few parts of northwest and north along the plains of Himalayas where probability of below normal precipitation is likely. The same for FMA season indicates that except for small pockets in northeast and northwest, most of the regions of South Asia is likely to experience enhanced probability of below normal precipitation.

MMCFS Rainfall % Probability Forecast 2024 : Dec IC

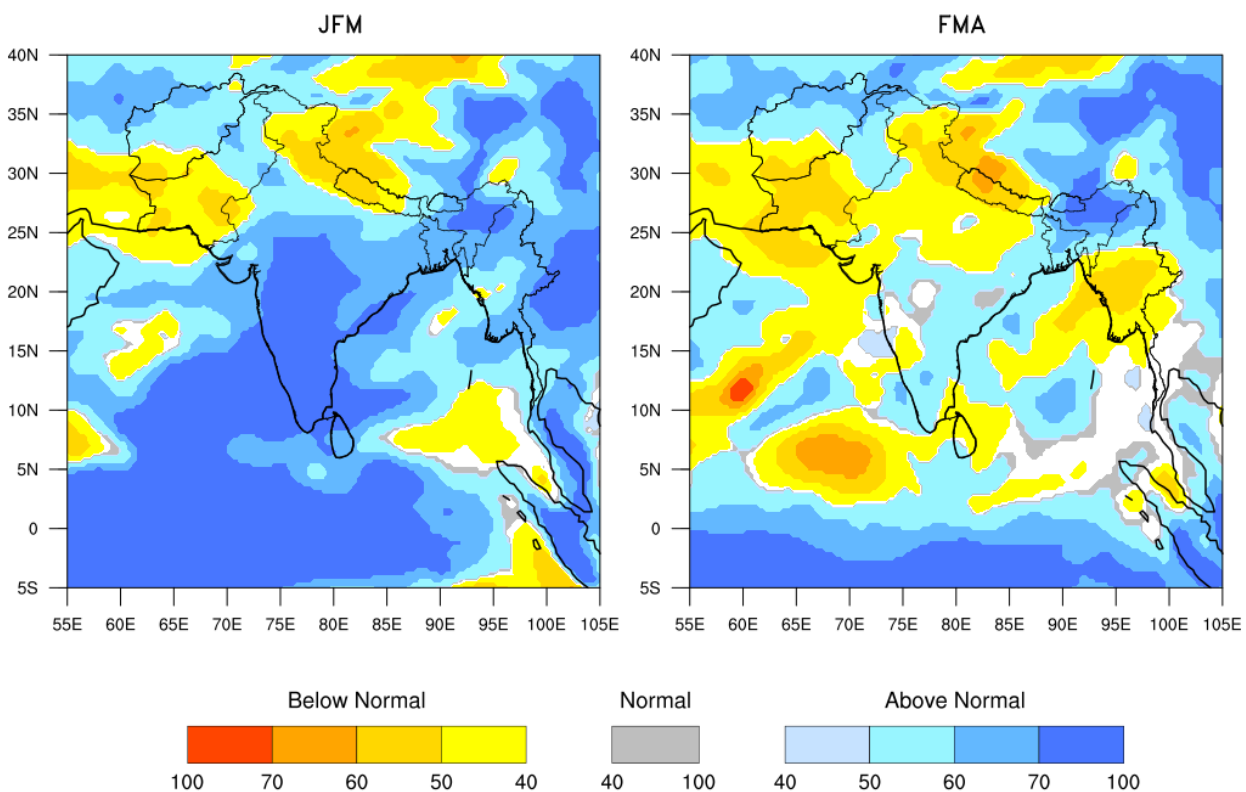


Fig.7: Seasonal probability (%) forecasts of precipitation for (a) JFM 2024 (left) and (b) FMA 2024 (right) based on initial conditions of December 2023. The white colour indicates climatological probability.

2.2. Temperature Probability Forecast:

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

MMCFS Temperature % Probability Forecast 2024 : DecIC

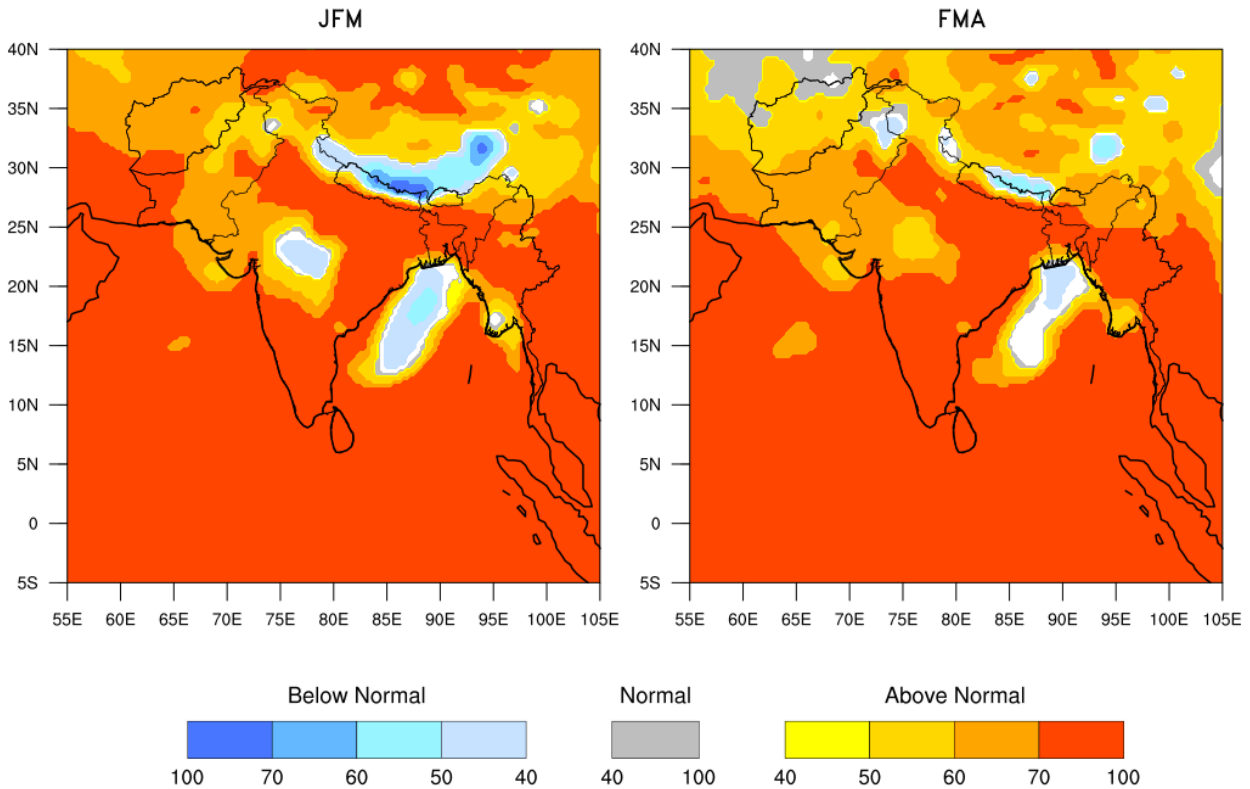


Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) JFM 2024 (left) and (b) FMA 2024 (right) based on initial conditions of December 2023. The white colour indicates climatological probability.

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 January to April 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 January, March and April 2024, the country averaged monthly precipitation is likely to be normal to above normal for all south Asian countries. In February it is likely to be normal to above normal for Afghanistan, Bangladesh, Bhutan and Myanmar and below normal for India, Maldives, Nepal, Pakistan and Sri Lanka.

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

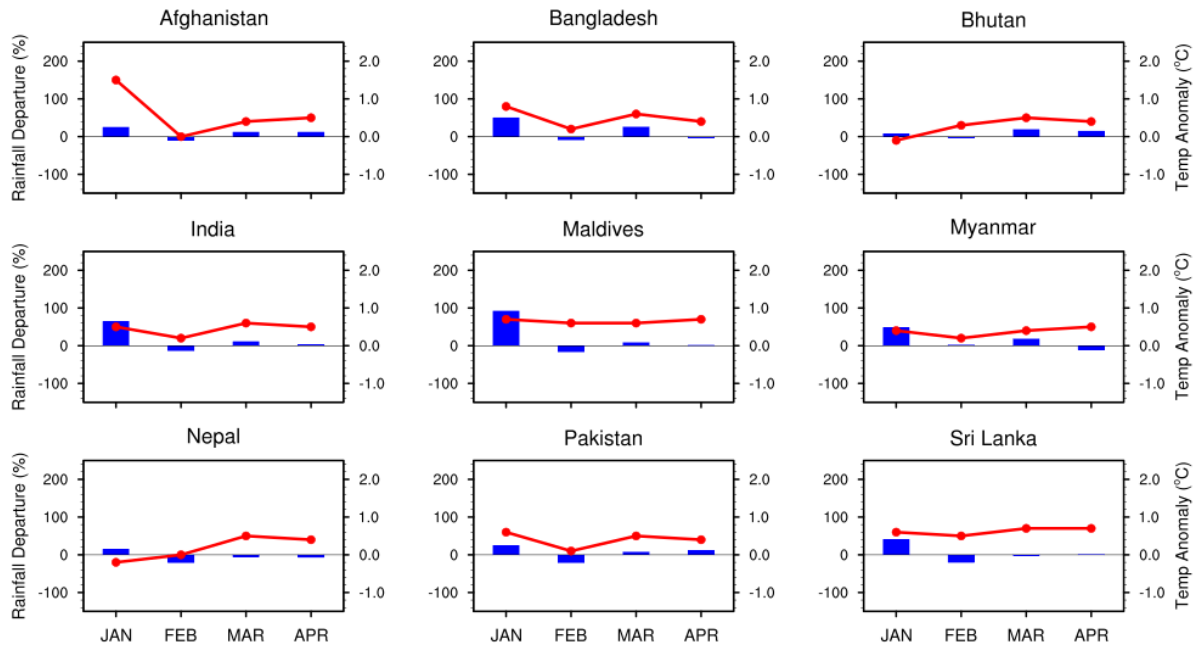


Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during January to April 2024. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale for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