



**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

(December 2022 to March 2023)

- Currently, La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that the La Niña conditions are likely to continue up to the first quarter of next year and turn to neutral ENSO conditions thereafter.
- The probability forecast for precipitation for December – February (DJF) season indicates that enhanced probability of below normal precipitation is likely over most parts of South Asia except over some parts of southern and southeast of South Asia where enhanced probability of above normal precipitation is likely. The same for January - March (JFM) indicates that enhanced probability for below normal precipitation is likely over most parts of South Asia except over few areas of northwest, southeast and southern parts of South Asia where above average precipitation is likely.
- The country averaged monthly precipitation is likely to be normal to below normal for all the months viz. December 2022 to March 2023 for Afghanistan, Bangladesh, India, Myanmar and Nepal. It is likely to be below normal in December to February and above normal in March for Bhutan, Maldives and Pakistan. Sri Lanka is likely to experience normal to above normal in all the months viz. December to March.
- The temperature probability forecast for DJF season indicates that above normal temperatures are likely over most parts of northwest, north along the plains of Himalayas, east, northeast and southeast of South Asia. It is likely to be below normal for some parts of central and south of South Asia. Temperature probability forecast for JFM season indicates enhanced probability for above normal temperatures over most parts of east, northeast and southeast and some parts of north and northwest of South Asia. It is likely to be below normal over most parts of central and south of South Asia.
- In general, the country averaged monthly temperatures during December 2022 to March 2023, are likely to be normal to above normal for Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. It is likely to be normal to below normal for Afghanistan, Maldives and Myanmar for all the months.

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 November 2022 cooler than normal SSTs were observed across the central and eastern tropical Pacific Ocean, and warmer than normal SSTs were observed over west 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. As compared to the last month, warming of SST anomalies were observed over equatorial Pacific Ocean (Fig.1b) and cooling of SST anomalies are observed over parts of north and south Pacific Ocean. Forecast part w.r.t Fig.2 is not included.

1.2 Sea Surface Temperatures over Indian Ocean

In the north Indian Ocean, positive SST anomalies were observed over the Bay of Bengal and northern parts of Arabian Sea. Negative SST anomalies were observed over south Arabian Sea. A positive SST anomaly was observed over eastern equatorial Indian Ocean and negative SST anomalies were observed over western equatorial Indian Ocean. Also, there were positive SST anomalies observed over western parts of the south Indian Ocean and negative SST anomalies observed over eastern parts of south Indian Ocean (Fig. 1a). As compared to the last month, cooling of SST anomalies were observed over north Arabian Sea, north Bay of Bengal and eastern equatorial Indian Ocean. The warming of SST anomalies was over the western equatorial Indian Ocean (Fig. 1b). Forecast part w.r.t Fig.3 is not included.

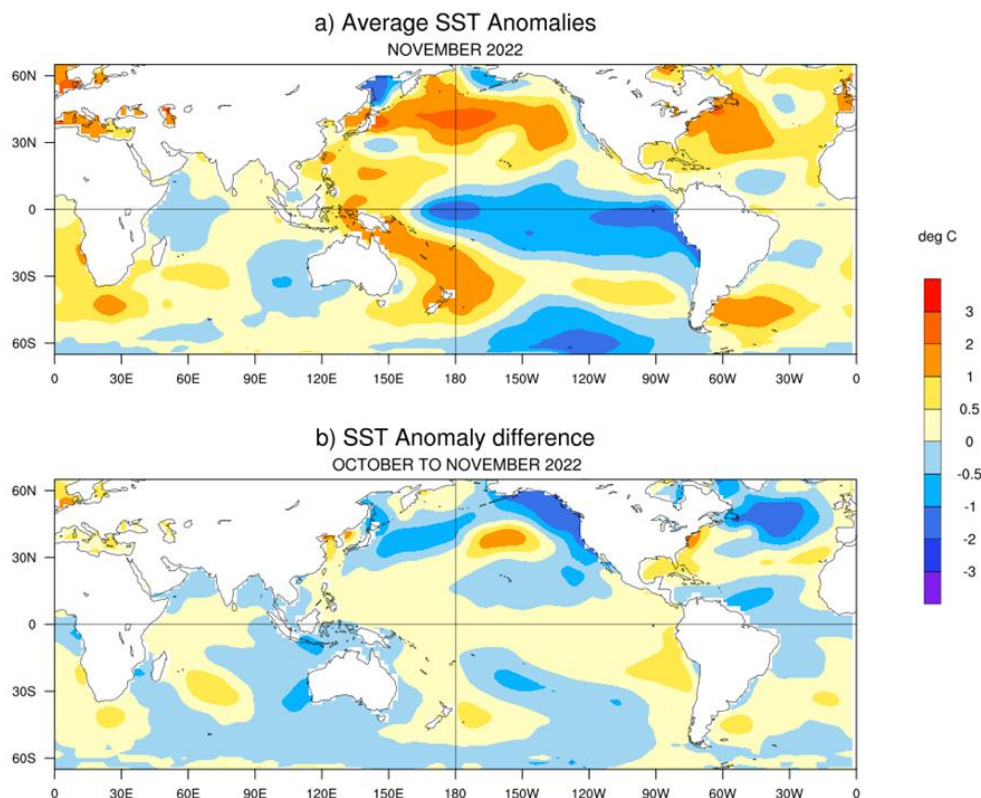


Fig.1: (a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during November 2022 and (b) changes in the SST anomalies ($^{\circ}\text{C}$) from October 2022 to November 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

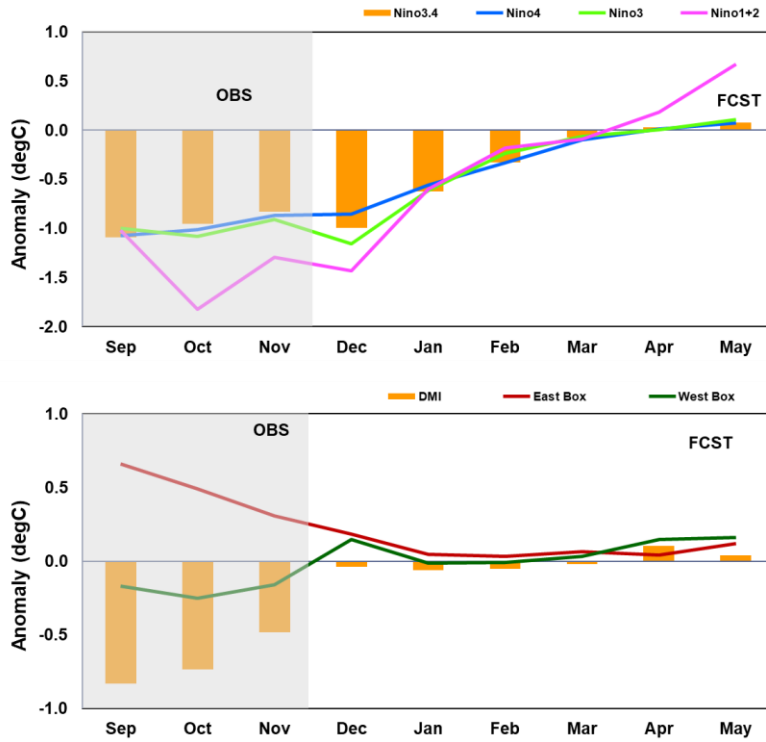


Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 November 2022 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over most parts of southeast of south Asia, east equatorial Indian Ocean, maritime continent and northern most parts of Australia. Negative OLR anomalies are also present in north and south tropical Pacific Ocean near dateline and northeast parts of South America. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over equatorial west Indian Ocean, west and central equatorial Pacific Ocean and parts of South America.

Average OLR Anomalies

November 2022

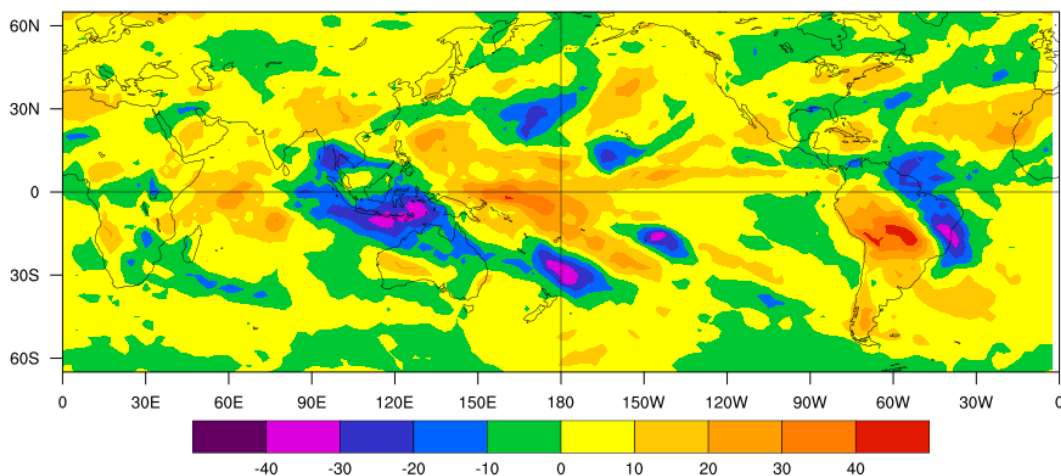


Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m^2) for November 2022 (Data source: NCEP-NOAA)

1.4 Snow Cover Area over the Northern Hemisphere (NH)

The November 2022, NH snow cover area (37.75 million Sq. km) was more than the 1991-2020 normal by 2.7 million Sq. km (Fig. 5). Eurasian Snow cover area (22.5 million Sq. km) was 1.3 million Sq. km more than the 1991-2020 normal and was having less area under snow in November 2022 compared to November 2021. North America snow cover area of 15.25 million sq. Km was more by 1.4 million Sq. Km with respect to 1991-2020 normal.

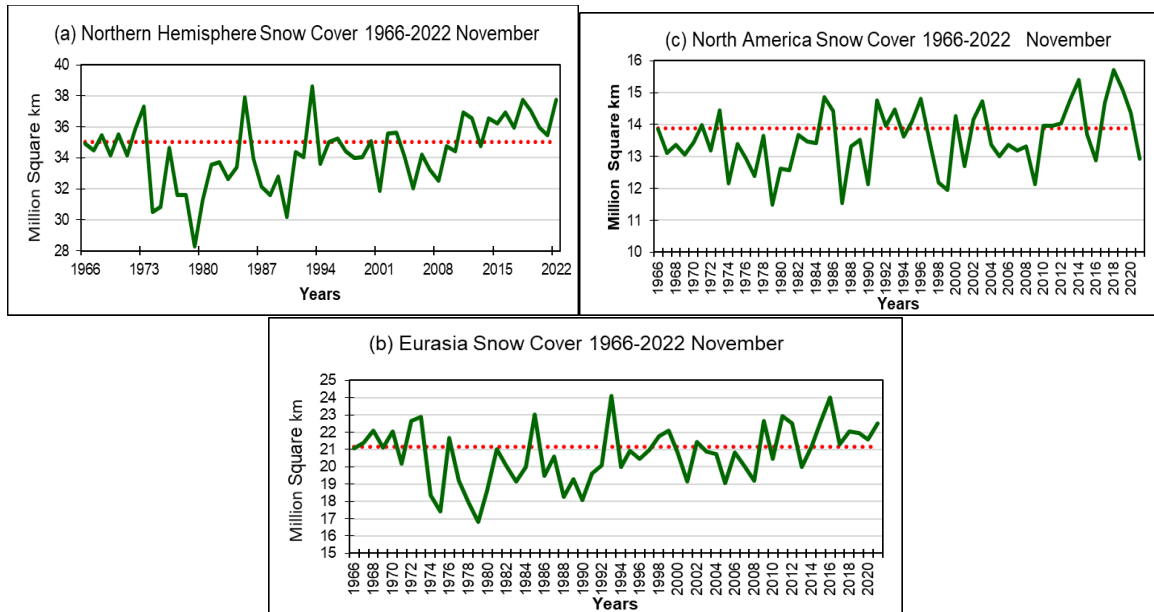


Fig.5. Snow cover area (million Sq. km) for the month of November during the period 1966-2022 (green solid lines) and normal value (1991-2022) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO)

During the first week of November 2022, the MJO propagated eastwards from phase 7 (Western Pacific) to phase 8 and 1 (Western Hemisphere. Africa) with enhanced strength. Thereafter, in second week it moved to phase 2 and phase 3 (Indian Ocean) with reduced strength. In the third week it moved to phase 4 and phase 5 (maritime continent) and then back to phase 7 by November end. The MJO phase diagram illustrates the progression of the MJO through different phases, which generally coincide with locations along the equator around the globe.

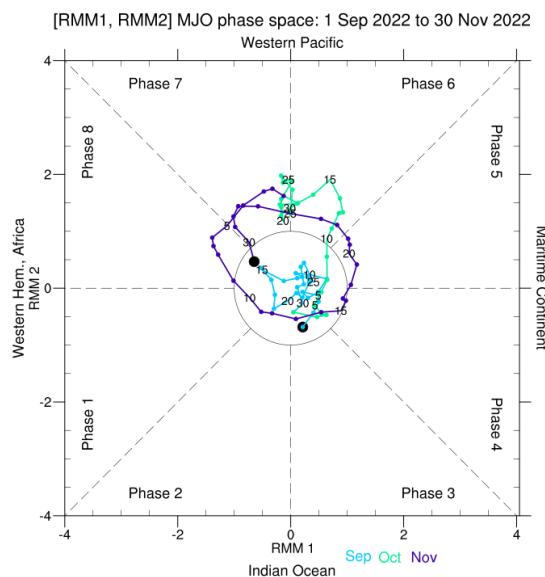


Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period September to November 2022. (Data Source: <http://www.bom.gov.au/climate/mjo/>).

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 December 2022 to February 2023 (DJF) and January to March 2023 (JFM) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the November initial conditions. The probability forecast for precipitation for DJF (Fig.7a) indicates that enhanced probability of below normal precipitation is likely over most parts of South Asia except over some parts of southern and southeast of South Asia, where enhanced probability of above normal precipitation is likely. The same for JFM (Fig 7b) indicates that enhanced probability for below normal precipitation is likely over most parts of South Asia except over few areas of northwest, southeast and southern parts of South Asia where above average precipitation is likely.

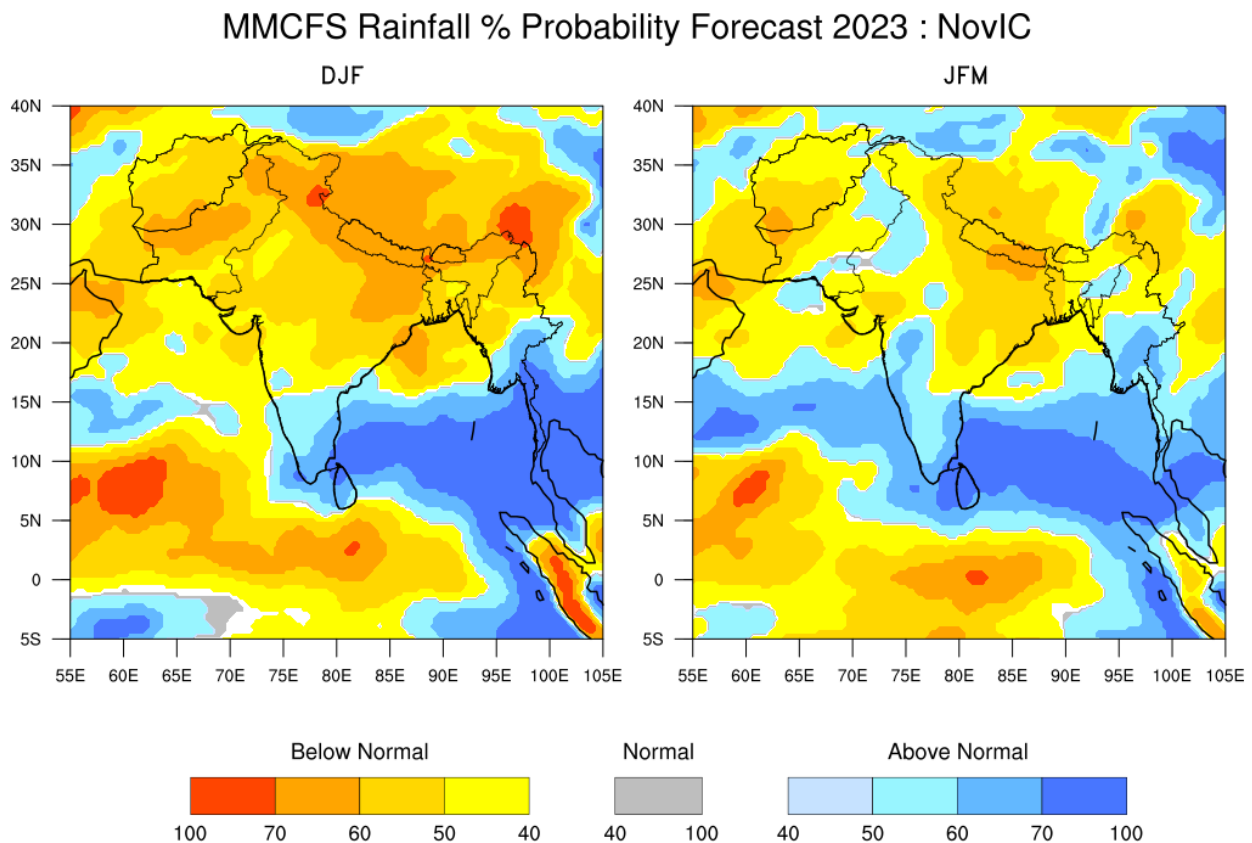


Fig.7: Seasonal probability (%) forecasts of precipitation for (a) DJF 2022/23 (left) and (b) JFM 2023 (right) based on initial conditions of November 2022. The white colour indicates climatological probability.

2.2. Temperature Probability Forecast:

The probability forecasts for temperature for the season December 2022 to February 2023 (DJF) and January to March 2023 (JFM) are given in the Figures 8a and 8b respectively. The

forecast is prepared based on the November initial conditions. Temperature probability forecast for DJF season (Fig. 8a) indicates that above normal temperatures are likely over most parts of northwest, north along the plains of Himalayas, east, northeast and southeast of South Asia. It is likely to be below normal for some parts of central and south of South Asia. Temperature probability forecast for JFM season (Fig.8b) indicates enhanced probability for above normal temperatures over most parts of east, northeast and southeast and some parts of north and northwest of South Asia. It is likely to be below normal over most parts of central and south of South Asia. (white colour indicates climatological probability).

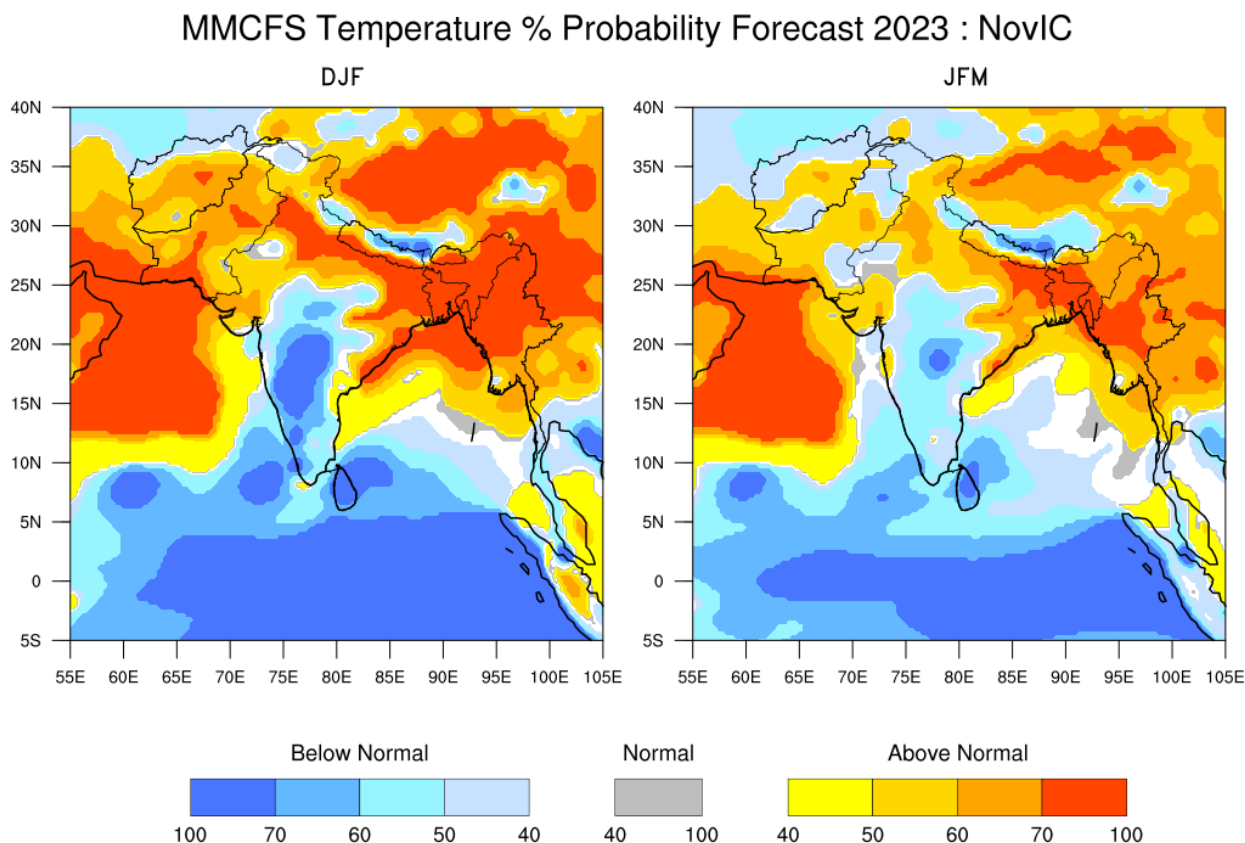


Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) DJF 2022/23 (left) and (b) JFM 2023 (right) based on initial conditions of November 2022.

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 December 2022 to March 2023) averaged over the 9 south Asian countries viz., Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan and Sri Lanka is 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 December 2022 and January and February 2023, the country averaged monthly precipitation is likely to be normal to below normal for all south Asian countries except Sri Lanka (Fig.9) where it is likely to be normal in December and above normal in January and February. In March the country averaged monthly precipitation is likely to be normal to above normal for all the countries.

The country averaged monthly precipitation is likely to be normal to below normal for all the months viz. December 2022 to March 2023 for Afghanistan, Bangladesh, India, Myanmar and Nepal. It is likely to be below normal in December to February and above normal in March for Bhutan, Maldives and Pakistan. Sri Lanka is likely to experience normal to above normal in all the months viz. December to March.

The country averaged monthly temperatures during December 2022 to March 2023, are likely to be normal to above normal for Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. It is likely to be normal to below normal for Afghanistan, Maldives and Myanmar for all the months.

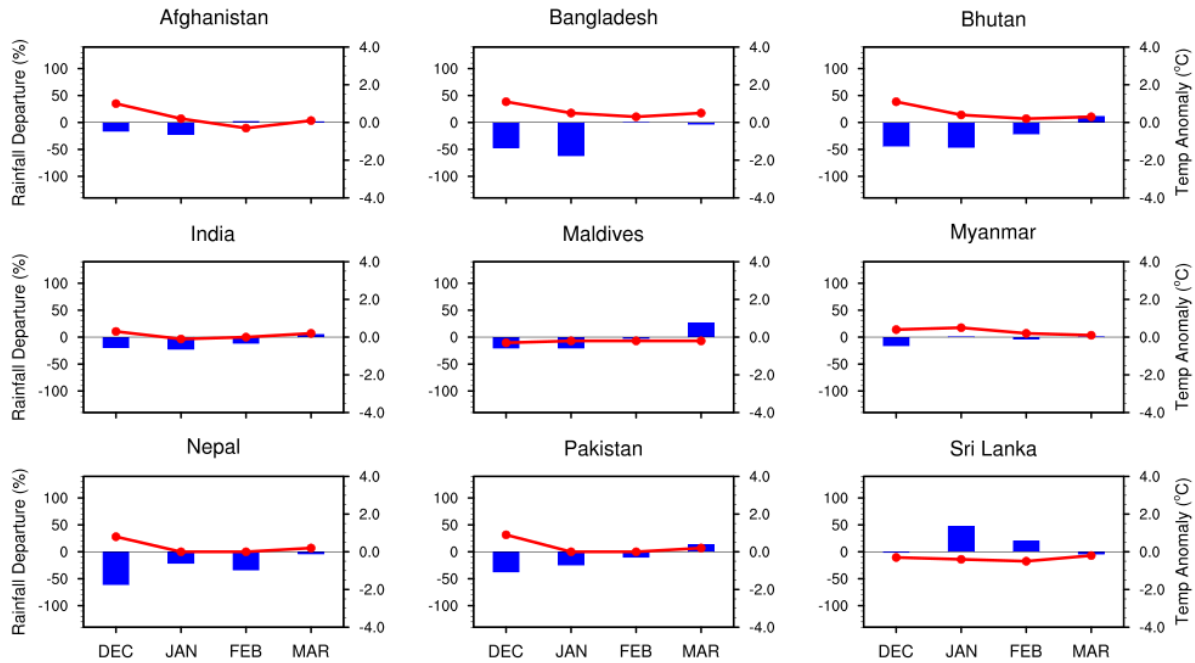


Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during December 2022 to March 2023. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale 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).