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 2023 to March 2024)

Highlights

- Currently, strong El Niño conditions are prevailing over equatorial Pacific and the sea surface temperatures (SSTs) are above average over most of the equatorial Pacific Ocean. The latest MMCFS forecast indicates moderate to strong El Niño conditions are likely to continue during the upcoming season and weaken thereafter.

- Positive IOD conditions are observed over the Indian Ocean and the latest MMCFS forecast indicates weakening of positive IOD conditions and then turn to neutral conditions during the upcoming season.

- The probability forecast for precipitation for December – February (DJF) and January to March (JFM) seasons indicates enhanced probability of above normal precipitation in most parts of South Asia except over few parts of west and extreme south of South Asia where probability of below normal precipitation is likely.

- The country averaged monthly precipitation for the month of December 2023, January and March 2024 is likely to be normal to above normal for all south Asian countries. In February it is likely to be normal to below normal for all countries.

- Temperature probability forecast for DJF and JFM seasons indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over most parts of north along the Himalayan Plains where probability of below normal temperature is likely.

- The country averaged monthly temperatures during December, February and March are likely to be normal to above normal for all south Asian countries. In January it is likely to be normal to above normal for Bangladesh, India, Maldives, Myanmar, and Sri Lanka and below normal for Afghanistan, Bhutan, Nepal and Pakistan.

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1. Important Global Climate Factors

1.1 Sea Surface Temperatures over the Pacific Ocean

During November 2023, warmer than normal SSTs were observed over most of the equatorial Pacific Ocean (Fig.1a). Warmer than normal SSTs were also observed over most of the northern extra-tropical regions. As compared to the last month, warming of SSTs were observed over the central equatorial Pacific Ocean near the Date Line (Fig.1b) but cooling of SSTs were observed over the eastern and western equatorial Pacific Ocean. Cooling of SSTs were also observed over some region of the higher latitudes of North Pacific Ocean. The latest MMCFS forecast indicates moderate to strong 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 November 2023, warmer than normal SST anomalies were observed over the north Arabian Sea, North Bay of Bengal and western equatorial Indian Ocean (Fig.1a). However, cold SST anomalies were observed over eastern equatorial Indian Ocean. Compared to the previous month, warm SSTs were observed over Bay of Bengal and western equatorial Indian Ocean. However, cold SSTs were observed over north Arabian Sea. (Fig. 1b). The latest MMCFS forecast indicates weakening of positive IOD conditions and then turn to neutral conditions during the upcoming season. (Fig.3).
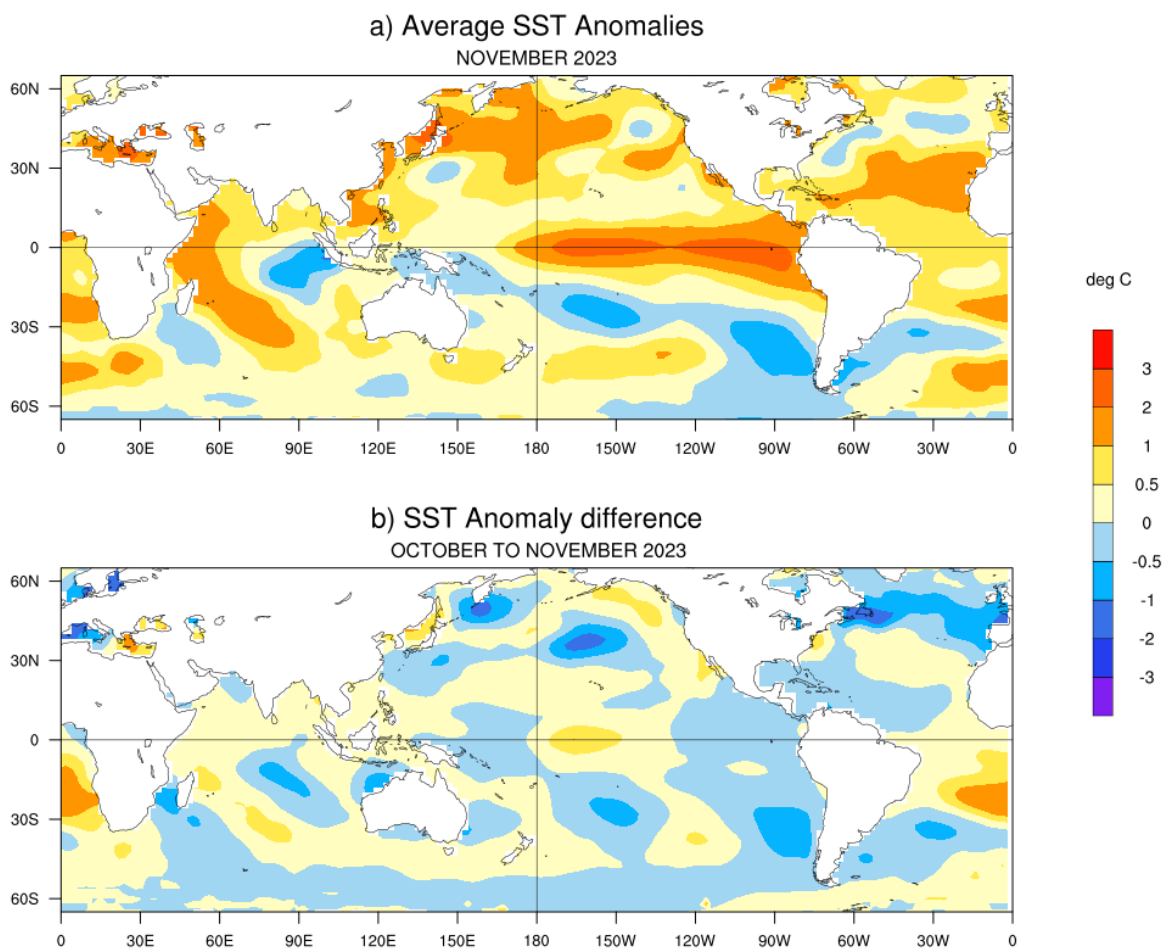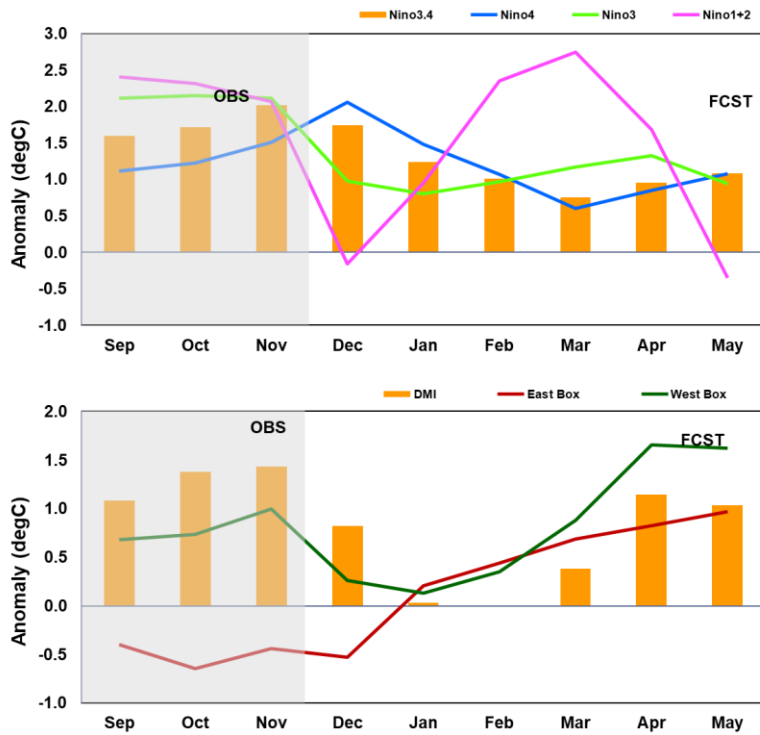

Fig.1(a) Sea surface temperature (SST) anomalies (°C) during November 2023 and (b) changes in the SST anomalies (°C) from October to November 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) long term mean.

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 November 2023 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over western Indian Ocean, North Bay of Bengal, 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.
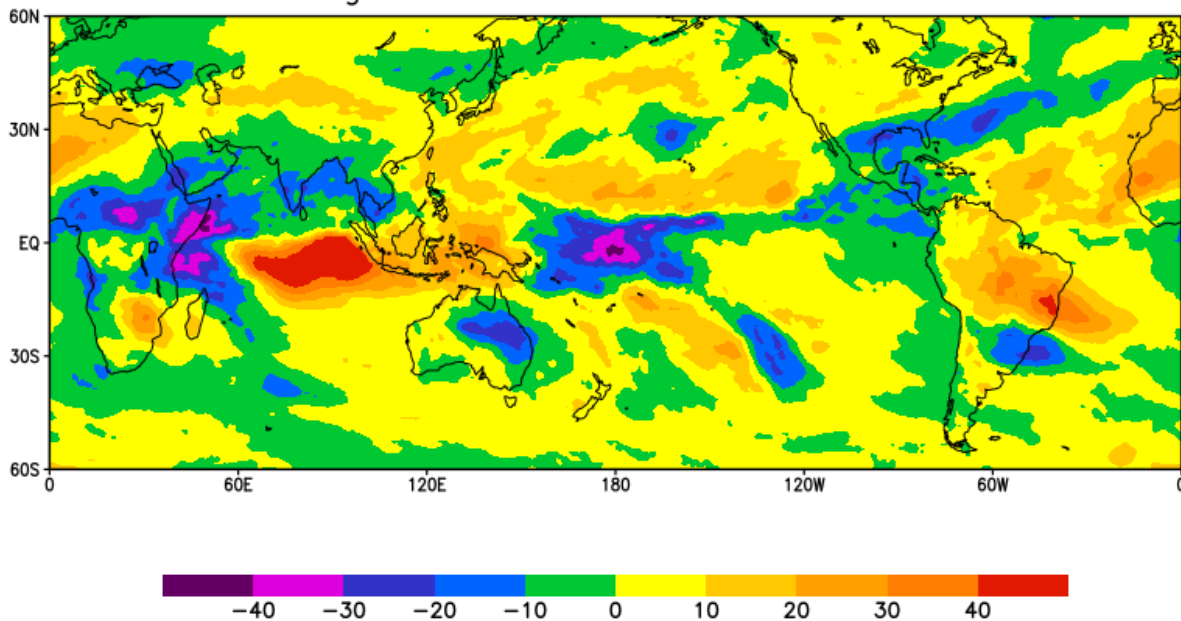

Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m²) for November 2023
(Data source: NCEP-NOAA)

## 1.4 Snow Cover Area over the Northern Hemisphere (NH)

During November 2023, the NH snow cover area (35.59 million Sq. km) was more than the 1991-2020 normal by 0.5 million Sq. km (Fig. 5). Eurasian Snow cover area (21.99 million Sq. km) was 0.81 million Sq. km more than the 1991-2020 normal. North America snow cover area of 13.59 million sq. km was less by 0.28 million Sq. Km with respect to 1991-2020 normal.
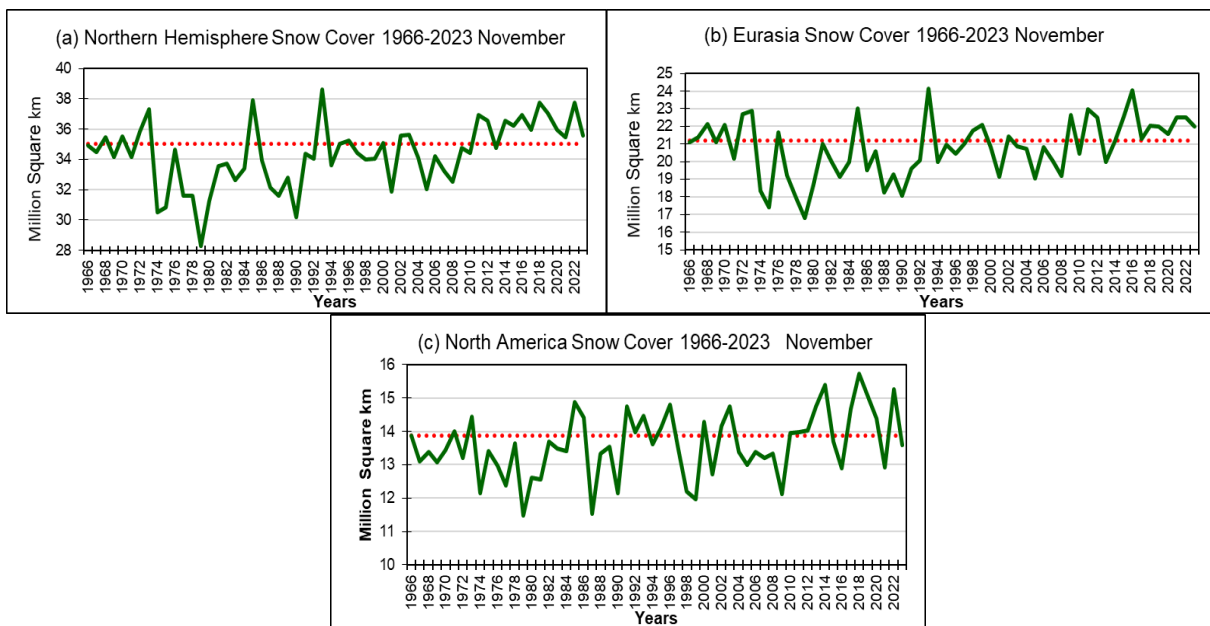
Fig.5. Snow cover area (million Sq. km) for the month of November during the period 1966-2023 (green solid lines) and normal value (1991-2020) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO)

During the first week of November 2023, MJO propagated from phase 1 (Western Hemisphere and Africa) to phase 6 (Western Pacific) with reduced strength. In the second week it moved to phase 7 (Western Pacific) with increased strength. In the third week it moved from phase 7 to phase 1 with increased strength. In the last week it entered phase 3 (Indian Ocean) 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.
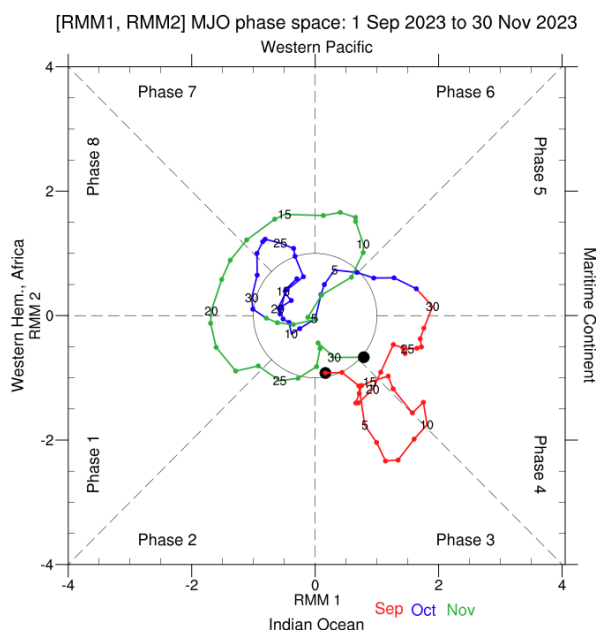

Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period September to November 2023. (Data Source: http://www.bom.gov.au/climate/mjo/).

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 December to February 2024 (DJF) and January to March 2024 (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 and JFM indicates enhanced probability of above normal precipitation in most parts of South Asia except over few parts of west and extreme south of South Asia where probability of below normal precipitation is likely.
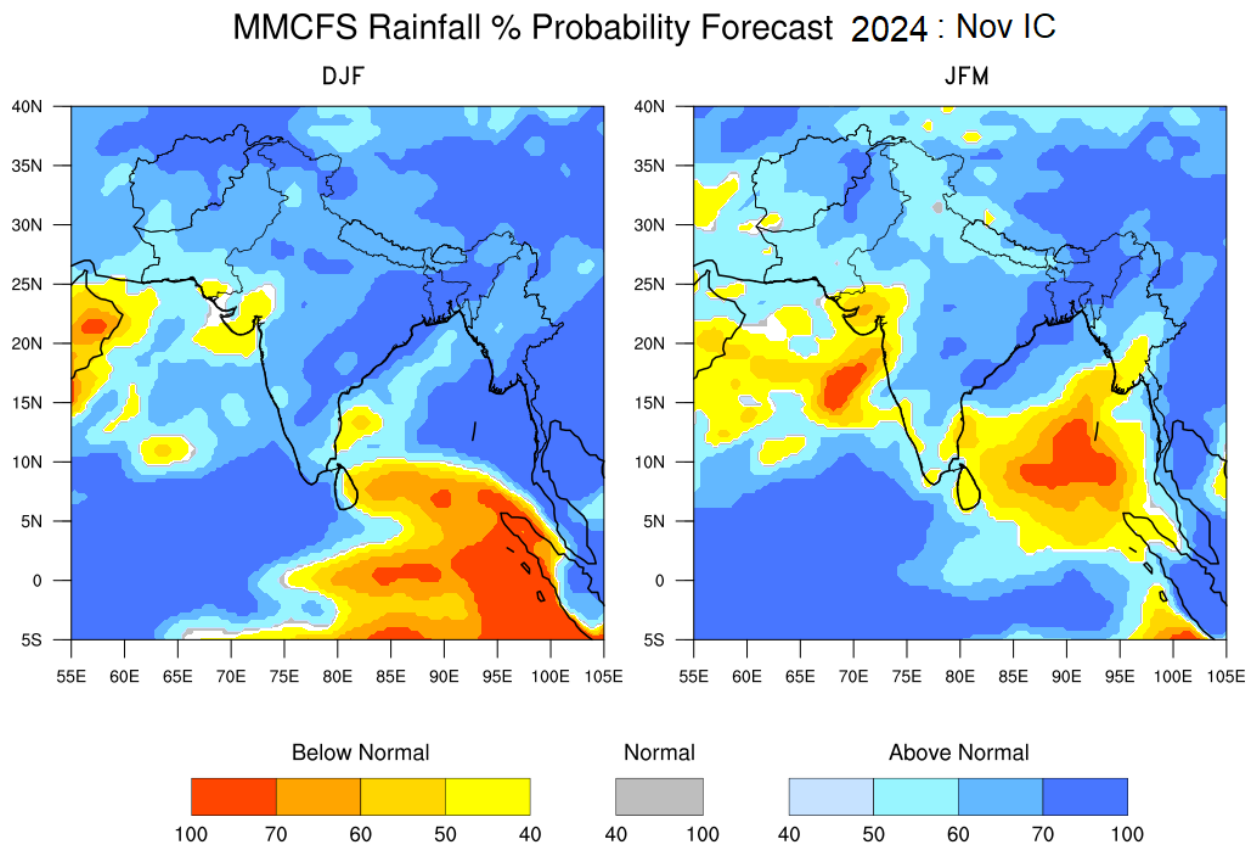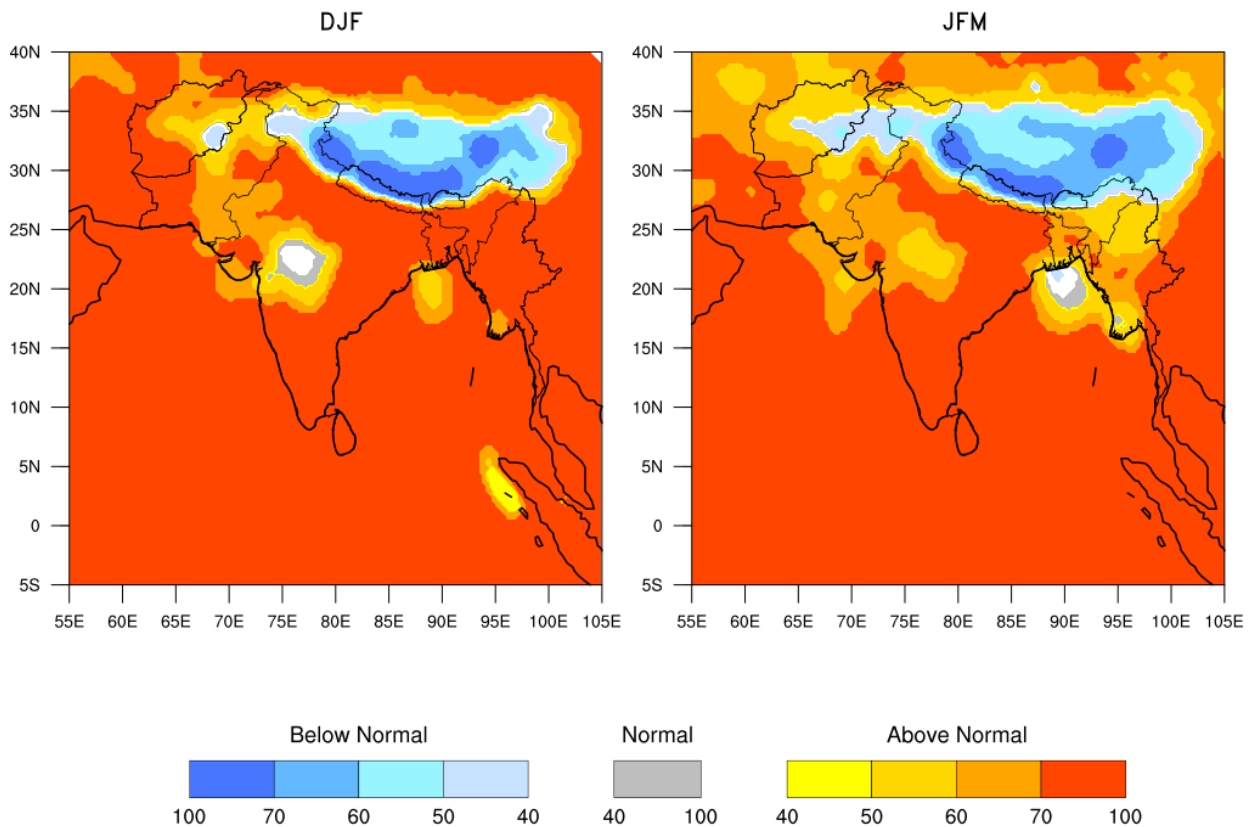

Fig.7: Seasonal probability (%) forecasts of precipitation for (a) DJF 2024 (left) and (b) JFM 2024 (right) based on initial conditions of November 2023.The white colour indicates climatological probability.

2.2.   Temperature Probability Forecast:

The probability forecasts for temperature for the season December to February 2024 (DJF) and January to March 2024 (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 and JFM season indicates that enhanced probability of above normal temperatures is likely over most parts of South Asia except over most parts of north along the Himalayan Plains where probability of below normal temperature is likely.

**MMCFS Temperature % Probability Forecast 2024: Nov IC**

Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) DJF 2024 (left) and (b) JFM 2024 (right) based on initial conditions of November 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 December 2023 to March 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 December 2023, January and March 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 below normal for all countries.

The country averaged monthly temperatures during December, February and March are likely to be normal to above normal for all south Asian countries. In January it is likely to be normal to above normal for Bangladesh, India, Maldives, Myanmar, and Sri Lanka and below normal for Afghanistan, Bhutan, Nepal and Pakistan.
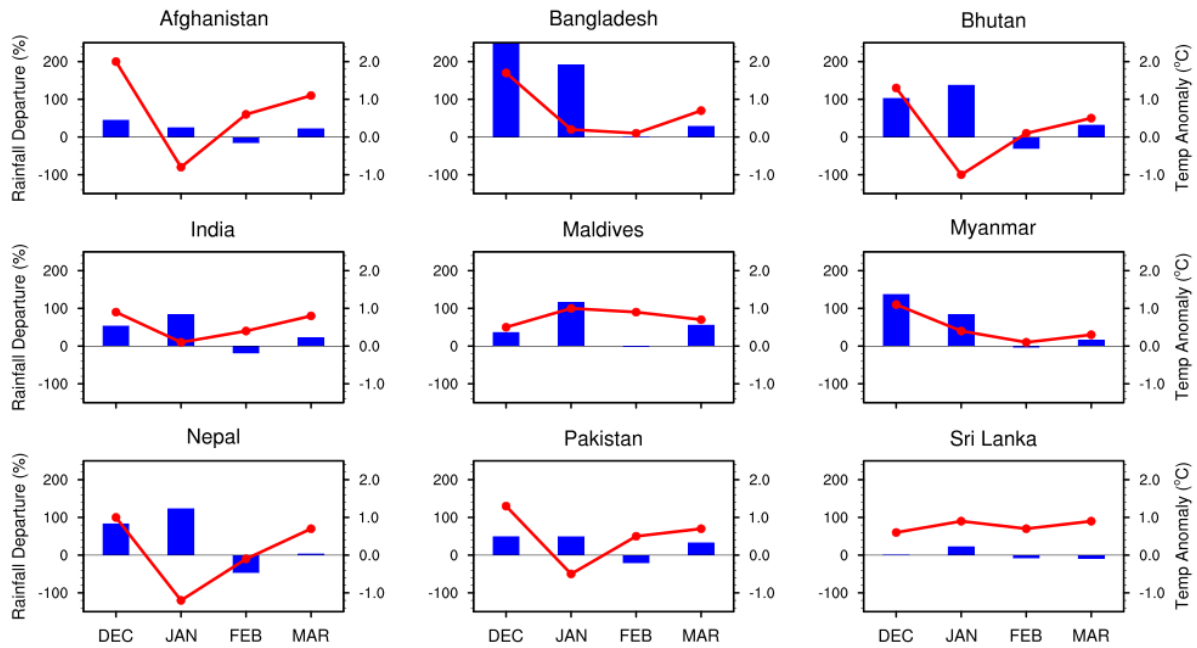
Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during December 2023 to March 2024. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale 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).