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SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA
(October 2022 to January 2023)

- The 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. Other climate models are also indicating continuation of La Niña conditions until December to February (DJF) 2023 season and turn to neutral ENSO conditions thereafter.

- The negative IOD conditions are prevailing over the Indian Ocean since June 2022. The latest MMCFS forecast indicates that the negative IOD conditions are likely to weaken and turn to neutral IOD conditions by the end of this year.

- The probability forecast for precipitation for OND indicates that enhanced probability of above normal precipitation is likely over most parts of central, east, south and few parts of northeast of South Asia and enhanced probability of below normal precipitation is likely over most parts of northwest, extreme north and southeast of South Asia. The same for NDJ indicates that enhanced probability for above normal precipitation is likely over few parts of northwest, south, east and northeast of the South Asia and enhanced probability of below average precipitation over most parts of northwest, west, extreme north, central, extreme south and southeast of South Asia.

- In general, the country averaged monthly precipitation is likely to be normal to above normal for all the months viz. October to January 2023 for India. It is likely to be normal to above normal in October and November and below normal in December and January for Bangladesh, Bhutan, Myanmar and Sri Lanka. It is likely to be below normal to normal for the months under study for Maldives. Afghanistan and Pakistan are likely to experience below normal in October, November and December and above normal in January. It is likely to experience normal to above normal in October, November and January and below normal in December for Nepal.

- Temperature probability forecast for OND season indicates that above normal temperatures are likely over some parts of extreme northwest, extreme north along the plains of Himalayas, east and most parts of northeast and southeast of south Asia. It is likely to be below normal for some parts of northwest, west, central and south of South Asia. Temperature probability forecast for NDJ season indicates enhanced probability for above normal temperatures over most parts of northwest, north along the plains of Himalayas, northeast and southeast of South Asia. It is likely to be below normal over central and south of South Asia.

- In general, the country averaged monthly temperatures during October 2022 to January 2023, are likely to be normal to above normal for Afghanistan, Bangladesh, Bhutan, India, Myanmar, Nepal and Pakistan and below normal during all the months viz. October 2022 to January 2023 for Sri Lanka and Maldives.

1. Important Global Climate Factors

1.1 Sea Surface Temperatures over the Pacific Ocean

During September 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. Also, warm SST anomalies were observed over most parts of the northern Pacific Ocean. As compared to the last month, cooling of SST anomalies were observed extending over central to eastern equatorial Pacific Ocean (Fig.1b). Cooling of SST anomalies were also observed over central north and extreme northwest Pacific Ocean. The 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. Other climate models are also indicating continuation of La Niña conditions until December to February (DJF) 2023 season and turn to neutral ENSO conditions thereafter (Fig.2).

1.2 Sea Surface Temperatures over Indian Ocean

In the north Indian Ocean, negative SST anomalies were observed over the southern parts of Arabian Sea and positive SST anomalies over Bay of Bengal and north Arabian Sea. A positive SST anomaly was observed over eastern equatorial Indian Ocean and negative SST anomalies were observed over western equatorial Indian Ocean, resembling with the characteristics of negative Indian Ocean Dipole. Also, there were positive SST anomalies observed over eastern parts of the south Indian Ocean (Fig. 1a). As compared to the last month, cooling of SST anomalies were observed over north Bay of Bengal and warming of SST anomalies were over north Arabian Sea (Fig. 1b). The negative IOD conditions are prevailing over the Indian Ocean since June 2022. The latest MMCFS forecast indicates that the negative IOD conditions are likely to weaken and turn to neutral IOD conditions by the end of this year (Fig. 3).
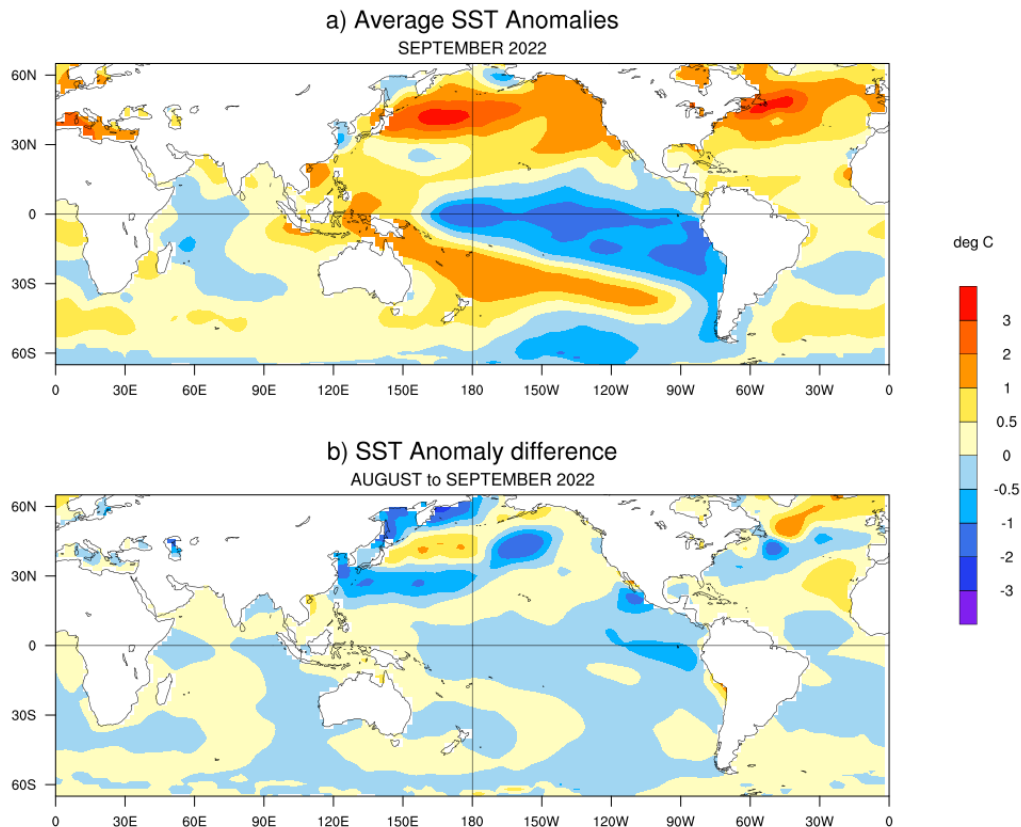

Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during September 2022 and **(b)** changes in the SST anomalies (°C) from August 2022 to September 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.
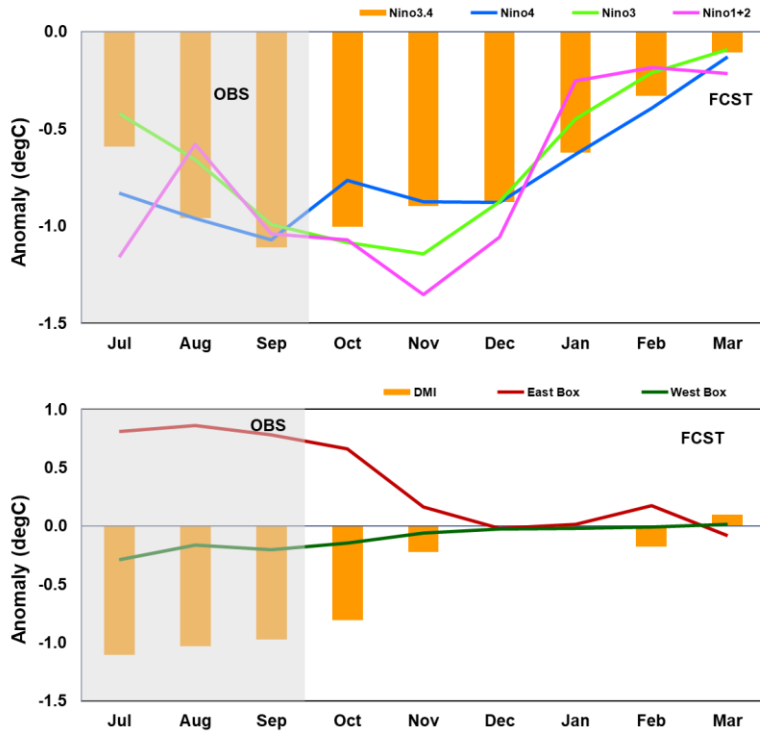
Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 Long Wave Radiation (OLR) anomaly of September 2022 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over few parts of west of South Asia, parts of Africa, east central Arabian Sea, most parts of the Maritime Continent and Australia. Negative OLR anomalies are also present in north western tropical Pacific Ocean, southern Tropical Pacific Ocean near dateline and western coast of North America. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over south Bay of Bengal, equatorial Indian Ocean, west equatorial Pacific Ocean and parts of North and South America.
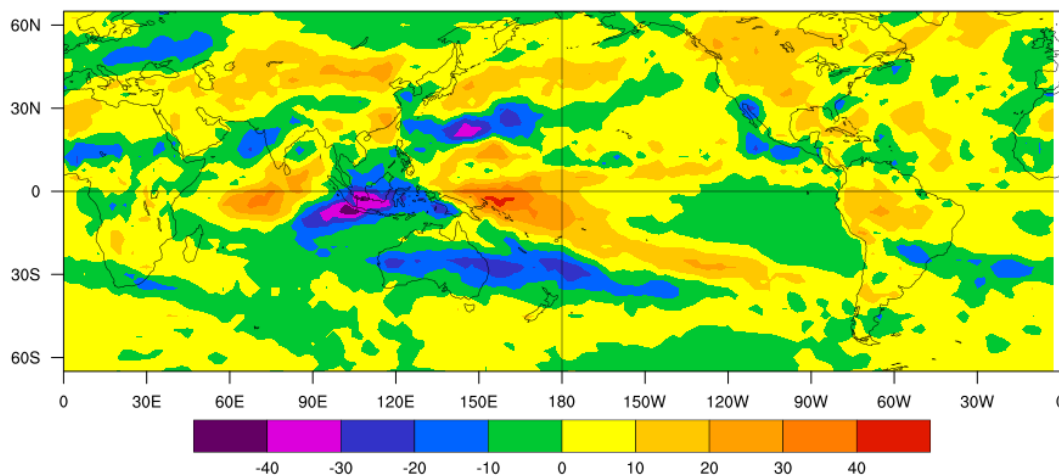

Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m2) for September 2022
(Data source: NCEP-NOAA)

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

The September 2022, NH snow cover area (5.93 million Sq. km) was more than the 1991-2020 normal by 0.42 million Sq. km (Fig. 5). Eurasian Snow cover area (2.52 million Sq. km) was 0.9 million Sq. km more than the 1991-2020 normal and was having more area under snow in September 2022 compared to September 2021. North America snow cover area of 3.41 million sq. Km was less by 0.5 million Sq. Km with respect to 1991-2020 normal.
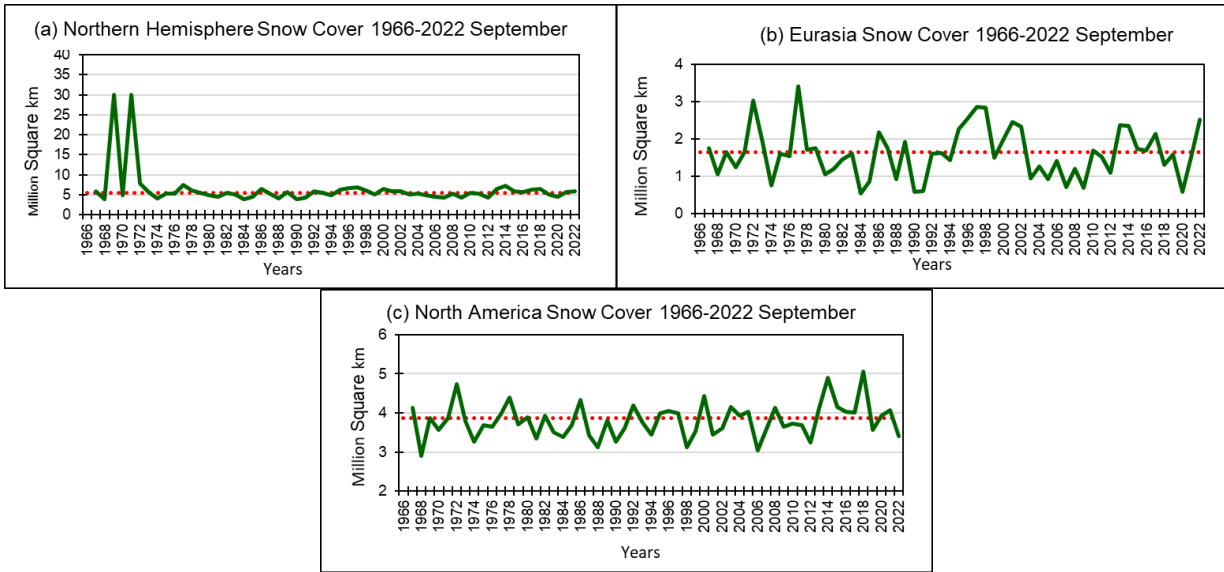

Fig.5. Snow cover area (million Sq. km) for the month of September during the period 1966-2022 (green solid lines) and normal value (1991-2022) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO):

During the most of the time of September 2022, the MJO was having very weak signal and remained within the circle. The MJO phase diagram illustrates the progression of the MJO through different phases, which generally coincide with locations along the equator around the globe.
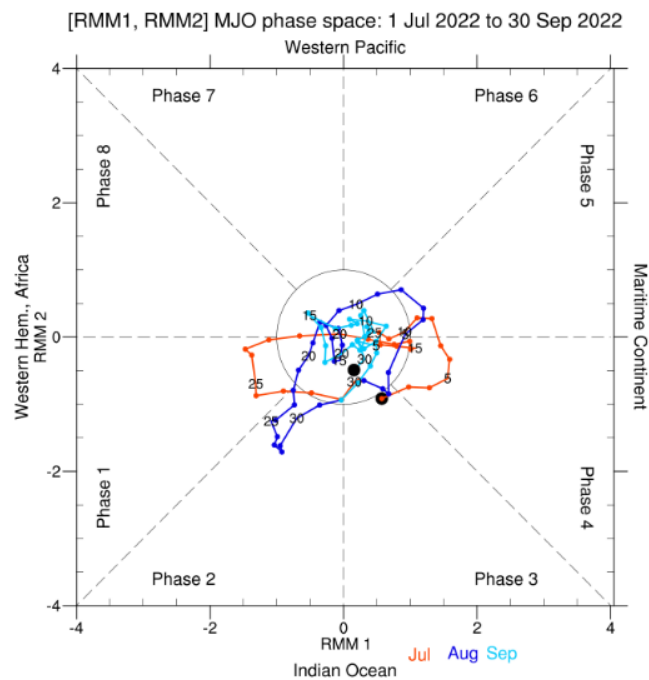

Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period July to September 2022. (Data Source: http://www.bom.gov.au/climate/mjo/).

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 October to December 2022 (OND) and November to January 2023 (NDJ) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the September initial conditions. The probability forecast for precipitation for OND (Fig.7a) indicates that enhanced probability of above normal precipitation is likely over most parts of central, east, south and few parts of northeast of South Asia and enhanced probability of below normal precipitation is likely over most parts of northwest, extreme north and southeast of South Asia. The same for NDJ (Fig 7b) indicates that enhanced probability for above normal precipitation is likely over few parts of northwest, south, east and northeast of the South Asia and enhanced probability of below average precipitation over most parts of northwest, west, extreme north, central, extreme south and southeast of South Asia. (white colour indicates climatological probability).
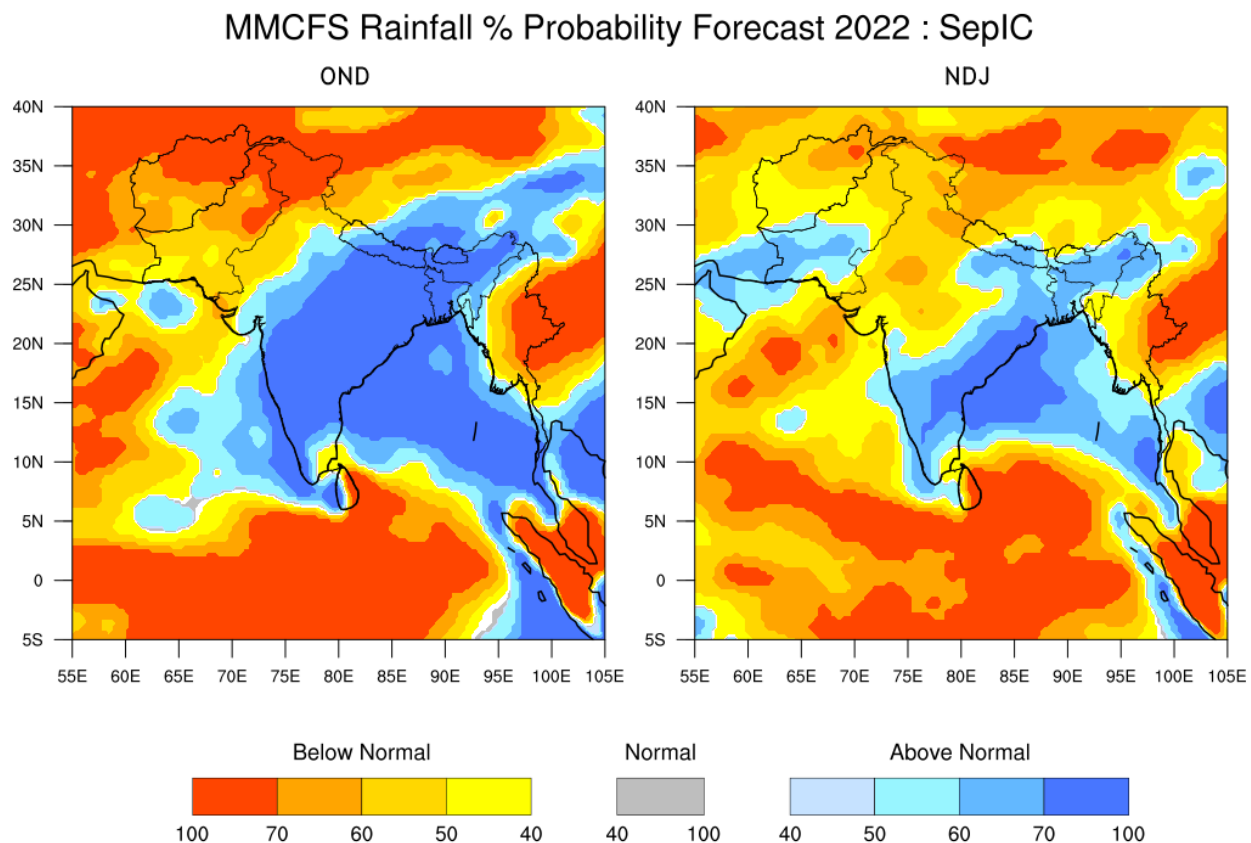

Fig.7: Seasonal probability (%) forecasts of precipitation for (a) OND 2022 (left) and (b) NDJ 2023 (right) based on initial conditions of September 2022.

2.2. Temperature Probability Forecast*:*

The probability forecasts for temperature for the season October to December 2022 (OND) and November to January 2023 (NDJ) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the September initial conditions. Temperature probability forecast for OND season (Fig. 8a) indicates that above normal temperatures are likely over some

parts of extreme northwest, extreme north along the plains of Himalayas, east and most parts of northeast and southeast of south Asia. It is likely to be below normal for some parts of northwest, west, central and south of South Asia. Temperature probability forecast for NDJ season (Fig.8b) indicates enhanced probability for above normal temperatures over most parts of northwest, north along the plains of Himalayas, northeast and southeast of South Asia. It is likely to be below normal over central and south of South Asia (white colour indicates climatological probability).
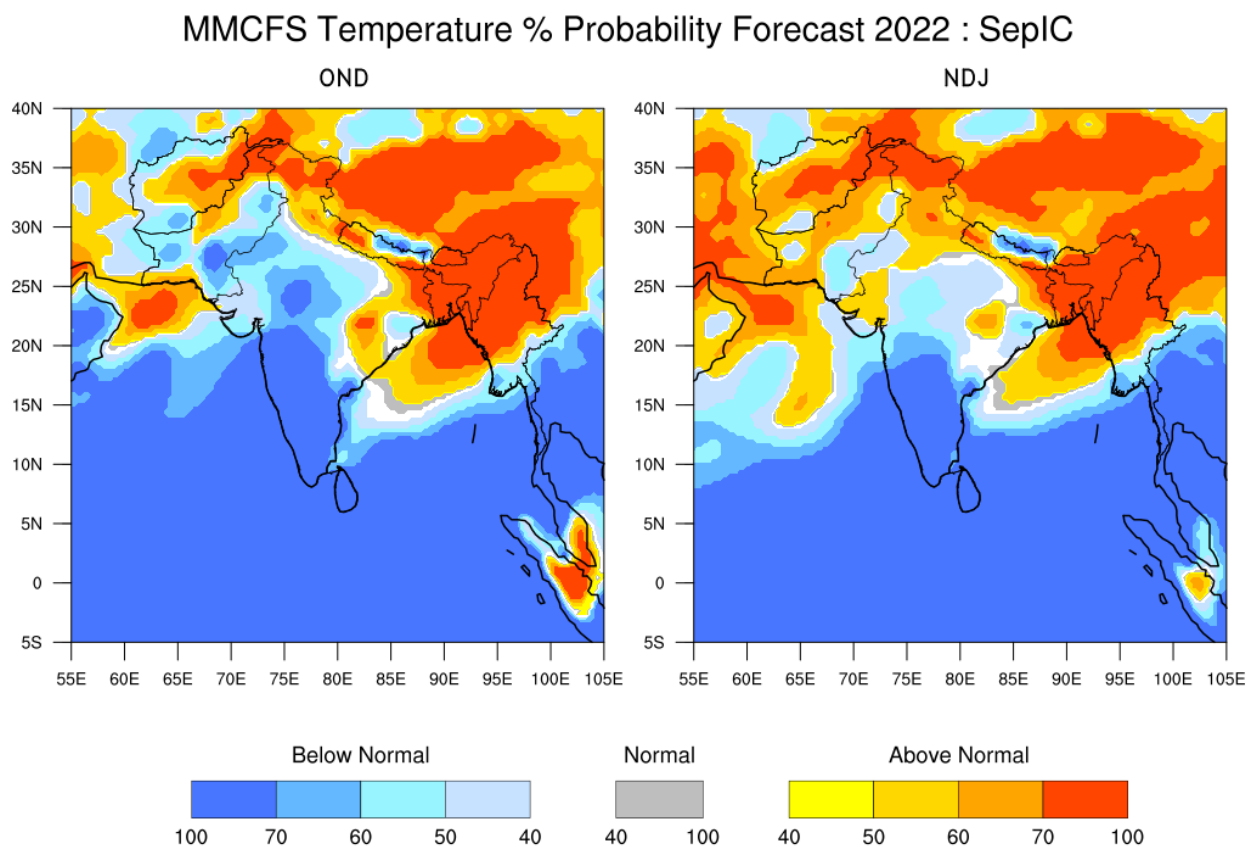

Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) OND 2022 (left) and (b) NDJ 2023 (right) based on initial conditions of September 2022.

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 October 2022 to January 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 October, the country averaged monthly precipitation is likely to be normal to above normal for all south Asian countries except Afghanistan and Pakistan (Fig.9) where it is likely to be below normal. In November, the country averaged monthly precipitation is likely to be normal to above normal for all the countries except Afghanistan, Maldives and Pakistan where it is likely to experience below normal precipitation. In December, the country averaged monthly precipitation is likely to be below normal to normal for all the countries. In January, the country averaged monthly precipitation is likely to be normal to above normal for Afghanistan, India, Maldives, Nepal and Pakistan and below normal precipitation is likely for rest of the countries.

In general, the country averaged monthly precipitation is likely to be normal to above normal for all the months viz. October to January 2023 for India. It is likely to be normal to above normal in October and November and below normal in December and January for Bangladesh, Bhutan, Myanmar and Sri Lanka. It is likely to be below normal to normal for the all the months for Maldives. Afghanistan and Pakistan are likely to experience below normal in October, November and December and above normal in January. It is likely to experience normal to above normal in October, November and January and below normal in December for Nepal.

Country averaged monthly temperatures during October 2022 to January 2023, are likely normal to above normal for all the countries except Maldives and Sri Lanka where they are likely to remain below average for all the months.

In general, the country averaged monthly temperatures during October 2022 to January 2023, are likely to be normal to above normal for Afghanistan, Bangladesh, Bhutan, India, Myanmar, Nepal and Pakistan and below normal during all the months viz. October 2022 to January 2023 for Sri Lanka and Maldives.
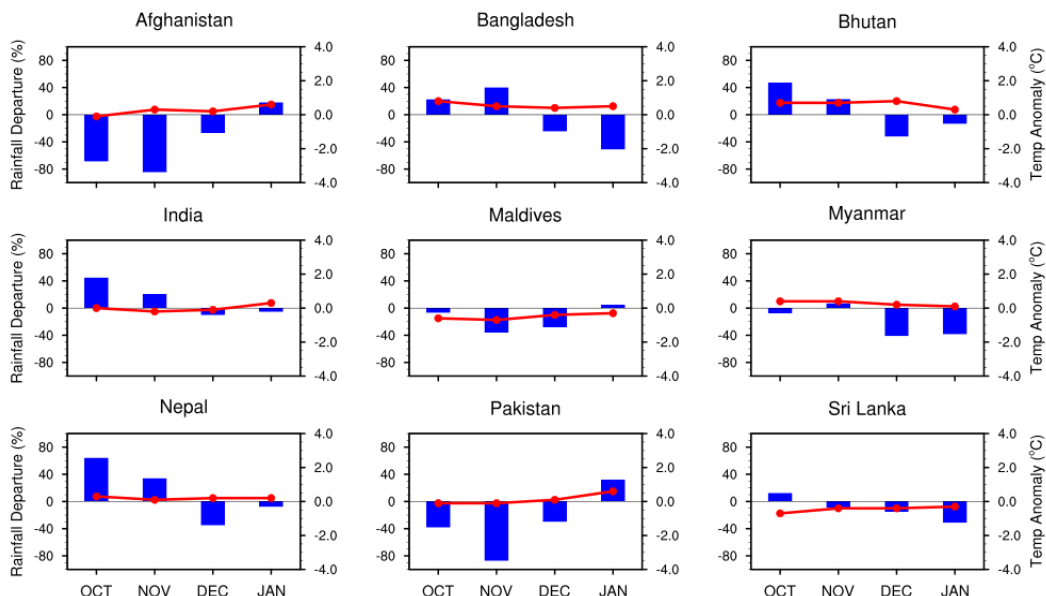

Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during October 2022 to January 2023. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis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