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SEASONAL CLIMATE OUTLOOK FOR SOUTH ASIA

(September to December 2022)

- 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 end of the year. Other climate models are also indicating continuation of La Niña conditions during the upcoming season.

- The probability forecast for precipitation for SON and OND indicates that enhanced probability for above normal precipitation is likely over most parts of the South Asia except over extreme northwest, extreme north and few parts of extreme east of South Asia where enhanced probability of below normal precipitation is likely.

- In general, the country averaged monthly precipitation is likely to be normal to above normal for all the months viz. September to December 2022 for Bangladesh. Bhutan is likely to experience normal to above normal for all the months except November where it is likely to experience below normal. India, Nepal and Sri Lanka are likely to experience normal to above normal for all the months except December where it is likely to experience below normal rainfall. Maldives, Myanmar and Pakistan are likely to have normal to above normal precipitation in September and October and below normal in November and December. Bangladesh is likely to experience below normal to normal precipitation in all the months.

- Temperature probability forecast for SON and OND seasons indicate that enhanced probability for below normal temperatures are likely over some parts of northwest and southeast, most parts of central, west and south of South Asia whereas enhanced probability of above normal temperatures is likely over most parts of east north along the foothills of Himalayas and northeast of South Asia and few parts of northwest where enhanced probability of above normal temperatures is likely.

- In general, the country averaged monthly temperatures during September to December are likely to be normal to above normal for Bangladesh, Bhutan, Myanmar and Nepal. Pakistan and Sri Lanka are likely to experience below normal to normal temperatures for all the months. Afghanistan and Pakistan are likely to experience normal to above normal in September, October and December and below normal temperatures in November. India is likely to experience below normal temperatures in September and normal to above normal from October to December.

1.   Important Global Climate Factors

## 1.1   *Sea Surface Temperatures over the Pacific Ocean*

During August 2022 cooler than normal SSTs were observed across the central, eastern, and south 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 the far eastern equatorial eastern Pacific Ocean but cooling of SST anomalies were observed over the central equatorial Pacific Ocean near the Date Line (Fig.1b). Cooling of SST anomalies were also observed over extreme north Pacific Ocean. 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 end of the year. Other climate models are also indicating continuation of La Niña conditions during the upcoming season (Fig.2).

1.2   *Sea Surface Temperatures over Indian Ocean*

In the north Indian Ocean, negative SST anomalies were observed over the most parts of the Arabian Sea and positive SST anomalies over Bay of Bengal. A positive SST anomaly was observed over eastern equatorial Indian Ocean and far western equatorial Indian Ocean. However, negative SST anomalies were observed over central equatorial Indian Ocean. 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 central Indian Ocean where warming of SST anomalies were over western and eastern Indian Ocean (Fig. 1b). At present the negative IOD conditions are prevailing since June 2022 over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to continue up to the end of year. (Fig. 3).
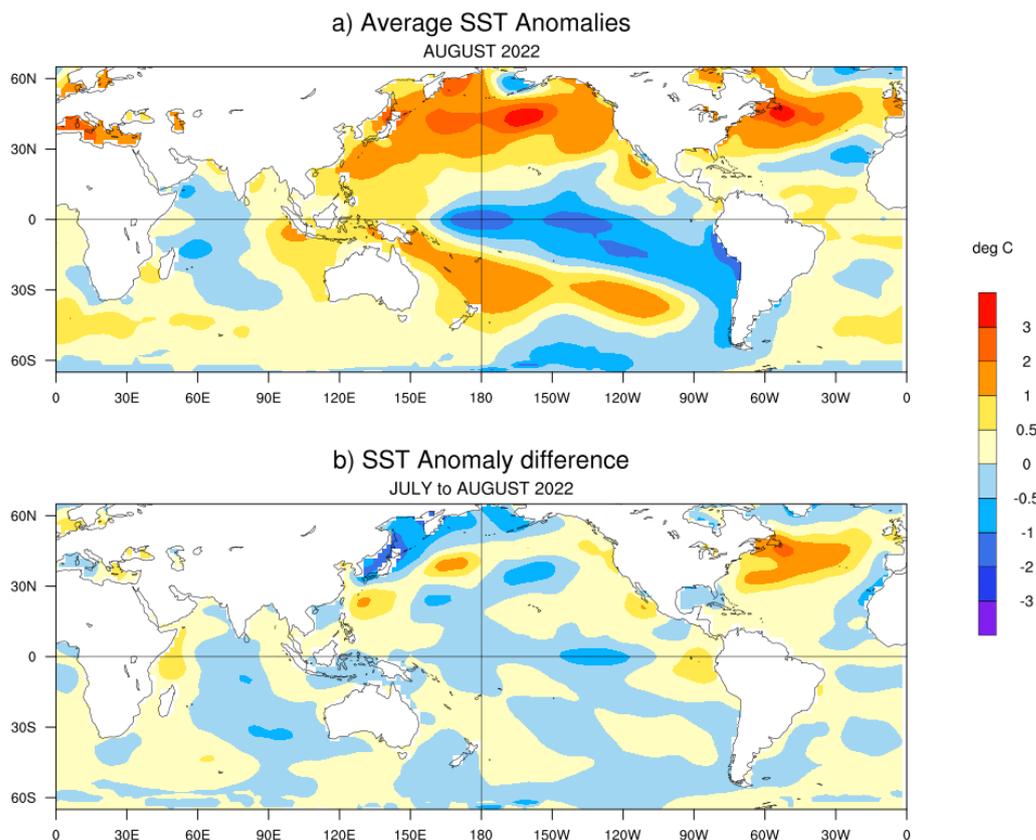
Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during August 2022 and **(b)** changes in the SST anomalies (°C) from July 2022 to August 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.
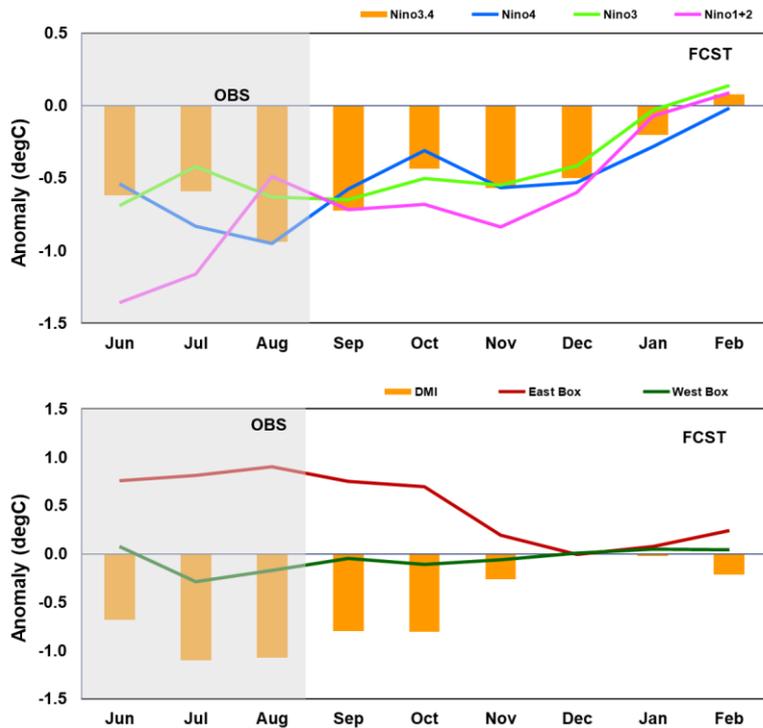
Fig.2: Time series of monthly area-averaged SST anomalies (°C) in the 4 Niño regions. ERSSTv5 observed anomaly for the last 3 months and MMCFS model PDF corrected anomaly forecast for the next 6 months.

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 August 2022 is shown in (Fig.4). Negative OLR anomalies (enhanced convection, blue shading) were observed over most parts of northwest South Asia, west equatorial Indian ocean, southeast tropical Indian ocean and adjoining maritime continent. Negative OLR anomalies are also present near South China Sea and some parts of north America. Positive OLR anomalies (suppressed convection, orange/red shading) were observed over most parts of east and northeast of South Asia and western Pacific Ocean as well as parts of South Africa and North and South Americas.
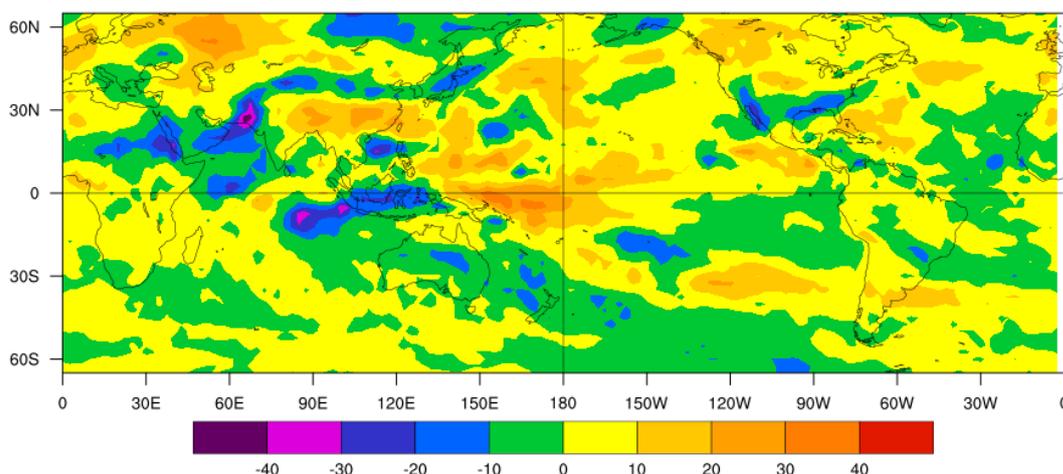

Fig.4: Outgoing Long Wave Radiation (OLR) Anomaly (W/m2) for August 2022
(Data source: NCEP-NOAA)

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

The August 2022, NH snow cover area (2.44 million Sq. km) was less than the 1991-2020 normal by 0.24 million Sq. km (Fig. 5). Eurasian Snow cover area (0.15 million Sq. km) was 0.12

million Sq. km less than the 1991-2020 normal and was having same area under snow in August 2022 compared to August 2021. North America snow cover area of 2.3 million sq. Km was less by 0.11 million Sq. Km with respect to 1991-2020 normal.
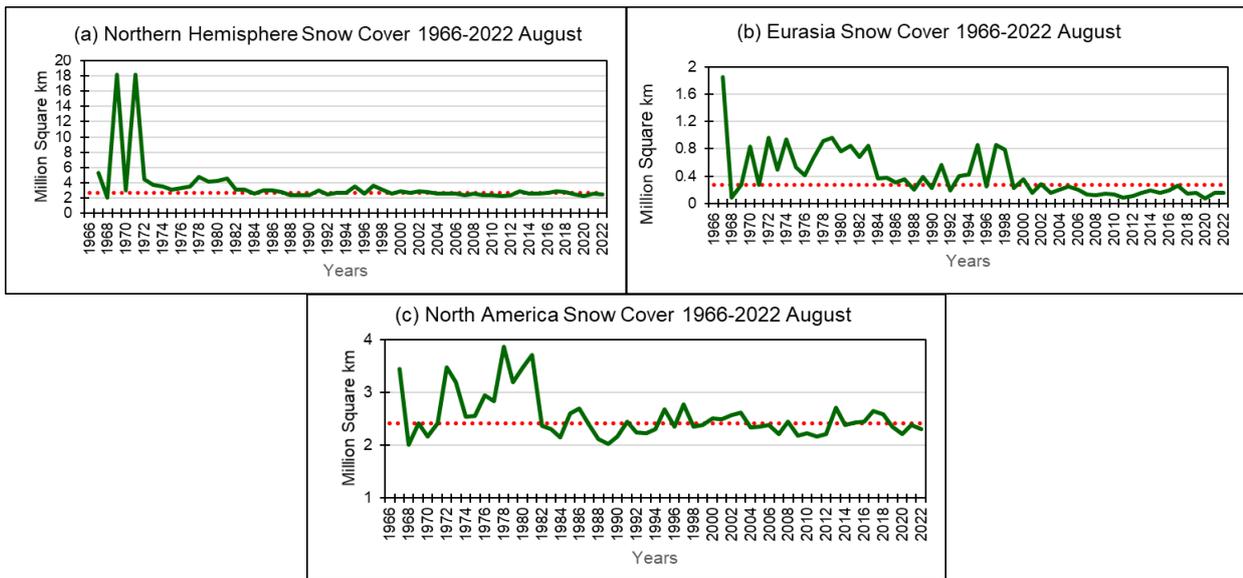
Fig.5. Snow cover area (million Sq. km) for the month of August during the period 1966-2022 (green solid lines) and normal value (1991-2022) (red dotted line) for (a) Northern Hemisphere (b) Eurasia and (c) North America. (Data Source: Rutgers University Snow Lab).

1.5. Madden Julian Oscillation (MJO):

During the first week of August 2022, the MJO moved from phase 3 (Indian Ocean) to phase 4 (Maritime Continent). In the second and third week it propagated from phase 4 to phase 1 (Western Hemisphere and Africa) with weak signal. In the fourth week it entered Indian Ocean (Phase 3) 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.
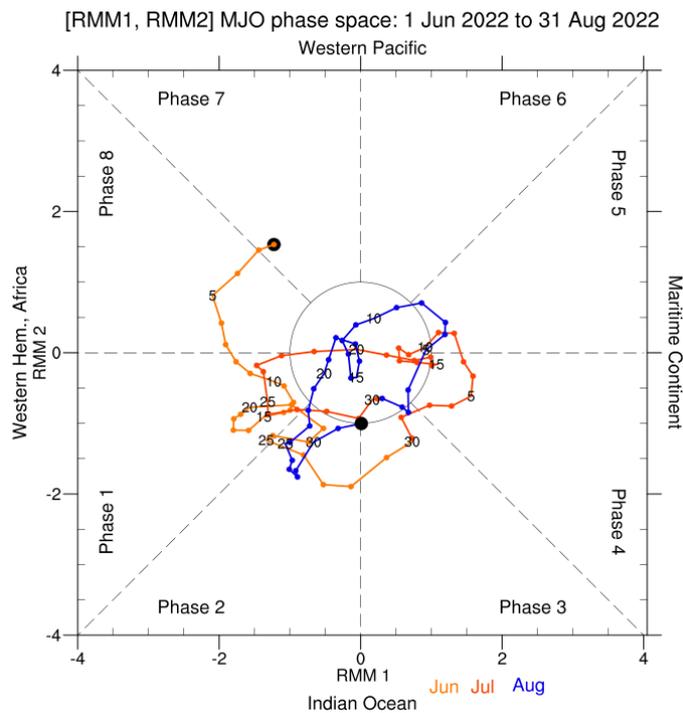
Fig.6. RMM phase diagram for Madden Julian Oscillation (MJO) for the period June to August 2022. (Data Source: http://www.bom.gov.au/climate/mjo/).

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.

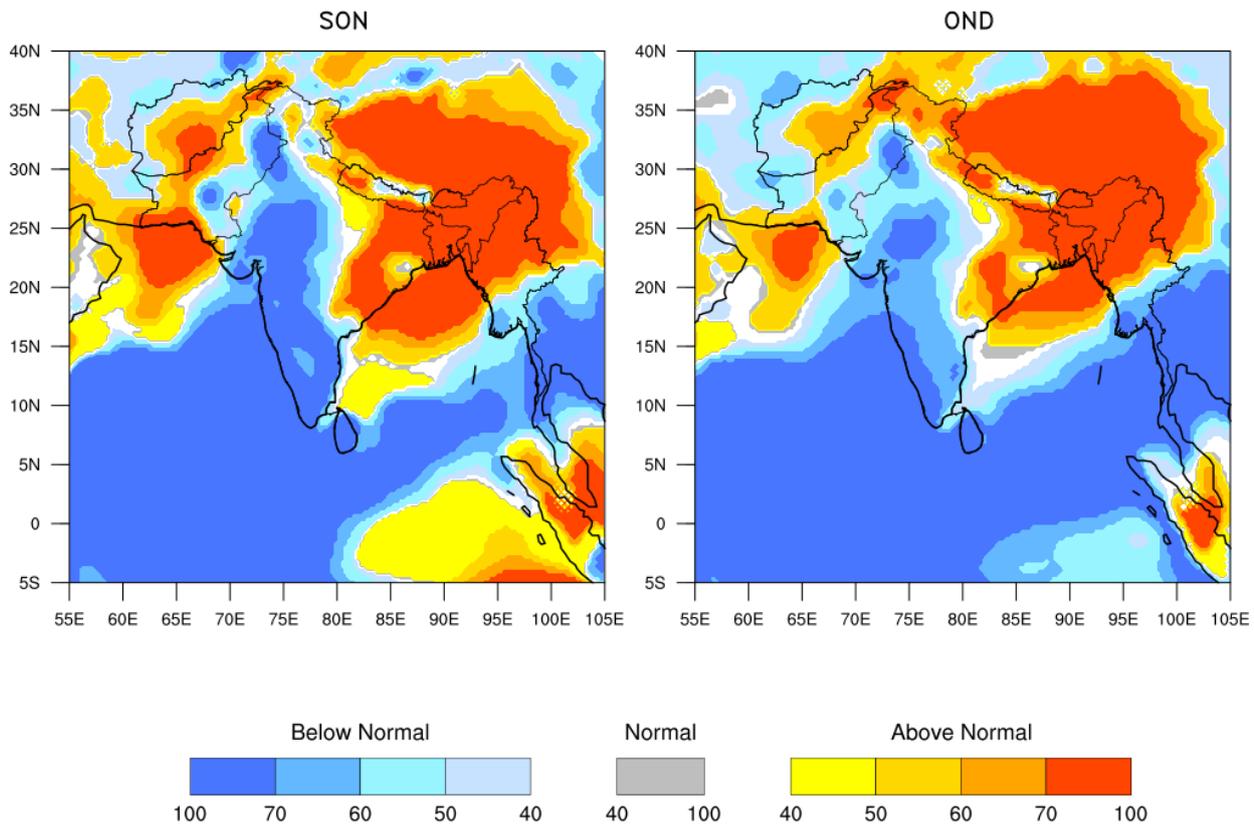### 2.1.   *Precipitation Probability Forecast:*

The probability forecasts for precipitation for the seasons September to November 2022 (SON) and October to December 2022 (OND) are given in the Figures 7a and 7b respectively. The forecast is prepared based on the August initial conditions. The probability forecast for precipitation for SON (Fig.7a) and OND (Fig 7b) indicates that enhanced probability for above normal precipitation is likely over most parts of the South Asia except over extreme northwest, extreme north and few parts of extreme east of South Asia where enhanced probability of below normal precipitation is likely (white colour indicates climatological probability).
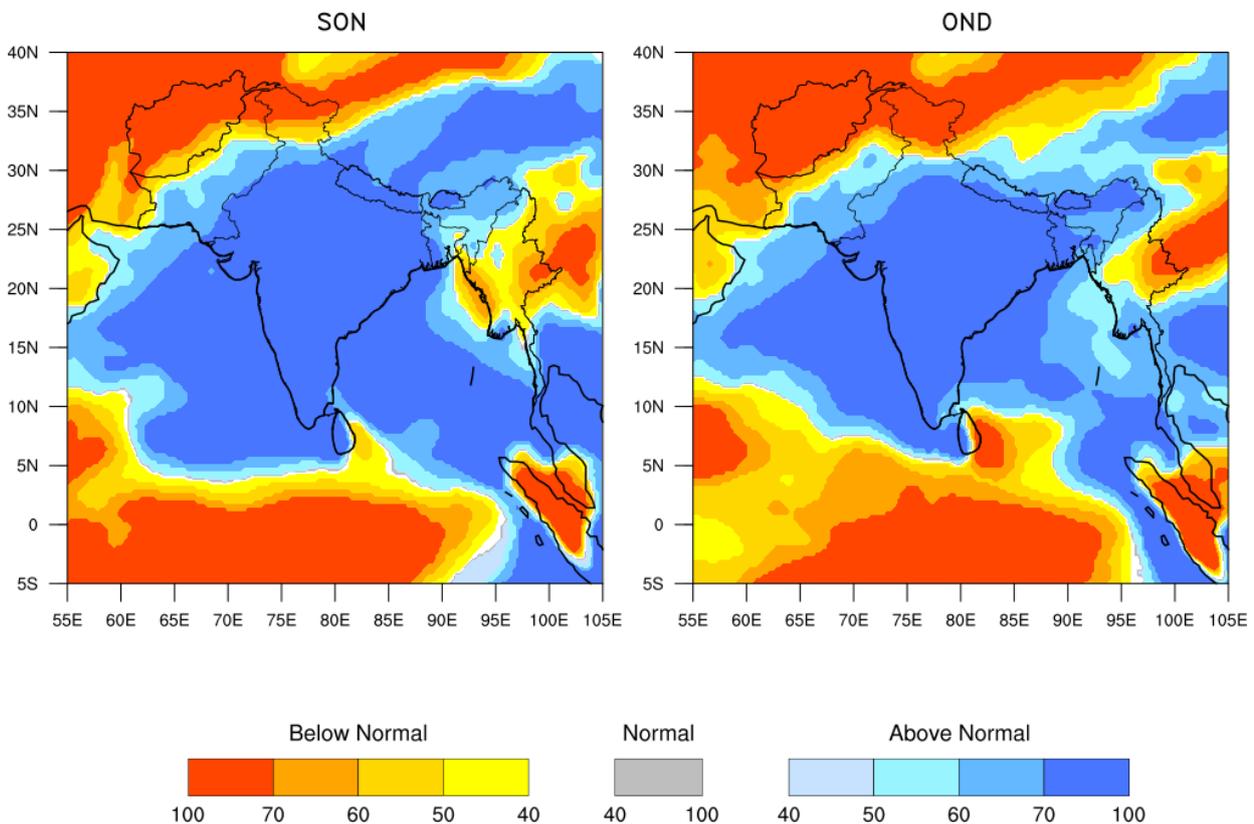
Fig.7: Seasonal probability (%) forecasts of precipitation for (a) SON 2022 (left) and (b) OND 2022 (right) based on initial conditions of August 2022.

2.2.   **Temperature Probability Forecast*:***

The probability forecasts for temperature for the season September to November 2022 (SON) and October to December 2022 (OND) are given in the Figures 8a and 8b respectively. The forecast is prepared based on the August initial conditions. Temperature probability forecast for SON and OND seasons indicate that enhanced probability for below normal temperatures are likely over some parts of northwest and southeast, most parts of central, west and south of South Asia whereas enhanced probability of above normal temperatures is likely over most parts of east north along the foothills of Himalayas and northeast of South Asia (white colour indicates climatological probability).

Fig. 8: Probability (%) forecast for the seasonal mean temperature for (a) SON 2022 (left) and (b) OND 2022 (right) based on initial conditions of August 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 September to December 2022) 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 September, the country averaged monthly precipitation is likely to be normal to above normal for all south Asian countries (Fig.9). In October the country averaged monthly precipitation is likely to be normal to above normal for all the countries except Afghanistan where it is likely to experience below normal precipitation. In November, the country averaged monthly precipitation is likely to be normal to above normal for Bangladesh, India, Nepal and Sri Lanka and below normal for Afghanistan, Bhutan, Maldives, Myanmar and Pakistan. In December, the country averaged monthly precipitation is likely to be normal to above normal for Bangladesh and Bhutan 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. September to December 2022 for Bangladesh. Bhutan is likely to experience normal to above normal for all the months except November where it is likely to experience below normal. India, Nepal and Sri Lanka are likely to experience normal to above normal for all the months except December where it is likely to experience below normal rainfall. Myanmar, Pakistan and Maldives are likely to have normal to above normal precipitation in September and October and below normal in November and December. Bangladesh is likely to experience below normal to normal precipitation in all the months under study.

During September, the country averaged monthly temperatures are normal to above normal for all the countries except India, Maldives and Sri Lanka where it is likely to be below normal. During October and December, it is likely to be normal to above normal for all the countries except Maldives and Sri Lanka where it is likely to be below normal. In November, it is likely to be normal to above normal all the countries except Afghanistan, Maldives and Pakistan.

In general, the country averaged monthly temperatures during September to December are likely to be normal to above normal for Bangladesh, Bhutan, Myanmar and Nepal. Pakistan and Sri Lanka are likely to experience below normal to normal for all the months. Afghanistan and Pakistan are likely to experience normal to above normal in September, October and December months and below normal temperatures in November. India is likely to experience below normal temperatures in September and normal to above normal in rest of the months.
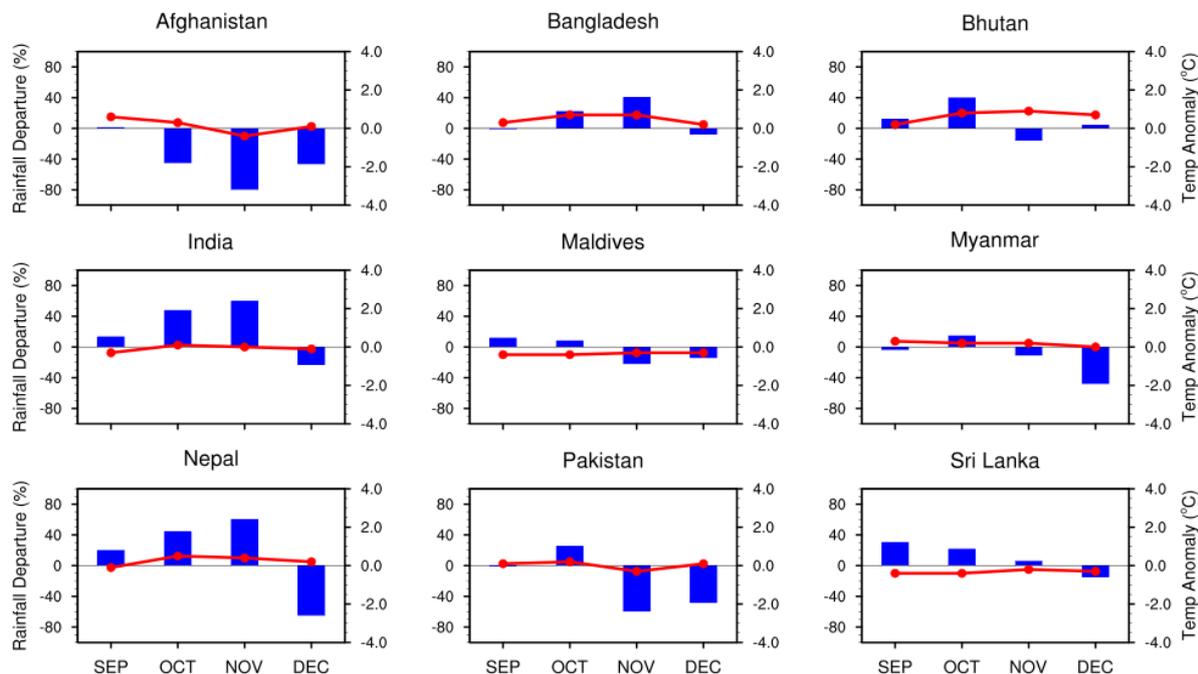
Fig. 9: Monthly country averaged rainfall forecast expressed as percentage departures (%) and Monthly country averaged temperature anomaly (°C) forecast during September to December 2022. Here, the normal range for country averaged monthly precipitation is taken as -10% to +10% (Left Vertical Axis Scale 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).