



**Earth System Science Organization (ESSO)
Ministry of Earth Sciences (MoES)
India Meteorological Department (IMD)**

**El Niño Southern Oscillation (ENSO) and
Indian Ocean Dipole (IOD) Bulletin**

December 2022

Highlights

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 during December – February season (DJF 2022/23) and weaken thereafter.

The neutral IOD conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming season.

1. Current Sea Surface Temperature (SST) Conditions over Pacific and Indian Oceans

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.

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).

1.1. El Niño Southern Oscillation (ENSO) conditions over the Pacific Ocean

The monthly time series of Niño3.4 SST anomalies for the last 12 months from December 2021 to November 2022 is shown in Fig.2a. The La Niña conditions were prevailing from December 2021 to May 2022. The strength of La Niña conditions was decreased during June and July 2022 and then strengthened during August and subsequent month of September 2022. However, the strength of La Niña conditions was slightly weakened during October and November 2022. Currently, La Niña conditions are prevailing over the Pacific. In the month of November 2022, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20° isotherm and thermocline depth) which were

extending up to 170°W (Fig.2b). However, the subsurface temperature anomalies were negative in the subsurface regions of central and eastern Pacific Ocean.

1.2. Indian Ocean Dipole (IOD) conditions over the Indian Ocean

The monthly time series of Dipole Mode Index (DMI) for the last 12 months from December 2021 to November 2022 is shown in Fig.2c. During December 2021 to April 2022, neutral IOD conditions were observed over the Indian Ocean and the DMI was negative side of its normal. The negative DMI value strengthened from May to July 2022 and weakened from August 2022 to October 2022. At present neutral IOD conditions are present over the Indian Ocean. In the month of November 2022, positive subsurface temperature anomalies (Fig. 2d) were seen over the west around 55°E and over the east along 95°-105°E between 20°C isotherm and thermocline depth. A weak negative subsurface temperature anomaly was observed over central equatorial Indian Ocean.

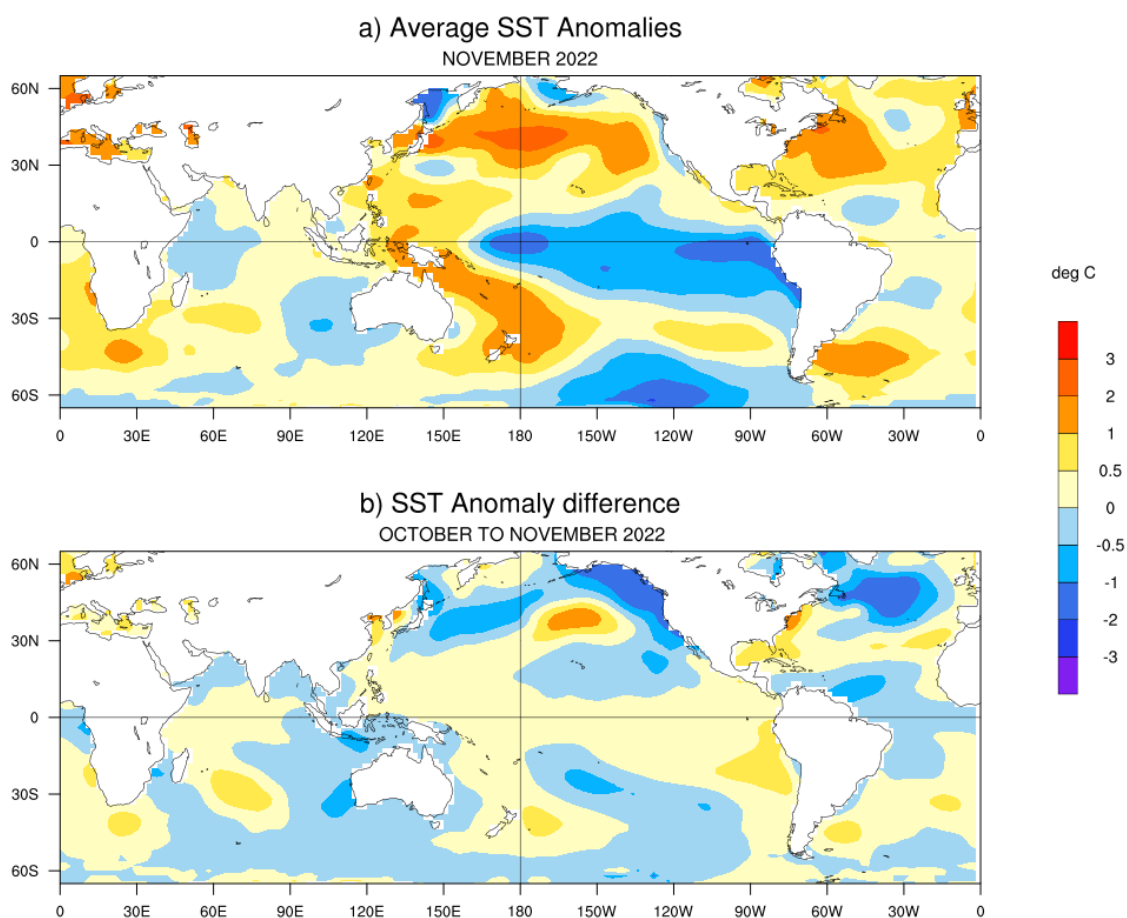


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during November 2022 and **(b)** changes in the SST anomalies (°C) from October 2022 to November 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

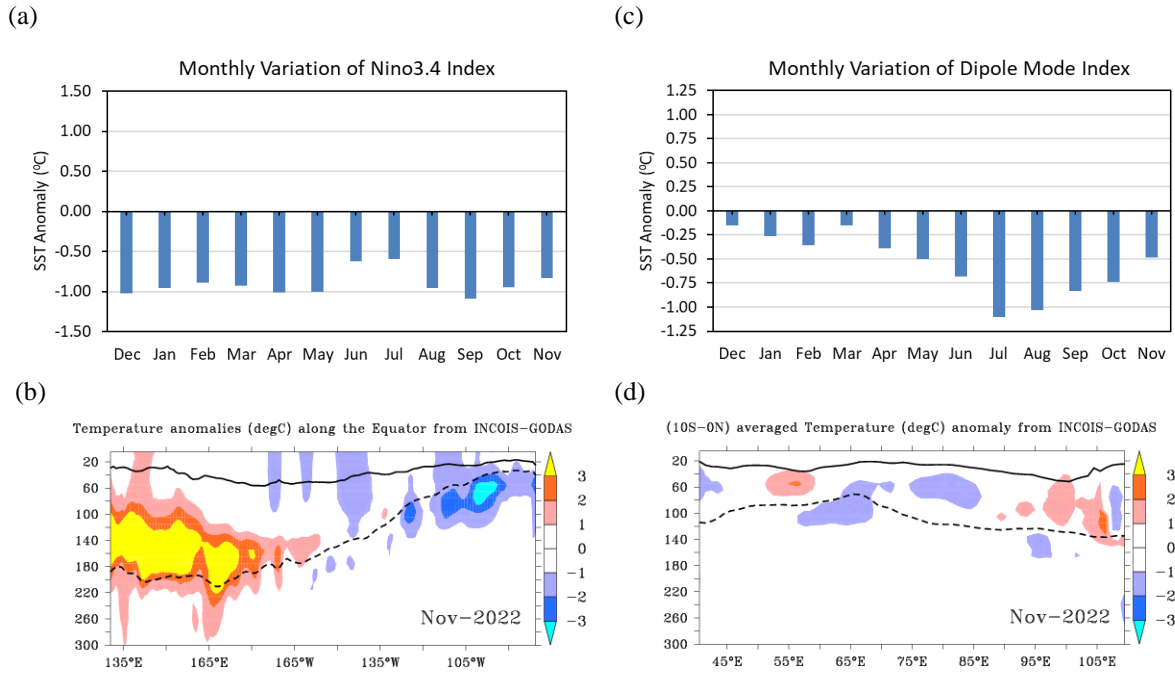


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (b) Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of November, 2022. (c) Same as (a) but for Dipole Mode Index (DMI). (d) Same as (b) but for the tropical Indian Ocean (10°S-Eq). The anomalies in (a) and (b) were computed using the base period of 1981-2010 (Data Source: ERSSTv5, NOAA). The solid dark line in (b) and (d) is the 20°C isotherm and the dashed line is thermocline depth (Data Source: INCOIS-GODAS).

2. ENSO & IOD Forecast

The SST forecast was prepared using the high-resolution Monsoon Mission Coupled Forecast System (MMCFS) (AGCM T382L64; ~38 km and OGCM 25 km in tropics) based on the 2022 November initial conditions. The initial conditions for the model runs were obtained from ESSO-INCOIS and ESSO-NCMRWF analysis. Probability density function (PDF) bias correction was applied on the forecasts of Niño3.4 index (Fig.4a) and DMI (Fig.4b) based on hindcasts for the period 1999-2008 and anomalies were calculated based on 1982-2008 climatology.

The 3-month season averaged SST anomaly forecast (Fig.3) indicates that negative SST anomalies are likely over most parts of the central and eastern equatorial Pacific Ocean until the December – February (DJF) 2022/23 season and likely to weaken thereafter. Currently, the La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that La Niña conditions are likely to continue until the first quarter of next year and turn to neutral ENSO conditions thereafter (Fig.4a). The probability forecast for ENSO (Fig.5a) indicates that La Niña conditions to continue during DJF 2022/23 season. IMD is closely monitoring ENSO conditions and monthly updates are provided as per observed changes in the Pacific Ocean SSTs.

At present the neutral IOD conditions are prevailing over the Indian Ocean and the latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming season (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates the neutral IOD conditions during the coming season.

MMCFS SST Anomaly Forecast : Nov 2022 IC

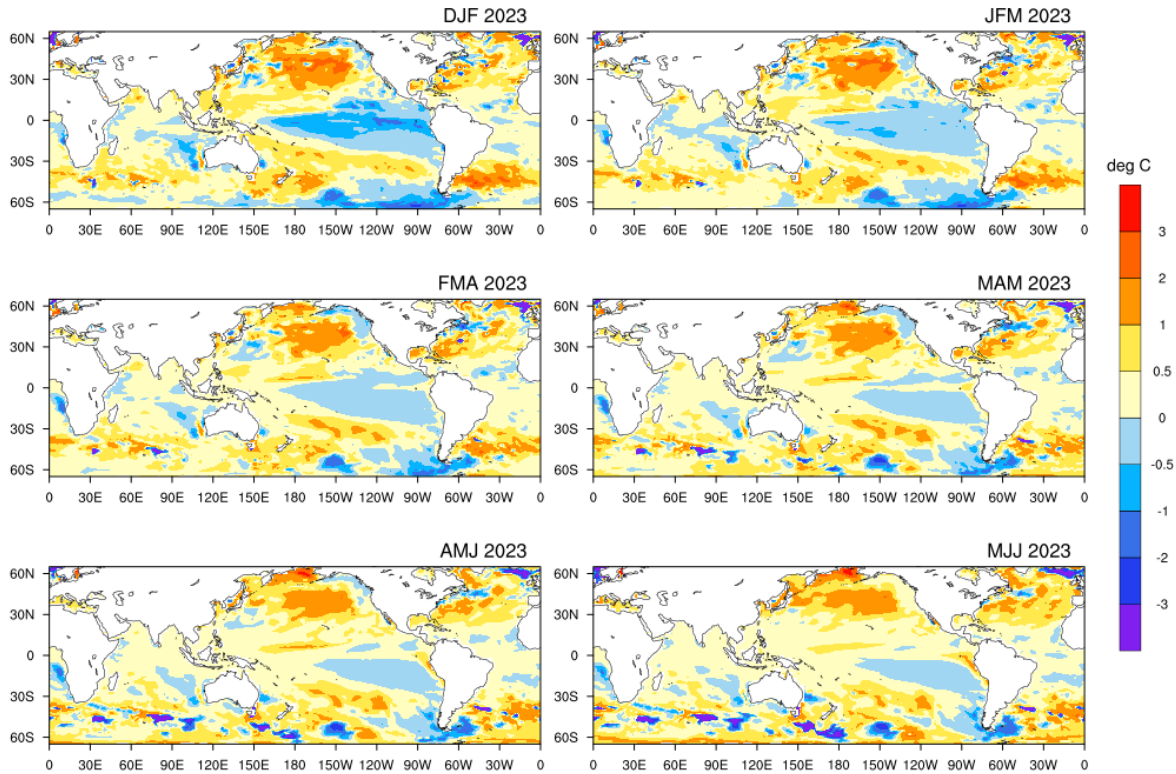


Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) December to February (DJF 2023), (b) January to March (JFM 2023), (c) February to April (FMA 2023), (d) March to May (MAM 2023), (e) April to June (AMJ 2023) and (f) May to July (MJJ 2023). (Model bias correction base period: 1999-2008; Climatology base period:1982-2008).

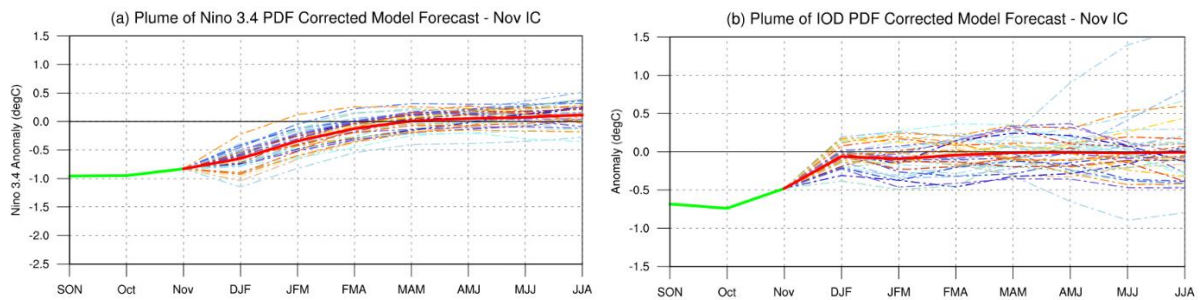


Fig.4: Plume of (a) Niño 3.4 SST index, (b) Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 38 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

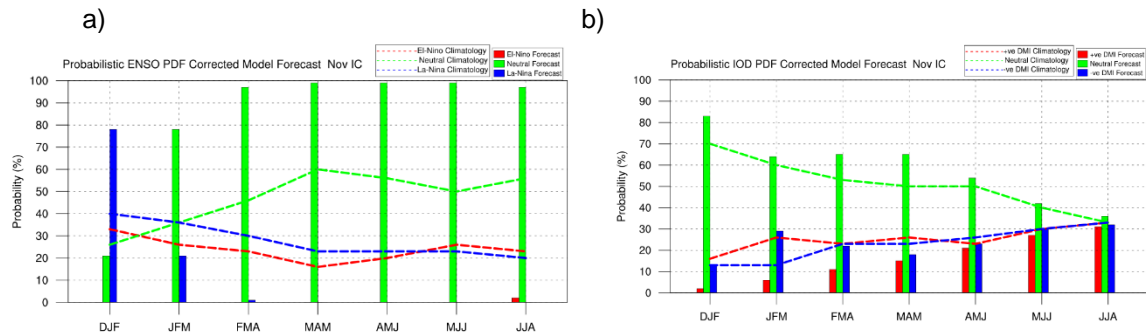


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5 , Neutral <0.5 to >-0.5 , El Niño ≥ 0.5 . Criteria used for Probabilistic DMI Forecast: negative DMI ≤ -0.2 , Neutral <0.2 to >-0.2 , positive DMI ≥ 0.2 .