



**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**

January 2023

Highlights

The La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that the current La Niña conditions are likely to weaken during January-March season and to reach cold ENSO neutral conditions 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 seasons.

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

During December 2022 cooler than normal SSTs were observed across the central and eastern tropical Pacific Ocean, and warmer than normal SSTs were observed in the far western 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, warming of SST anomalies were observed over some parts of equatorial and north Pacific Ocean as well on south Pacific Ocean ((Fig.1b). Cooling of SST anomalies are observed over some parts of north and west Pacific Ocean.

Normal to warmer than normal SSTs were observed over most parts of Arabian Sea and Bay of Bengal (Fig.1a). Normal to cooler than normal SSTs were observed over the south of central and equatorial Indian Ocean. As compared to the last month, warming of SST anomalies were observed over north Indian Ocean especially over the north Arabian Sea and Bay of Bengal whereas cooling of SST anomalies was observed over the eastern 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 January 2022 to December 2022 is shown in Fig.2a. The La Niña conditions were prevailing from January 2022 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 to December 2022. Currently, La Niña conditions are prevailing over the Pacific. In the month of December 2022, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20° C 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 January 2022 to December 2022 is shown in Fig.2c. During January 2022 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 November 2022. The DMI has remained within the average and neutral IOD conditions were observed in the month of December 2022. At present neutral IOD conditions are present over the Indian Ocean. In the month of December 2022, negative subsurface temperature anomalies (Fig. 2d) were seen over the western Indian Ocean along 45° E - 70° E and positive over the eastern Indian Ocean along 85° E - 110° E between 20° C isotherm and thermocline depth. A weak negative subsurface temperature anomaly was observed over central equatorial Indian Ocean.

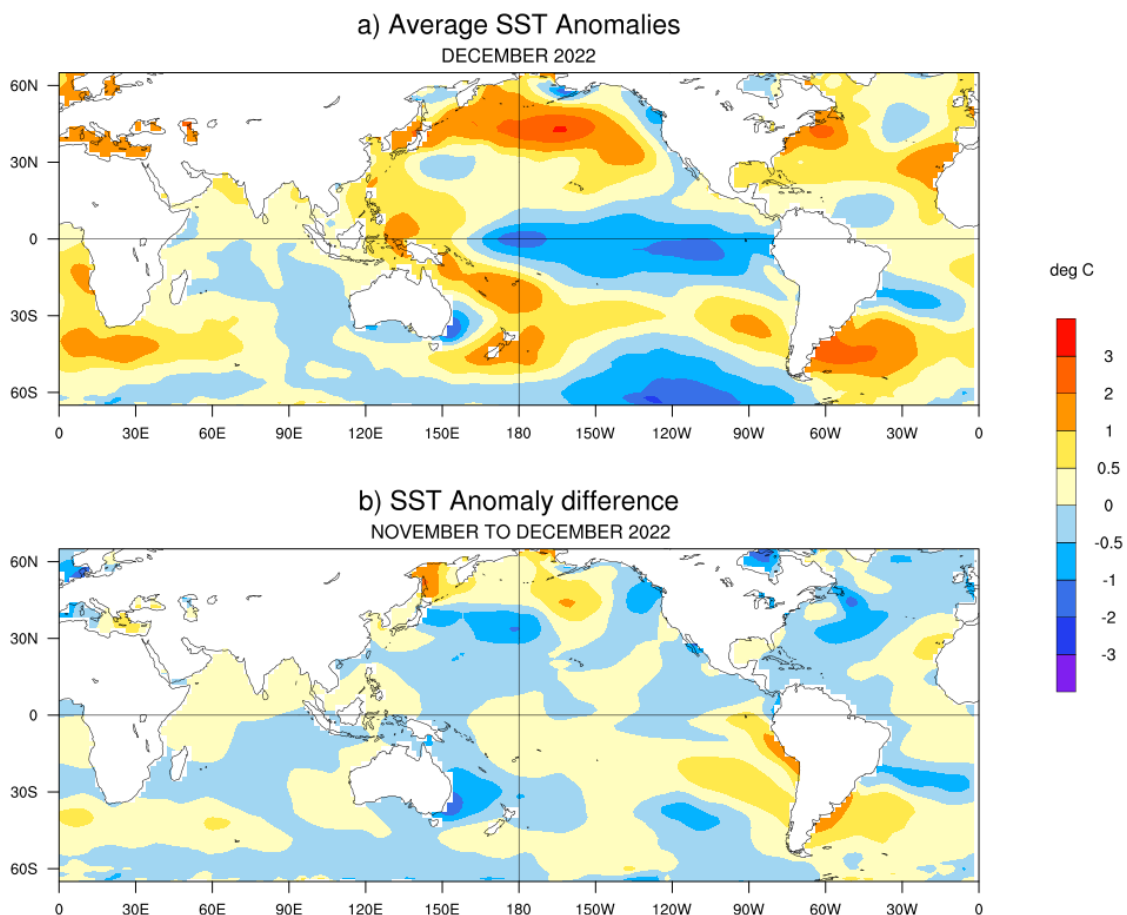


Fig.1: (a) Sea surface temperature (SST) anomalies ($^{\circ}$ C) during December 2022 and **(b)** changes in the SST anomalies ($^{\circ}$ C) from November 2022 to December 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

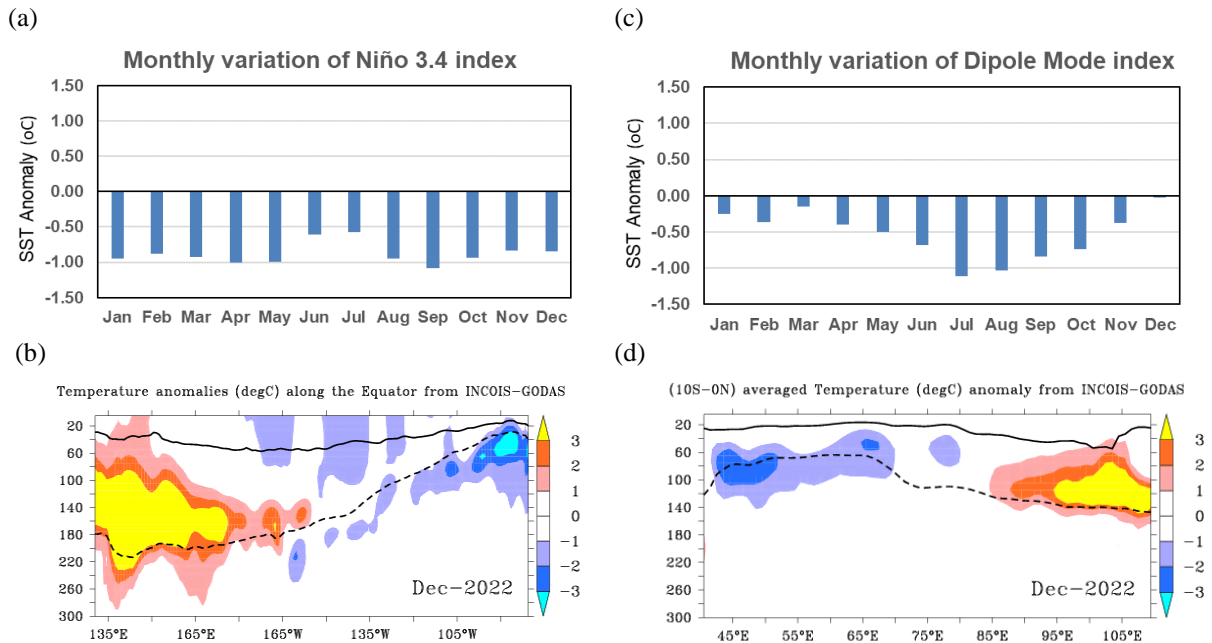


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (b) Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of December, 2022. (c) Same as (a) but for Dipole Mode Index (DMI). (d) Same as (b) but for the tropical 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 2023 December 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 to weaken over most parts of the central and eastern equatorial Pacific Ocean from January-March (JFM) to the end of forecast period. Currently, the La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that the current La Niña conditions are likely to weaken during January-March season (Fig. 4a). The probability forecast for ENSO (Fig.5a) indicates that La Niña conditions are likely to weaken during January - March season (JFM 2023) and become cool ENSO neutral conditions for the next couple of seasons. 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 (Fig. 3) and the latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue during the upcoming seasons (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates enhanced probability for neutral IOD conditions during most of the forecast period.

MMCFS SST Anomaly Forecast : Dec 2022 IC

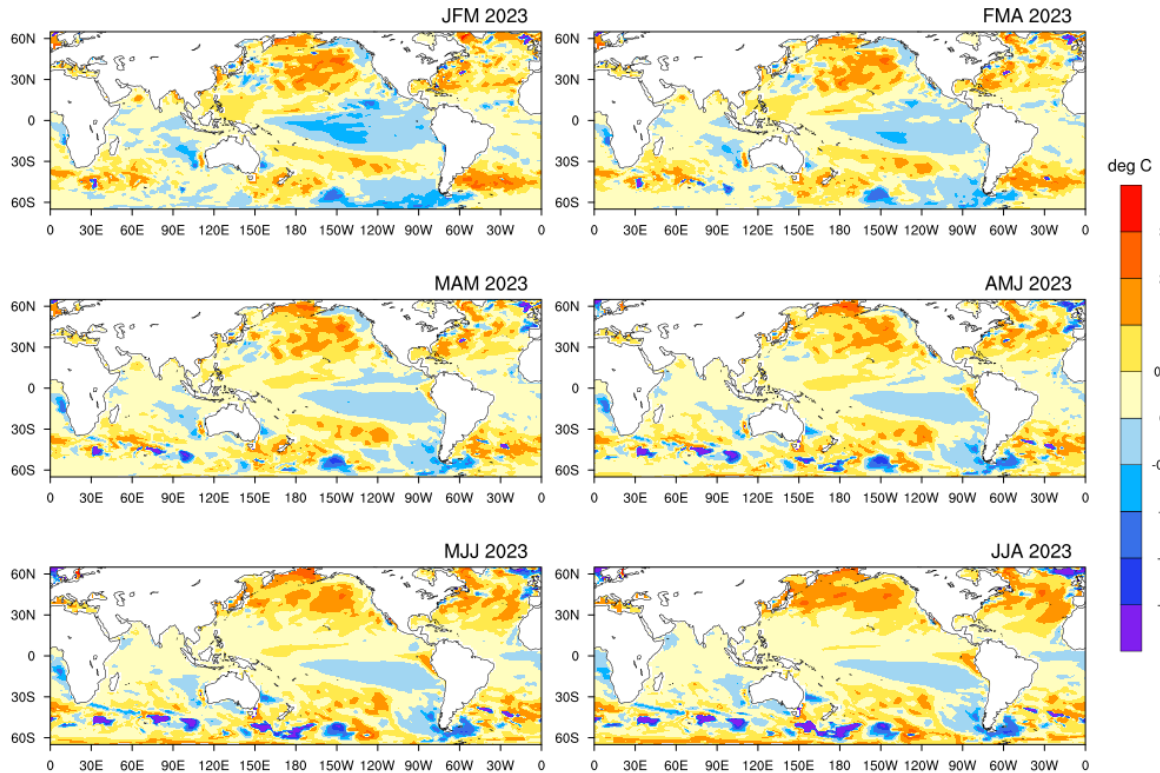


Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) January to March (JFM 2023), (b) February to April (FMA 2023), (c) March to May (MAM 2023), (d) April to June (AMJ 2023), (e) May to July (MJJ 2023) and (f) June to August (JJA 2023). (Model bias correction base period: 1999-2008;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

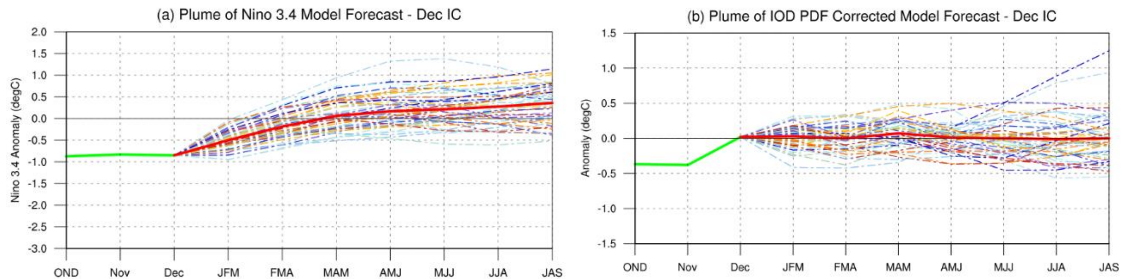


Fig.4: Plume of (a) Niño 3.4 SST index, (b) Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 48 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

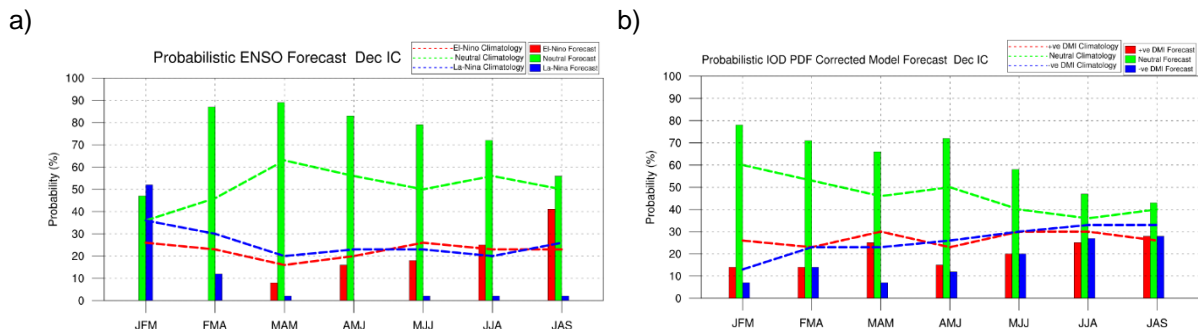


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5 , Neutral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