



**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**

March 2023

Highlights

The La Niña conditions are prevailing over the equatorial Pacific region, but the strength of the La Niña is continuing to weaken for the past few months. The latest MMCFS forecast indicates that the ENSO-neutral conditions are expected to start from the next season and the El Niño is likely to develop during the second half of the southwest monsoon season.

The neutral Indian Ocean Dipole (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, but a positive IOD is likely to develop towards the end of the southwest monsoon season.

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

During February 2023 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 western Pacific Ocean. As compared to the last month, warming of SST anomalies were observed over some parts of central and eastern Pacific Ocean (Fig.1b). Cooling of SST anomalies were observed over many parts of the north Pacific Ocean.

Warm SST anomalies were observed over the north Arabian Sea and north Bay of Bengal (Fig.1a). However, cold SST anomalies were also observed over the equatorial Indian Ocean. As compared to the last month, close to normal with cool SST anomalies were observed over most parts of northern Indian Ocean whereas warm SST anomalies were observed over most parts of southern 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 March 2022 to February 2023 is shown in Fig.2a. The La Niña conditions were prevailing throughout this period. The strength of La Niña conditions was decreased from Mar-May 2022 to June-July 2022 and then strengthened during August and subsequent month of September 2022. However, the strength of La Niña conditions was weakened from October 2022 to February 2023. Currently, weak La Niña conditions are prevailing over the Pacific. In the month of February 2023, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20 0C isotherm and thermocline depth) which were extending up to

160 °W (Fig.2b). However, the subsurface temperature anomalies were negative in the subsurface regions (below thermocline depth) 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 March 2022 to February 2023 is shown in Fig.2c. From March 2022 to May 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 December 2022. The DMI has remained within the average and neutral IOD conditions were observed during January and February 2023. At present neutral IOD conditions are present over the Indian Ocean. In the month of February 2023, negative subsurface temperature anomalies (Fig. 2d) were seen over the west along 50° E - 70° E and positive subsurface temperature anomalies (between 20° C isotherm and thermocline depth) were seen over the east along 95° E-110° E.

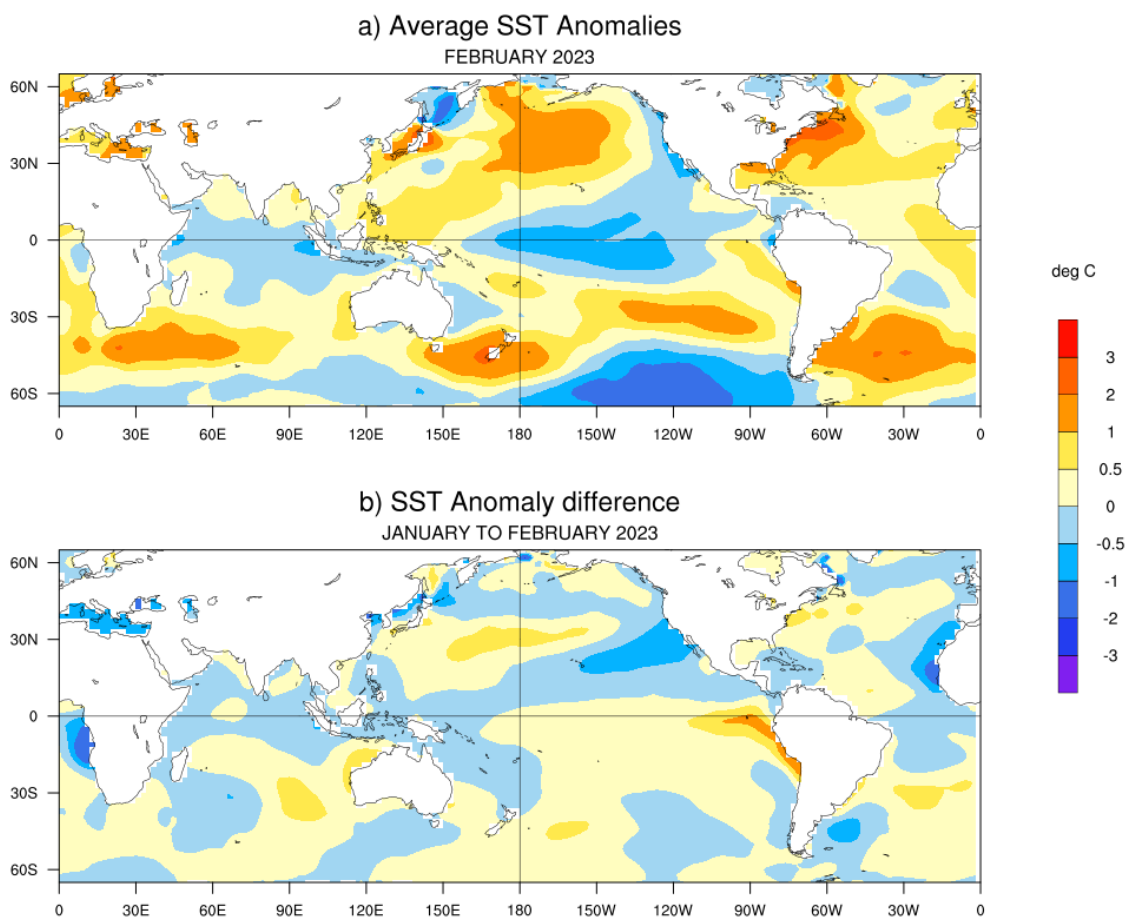


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during February 2023 and **(b)** changes in the SST anomalies (°C) from January 2022 to February 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

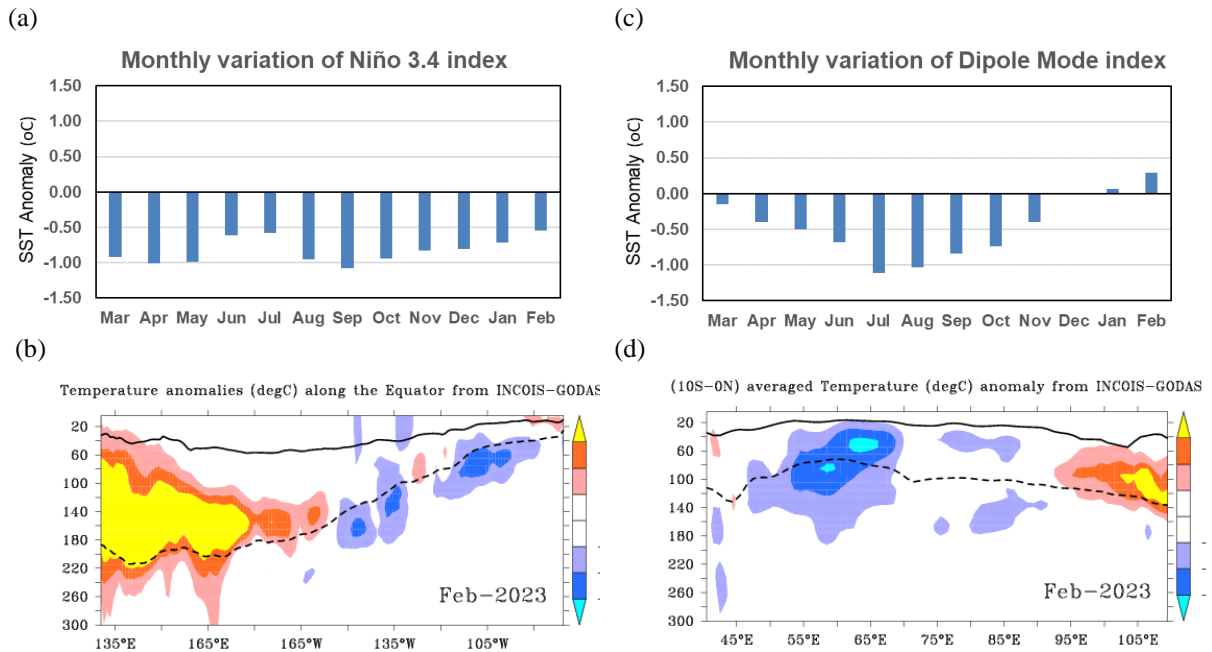


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (b) Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of February, 2023. (c) Same as (a) but for Dipole Mode Index (DMI). (d) Same as (b) but for the tropical Indian Ocean (10°S-Eq). The anomalies in (a) and (c) 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 February 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 for the entire forecast period. Currently, the weak La Niña conditions are prevailing over the equatorial Pacific region. However, the strength of the La Niña has weakened since October 2022. The latest MMCFS Plume forecast (Fig.4a) indicate that the La Niña to turn ENSO-neutral conditions during the upcoming season. The probability forecast for ENSO (Fig.5a) indicate that the ENSO-neutral conditions are expected to start from the next season and the El Niño is likely to develop during the second half of the southwest monsoon season. IMD is closely monitoring the ENSO conditions and monthly updates are provided as per observed changes in the Pacific Ocean.

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 seasons (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates about 45% probability for neutral IOD conditions and 28 % (higher than the climatological probability) of development of a positive IOD towards the end of the southwest monsoon season.

MMCFS SST Anomaly Forecast : Feb 2023 IC

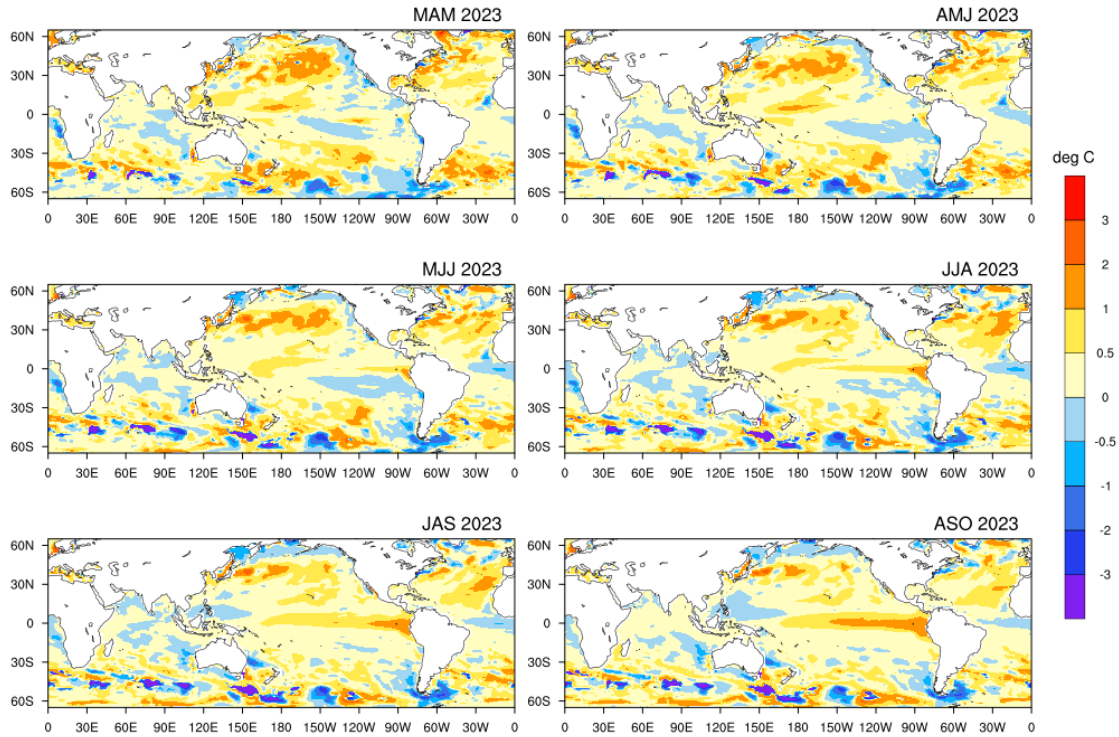


Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) March to May (MAM 2023), (b) April to June (AMJ 2023), (c) May to July (MJJ 2023), (d) June to August (JJA 2023) (e) July to September (JAS 2023), and (f) August to October (ASO 2023). (Model bias correction base period: 1999-2008;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

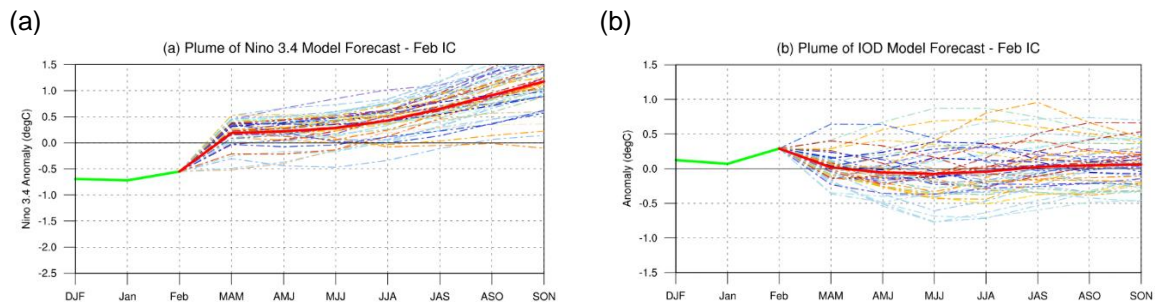


Fig.4: Plume of (a) Niño 3.4 SST index, (b) Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 53 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

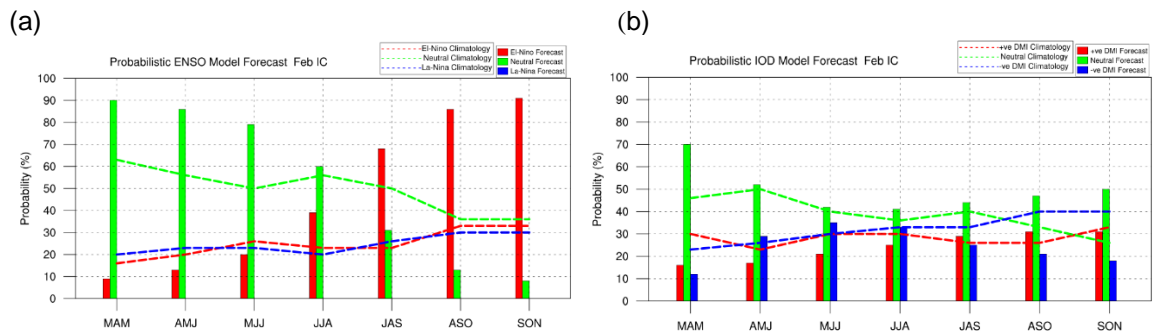


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5 , Neutral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