



**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**

April 2023

Highlights

Currently ENSO neutral conditions are being observed over the Pacific Ocean. The latest MMCFS forecast indicates that the ENSO-neutral conditions are expected to prevail over the Pacific Ocean in the upcoming season and an El Niño is likely to develop during 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.

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

During March 2023, Equatorial sea surface temperatures (SSTs) are near average across most of the Pacific Ocean (Fig.1a). Equatorial SSTs have been near normal in the central Pacific Ocean and above average in the far eastern Pacific Ocean, as well as in the central Atlantic Ocean. Warmer than normal SSTs were also observed in the western tropical Pacific Ocean and 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 central and eastern Pacific Ocean (Fig.1b). Cooling of SST anomalies were observed over many parts of the north and south Pacific Ocean.

Warmer than normal SST anomalies were observed over the north Arabian Sea (Fig.1a). However, cool SST anomalies were also observed over most parts the equatorial Indian Ocean. As compared to the last month, close to normal SSTs were observed over the equatorial Indian Ocean and close to normal with cool SST anomalies were observed over the north Bay of Bengal whereas warmer than normal SST anomalies were observed over the north Arabian Sea (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 April 2022 to March 2023 is shown in Fig.2a. The figure shows that La Niña conditions from April 2022 have continued till January 2023. During February, La Niña conditions were turned into ENSO-neutral conditions and it continued thereafter. Since April-May 2022 to June-July 2022, the strength of La Niña conditions was decreased and then strengthened during August and subsequent month of September 2022. However, the strength of La Niña conditions was weakened from October 2022 to January 2023. Currently, Equatorial sea surface temperatures are near average across most of the Pacific Ocean. ENSO neutral conditions are prevailing over the Pacific Ocean and atmospheric conditions also indicate ENSO neutral

pattern over equatorial Pacific. In the month of March 2023, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20 °C isotherm and thermocline depth) which were extending up to 155 °W (Fig.2b). Positive subsurface temperature anomalies were also observed over the far eastern Pacific Ocean near 20 °C isotherm line. However, the subsurface temperature anomalies were negative in the subsurface regions (below thermocline depth) of central-east 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 April 2022 to March 2023 is shown in Fig.2c. From April 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 June to July 2022 and weakened from August 2022 to December 2022. The DMI has remained within the average and neutral IOD conditions were observed from January to March 2023. At present neutral IOD conditions are present over the Indian Ocean. In the month of March 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.

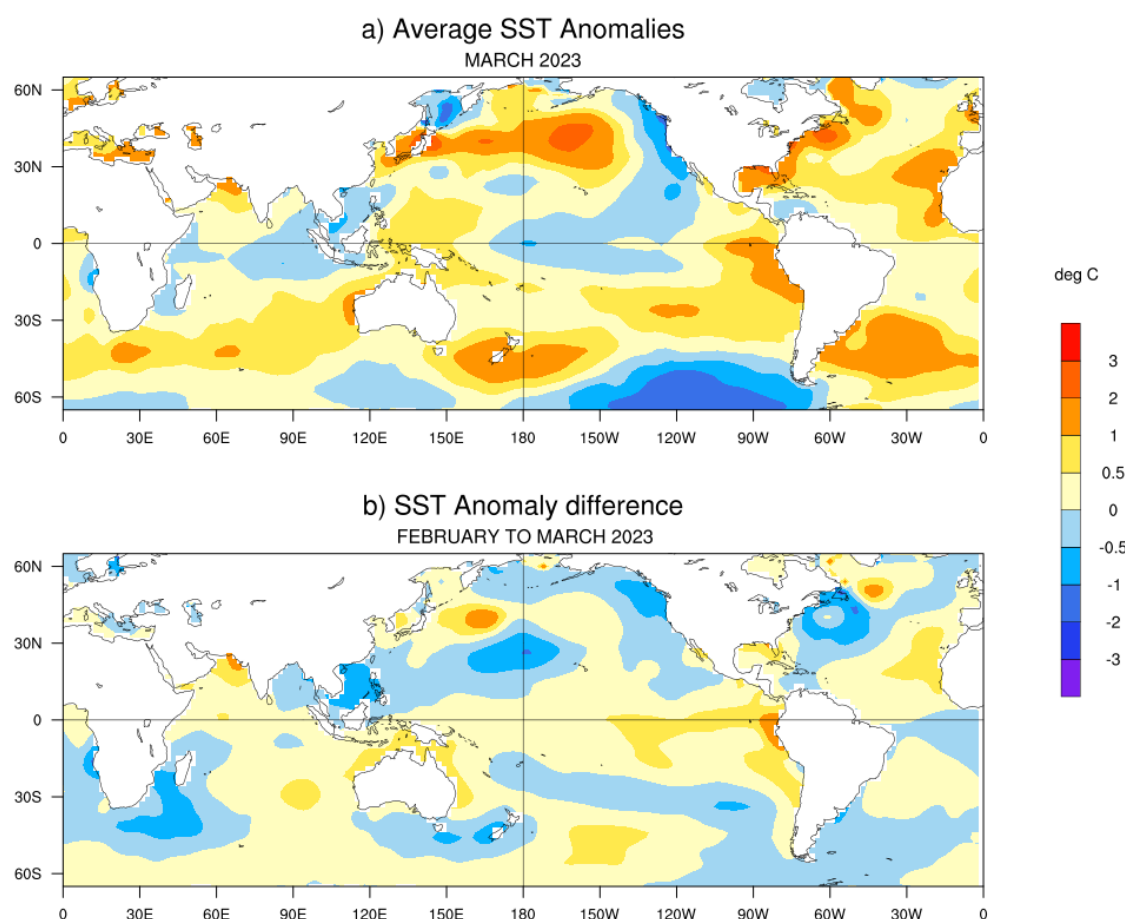


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during March 2023 and (b) changes in the SST anomalies (°C) from February 2022 to March 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

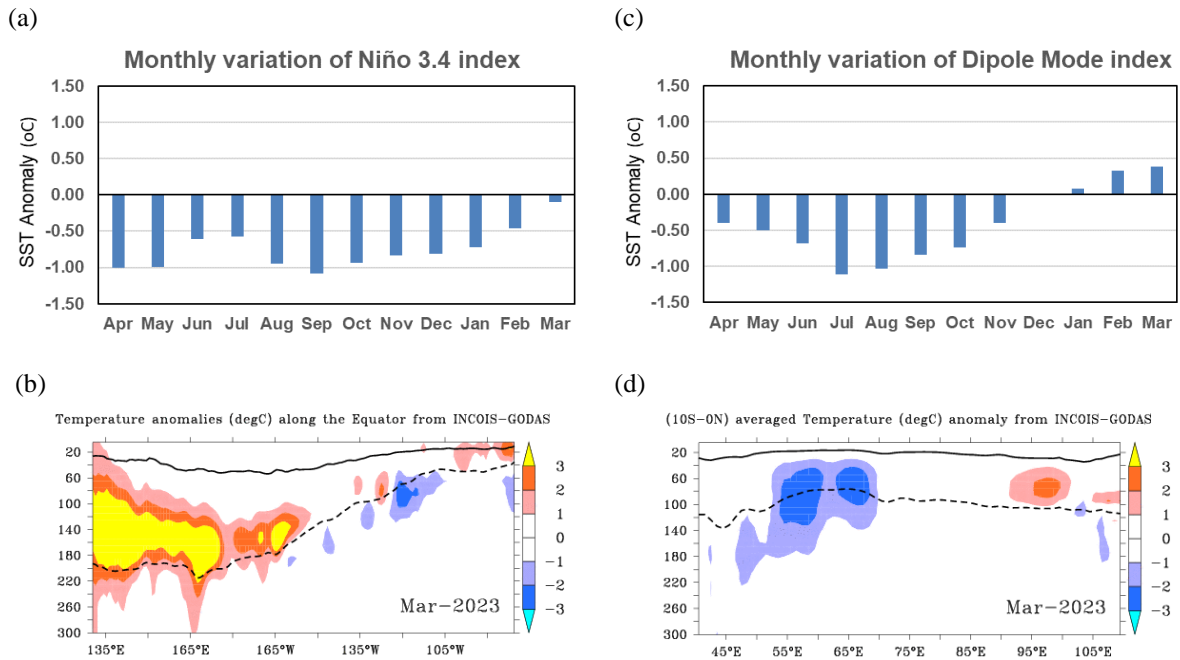


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and **(b)** Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of March, 2023. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the 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 March 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 most parts of eastern equatorial Pacific Ocean are likely to experience warmer than normal SST anomalies throughout the forecast period. From the AMJ to JJA season the central Pacific Ocean is expected to have near-normal SSTs with some warm anomalies. However, from the JAS season onwards, warm equatorial SST anomalies are likely to increase over the central Pacific region. The latest MMCFS Plume and Probability forecast (Fig.4a) & (Fig.5a) indicates that the ENSO-neutral conditions are expected to prevail over the Pacific Ocean in the upcoming season and there is possibility to develop an El Niño during the South West monsoon season.

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 indicate neutral IOD conditions during upcoming seasons. IMD is closely monitoring the ENSO conditions and monthly updates are provided as per observed changes in the Pacific Ocean.

MMCFS SST Anomaly Forecast : Mar 2023 IC

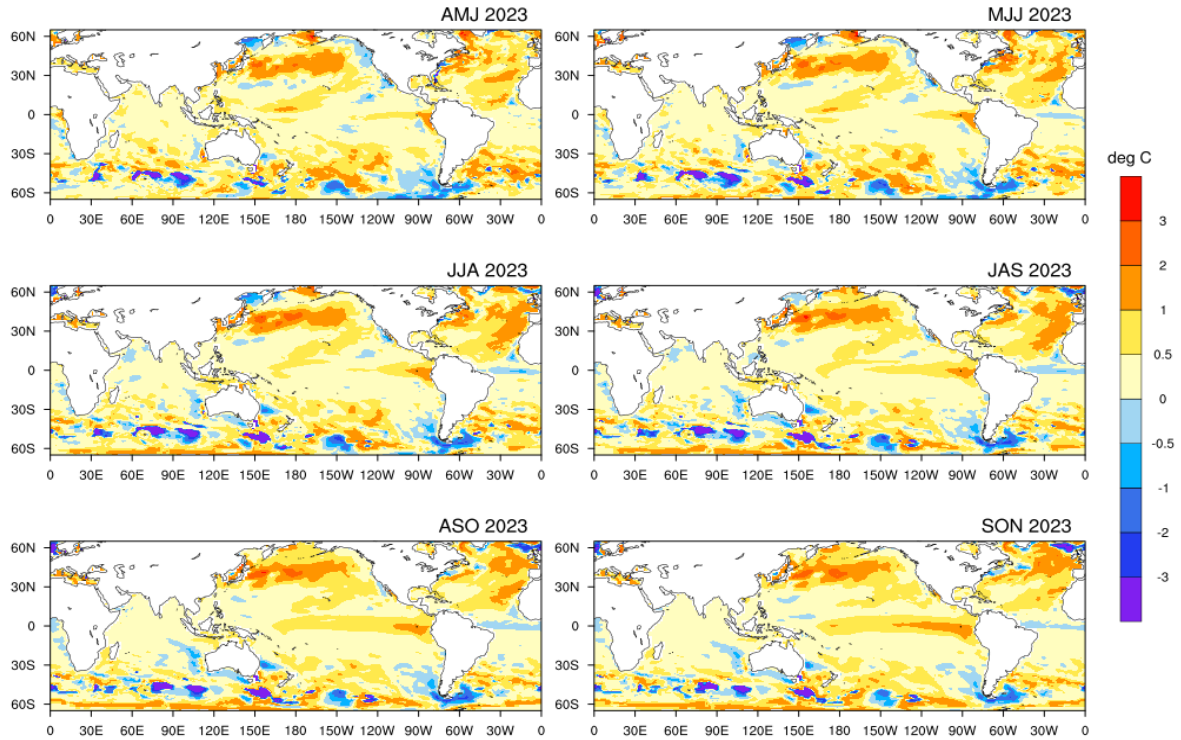


Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) April to June (AMJ 2023), (b) May to July (MJJ 2023), (c) June to August (JJA 2023) (d) July to September (JAS 2023), (e) August to October (ASO 2023) and (f) September to November (SON 2023). (Model bias correction base period: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

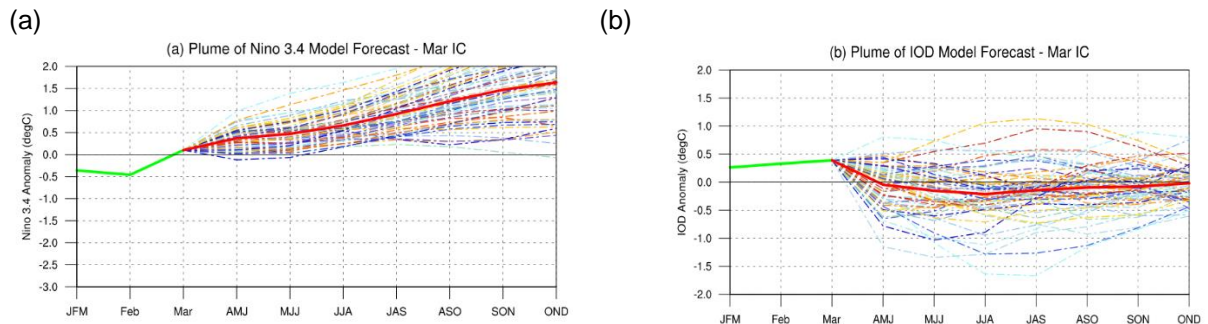


Fig.4: Plume of (a) Niño 3.4 SST index, (b) Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 61 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

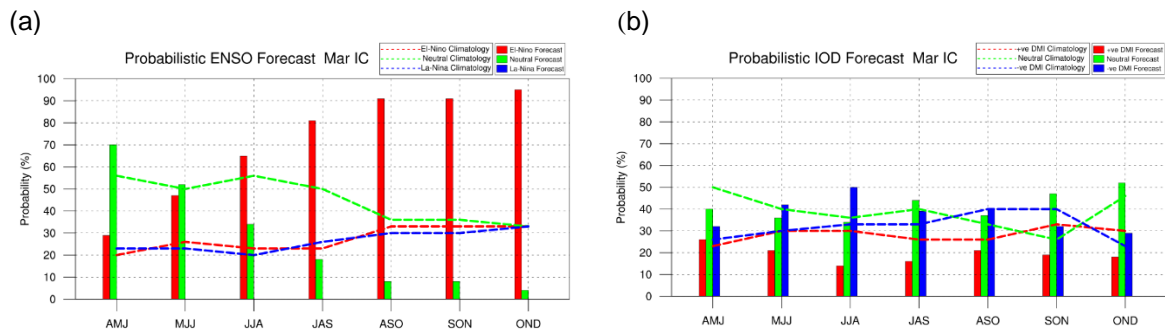


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5 , Neutral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