



**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**

**August 2023**

**Highlights**

Currently, El Niño conditions are prevailing over equatorial Pacific and the sea surface temperatures (SSTs) are above average over most of the equatorial Pacific Ocean. The latest MMCFS forecast indicates El Niño conditions are likely to continue up to the first quarter of next year.

The neutral Indian Ocean Dipole (IOD) conditions with IOD index very close to positive IOD threshold are prevailing over the Indian Ocean. The latest MMCFS forecast indicates a weak positive IOD conditions are likely to develop during the upcoming season.

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

During July 2023, warmer than normal SSTs were observed over most of the equatorial Pacific Ocean (Fig.1a). Warmer than normal SSTs were also observed over the extra-tropical regions of the north and south Pacific Ocean. As compared to the last month, increase in warming of SSTs is seen over central and eastern equatorial Pacific Ocean (Fig.1b) and also over the north Pacific Ocean.

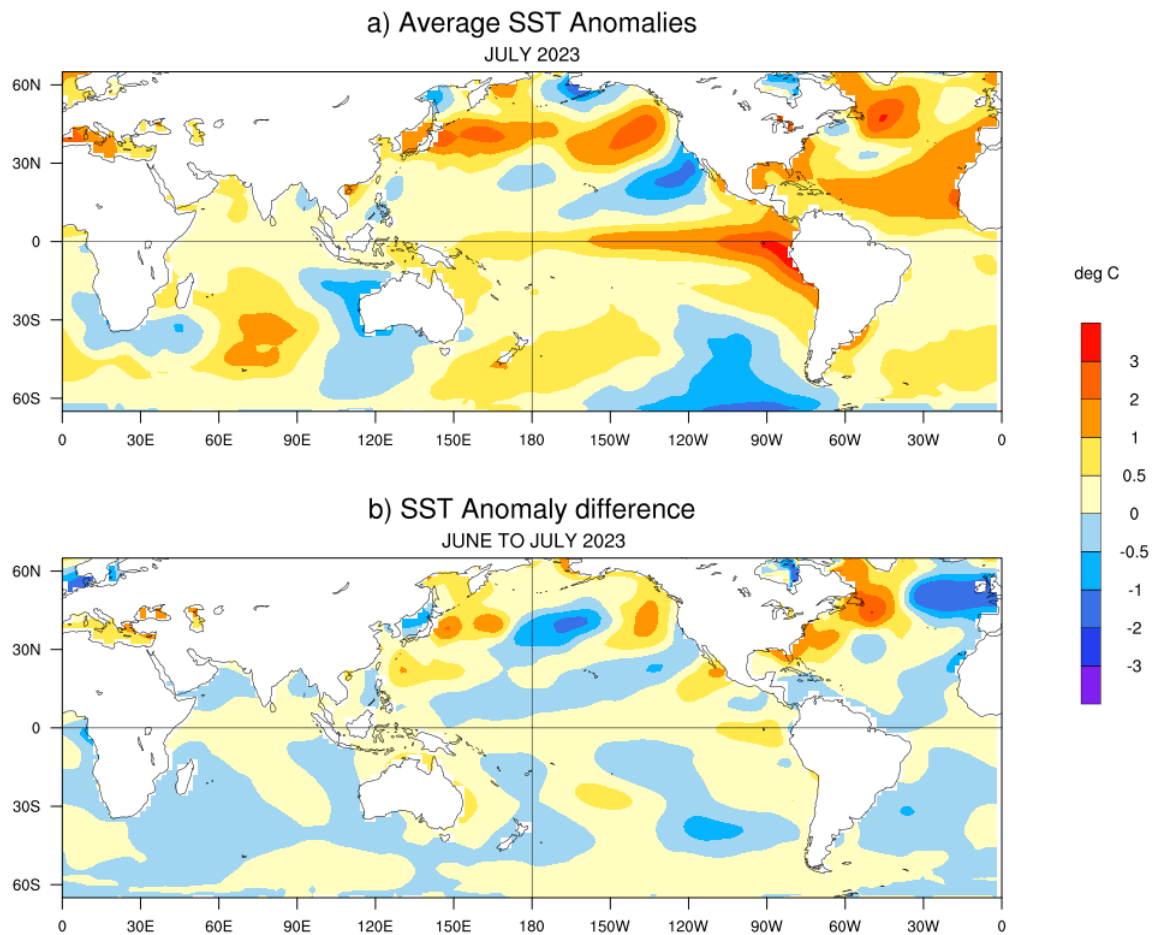
In the month of July 2023, warm SST anomalies were observed over the Indian Ocean, especially over north Arabian Sea (Fig.1a). In the south Indian Ocean, warm SST anomalies are observed over the western part whereas cold SST anomalies are observed over the eastern part. As compared to the last month, warmer SSTs are observed over most parts of the equatorial Indian Ocean and cooler SSTs are observed over north Arabian Sea and some parts of Bay of Bengal (Fig. 1b).

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

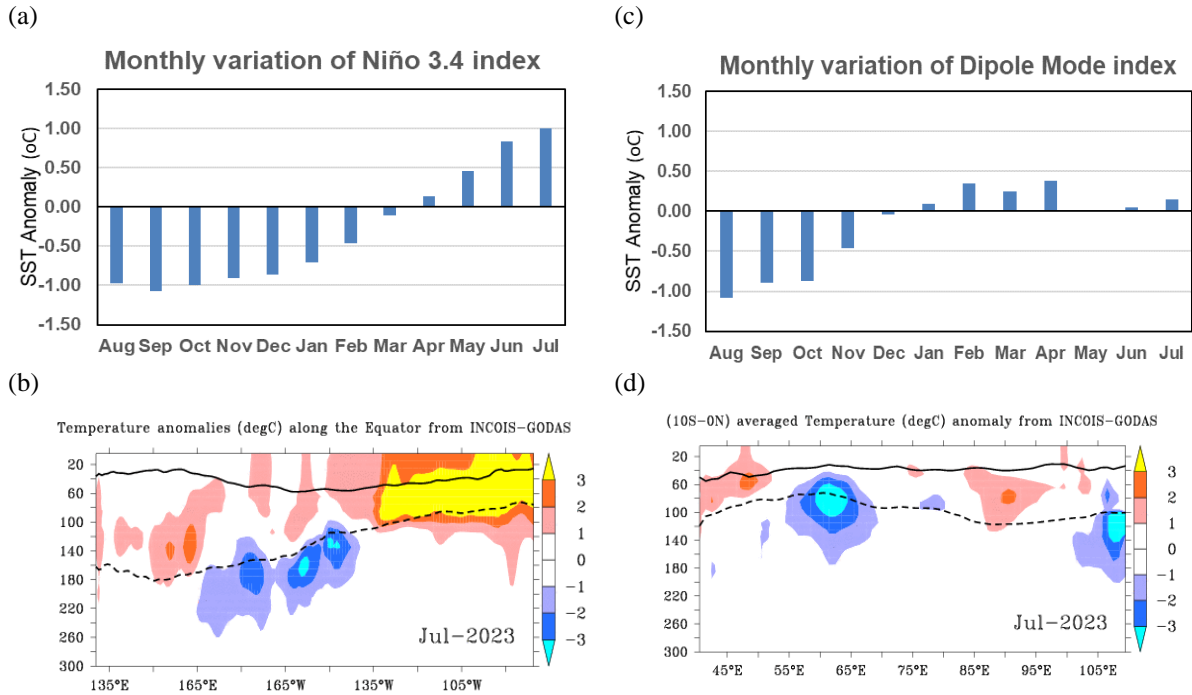
The monthly time series of Niño3.4 SST anomalies for the last 12 months from August 2022 to July 2023 is shown in Fig.2a. The La Niña conditions were prevailing till early this year with maximum strength in September 2022. Thereafter ENSO neutral conditions were observed over the Pacific Ocean from February to May 2023. However, weak El Niño conditions developed during June 2023 and continued in July 2023. The positive subsurface anomalies observed over most parts of the equatorial Pacific Ocean with maximum strength close to surface along the eastern Pacific Ocean (Fig.2 b).

## 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 August 2022 to July 2023 is shown in Fig.2c. The negative DMI value weakened from August 2022 to December 2022. The DMI has remained within the average and neutral IOD conditions were observed between January and June 2023. At present neutral IOD conditions are present over the Indian Ocean with positive subsurface temperature anomalies (Fig. 2d) were seen over the western and east-central equatorial Indian Ocean with a strong magnitude in between 20°C isotherm and thermocline depth. Some pockets of negative subsurface anomalies were seen over the west-central and eastern equatorial Indian Ocean near and below the thermocline depth.



**Fig.1: (a)** Sea surface temperature (SST) anomalies (°C) during July 2023 and **(b)** changes in the SST anomalies (°C) from June 2023 to July 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) 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 July 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 1991-2020 (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).

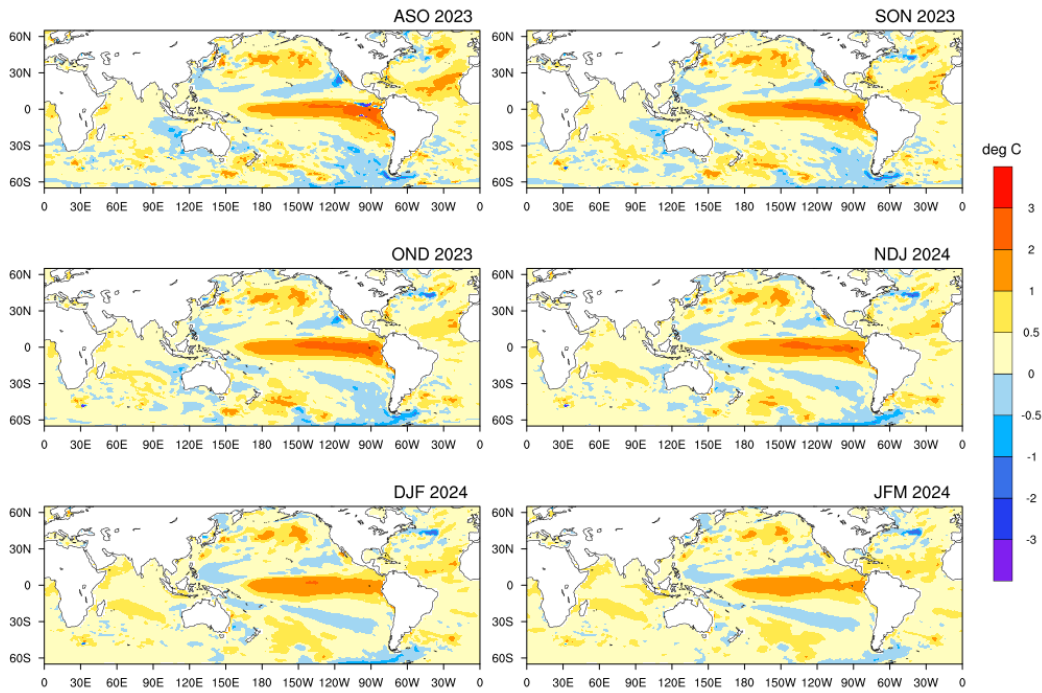
## 2. ENSO & IOD Forecast

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 June 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 1991-2020 climatology.

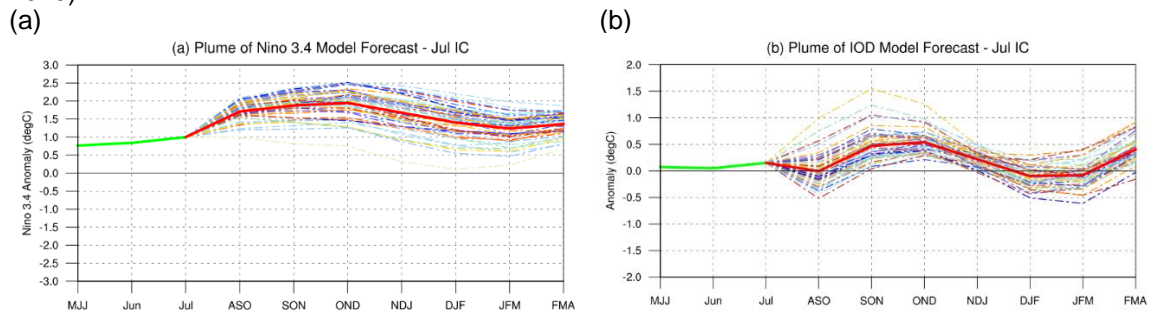
The 3-month season averaged SST anomaly forecast (Fig.3) indicates that positive SST anomalies are likely over most parts of the central and eastern equatorial Pacific Ocean for the entire forecast period. Currently, the sea surface temperatures (SSTs) are above average over most of the equatorial Pacific Ocean and El Niño conditions are prevailing. The latest MMCFS Plume forecast (Fig.4a) indicate that El Niño conditions are likely to continue until the first quarter of next year. The probability forecast for ENSO indicates the enhanced probability for El Niño conditions (Fig.5a) during all the forecasted seasons. IMD is closely monitoring the El Niño conditions and monthly updates are provided as per observed changes in the Pacific Ocean.

The neutral Indian Ocean Dipole (IOD) conditions with very close to positive IOD threshold are prevailing over the Indian Ocean. As per the latest MMCFS forecast a weak positive IOD conditions likely to develop during the upcoming season (Fig.4b). The probability forecast for IOD (Fig.5b) indicates the probability of the development of a positive IOD during September-November 2023 season.

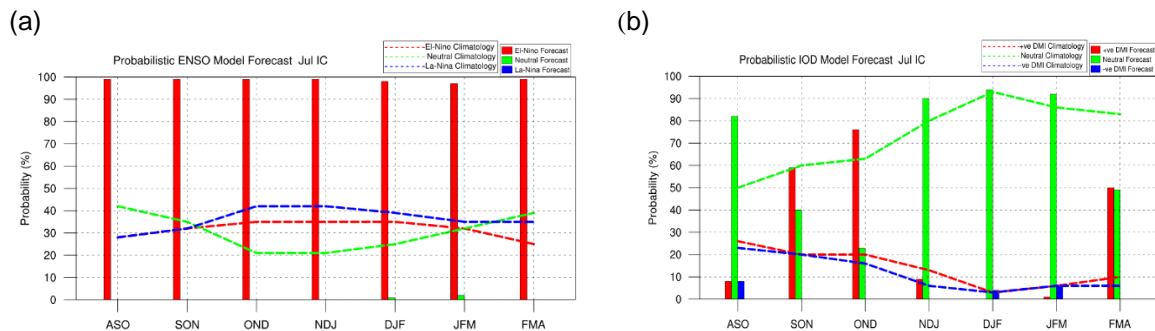
### MMCFS SST Anomaly Forecast :Jul 2023 IC



**Fig.3:** Forecasted Seasonal mean SST anomalies for three monthly (a) August to October (ASO 2023) (b) September to November (SON 2023), (c) October to December (OND 2023), (d) November 2023 to January 2024 (NDJ 2024), (e) December 2023 to February 2024 (DJF 2024) and (f) January 2024 to March 2024 (JFM 2024). (Model bias correction base period: 1999-2008; Climatology base period:1991-2020).



**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 51 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  $\leq -0.5$ , Neutral  $<0.5$  to  $>0.5$ , El Niño  $\geq 0.5$ . Criteria used for Probabilistic DMI Forecast: negative DMI  $\leq -0.4$ , Neutral  $<0.4$  to  $>0.4$ , positive DMI  $\geq 0.4$ .