



**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 2024**

**Highlights**

The sea surface temperatures are cooler than normal in the eastern equatorial Pacific Ocean. Currently, El Niño-Southern Oscillation (ENSO) neutral conditions are observed over the equatorial Pacific. The probability forecast further suggests a higher likelihood of La Niña conditions emerging around the SON 2024 season.

At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. Most global climate models suggest that neutral IOD conditions are expected to persist through the remainder of the monsoon season. However, the latest MMCFS forecast indicates that the current neutral IOD conditions may shift to negative IOD conditions for a short span of time towards the end of the season and then again turn back into neutral IOD conditions.

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

In July 2024, below-average sea surface temperatures (SSTs) were observed over the parts of the eastern Pacific Ocean, while above-average SSTs were seen across the western Pacific and near average SSTs in the east-central Pacific (Fig.1a). Warmer than average SSTs were observed over some parts of the northern and southern extra-tropical Pacific region. Cooler than average SSTs were observed over parts of the south of the extra-tropical Pacific region. Compared to June 2024, negative SST anomalies were seen over the central and western equatorial Pacific Ocean. Positive SST anomalies were seen over the eastern equatorial Pacific Ocean (Fig.1b).

In July 2024, warmer-than-average SSTs were observed over most parts of the Indian Ocean (Fig.1a), including the Bay of Bengal and the Arabian Sea. Cooler than average SSTs were observed over a small region near western equatorial Indian Ocean. Compared to June 2024, cool SSTs were observed over the north Bay of Bengal, and warm SSTs were observed over the equatorial Indian Ocean and some parts of north Arabian Sea (Fig.1b).

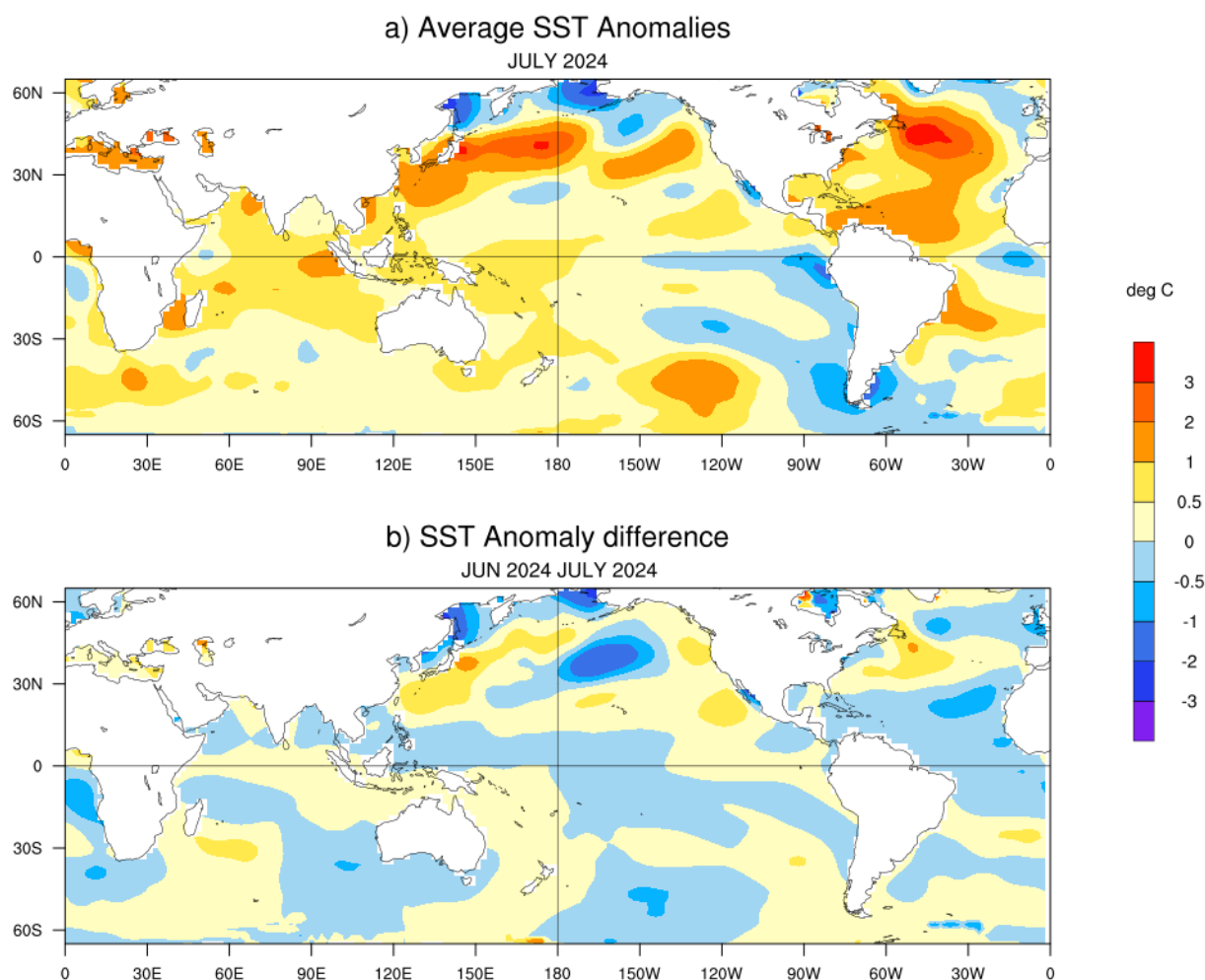
**1.1 El Niño Southern Oscillation (ENSO) conditions over the Pacific Ocean**

The monthly time series of Niño3.4 SST anomalies for the last 12 months from August 2023 to July 2024 is shown in Fig. 2(a). In August 2023, moderate El Niño conditions were observed over the Pacific Ocean. These conditions strengthened to strong El Niño during the

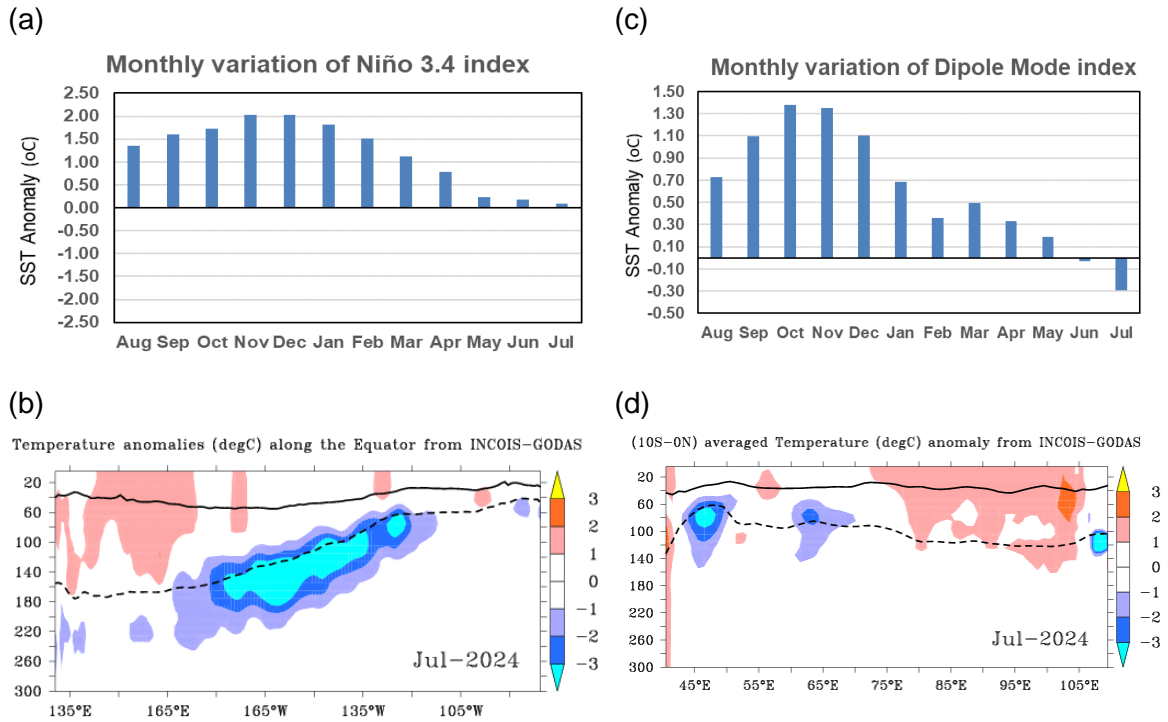
latter part of 2023. After reaching its maximum intensity during November-December 2023, the El Niño conditions started to weaken. However, a gradual weakening of El Niño conditions was seen from January to April. By the end of May, El Niño conditions turned into ENSO neutral conditions and continued to be ENSO neutral till July 2024. Currently, ENSO-neutral conditions are observed. Weak positive subsurface temperature anomalies are observed over parts of the western Pacific Ocean, both near and above the 20°C isotherm depth (Fig. 2b). The negative subsurface temperature anomalies are observed over the western, central and eastern equatorial Pacific Ocean with the highest magnitudes both near and below the thermocline depth (Fig.2b).

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

The figure shows the monthly time series of the Dipole Mode Index (DMI) for the past 12 months from August 2023 to July 2024. After staying neutral for most of the first half of 2023, the Indian Ocean Dipole (IOD) conditions turned positive in August 2023, lasting until January 2024. In February, the IOD conditions weakened from positive to neutral and continued till July 2024. At present, neutral IOD conditions are prevailing over the Indian Ocean. Positive subsurface temperature anomalies (Fig. 2d) were observed in the eastern equatorial Indian Ocean, near or above the 20°C isotherm depth, and at some places extending to the thermocline depth. Conversely, certain regions in the western equatorial Indian Ocean displayed negative subsurface anomalies, particularly below the thermocline depth.



**Fig.1:** (a) Sea surface temperature (SST) anomalies ( $^{\circ}\text{C}$ ) during July2024 and (b) changes in the SST anomalies ( $^{\circ}\text{C}$ ) from June 2024 to July 2024. SSTs are based on the ERSSTv5, NOAA, and anomalies are 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 sub surface temperature anomalies in the equatorial ( $5^{\circ}\text{S}$ - $5^{\circ}\text{N}$ ) Pacific Ocean for the month of July 2024. **(c)** Same as **(a)** but for the Dipole Mode Index (DMI). **(d)** Same as **(b)** but for the tropical Indian Ocean ( $10^{\circ}\text{S}$ -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  $20^{\circ}\text{C}$  isotherm and the dashed line is thermocline depth (Data Source: INCOIS-GODAS).

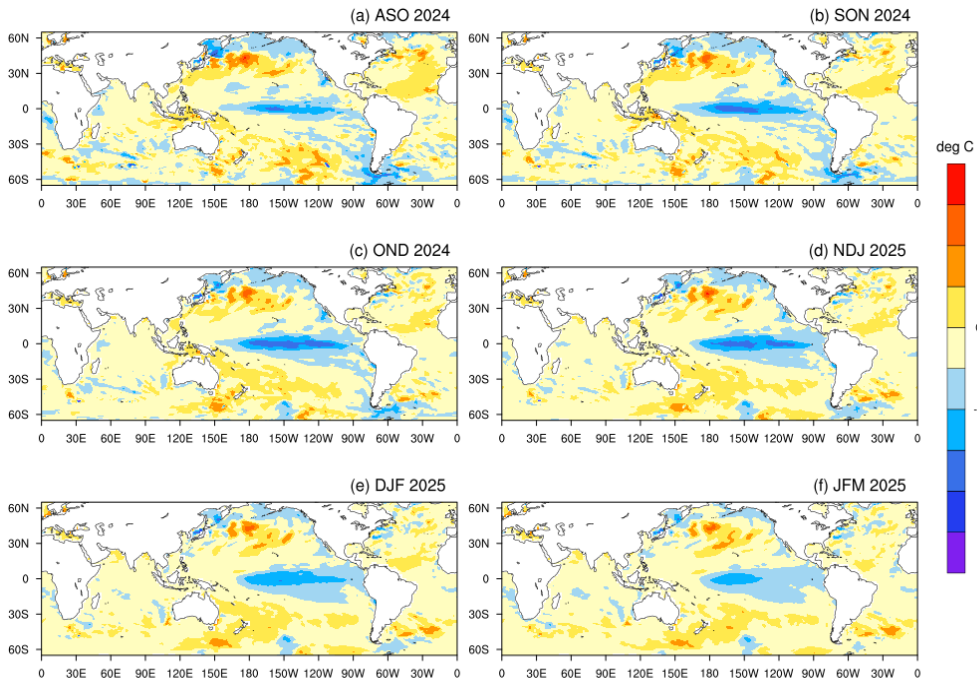
## 2. ENSO and IOD Forecast

The SST forecast was prepared using the high-resolution Monsoon Mission Coupled Forecast System (MMCFS) (AGCM T382L64;  $\sim 38$  km and OGCM 25 km in tropics) based on the 2024 July 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 to 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.

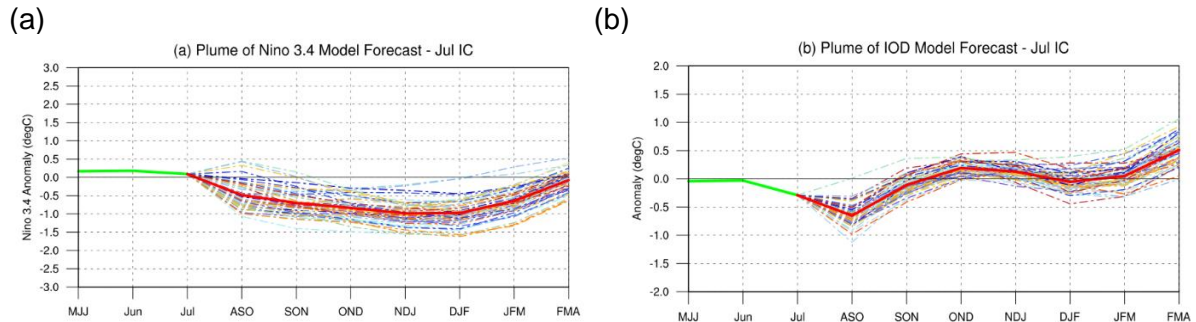
The sea surface temperatures are colder than normal in the eastern equatorial Pacific, above average in the western Pacific and near average in the east-central Pacific Ocean. The 3-month season-averaged SST anomaly forecast (Fig. 3) indicates that negative SST anomalies over the eastern equatorial Pacific Ocean will strengthen in the upcoming season. The latest MMCFS plume forecast (Fig. 4a) indicates a transition from ENSO-neutral conditions, with a likely shift to La Niña during the ASO period. The probability forecast (Fig. 5a) further suggests a higher likelihood of La Niña conditions emerging around the SON 2024 season. IMD closely monitors El Niño conditions and provides monthly updates, reflecting the latest observations and changes in the Pacific Ocean.

The 3-month season-averaged SST anomaly forecast (Fig. 3) indicates that near average SST anomalies are likely over most parts of the Indian Ocean during the entire forecast period. Most global climate models suggest that neutral IOD conditions are expected to persist through the remainder of the monsoon season. However, the latest MMCFS forecast indicates that the current neutral IOD conditions may shift to negative IOD conditions for a short span of time towards the end of the season and then again turn back into neutral IOD conditions (Fig. 4b and 5b).

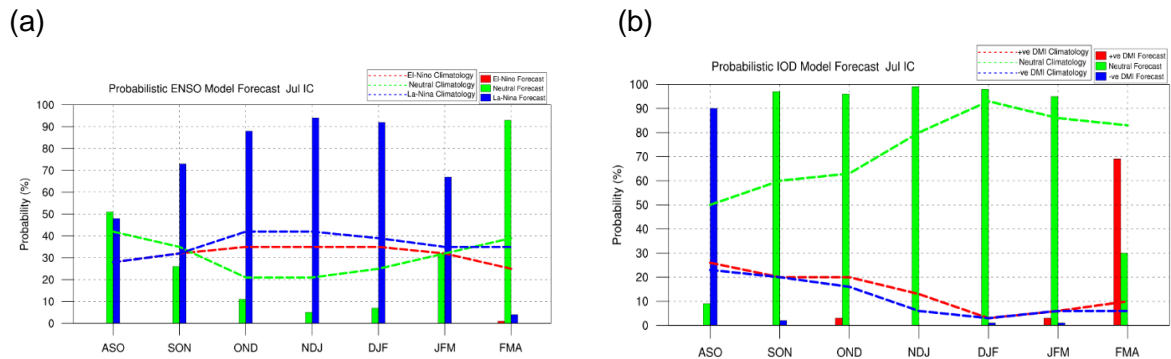
### MMCFS SST Anomaly Forecast :Jul 2024 IC



**Fig.3:** Forecasted Seasonal mean SST anomalies for three-monthly (a) August 2024 to October 2024 (ASO 2024) (b) September 2024 to November 2024 (SON 2024), (c) October 2024 to December 2024 (OND 2024) (d) November 2024 to January 2025 (NDJ2025), (e) December to February 2025 (DJF 2025) and (f) January to March 2025 (JFM 2025) (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 (IOD) 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 52 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 (IOD) 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  $\geq 0.4$ .