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El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) Bulletin

September 2024

Highlights

The sea surface temperatures are below average in the eastern equatorial Pacific Ocean. Currently, neutral El Nino-Southern Oscillation (ENSO) conditions are observed over the equatorial Pacific. The probability forecast indicates a higher chance of La Niña conditions developing around the SON 2024 season and an enhanced probability of La Niña conditions until early next year.

Above-average sea surface temperatures (SSTs) are currently seen across most of the Indian Ocean. Currently, neutral Indian Ocean Dipole (IOD) conditions prevail over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to continue for next several months.

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

In August 2024, sea surface temperatures (SSTs) in the eastern Pacific Ocean were below average, while they were average to above average in the western and adjoining 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 July 2024, negative SST anomalies were seen over the central and western equatorial Pacific Ocean. Positive SST anomalies were seen over the parts of eastern most equatorial Pacific Ocean (Fig.1b).

In August 2024, above-average sea surface temperatures (SSTs) were observed across most of the Indian Ocean, including the Bay of Bengal and the Arabian Sea (Fig. 1a). Compared to July 2024, cooler SSTs were observed in the northern Bay of Bengal and in most parts of the Arabian Sea and eastern equatorial Indian Ocean, while warmer SSTs were observed in the western and central equatorial Indian Ocean, as well as in parts of the Bay of Bengal and the 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 September 2023 to August 2024 is shown in Fig. 2(a). In September 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 August 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 and central equatorial Pacific Ocean with the highest magnitudes both near and below the thermocline depth between 180ºW to 120ºW (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 September 2023 to August 2024. The positive Indian Ocean Dipole (IOD) conditions from August 2023 have continued in September 2023 and lasted up to January 2024. In February, the IOD conditions weakened from positive to neutral and continued till August 2024. At present, neutral IOD conditions are prevailing over the Indian Ocean. Positive subsurface temperature anomalies (Fig. 2d) were observed in the western and central equatorial Indian Ocean, near and above the 20°C isotherm depth, and at some places extending to the thermocline depth. Conversely, certain regions in the eastern equatorial Indian Ocean has shown negative subsurface anomalies, particularly below the thermocline depth.

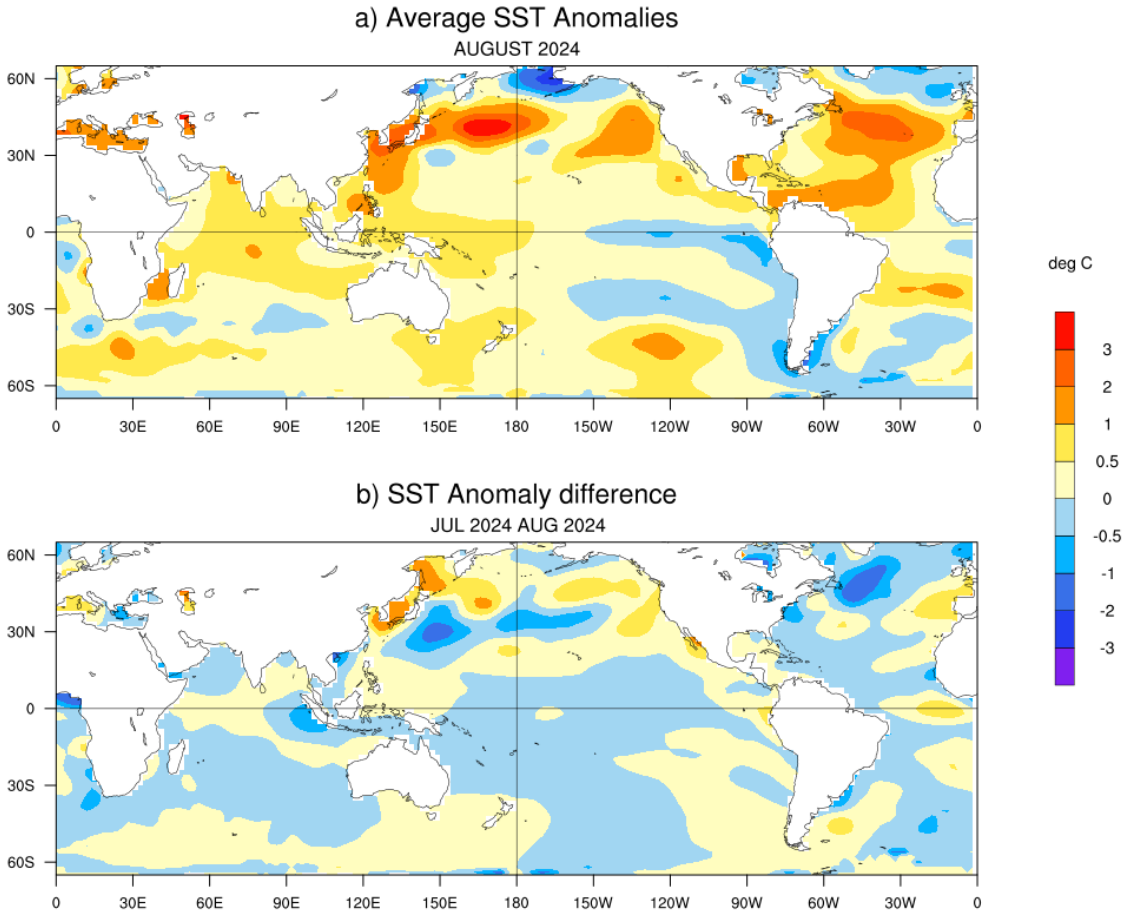

Fig.1: (a) Sea surface temperature (SST) anomalies (^{0}C) during August 2024 and (b) changes in the SST anomalies (^{0}C) from July 2024 to August 2024. SSTs are based on the ERSSTv5, NOAA, and anomalies are computed with respect to 30-year (1991-2020) long term mean.

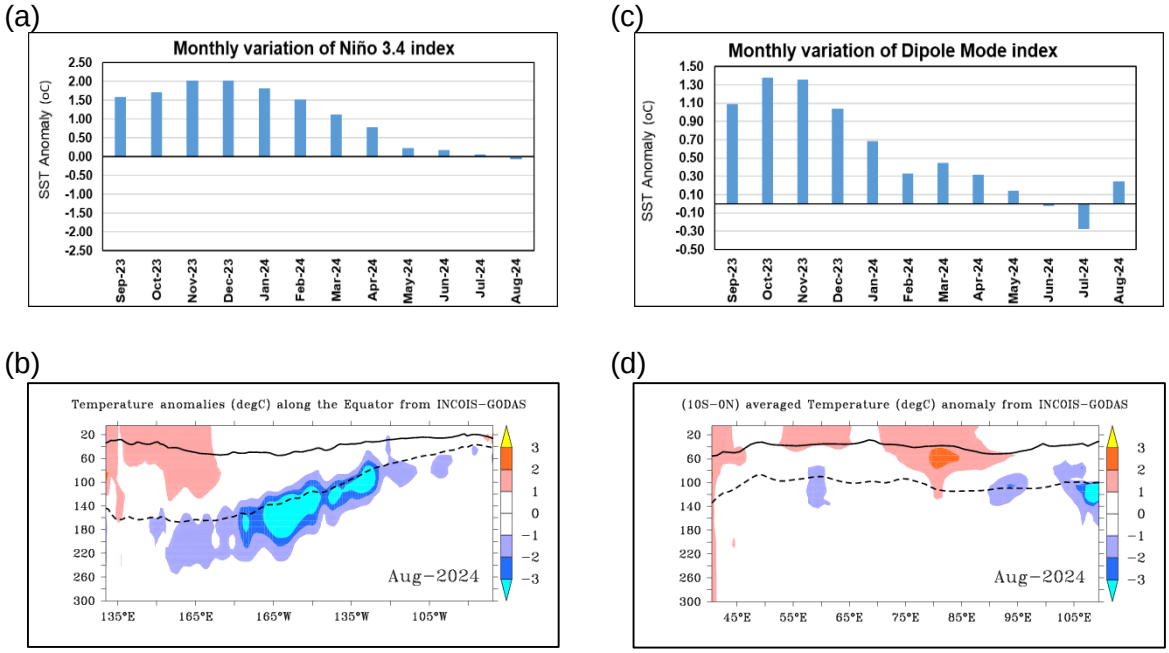

Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (**b**) Depth-longitude section of sub surface temperature anomalies in the equatorial (5^0S-5^0N) Pacific Ocean for the month of August 2024. (**c**) Same as (**a**) but for the Dipole Mode Index (DMI). (**d**) Same as **(b)** but for the tropical Indian Ocean (10^0S-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 20^0C 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; ~38 km and OGCM 25 km in tropics) based on the 2024 August 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.

In August, sea surface temperatures (SSTs) were above average in the western Pacific Ocean, around the Maritime Continent, the Indian Ocean, and most of the Atlantic Ocean. Near to below-average SSTs were evident in the east-central and eastern Pacific Ocean.

The 3-month season-averaged SST anomaly forecast over the Pacific Ocean, (Fig. 3) indicates that negative SST anomalies over the eastern equatorial Pacific Ocean will strengthen in the upcoming seasons, especially during OND 2024. The latest MMCFS plume forecast (Fig. 4a) indicates a transition from ENSO-neutral conditions, likely shifting to La Niña during the SON period. The probability forecast (Fig. 5a) indicates a higher chance of La Niña conditions developing around the SON 2024 season and an enhanced probability of La Niña conditions until early next year. 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 for the Indian Ocean (Fig. 3) suggests that near-average SST anomalies are expected across most parts of the Indian Ocean for the entire forecast period. The latest MMCFS forecast indicates that the current neutral IOD conditions are expected to continue for the next several months (see Fig. 4b and 5b).

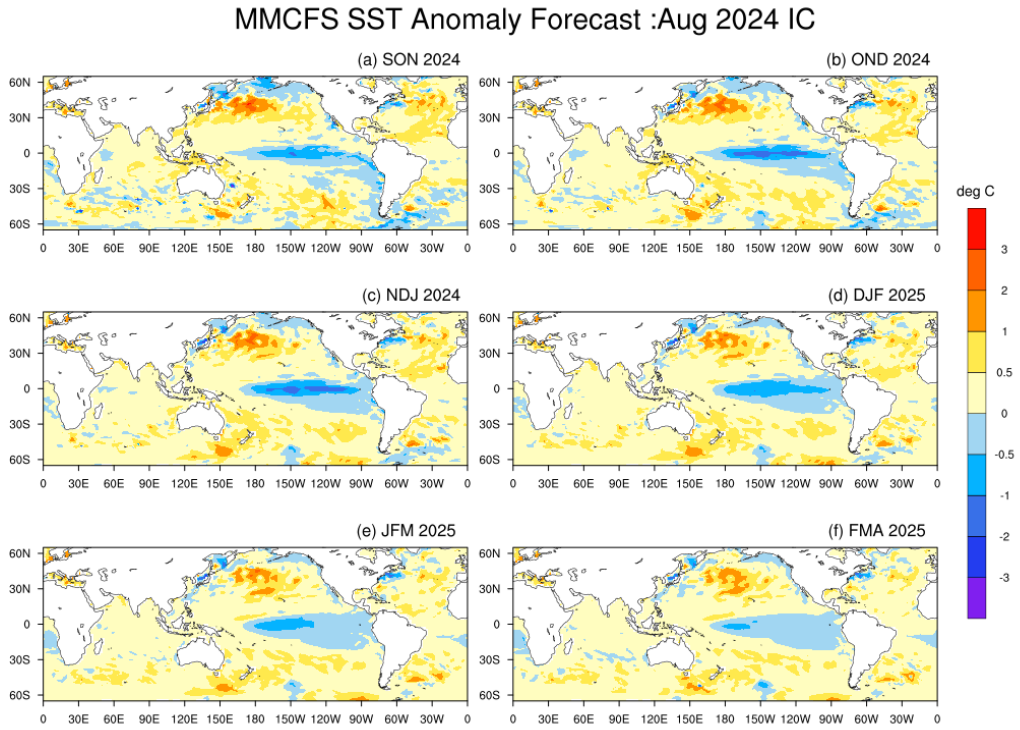

Fig.3: Forecasted Seasonal mean SST anomalies for three-monthly (a) September 2024 to November 2024 (SON 2024), (b) October 2024 to December 2024 (OND 2024) (c) November 2024 to January 2025 (NDJ 2025), (d) December to February 2025 (DJF 2025) (e) January to March 2025 (JFM 2025) and (f) February to April (FMA 2025) (Model bias correction base period: 1999-2008; Climatology base period:1991-2020).

(a) (b)

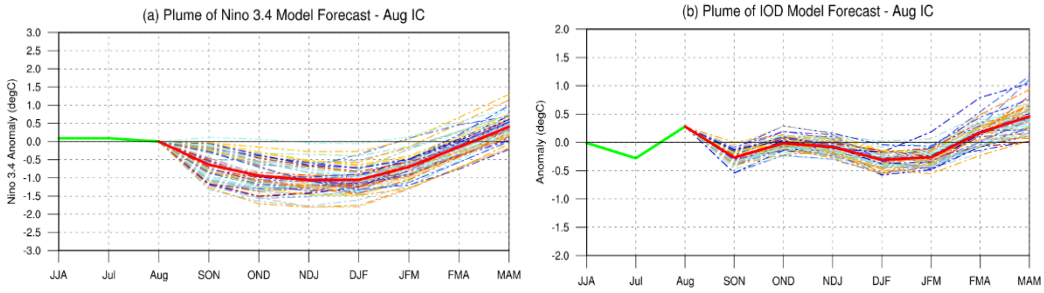

Fig.4: Plume of **(a)** Niño 3.4 SST index, **(b)** Indian Ocean Dipole (IOD) Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly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

(a) (b)

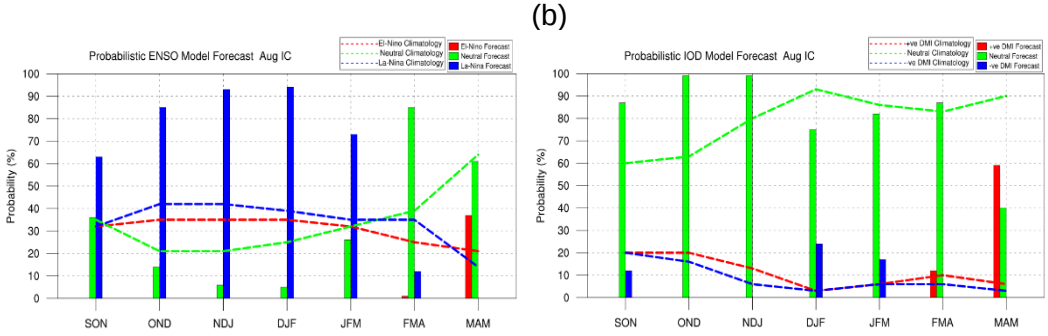

Fig.5: Probability forecast along with climatological probabilities of **(a)** Niño 3.4 and **(b)** Indian Ocean Dipole (IOD) Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5, Neutral <0.5 to >-0.5, El Niño ≥ 0.5. Criteria used for Probabilistic DMI Forecast: negative DMI ≤ -0.4, Neutral <0.4 to >-0.4, positive DMI ≥ 0.4.