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

February 2025

Highlights

Over the equatorial Pacific Ocean, sea surface temperatures (SSTs) are below average in most of the central and east-central Pacific Ocean. The weak La Niña conditions are present over Pacific and are expected to persist through the February to March (FMA) season. After that, a transition to ENSO-neutral conditions is likely.

Near-average sea surface temperatures (SSTs) are currently seen across most of the Indian Ocean. Currently, neutral Indian Ocean Dipole (IOD) conditions are observed over the Indian Ocean. The latest MMCFS forecast indicates that the neutral IOD conditions are likely to turn to negative IOD conditions for a short period of time.

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

In January 2024, sea surface temperatures (SSTs) were below average in most of the central and east-central Pacific Ocean. Equatorial SSTs were near to above average across the western Pacific Ocean (Fig.1a). Warmer than average SSTs were observed over the extra-tropical Pacific region, while cooler than average SSTs were observed in parts of the southern extra-tropical Pacific region. Compared to December 2025, negative SST anomalies were present over the central equatorial Pacific Ocean, and around the Maritime Continent. Positive SST anomalies were observed over the east-central and western equatorial Pacific Ocean. Cool SST anomalies were observed over the higher latitudes of the North Pacific Ocean and some parts of the South Pacific Ocean. Warm SST anomalies were observed over some parts of the extra tropical Pacific Ocean (Fig.1b).

In January 2025, equatorial SSTs were above average across most of the western and eastern Indian Ocean, including the north Bay of Bengal (Fig. 1a). Cooler than average SSTs were observed over western Indian Ocean and most of the Arabian Sea. Compared to December 2025, cooler than normal SSTs were observed across the Indian Ocean, Arabian Sea, and 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 February 2024 to January 2025 is shown in Fig. 2(a). In February 2024, moderate El Niño conditions were observed over the Pacific Ocean. Thereafter El Niño conditions began to weaken, with a gradual weakening in El Niño intensity from January to April 2024. By the end of May 2024, El Niño conditions transitioned to ENSO neutral conditions, which persisted until November 2024. During December 2024, La Niña threshold has been surpassed and Currently, weak La Niña conditions are observed over the equatorial Pacific.

The strong positive subsurface temperature anomalies are observed over the western Pacific Ocean, both near and above the 20°C isotherm depth (Fig. 2b). Negative subsurface temperature anomalies are observed over the eastern and central equatorial Pacific Ocean, with the highest magnitudes occurring near and below the thermocline depth (Fig.2b).

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

Figure 2(c) shows the monthly time series of the Dipole Mode Index (DMI) for the past 12 months, from February 2024 to January 2025. In February 2024, positive Indian Ocean Dipole (IOD) conditions were observed over the Indian Ocean. In February 2024, IOD conditions weakened from positive to neutral and remained neutral until December 2024. Currently, negative IOD conditions are prevailing over the Indian Ocean.

Strong positive subsurface temperature anomalies (Fig. 2d) were observed in the eastern equatorial Indian Ocean, below the 20°C isotherm depth, extending down to the thermocline depth. Conversely, certain regions in the western equatorial Indian Ocean have shown significant negative subsurface anomalies, particularly near and below the thermocline depth.

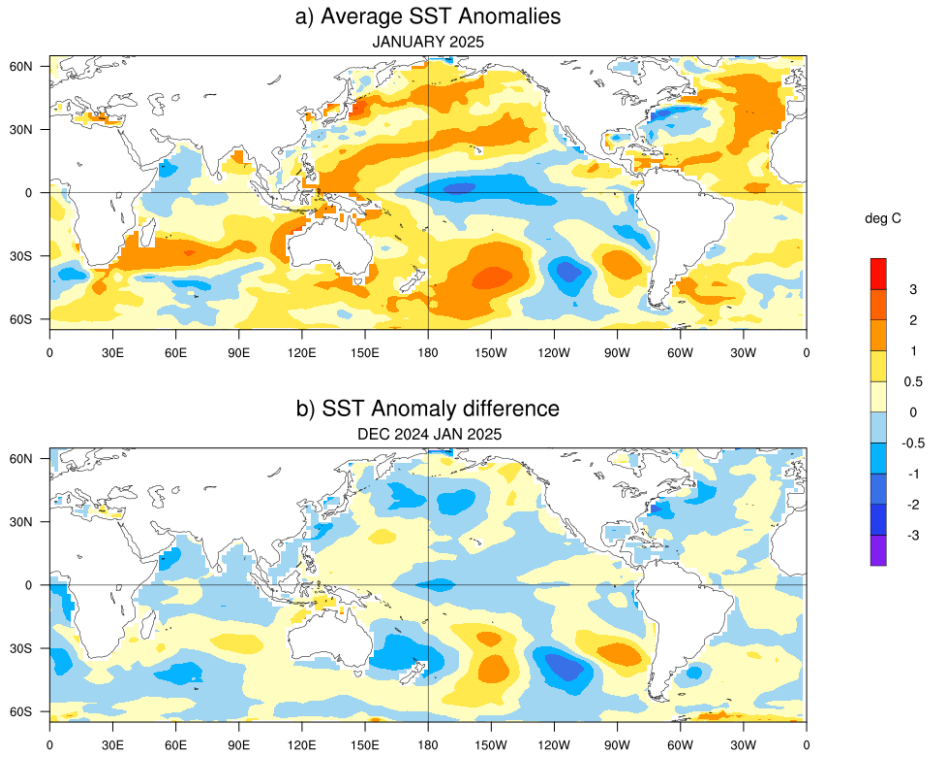

Fig.1: (a) Sea surface temperature (SST) anomalies (^{0}C) during January 2025 and (b) changes in the SST anomalies (^{0}C) from December 2024 to January 2024. SSTs are based on the ERSSTv5 (NCEp-NOAA), and anomalies are computed with respect to 30-year (1991-2020) long term mean.

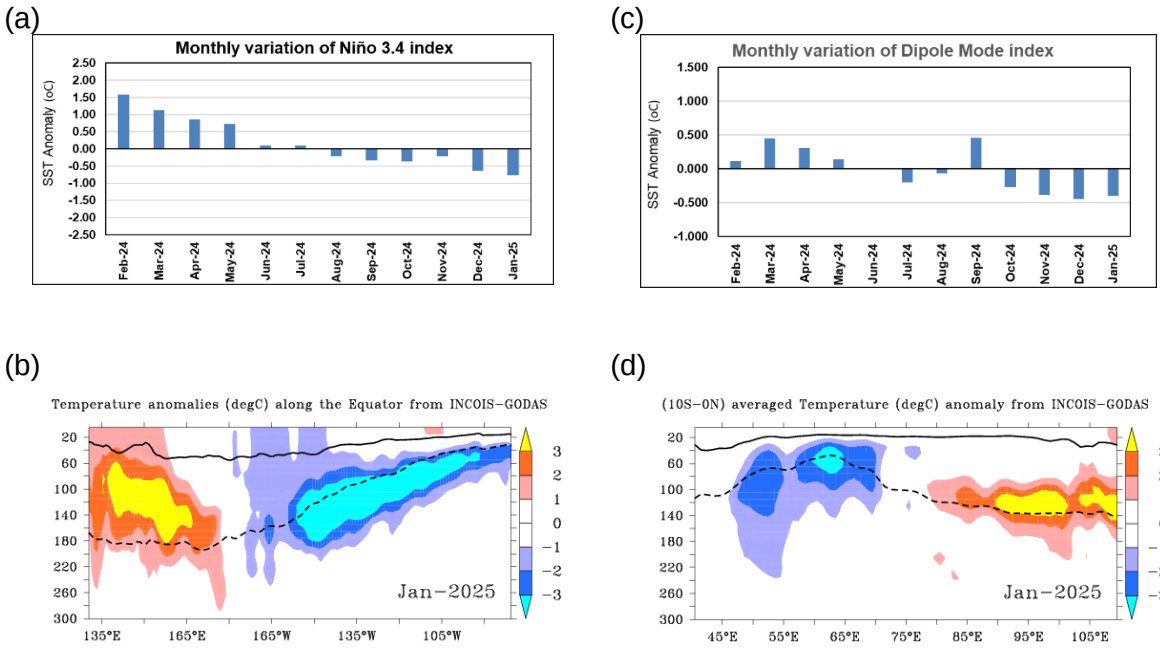

Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (**b**) Depth-longitude section of sub-surface temperature anomalies in the equatorial (5^0S-5^0N) Pacific Ocean for the month of January 2025. (**c**) Same as (**a**) but for the Dipole Mode Index (DMI). (**d**) Same as **(b)** 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) 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 the tropics) based on the January 2025 initial conditions. The initial conditions for the model runs were obtained from ESSO-INCOIS and ESSO-NCMRWF analyses. Probability density function (PDF) bias correction was applied to the forecasts of the Niño3.4 index (Fig. 4a) and the DMI (Fig. 4b), based on hindcasts for the period 1999-2008, and anomalies were calculated using the 1991-2020 climatology.

In January 2025, sea surface temperatures (SSTs) were below average in most of the central and east-central Pacific Ocean, while equatorial SSTs were above average across the western Pacific Ocean. The 3-month season-averaged SST anomaly forecast for the Pacific Ocean (Fig. 3) indicates cooler-than-normal SSTs over the central equatorial Pacific Ocean during FMA 2025. The strength of the cool SST anomalies is expected to decrease thereafter. The latest MMCFS plume forecast (Fig. 4a) indicates that weak La Niña conditions are likely to persist during the FMA season. The probability forecast (Fig. 5a) shows the highest probability of La Niña conditions continuing during the FMA season. However, probability for neutral ENSO conditions is more than climatological probability during FMA season. IMD is closely monitoring La Niña conditions. IMD 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. However, western Indian ocean is likely to remain slightly warmer during February to May as compared to the eastern Indian Ocean. The latest MMCFS forecast indicates that the current neutral IOD conditions are likely to turn to positive IOD conditions for a short period of time and then return to neutral IOD conditions (see Figs. 4b and 5b).

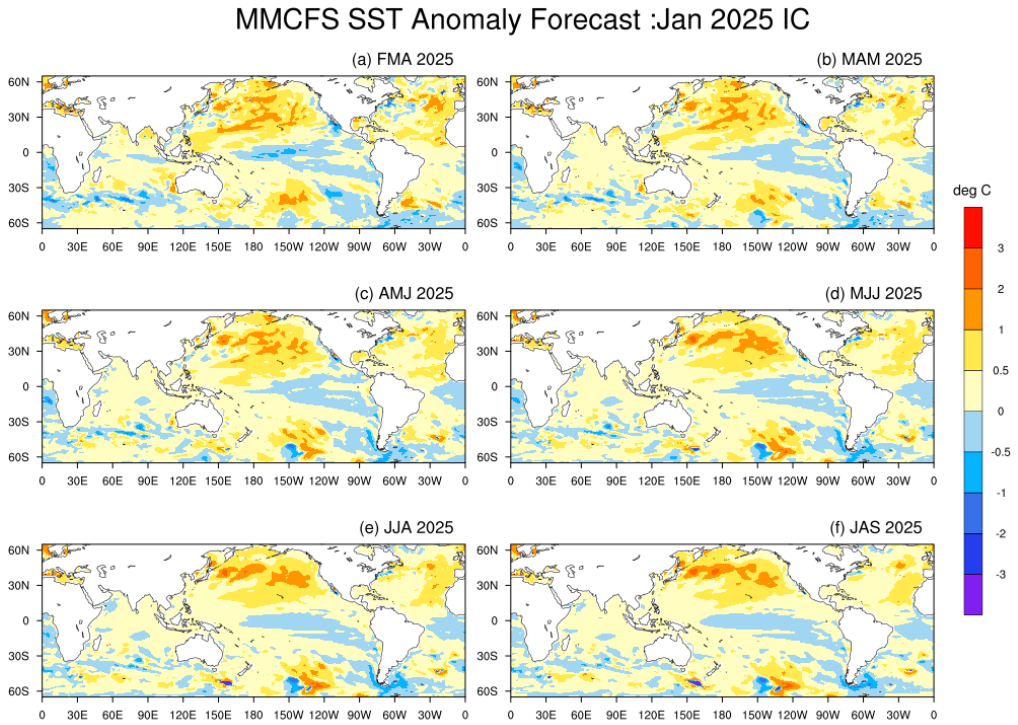

Fig.3: Forecasted Seasonal mean SST anomalies for three-monthly (a) January to March 2025 (JFM 2025), (b) February to April (FMA 2025) (c) March to May (MAM 2025), (d) April to June (AMJ 2025) ,(e) May to July (MJJ 2025) and (f) June to August (JJA 2025) (Model bias correction base period: 1999-2008; Climatology base period:1991-2020).

(a) (b)

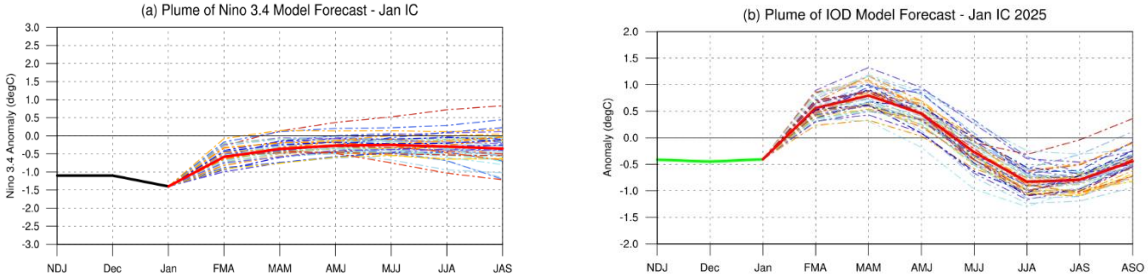

Fig.4: Plume of **(a)** Niño 3.4 SST index, **(b)** Indian Ocean Dipole (IOD) Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 41 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

(a) (b)

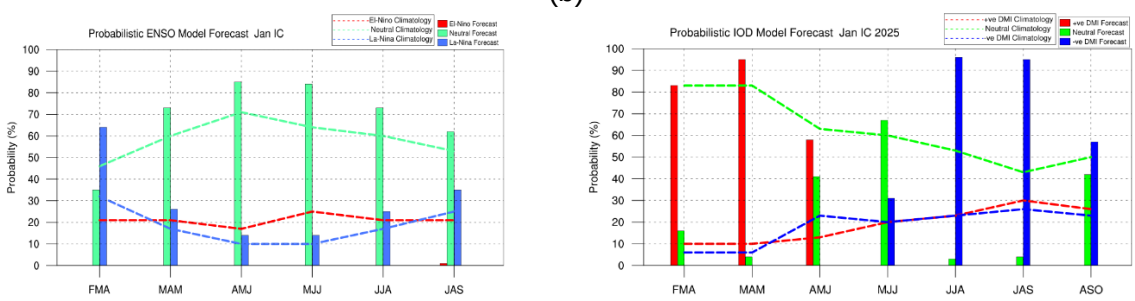

Fig.5: Probability forecast along with climatological probabilities of **(a)** Niño 3.4 and **(b)** Indian Ocean Dipole (IOD) Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña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