Earth System Science Organization (ESSO)
Ministry of Earth Sciences (MoES)
India Meteorological Department (IMD)
WMO Regional Climate Centre
Pune, India

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

March 2025

Highlights

Over the equatorial Pacific Ocean, sea surface temperatures (SSTs) are above average in the eastern and far western Pacific Ocean. Below-average SSTs were evident in the central Pacific Ocean. The El Niño-Southern Oscillation (ENSO) is transitioning from weak La Niña conditions to an ENSO-neutral state. The neutral ENSO conditions are expected to persist in the coming month, with a transition to ENSO-neutral likely occurring between March and May 2025.

Below-average sea surface temperatures (SSTs) are currently seen in some parts of the western 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 continue for the next several months.

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

In February 2025, sea surface temperatures (SSTs) were above average in the eastern and far western Pacific Ocean. Below-average SSTs were evident in the central 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 January 2025, negative SST anomalies were present over the western equatorial Pacific Ocean, and around the Maritime Continent. Positive SST anomalies were observed over the central and east-central equatorial Pacific Ocean. Cool SST anomalies were observed over some parts of the South Pacific Ocean (Fig.1b).

In February 2025, equatorial SSTs were in the neutral range across most of the central Indian Ocean (Fig. 1a). Above average SSTs were observed in the Northern Arabian Sea and north Bay of Bengal. Cooler than average SSTs were observed over parts of western Indian Ocean. Compared to January 2025, cool SSTs were observed across the Eastern Indian Ocean, some parts of western Indian Ocean and Bay of Bengal (Fig. 1b). Warm SSTs were observed over most parts of Arabian Sea.

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 March 2024 to February 2025 is shown in Fig. 2(a). In March 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 March to April 2024. By the end of May 2024, El Niño conditions transitioned to ENSO neutral conditions, which persisted until November 2024. Since December a weak La Niña conditions are observed over the equatorial Pacific till February 2025. Currently, El Niño-Southern Oscillation (ENSO) is transitioning from weak La Niña conditions to an ENSO-neutral state.

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 east 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 March 2024 to February 2025. In March 2024, positive Indian Ocean Dipole (IOD) conditions were observed over the Indian Ocean. Since last 12 months IOD conditions are within the neutral range and currently, neutral 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, the western equatorial Indian Ocean have shown significant negative subsurface anomalies, particularly near and below the thermocline depth.

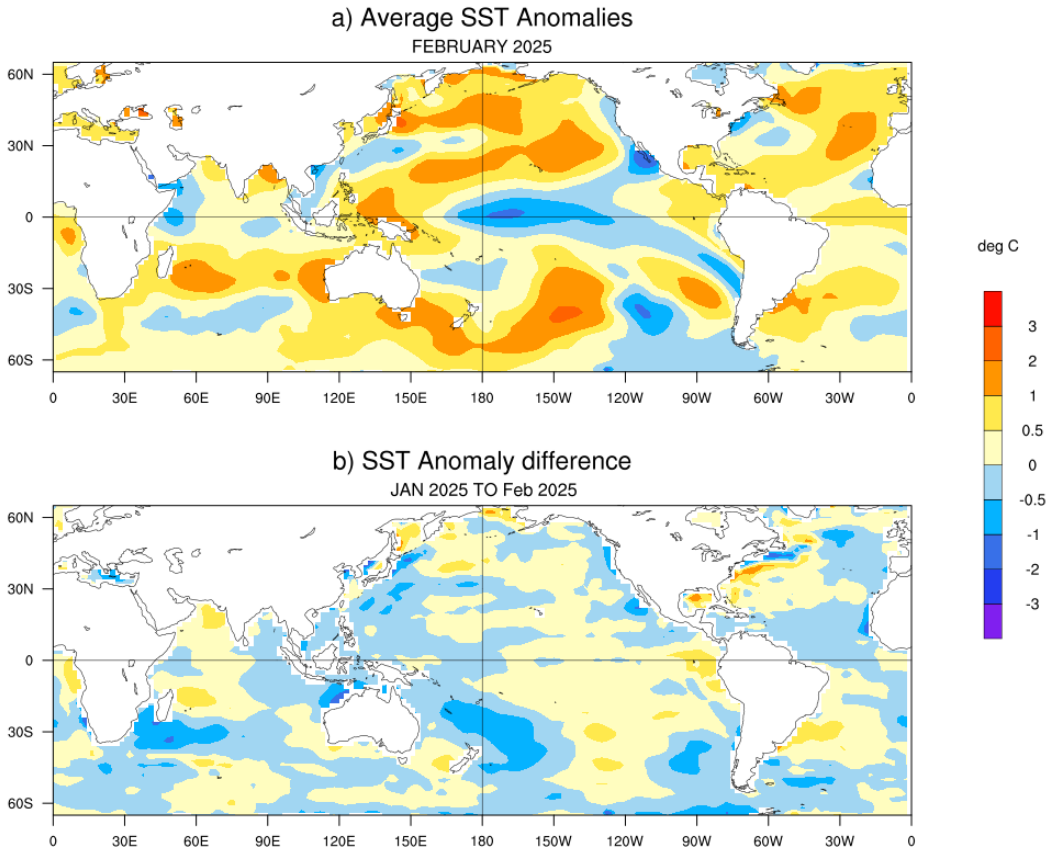
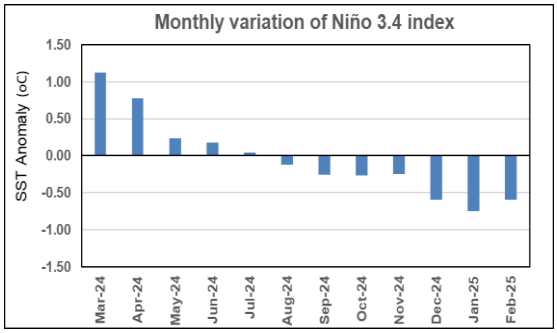
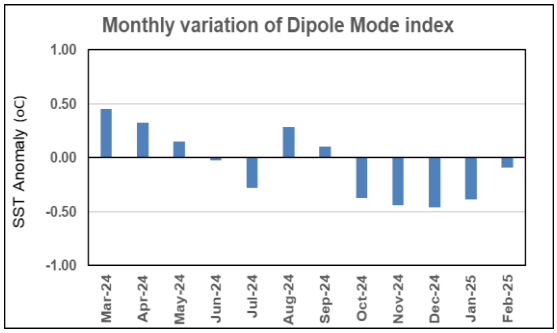


Fig.1: (a) Sea surface temperature (SST) anomalies (^{0}C) during February 2025 and (b) changes in the SST anomalies (^{0}C) from January 2025 to February 2025. SSTs are based on the ERSSTv5 (NCEP-NOAA), and anomalies are computed with respect to 30-year (1991-2020) long term mean.

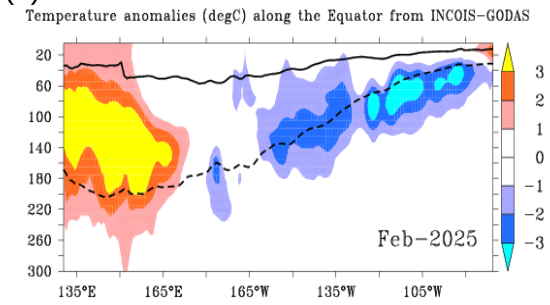
(a)



(c)



(b)



(d)

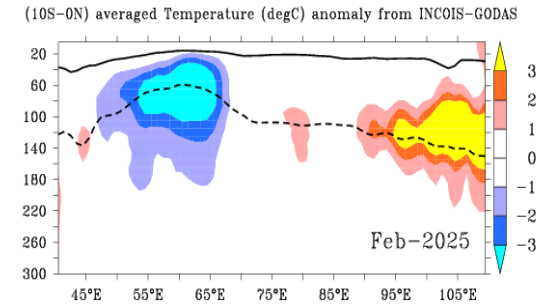


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and (**b**) Depth-longitude section of sub-surface temperature anomalies in the equatorial (5^{0}S-5^{0}N) Pacific Ocean for the month of February 2025. (**c**) Same as (**a**) but for the Dipole Mode Index (DMI). (**d**) Same as **(b)** but for the tropical Indian Ocean (10^{0}S-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^{0}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; ~38 km and OGCM 25 km in the tropics) based on the February 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 February 2025, sea surface temperatures (SSTs) were above average in the eastern and far western Pacific Ocean, while Below-average SSTs were evident in the central Pacific Ocean. The 3-month season-averaged SST anomaly forecast for the Pacific Ocean (Fig. 3) indicates negative SSTs over the central equatorial Pacific Ocean during MAM 2025. The spread of the negative SST anomalies is expected to decrease thereafter. The latest MMCFS plume forecast (Fig. 4a & 5a) indicates the highest probability for neutral ENSO conditions during the MAM season. IMD is closely monitoring ENSO 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. The latest MMCFS forecast indicates that the current neutral IOD conditions are likely to continue during MAM season and thereafter (see Figs. 4b and 5b).

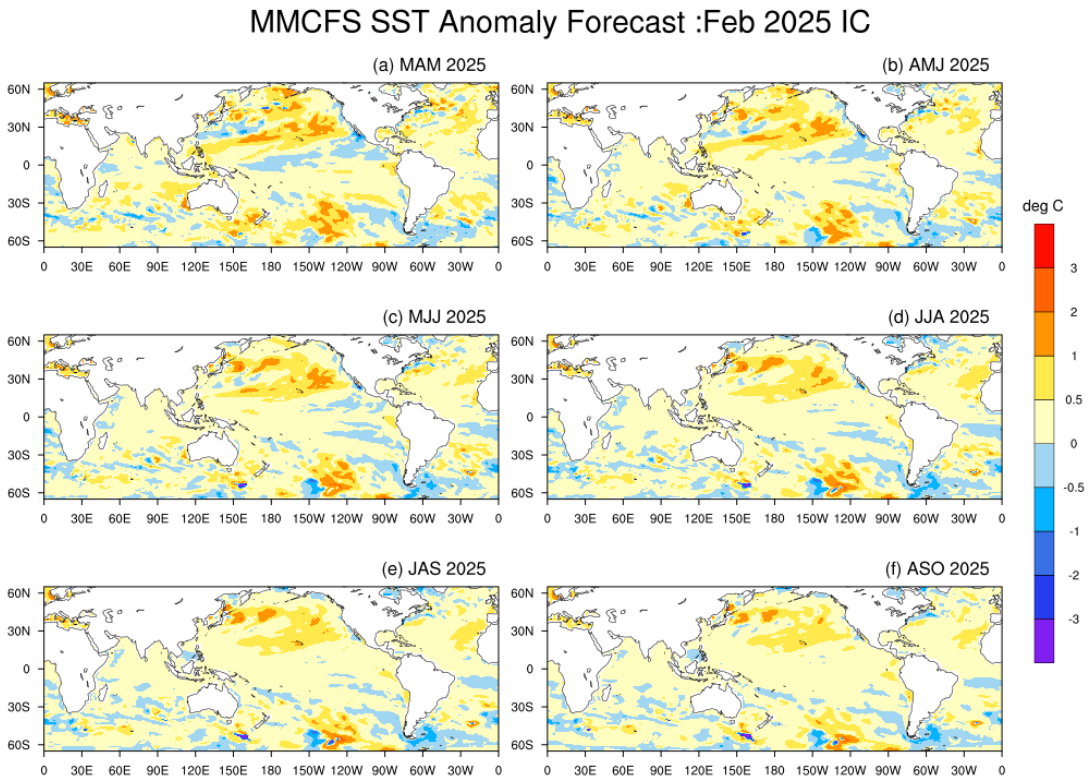


Fig.3: Forecasted Seasonal mean SST anomalies for three-monthly (a) March to May (MAM 2025), (b) April to June (AMJ 2025), (c) May to July (MJJ 2025), (d) June to August (JJA 2025), (e) July to September (JAS 2025) and (f) August to October (ASO 2025) (Model bias correction base period: 1999-2008; Climatology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

(a) (b)

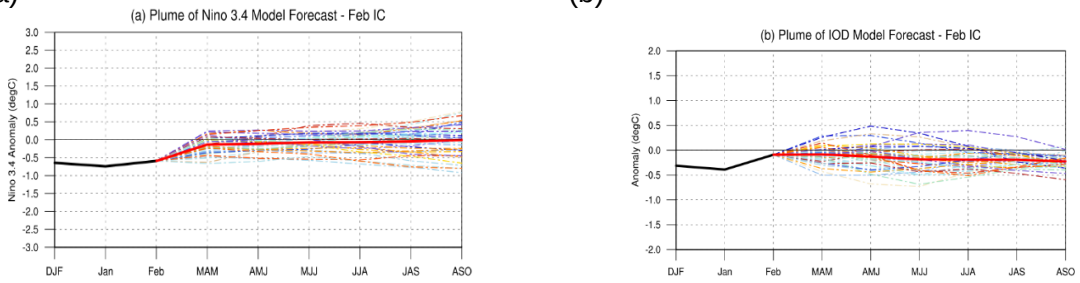


Fig.4: Plume of **(a)** Niño 3.4 SST index, **(b)** Indian Ocean Dipole (IOD) Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 38 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

(a) (b)

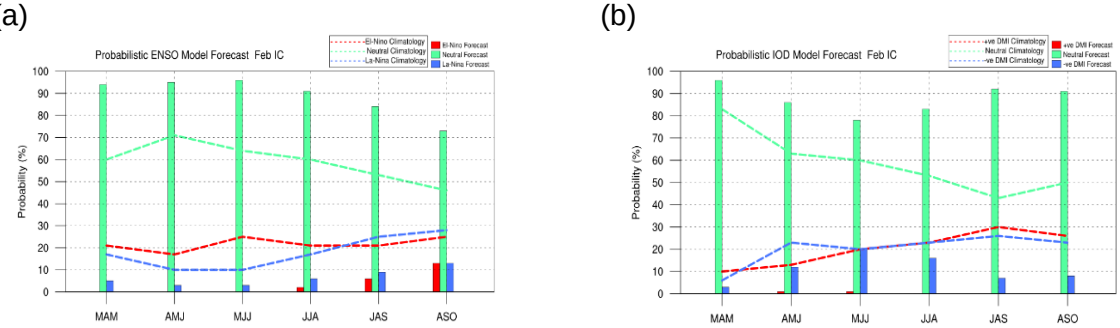


Fig.5: Probability forecast along with climatological probabilities of **(a)** Niño 3.4 and **(b)** Indian Ocean Dipole (IOD) Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña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