



**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**

September 2022

Highlights

Currently, La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that the La Niña conditions are likely to continue up to end of the year. Other climate models are also indicating continuation of La Niña conditions during the upcoming season.

At present the negative IOD conditions are prevailing since June 2022 over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to continue up to the end of year.

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

During August 2022 cooler than normal SSTs were observed across the central, eastern, and south eastern tropical Pacific Ocean, and warmer than normal SSTs were observed over west tropical Pacific Ocean (Fig.1a). Warmer than normal SSTs were also observed over the extra-tropical regions of the north and the south Pacific Ocean. As compared to the last month, warming of SST anomalies were observed over the far eastern equatorial eastern Pacific Ocean but cooling of SST anomalies were observed over the central equatorial Pacific Ocean near the Date Line (Fig.1b). Cooling of SST anomalies were also observed over extreme north Pacific Ocean.

In the north Indian Ocean, negative SST anomalies were observed over the most parts of the Arabian Sea and positive SST anomalies over Bay of Bengal. A positive SST anomaly was observed over eastern equatorial Indian Ocean and far western equatorial Indian Ocean. However, negative SST anomalies were observed over central equatorial Indian Ocean. Also, there were positive SST anomalies observed over eastern parts of the south Indian Ocean (Fig. 1a). As compared to the last month, cooling of SST anomalies were observed over central Indian Ocean where warming of SST anomalies were over western and eastern Indian Ocean (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 2021 to August 2022 is shown in Fig.2a. The cool SST anomalies over the eastern equatorial Pacific started strengthening and weak La Niña conditions were established by September 2021. Thereafter, the La Niña conditions kept strengthening to reach its maximum strength in December 2021. The La Niña conditions were slightly weakened in January and subsequently in February 2022, but slightly strengthened again in April and May 2022. The La Niña conditions were weakened in June and subsequently in July 2022 but strengthened again

in August 2022. Currently, La Niña conditions are prevailing over the Pacific. In the month of August 2022, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20° isotherm and thermocline depth) which were extending up to 165°E (Fig.2b). However, the subsurface temperature anomalies were slightly negative below the thermocline depth over the central and eastern Pacific Ocean.

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 September 2021 to August 2022 is shown in Fig.2c. During September 2021, neutral IOD conditions were observed over the Indian Ocean. During the months from October 2021 to April 2022, the DMI was negative side of its normal. The negative DMI value strengthened from May to August 2022. At present negative IOD conditions are evolving over the Indian Ocean. In the month of August 2022, positive subsurface temperature anomalies (Fig. 2d) were seen over the western and eastern equatorial Indian Ocean between 20°C isotherm and thermocline depth but a weak negative subsurface temperature anomaly were observed around 85° E.

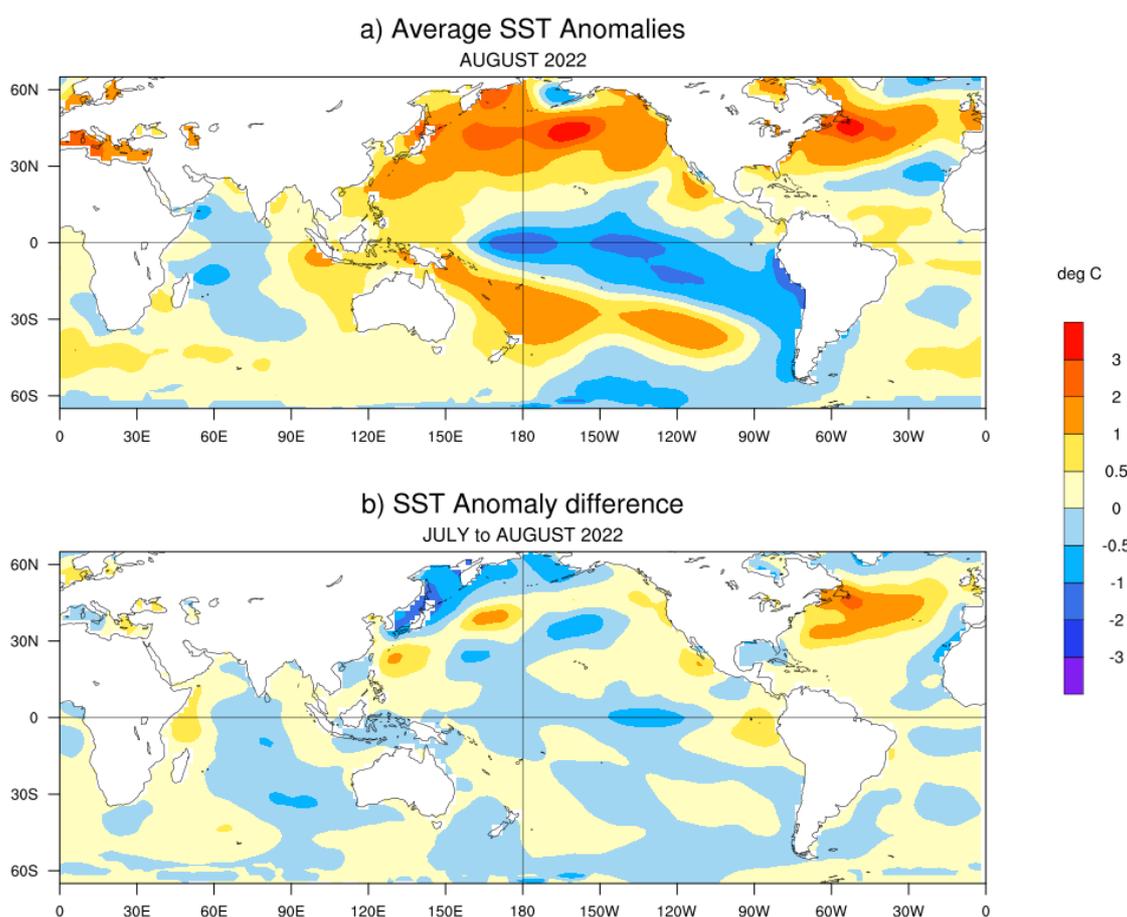


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during August 2022 and **(b)** changes in the SST anomalies (°C) from July 2022 to August 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.

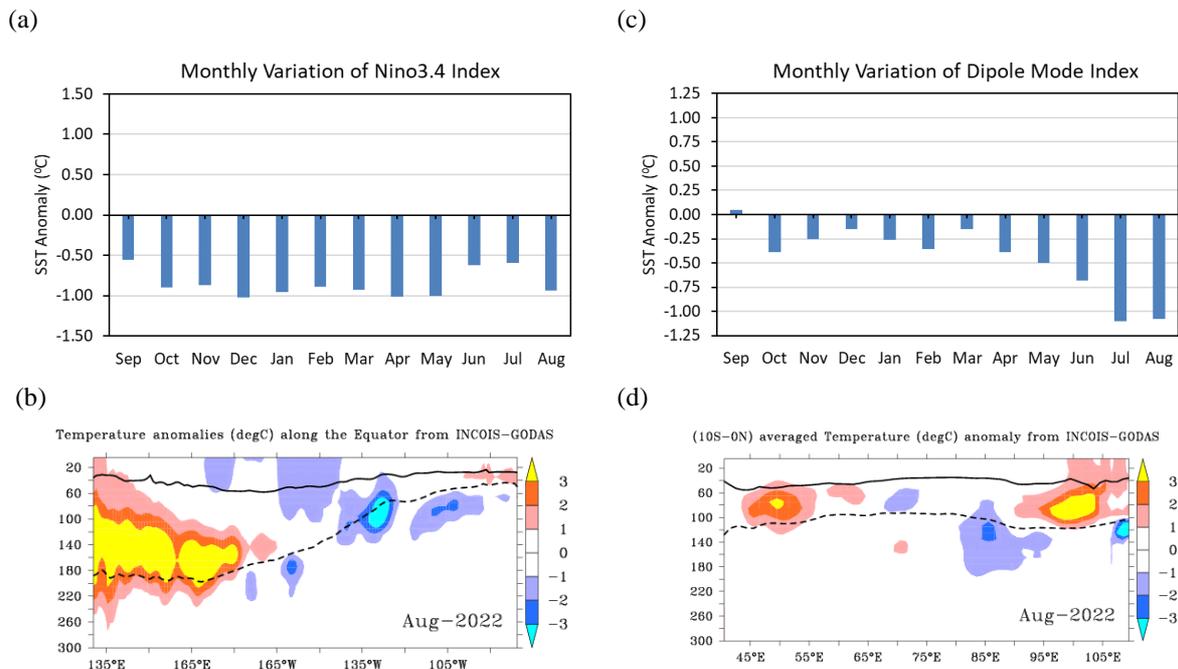


Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and **(b)** Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of August, 2022. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the tropical Indian Ocean (10°S-Eq). The anomalies in (a) and (b) were computed using the base period of 1981-2010 (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 2022 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 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 1982-2008 climatology.

The 3-month season averaged SST anomaly forecast (Fig.3) indicates that negative SST anomalies are likely over most parts of the central and eastern equatorial Pacific Ocean until the end of the year. Currently, La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that La Niña conditions are likely to continue most of the coming season (Fig.4a). The probability forecast for ENSO (Fig.5a) indicates that La Niña conditions to continue up to the end of the year. Other climate models are also indicating enhanced probability for La Niña conditions during the upcoming season. IMD is closely monitoring ENSO conditions and monthly updates are provided as per observed changes in the Pacific Ocean SSTs.

Western Indian Ocean likely to remain slightly cooler than normal and Eastern Indian Ocean likely to remain slightly warmer than the normal for the next couple of seasons. At present the negative IOD conditions are prevailing since June 2022 over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to continue up to the end of year (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates the enhanced probability for negative IOD conditions during SON season.

MMCFs SST Anomaly Forecast : Aug 2022 IC

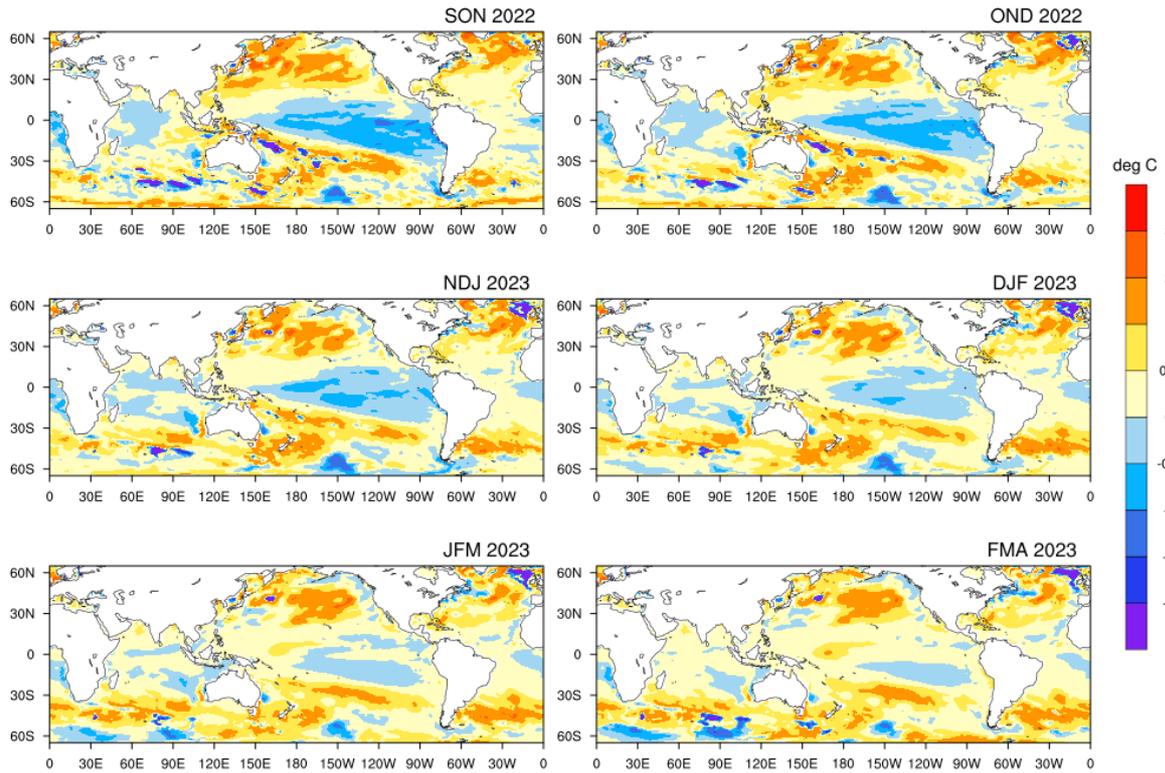


Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) September to November (SON), (b) October to December (OND), (c) November to January (NDJ 2023), (d) December to February (DJF 2023), (e) January to March (JFM 2023) and (f) February to April (FMA 2023) (Model bias correction base period: 1999-2008; Climatology base period:1982-2008).

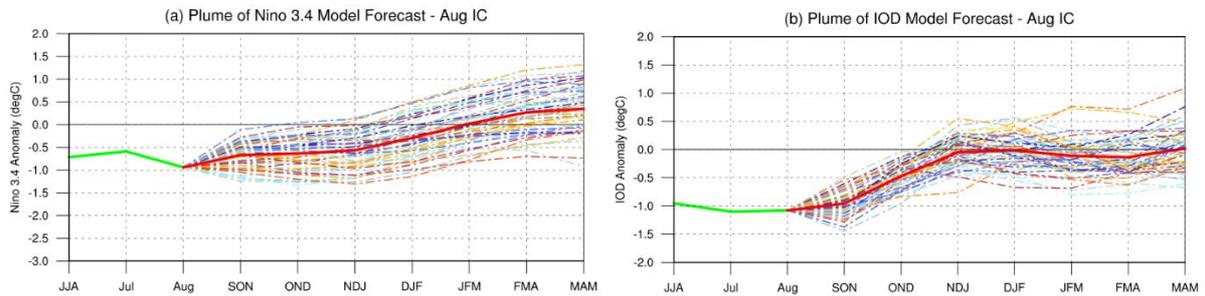


Fig.4: Plume of (a) Niño 3.4 SST index, (b) Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFs. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 52 members (MMCFs). The individual ensemble member forecasts are shown in light dotted lines of different colours.

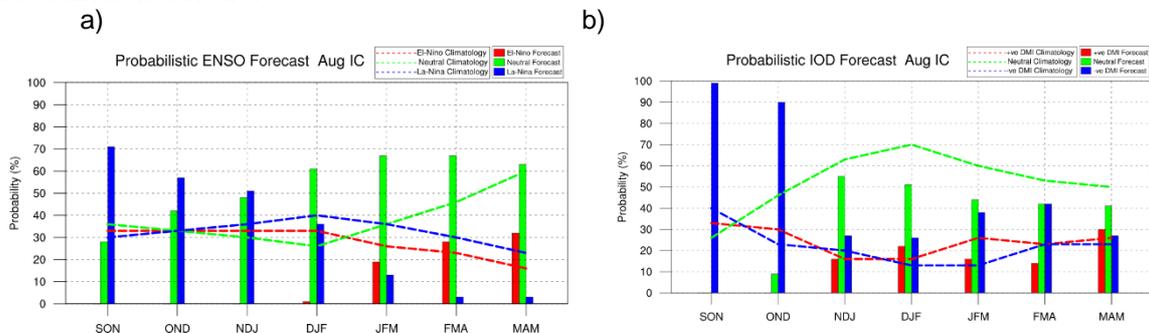


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFs. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5 , Neutral <0.5 to >-0.5 , El Niño ≥ 0.5 . Criteria used for Probabilistic DMI Forecast: negative DMI ≤ -0.2 , Neutral <0.2 to >-0.2 , positive DMI ≥ 0.2 .