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

July 2023

Highlights

Currently, weak El Niño conditions are prevailing over equatorial Pacific and the sea surface temperatures (SSTs) are above average over most of the equatorial Pacific Ocean. The latest MMCFS forecast indicates El Niño conditions are likely to continue up to the end of this year.

The neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The latest MMCFS forecast indicates a weak positive IOD conditions are likely to develop during the upcoming season.

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

During June 2023, warmer than normal SSTs were observed across the east central and eastern Pacific Ocean (Fig.1a). Warmer than normal SSTs were also observed over the extra-tropical regions of the north Pacific Ocean and Cooler than normal SSTs were observed over the western Pacific Ocean. As compared to the last month, SSTs have warmed over central and eastern equatorial Pacific Ocean (Fig.1b) and that over the western equatorial Pacific Ocean have cooled.

In the month of June 2023, warm SST anomalies were observed over most parts of the Indian Ocean, especially over north Arabian Sea and western part of the South Indian Ocean (Fig.1a). As compared to the last month, warmer SSTs are observed over most parts of the equatorial Indian Ocean and cooler SSTs are observed over north Arabian Sea and most parts of 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 July 2022 to June 2023 is shown in Fig.2a. The La Niña conditions were prevailing till early this year with maximum strength in September 2023. Thereafter ENSO neutral conditions were observed over the Pacific Ocean from February to May 2023. However, weak El Niño conditions developed during June 2023 with the positive subsurface anomalies observed over most parts of the equatorial Pacific Ocean at around thermocline depth along the western Pacific Ocean and with maximum strength close to surface along the eastern Pacific Ocean (Fig.2 b).

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 July2022 to May2023 is shown in Fig.2c. In the month of July 2022, neutral IOD conditions were observed over the Indian Ocean with DMI in the negative side of its normal and the neutral IOD conditions are prevailing till now. At present negative subsurface temperature anomalies (Fig. 2d) are seen spread over most parts of the equatorial Indian Ocean (near the thermocline depth) except a small region of positive subsurface temperature anomalies over the western Indian Ocean at around thermocline depth.
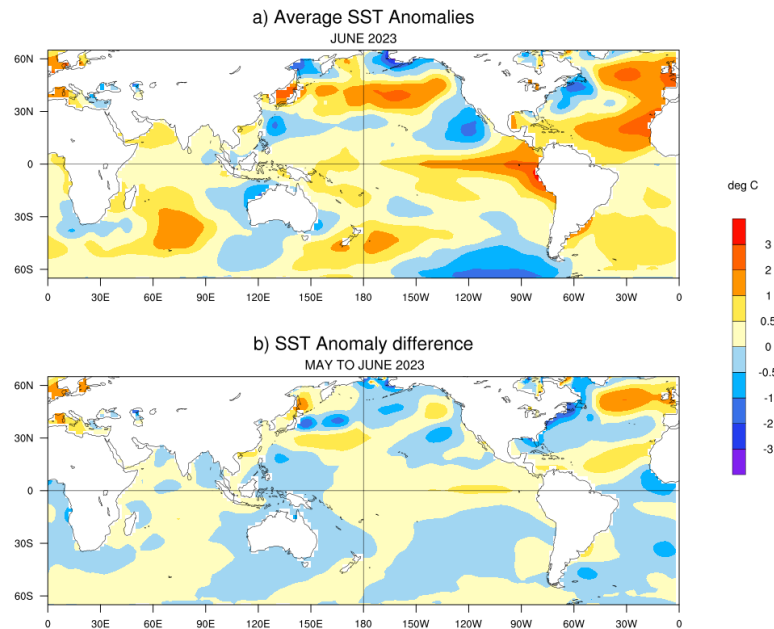

Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during June 2023 and **(b)** changes in the SST anomalies (°C) from May 2023to June 2023. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1991-2020) long term mean.
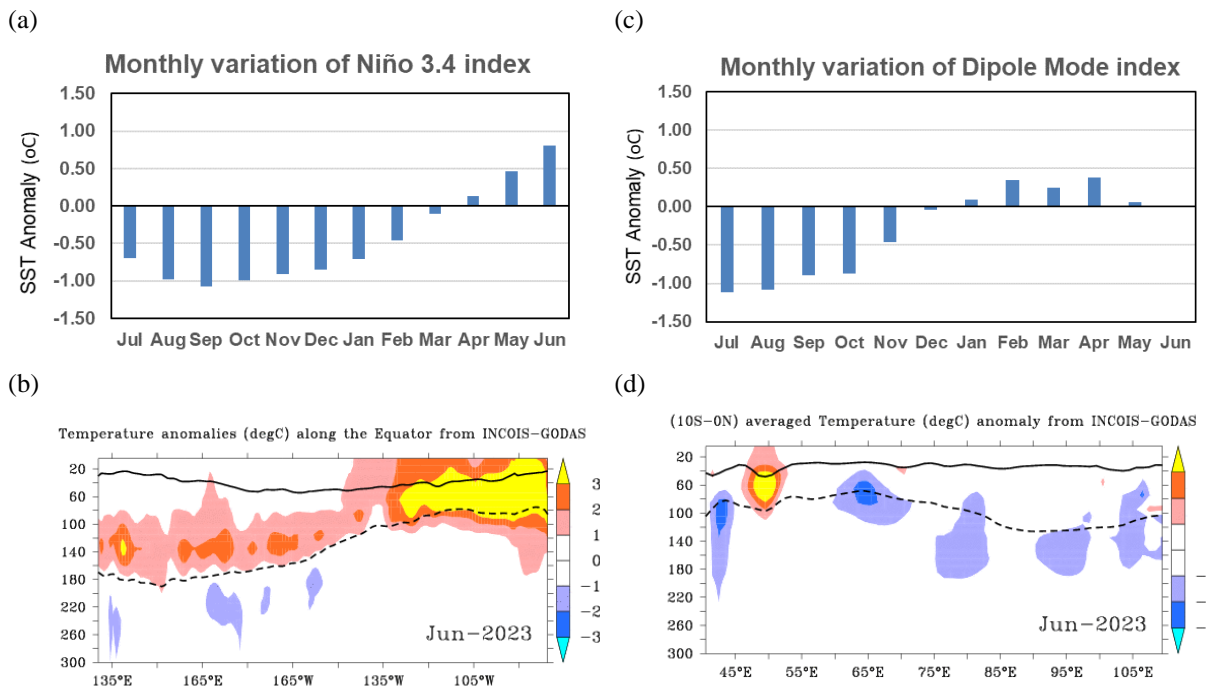

Fig.2: (a) Monthly variation of Niño 3.4 SST index for the last 12 months and**(b)** Depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of June 2023**. (c)**Same as (a) but for Dipole Mode Index (DMI). **(d)**Same as (b) but for the tropical Indian Ocean (10°S-Eq). The anomalies in (a) and (c) were computed using the base period of 1991-2020 (Data

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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 2023 June 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 1991-2020 climatology.

The 3-month season averaged SST anomaly forecast (Fig.3) indicates that positive SST anomalies are likely over most parts of the central and eastern equatorial Pacific Ocean for the entire forecast period. Currently, the sea surface temperatures (SSTs) are above average over most of the equatorial Pacific Ocean and weak El Niño conditions are prevailing. The latest MMCFS Plume forecast (Fig.4a) indicate that El Niño conditions are likely to continue until the end of this year. The probability forecast for ENSO indicates the enhanced probability for El Niño conditions (Fig.5a) during all the forecasted seasons. IMD is closely monitoring the El Nino conditions and monthly updates are provided as per observed changes in the Pacific Ocean.

As per the latest MMCFS forecast, the prevailing neutral IOD conditions are likely to turn to positive IOD conditions during the upcoming season (Fig.4b). The probability forecast for IOD (Fig.5b) indicates about 75% probability for positive IOD conditions and 25 % of probability for the development of a neutral IOD during July-September 2023 season.
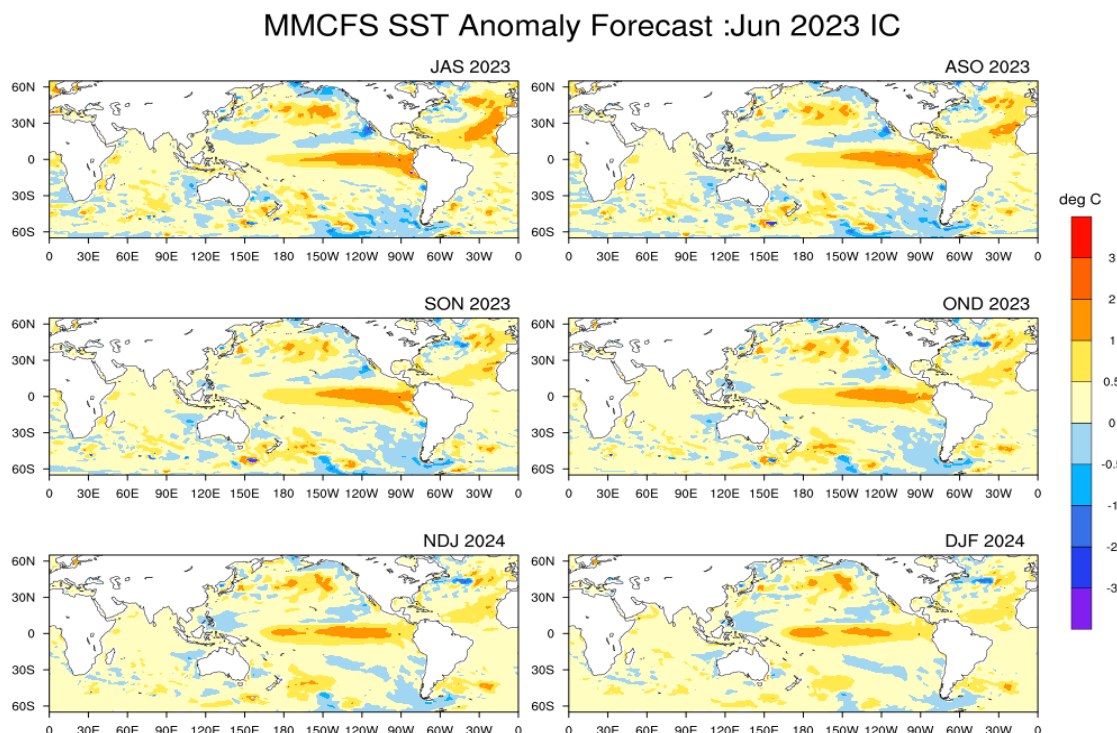

Fig.3: Forecasted Seasonal mean SST anomalies for three monthly (a) July to September (JAS 2023), (b) August to October (ASO 2023) (c) September to November (SON 2023), d) October to December (OND 2023), (e) November 2023 to January 2024 (NDJ 2024) and (f) December 2023 to February 2024 (DJF 2024). (Model bias correction base period: 1999-2008; Climatology base period:1991-2020).
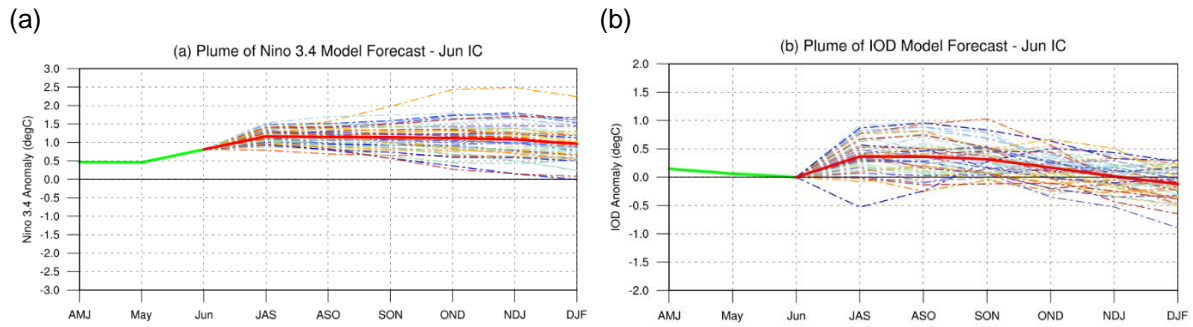
Fig.4: Plume of**(a)**Niño 3.4 SST index, **(b)**Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of50members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.
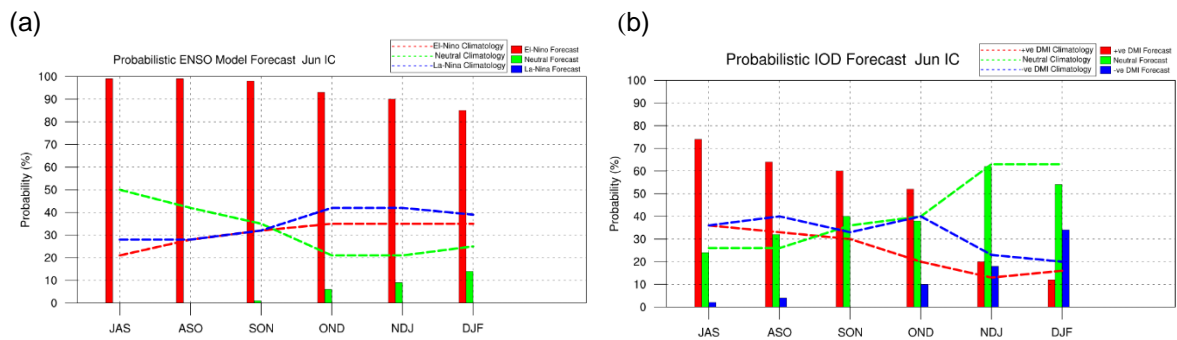

Fig.5: Probability forecast along with climatological probabilities of(a)Niño 3.4 and(b)Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5, Neutral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