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

June 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 throughout the forecast period. Other climate models are also indicating enhanced probability for La Niña conditions during the upcoming season.

At present neutral IOD conditions are present over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to develop during the upcoming season.

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

During May 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, cooling of SST anomalies were observed over the equatorial eastern Pacific Ocean (Fig.1b) and warming of SST anomalies were observed over north subtropical Pacific Ocean.

In the north Indian Ocean, warm SST anomalies were observed over the most parts of the Arabian Sea and Bay of Bengal. Also, there were positive SST anomalies observed over most parts of the south Indian Ocean (Fig. 1a). As compared to the last month, cooling of SST anomalies were observed over the most parts of north Indian Ocean and maximum cooling were observed head Bay of Bengal and northeast 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 June 2021 to May 2022 is shown in Fig.2a. Neutral (cool) ENSO conditions were observed during June-July 2021. The cool SST anomalies over the eastern equatorial Pacific started strengthening during August 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. Currently, moderate La Niña conditions are prevailing over the Pacific. In the month of May 2022, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20° isotherm and thermocline depth) (Fig.2b) which were extending up to 130^{0}W. The subsurface temperature anomalies were slightly negative below the thermocline depth over the eastern Pacific Ocean extending from 120°W to $85\,^{\circ}$W.

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 June 2021 to May 2022 is shown in Fig.2c. During June 2021, a weak negative IOD conditions were observed over the Indian Ocean which were weakened slightly in the month of July and August. During September, the negative IOD was weakened further and turned into neutral IOD conditions. During the months from October 2021 to April 2022, the DMI was negative side of its normal. At present neutral IOD conditions are prevailing over the Indian Ocean. In the month of May 2022, positive subsurface temperature anomalies (Fig. 2d) were seen over the western and eastern equatorial Indian Ocean between 20°C isotherm and thermocline depth with a stronger magnitude between 90°E and 105°E.
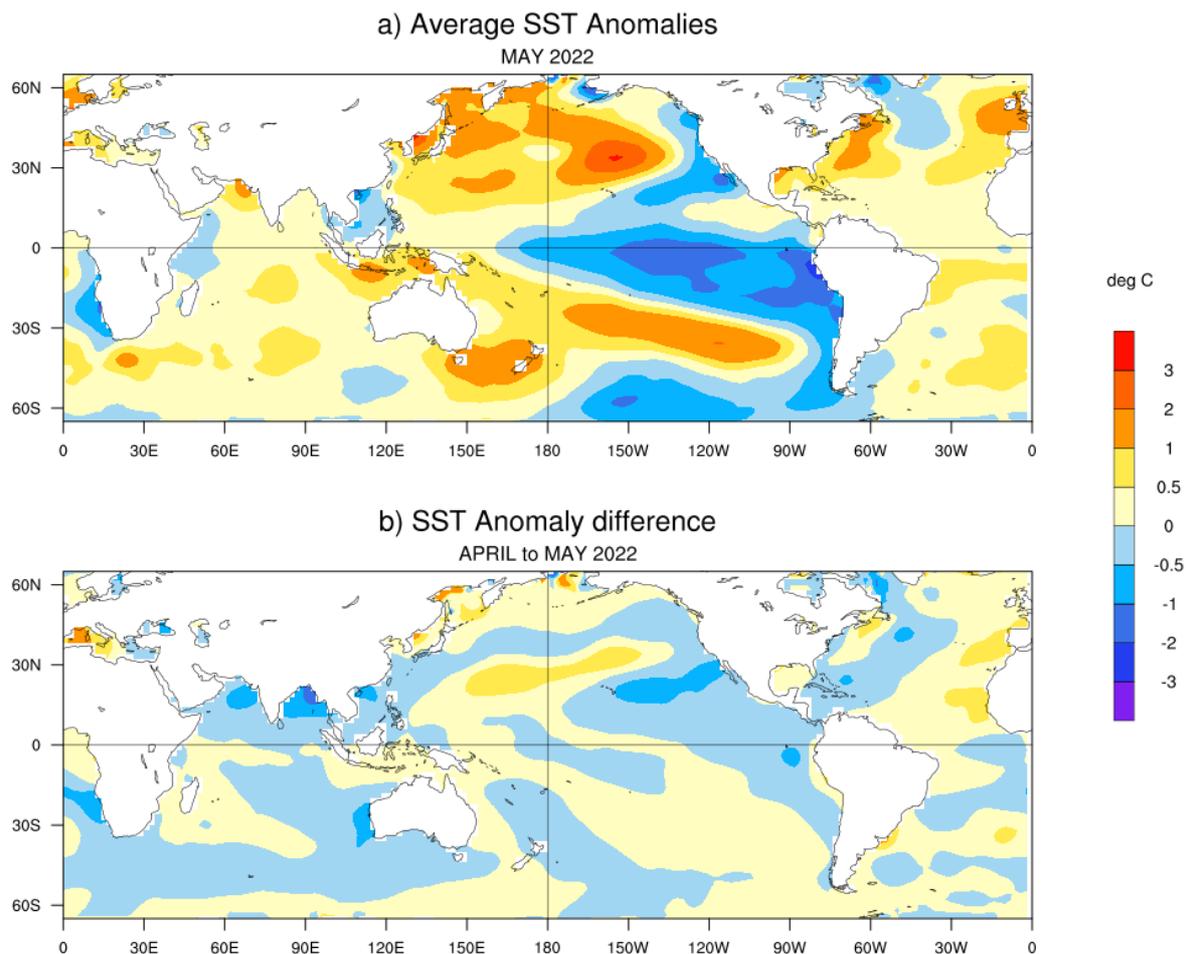

Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during May 2022 and **(b)** changes in the SST anomalies (°C) from April 2022 to May 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.
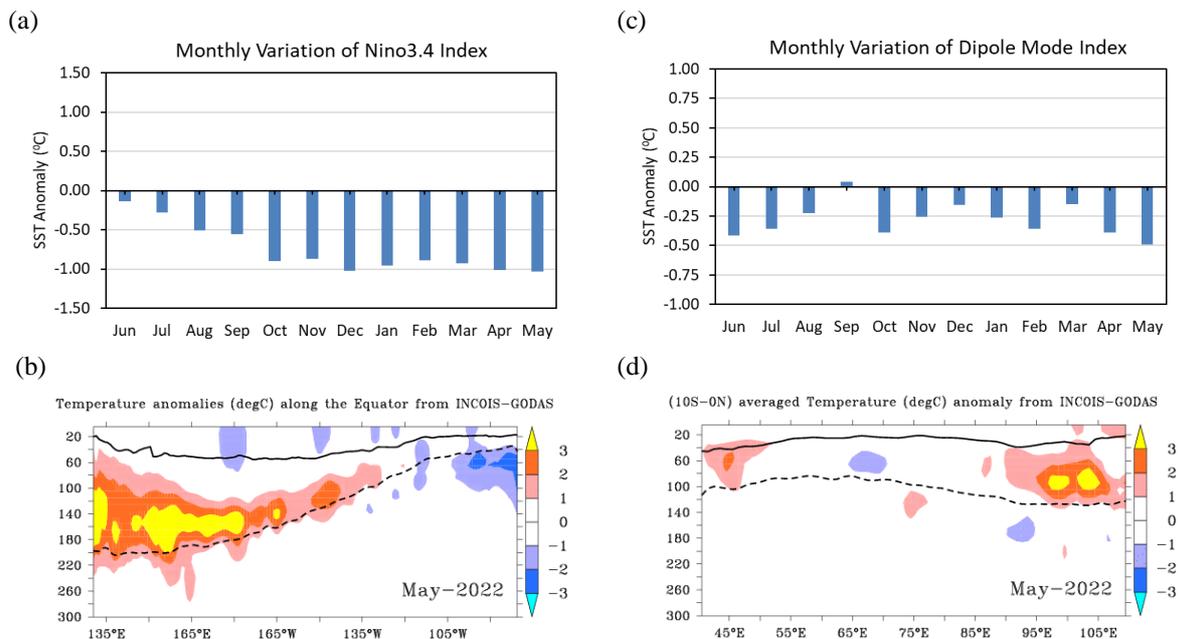
(a)

(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 ocean temperature anomalies in the equatorial (5°S-5°N) the Pacific Ocean for the month of May, 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 May 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 for the entire forecast period. Currently, moderate 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 the enhanced probability for La Niña conditions is likely during most of the forecasted seasons. 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 eastern Indian Ocean for next couple of seasons. Also, SST anomalies in the parts of the Arabian Sea are likely to turn into negative SST anomalies by the next couple of seasons (Fig.3). At present neutral IOD conditions are present over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to develop starting from May to July (MJJ) season (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates the enhanced probability for negative IOD conditions from MJJ season.
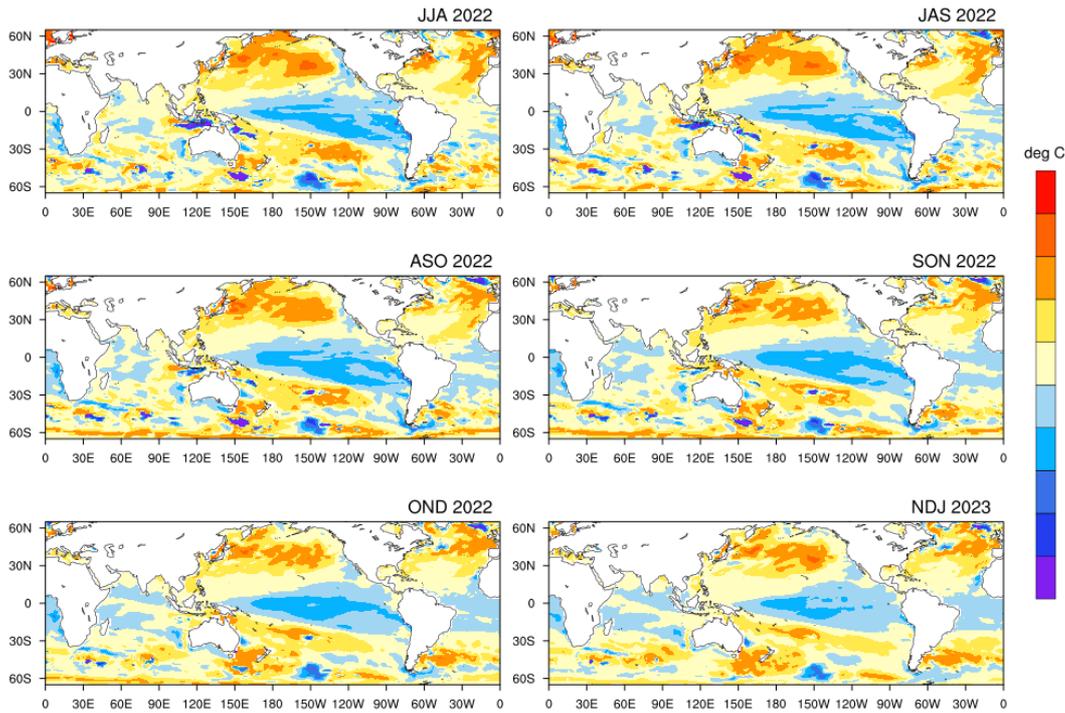
MMCFS SST Anomaly Forecast : May 2021 IC

Fig.3: Forecasted Seasonal mean SST anomalies for three monthly seasons, (a) June to August (JJA), (b) July to September (JAS), (c) August to October (ASO), (d) September to November (SON), and (e) October to December (OND), and (f) November to January (NDJ) (Model bias correction base period: 1999-2008; Climatology base period:1982-2008).
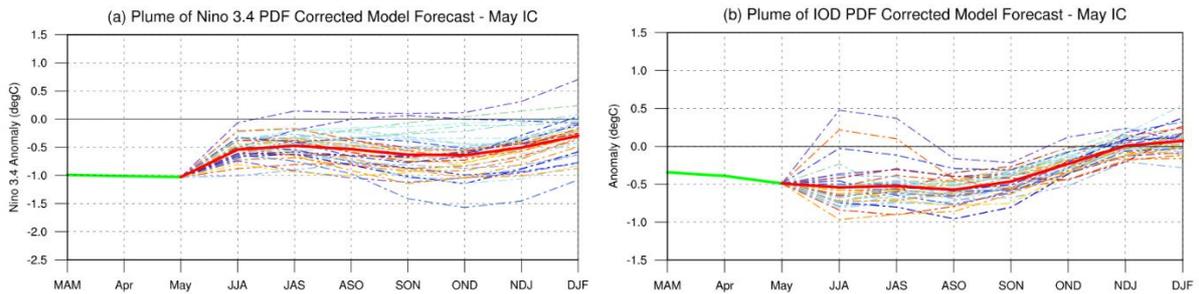

Fig.4: Plume of **(a)** Niño 3.4 SST index, **(b)** Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 55 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.
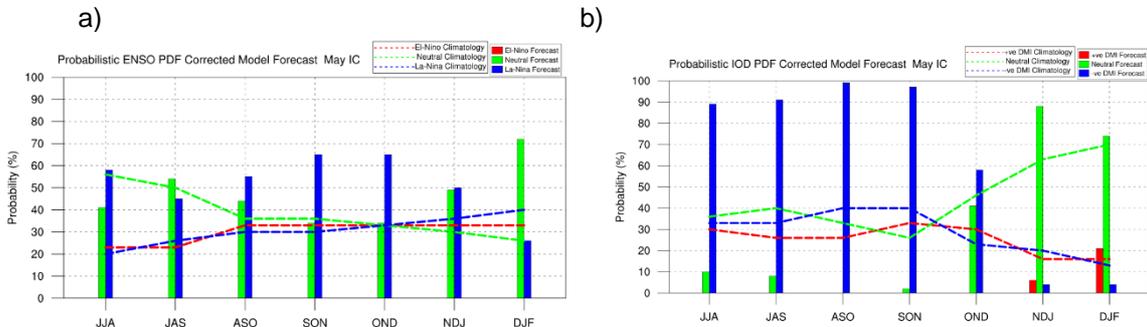

Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5, Neutral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