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

October 2022

Highlights

The 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 the first quarter of next year. Other climate models are also indicating continuation of La Niña conditions until December to February (DJF) 2023 season and turn to neutral ENSO conditions thereafter.

The negative IOD conditions are prevailing over the Indian Ocean since June 2022. The latest MMCFS forecast indicates that the negative IOD conditions are likely to weaken and turn to neutral IOD conditions by the end of this year.

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

During September 2022 cooler than normal SSTs were observed across the central and 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. Also, warm SST anomalies were observed over most parts of the northern Pacific Ocean. As compared to the last month, cooling of SST anomalies were observed extending over central to eastern equatorial Pacific Ocean (Fig.1b). Cooling of SST anomalies were also observed over central north and extreme northwest Pacific Ocean.

In the north Indian Ocean, negative SST anomalies were observed over the southern parts of Arabian Sea and positive SST anomalies over Bay of Bengal and north Arabian Sea. A positive SST anomaly was observed over eastern equatorial Indian Ocean and negative SST anomalies were observed over western equatorial Indian Ocean, resembling with the characteristics of negative Indian Ocean Dipole. 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 north Bay of Bengal and warming of SST anomalies were over north 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 October 2021 to September 2022 is shown in Fig.2a. The La Niña conditions were prevailing from October 2021 to May 2022. The strength of La Niña conditions was decreased during June and July 2022 and then again strengthened during August and subsequent month of September 2022. Currently, La Niña conditions are prevailing over the Pacific. In the month of September 2022, positive subsurface temperature anomalies were observed over the western Pacific Ocean (between 20° isotherm and thermocline depth) which were extending up to

175^{0}W (Fig.2b). However, the subsurface temperature anomalies were negative in the subsurface regions of 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 October 2021 to September 2022 is shown in Fig.2c. During October 2021 to April 2022, neutral IOD conditions were observed over the Indian Ocean and the DMI was negative side of its normal. The negative DMI value strengthened from May to July 2022 and slightly weakened during August-September 2022. At present negative IOD conditions are present over the Indian Ocean. In the month of September 2022, positive subsurface temperature anomalies (Fig. 2d) were seen over the western and eastern equatorial Indian Ocean between 20°C isotherm and thermocline depth and a weak negative subsurface temperature anomaly were observed over central equatorial Indian Ocean.
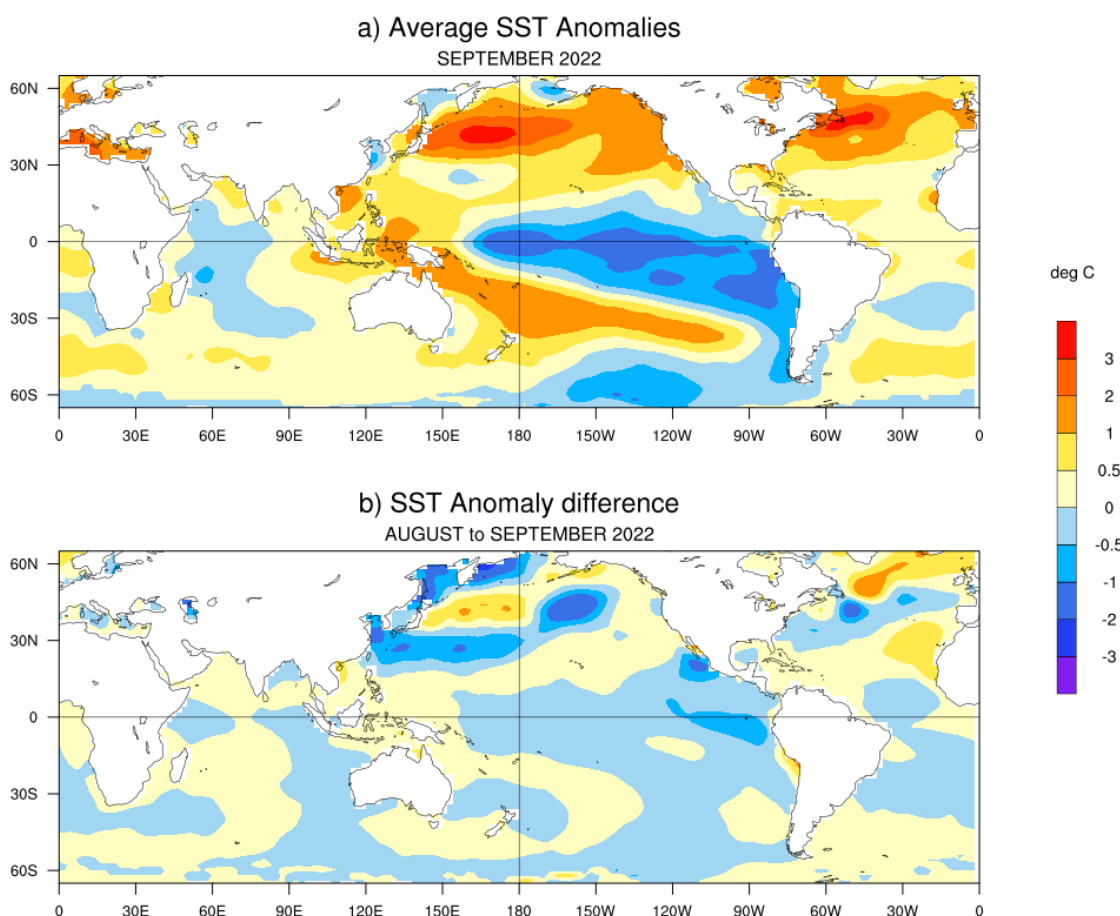

Fig.1: (a) Sea surface temperature (SST) anomalies (^{o}C) during September 2022 and **(b)** changes in the SST anomalies (^{o}C) from August 2022 to September 2022. SSTs were based on the ERSSTv5, NOAA, and anomalies were computed with respect to 30-year (1981-2010) long term mean.
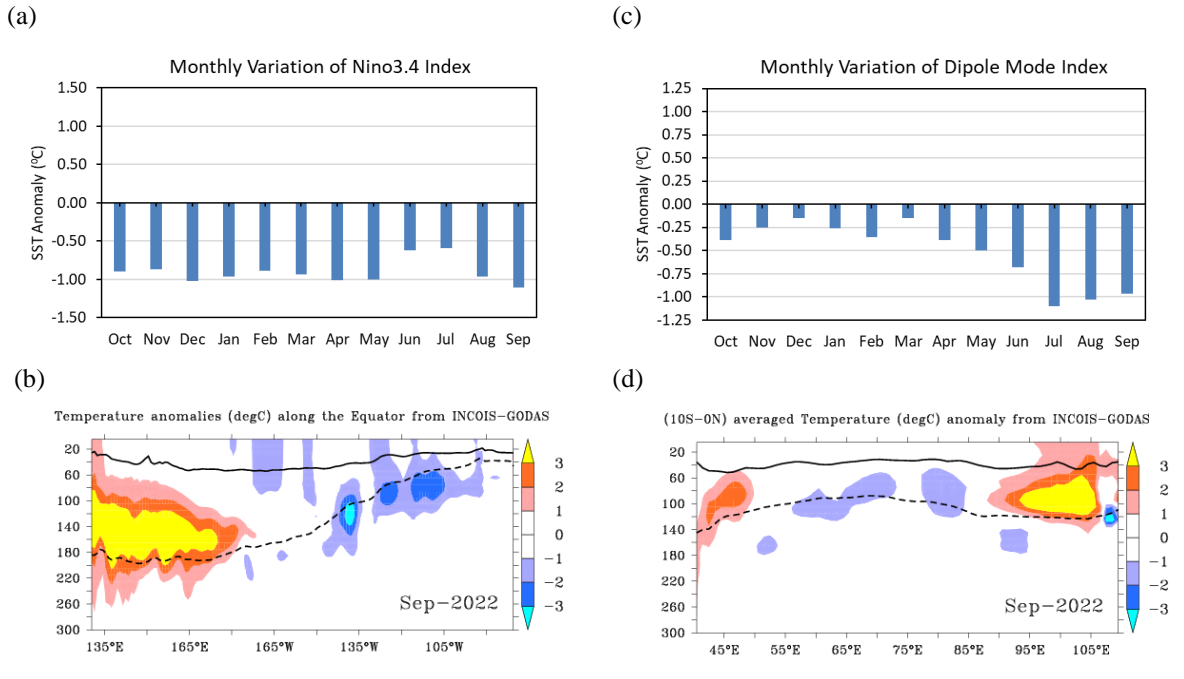
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(a)

Monthly Variation of Nino3.4 Index

(c)

Monthly Variation of Dipole Mode Index

(b)

Temperature anomalies (degC) along the Equator from INCOIS-GODAS

Sep-2022

(d)

(10S-0N) averaged Temperature (degC) anomaly from INCOIS-GODAS

Sep-2022

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 September, 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 September 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 DJF 2023 season and likely to weaken thereafter. Currently, the La Niña conditions are prevailing over the equatorial Pacific region. The latest MMCFS forecast indicates that La Niña conditions are likely to continue until the first quarter of next year and turn to neutral ENSO conditions thereafter (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 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 until OND 2022 season. At present the negative IOD conditions are prevailing over the Indian Ocean and the latest MMCFS forecast indicates that the negative IOD conditions are likely to weaken and turn to neutral IOD conditions by the end of this year (Fig.4b). The probability forecast for IOD (Fig.5b) also indicates the enhanced probability for negative IOD conditions during OND season and neutral IOD conditions thereafter.

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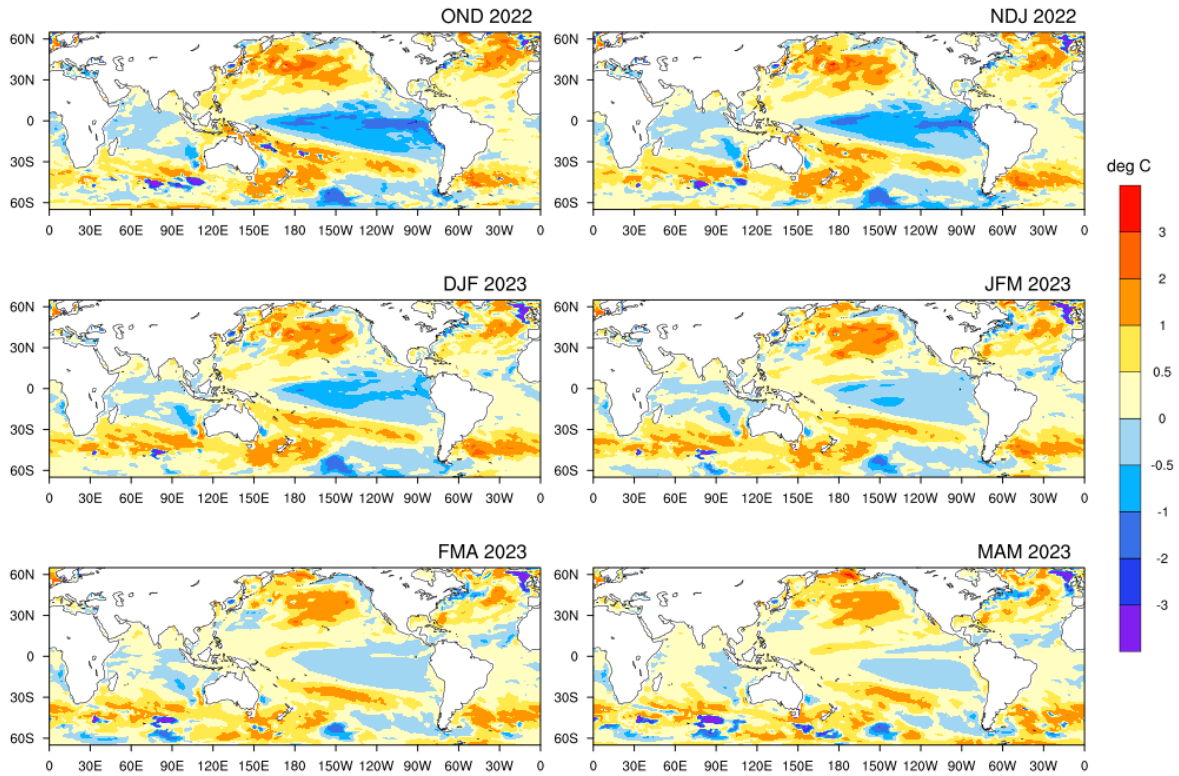## MMCFS SST Anomaly Forecast : Sep 2022 IC

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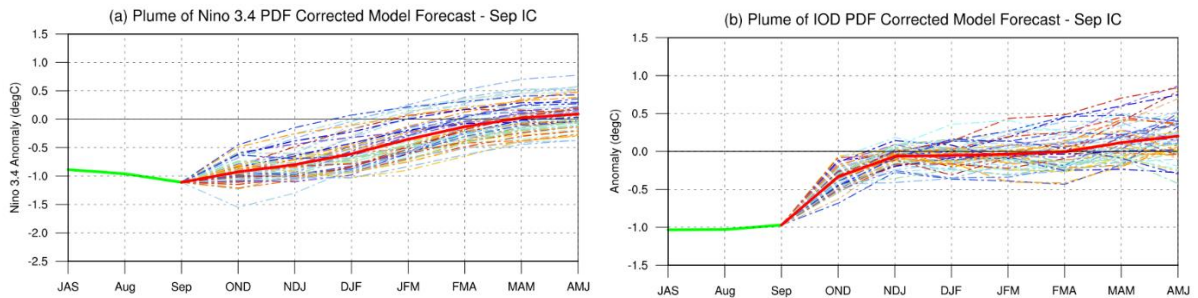

Fig.4: Plume of **(a)** Niño 3.4 SST index, **(b)** Indian Ocean Dipole Mode Index forecasted by high-resolution MMCFS. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and the solid red line is the ensemble mean SST anomaly forecast of 54 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.
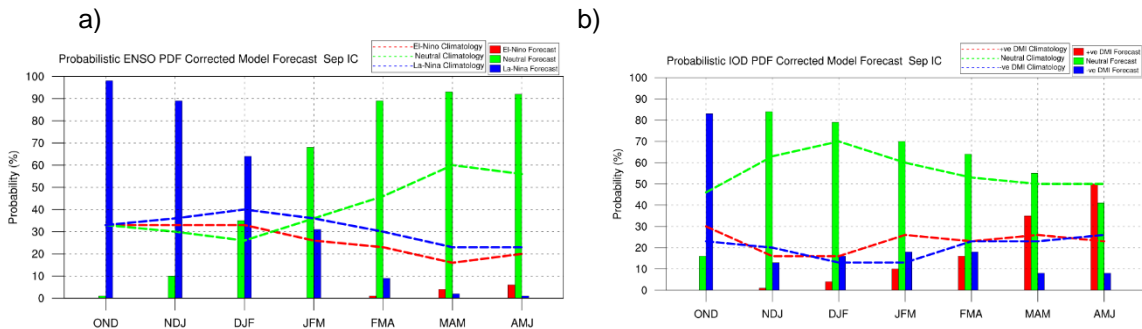

Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high-resolution MMCFS. The data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: La Niña ≤ -0.5, Neutral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