



**Earth System Science Organization (ESSO)  
Ministry of Earth Sciences (MoES)  
India Meteorological Department**

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

**August 2019**

**Highlights:**

Currently, ENSO-neutral conditions are prevailing over equatorial Pacific Ocean with below average sea surface temperatures in the eastern equatorial Pacific Ocean and above average SSTs in the central Pacific. Latest MMCFS forecast indicates these conditions are likely to continue during remaining part of the monsoon season.

At present, positive IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates positive IOD conditions are likely to continue during the monsoon season.

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

During July 2019, warmer than normal SST anomalies were observed over west and central parts of the equatorial Pacific Ocean and cooler than normal SST anomalies were observed over eastern parts of equatorial Pacific Ocean (Fig.1a). Positive SST anomalies were observed over most parts of the north Pacific Ocean and central parts of south Pacific Ocean. Negative SST anomalies were observed in some parts of north central and eastern part of southern Pacific Ocean. As compared to the last month, cooling of SSTs is seen over most of the Pacific Ocean except northeastern part of north Pacific Ocean and a small region of south west Pacific (Fig.1b).

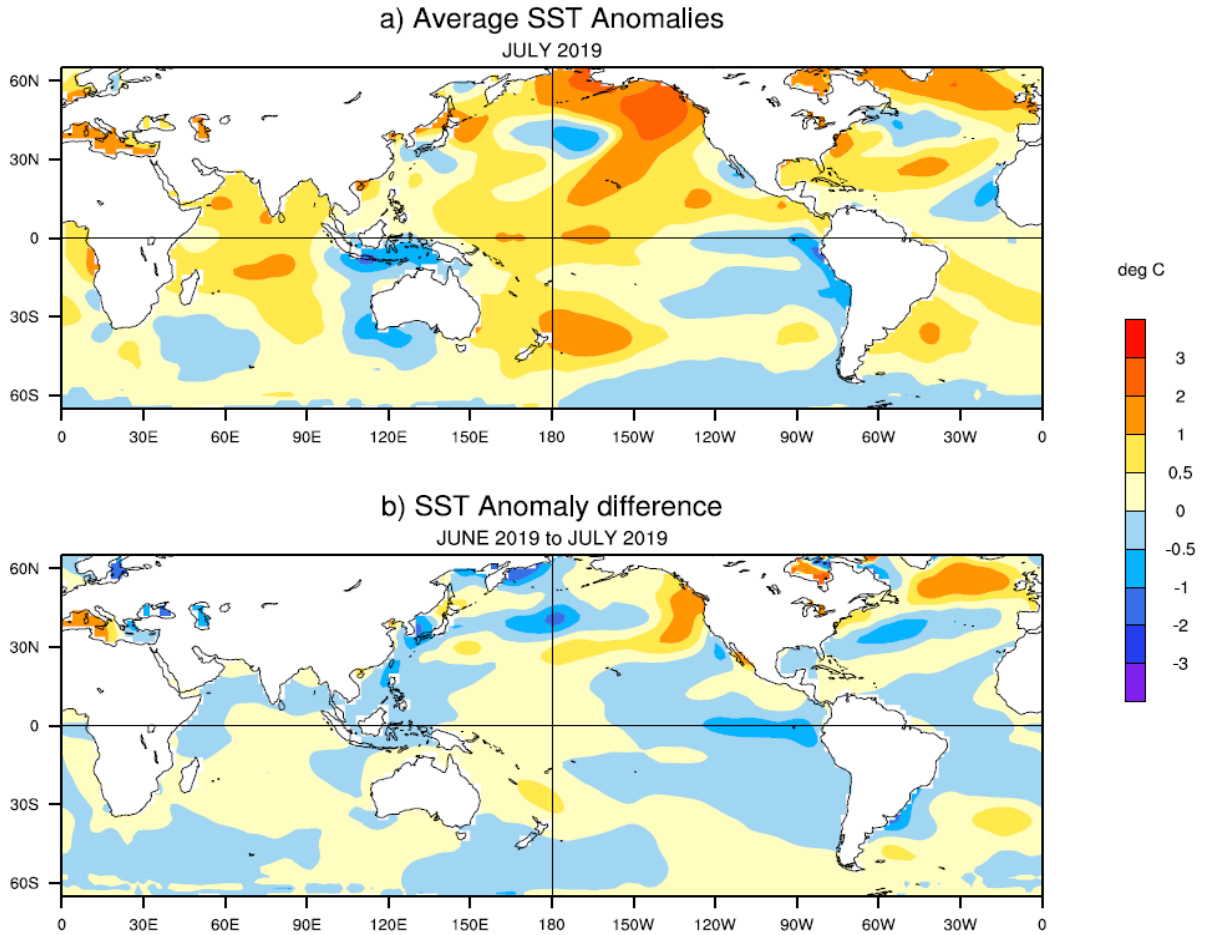
Warmer than normal SST anomalies were observed over most parts of Arabian Sea and Bay of Bengal. Positive SST anomalies were observed over west Indian Ocean and negative SST anomalies were observed over parts of southeast Indian Ocean off the west coast of Australia and near Indonesian region (Fig.1a). During July, cooling of SSTs was observed over most parts of the Arabian Sea and Bay of Bengal. However, warming of SSTs observed in the central parts of the Indian Ocean compared to the last month.

**1.1. El Niño Southern Oscillation (ENSO) conditions over the Pacific Ocean**

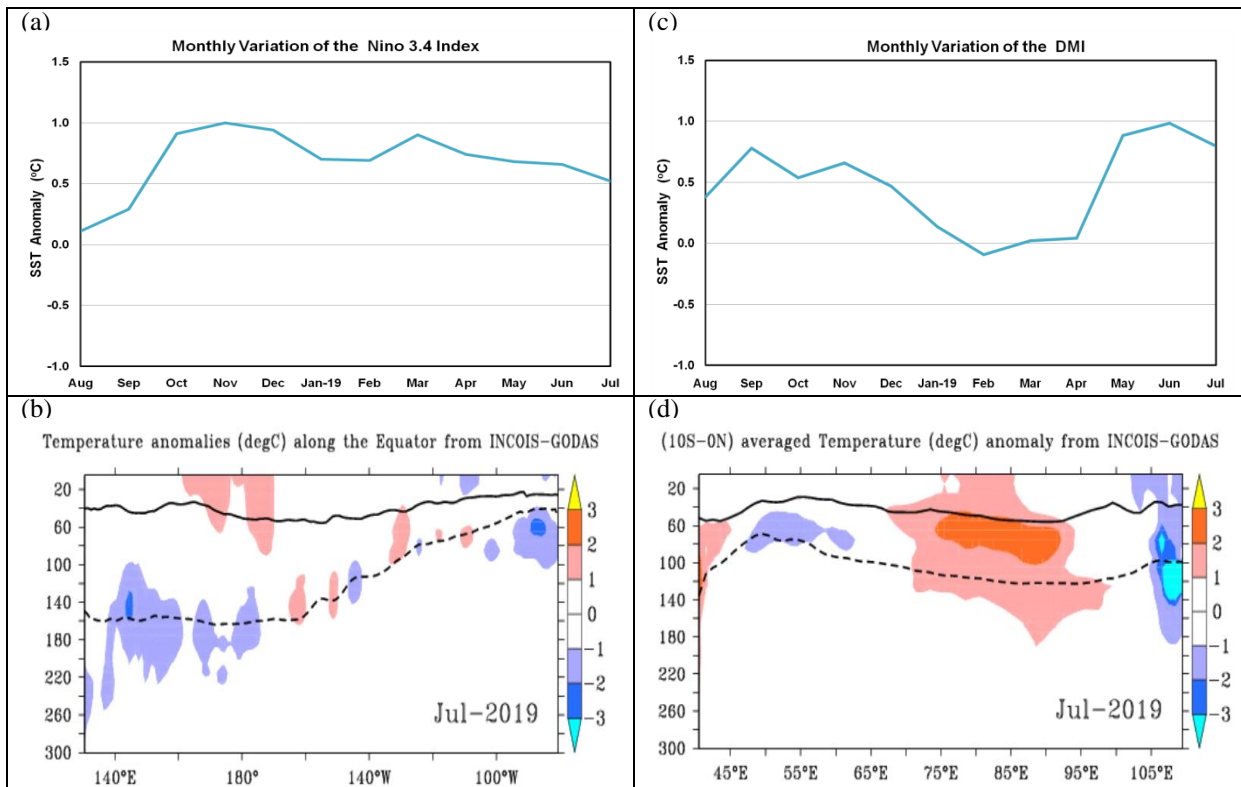
The monthly time series of Niño3.4 SST anomalies for the last 12 months i.e. from August 2018 to July 2019 (Fig.2a) suggests that ENSO neutral conditions from the month August 2018 continued till the month of September 2018. During October month, SST anomalies have crossed threshold value of El Niño conditions and continued till June 2019. During July, ENSO-neutral conditions are prevailing over the equatorial Pacific Ocean. The positive subsurface anomalies were observed over some parts of central and west equatorial Pacific Ocean above the 20°C isotherm (Fig.2 b) and negative subsurface anomalies were observed over parts of west and east equatorial Pacific Ocean with strongest magnitude spread over 80°W (at around thermocline depth).

**1.2. Indian Ocean Dipole (IOD) conditions over the Indian Ocean**

The DMI index for the last 12 months suggests that (Fig. 2c) in September neutral IOD conditions reached to positive IOD conditions and continued till November 2018. It turned into negative IOD conditions during December 2018 and subsequently turned into neutral IOD conditions during January 2019 and continued till April 2019. During month of May 2019 it again turned into positive IOD conditions and continued thereafter. Positive subsurface temperature anomalies (Fig. 2d) were seen over the parts of central equatorial Indian Ocean with stronger magnitude over 85°E-90°E and negative subsurface temperature anomalies were seen over the parts of east Indian Ocean at around thermocline depth with stronger magnitude over 110°E.



**Fig.1: (a)** Sea surface temperature (SST) anomalies ( $^{\circ}\text{C}$ ) during July, 2019 and, **(b)** changes in the SST anomalies ( $^{\circ}\text{C}$ ) from June 2019 to July 2019. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.



**Fig.2: (a)** Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial ( $5^{\circ}\text{S}$ - $5^{\circ}\text{N}$ ) Pacific Ocean for the month of July, 2019. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the tropical Indian Ocean ( $10^{\circ}\text{S}$ -Eq). The anomalies were computed using base period of 1981-2010, Data Source:ERSSTv5, NOAA. The solid dark line is the  $20^{\circ}\text{C}$  isotherm and the dashed line is thermocline depth, Data Source: INCOIS-GODAS.

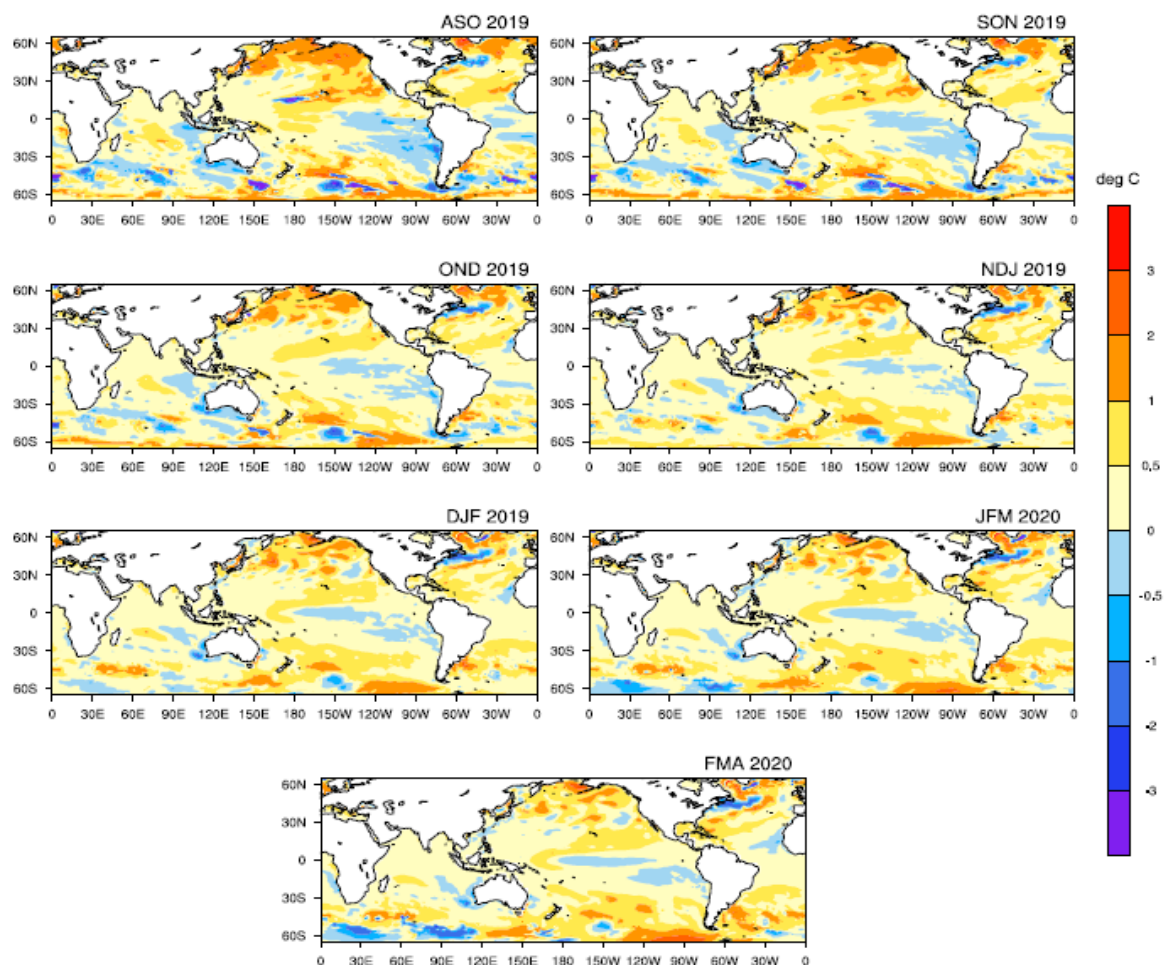
## 2. ENSO & IOD Forecast

The SST forecast were prepared using the high resolution Monsoon Mission Coupled Forecast System (MMCFS) (AGCM T382L64; 38 km and OGCM 25 km in tropics) based on the 2019 July 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.

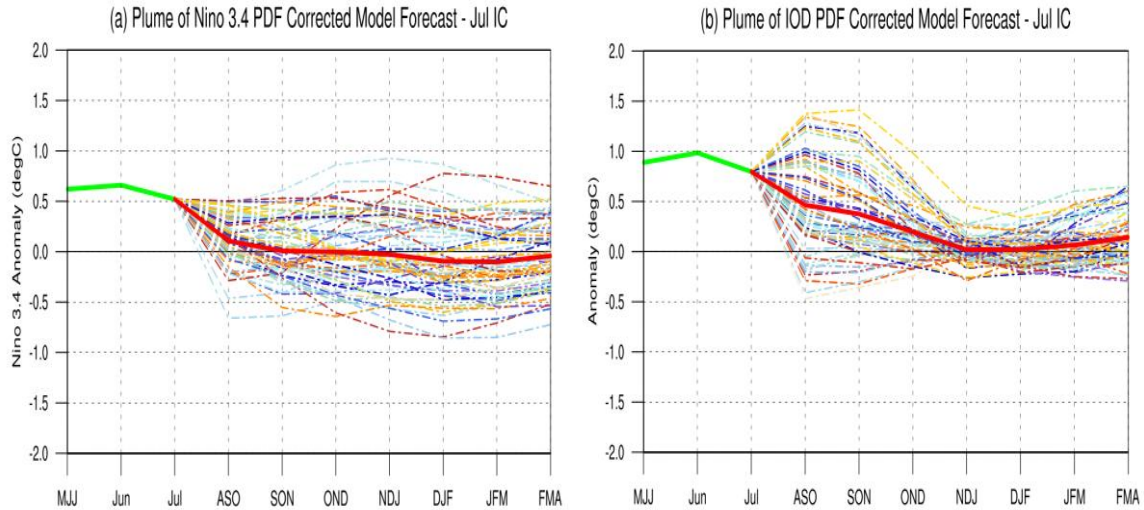
The 3-month season averaged SST anomaly forecast (Fig.3) indicate that warmer than normal SST anomalies are likely over some parts of central Pacific Ocean during ASO and SON seasons and this warming is likely to weaken in further forecasted seasons. Warmer than normal SST anomalies are also likely over northeast parts of north subtropical Pacific Ocean for most of the forecasted seasons. Cooler than normal SST anomalies over south east Pacific Ocean (extended up to some of the central parts towards west of it) are likely during most of the forecasted seasons. Currently, ENSO-neutral conditions with below average sea surface temperature in the eastern equatorial Pacific Ocean and above average SST in the central Pacific are prevailing over equatorial Pacific Ocean and latest MMCFS forecast indicates conditions are likely to continue during remaining part of the monsoon season (Fig.4a).

In the Indian Ocean, normal SST anomalies are likely in Bay of Bengal and Arabian Sea during the entire forecast period (Fig.3). Normal to warmer than normal SST anomalies are likely over west parts of equatorial Indian Ocean and cooler than normal SST anomalies are likely over eastern Indian Ocean off the west coast of Australia and around Indonesian region for most of the forecasted seasons. At present, positive IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates positive IOD conditions are likely to continue during the monsoon season (Fig.4b).

MMCFS SST Anomaly Forecast : Jul 2019 IC

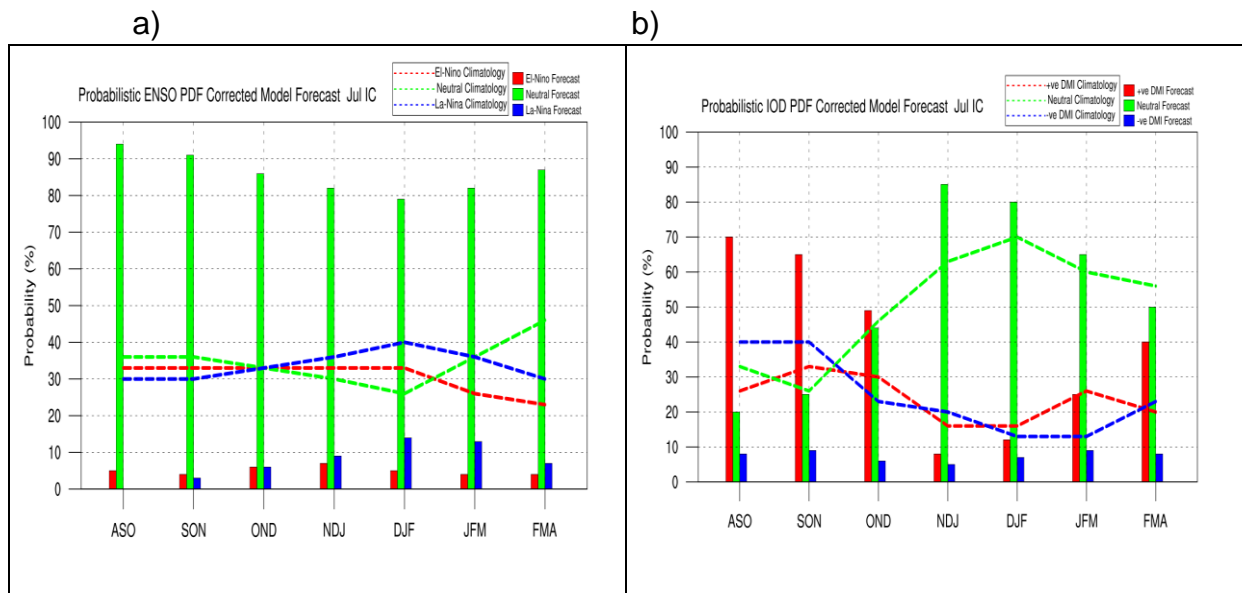


**Fig.3:** Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) August to October (ASO), (b) September to November (SON), (c) October to December (OND), (d) November to January (NDJ), (e) December to February (DJF), (f) January to March (JFM) and (g) February to April (FMA)(Model bias correction base period: 1999-2010; Climatology base period:1982-2010).



**Fig.4:** Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 59 members (MMCFS). The individual ensemble member forecasts are shown in light dotted lines of different colours.

### Probability Forecast for Niño 3.4 and India Ocean Dipole Mode Index



**Fig.5:**Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS .Data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast:  $\leq -0.5$  La Niña,  $>0.5$  to  $<-0.5$  neutral,  $\geq 0.5$  El Niño. Criteria used for Probabilistic DMI Forecast:  $\leq -0.2$  negative DMI,  $>0.2$  to  $<-0.2$  neutral,  $\geq 0.2$  positive DMI.

The probability forecast for ENSO (Fig.5a) indicates probability of neutral ENSO conditions is most likely for the entire forecast period.

The probability forecast for IOD (Fig.5b) indicates highest probability for positive IOD conditions during ASO and SON season. However, nearly equal probabilities for positive IOD and neutral IOD for OND season and highest probability for neutral IOD conditions is likely from NDJ season onwards till end of the forecast period.