



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

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

**April 2019**

**Highlights:**

Currently, weak El Niño conditions are prevailing over the equatorial Pacific Ocean and the latest MMCFS forecast indicates that these conditions are likely to weaken during the summer season.

At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates neutral IOD conditions are likely to turn into weak positive IOD conditions during coming forecasted seasons.

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

During March 2019, warm SST anomalies were observed over most parts of central to eastern equatorial Pacific Ocean and cool SST anomalies were observed over far west and extreme east equatorial Pacific Ocean (Fig.1a). Positive SST anomalies were observed over parts of north and south subtropical Pacific Ocean. Negative SST anomalies were observed in some parts of subtropical and southeast Pacific Ocean. Also, decrease in warming of SSTs is seen over some parts equatorial Pacific Ocean during March 2019. As compared to the last month, cooling of SST observed near date line and parts of southeast Pacific Ocean (Fig.1b). Cooling of SSTs is also seen over the northwest Pacific Ocean as compared to the last month.

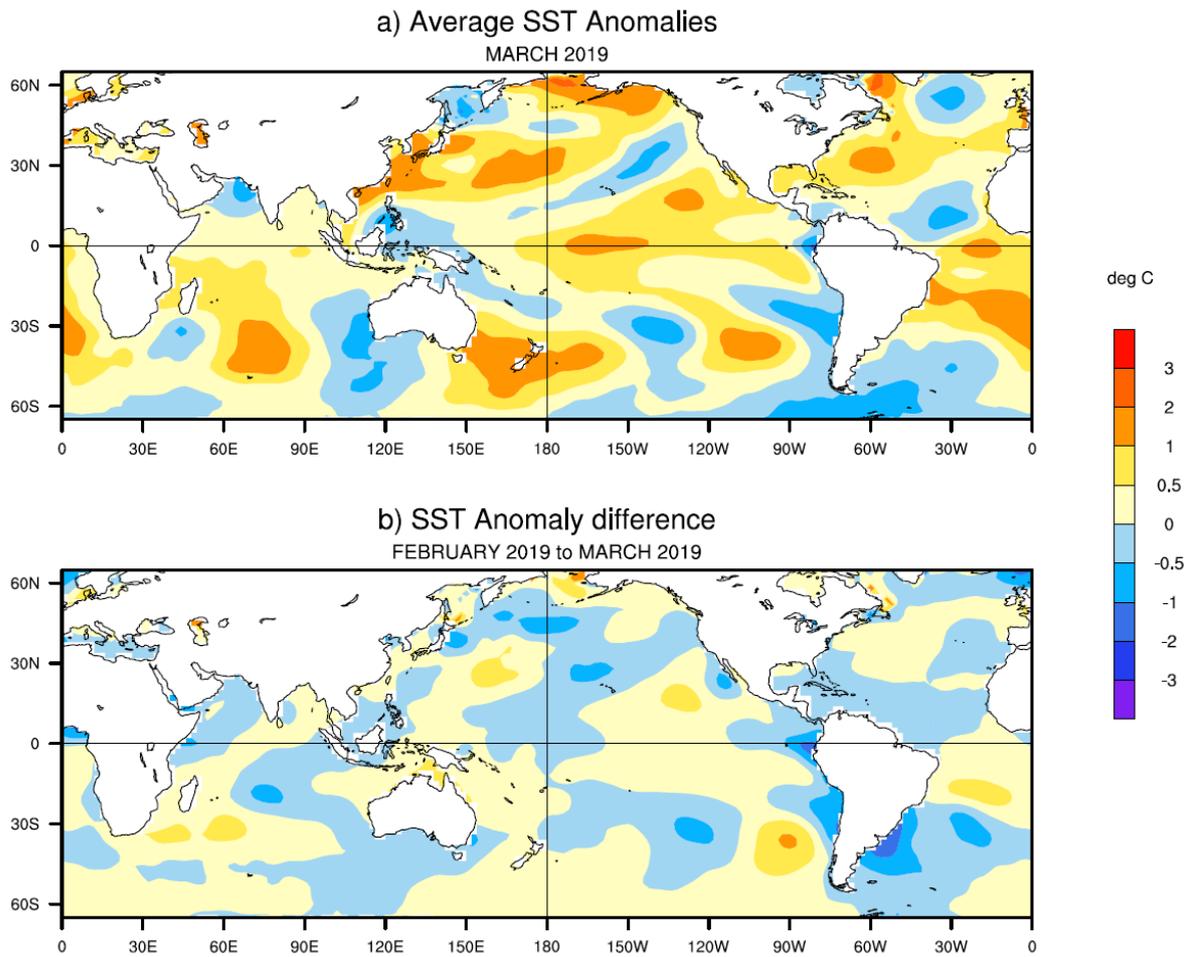
Normal SST anomalies were observed over the parts of Arabian Sea and Bay of Bengal. However, cooler than normal SST anomalies were observed over northern parts of Arabian Sea. Positive SST anomalies were observed over parts of west Indian Ocean and negative SST anomalies were observed over parts of east Indian Ocean off the west coast of Australia (Fig.1a). During March, cooling of SSTs was observed over most parts of the Arabian Sea and east Indian Ocean. However, warming of SSTs was also observed over parts of south of subtropical Indian Ocean (Fig.1b) as compared to the last month.

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

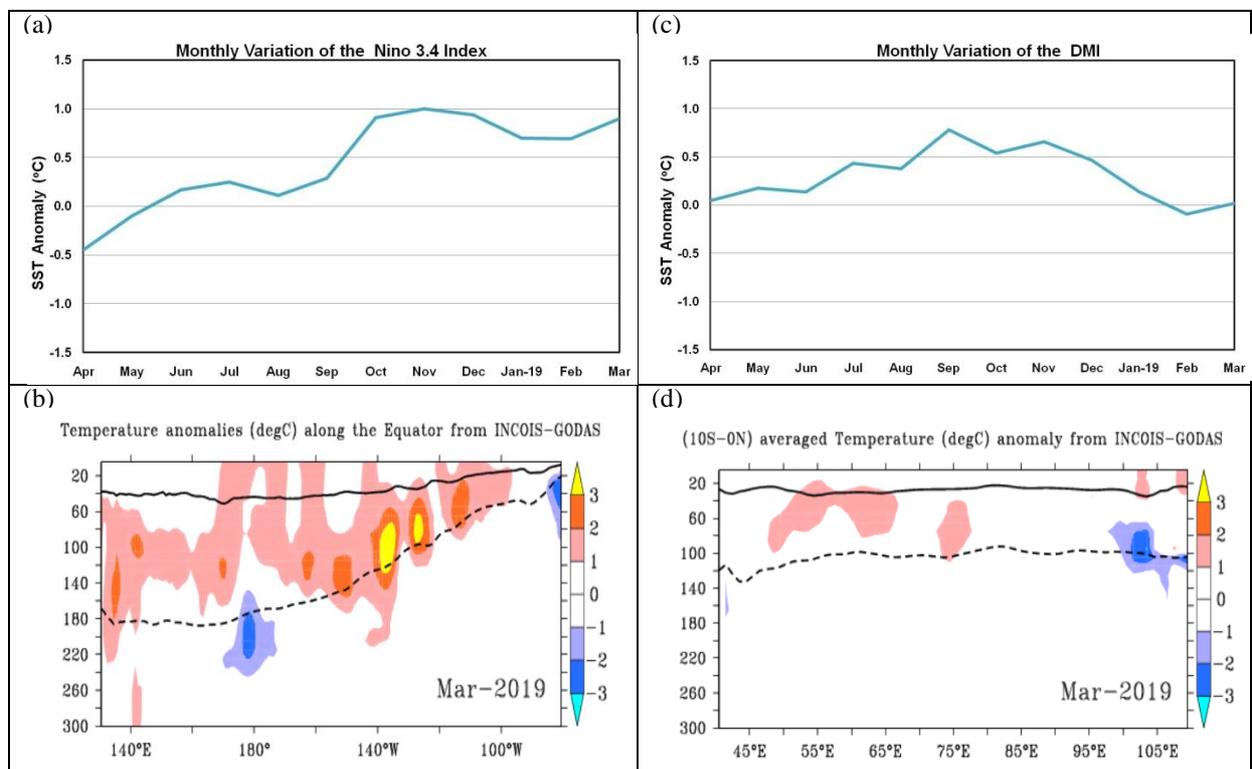
The monthly time series of Niño3.4 SST anomalies for the last 12 months i.e. from April 2018 to March 2019 (Fig.2a) suggests that prevailing ENSO neutral conditions from the month April 2018 continued till the month of September 2018. During October month, SST anomalies have crossed threshold value of El Niño conditions and continued till March 2019. Currently, weak El Niño conditions (SST anomalies between 0.5°C & 1.0°C) are prevailing over the equatorial Pacific. The positive subsurface anomalies were observed over most parts of the equatorial Pacific Ocean (Fig.2 b) (at around thermocline depth) with highest magnitudes spread at 150°W.

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

The DMI index for the last 12 months suggests that (Fig. 2c) neutral IOD conditions from April continued up to June 2018. In July, it reached to the threshold of positive IOD conditions and continued till December 2018. It turned into neutral IOD conditions during January 2019 and continued till March 2019. Positive subsurface temperature anomalies (Fig. 2d) were seen over the parts of west equatorial Indian Ocean (weaker magnitude) and negative subsurface temperature anomalies were seen over the parts of east Indian Ocean with stronger magnitude around 105°E at around thermocline depth.



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



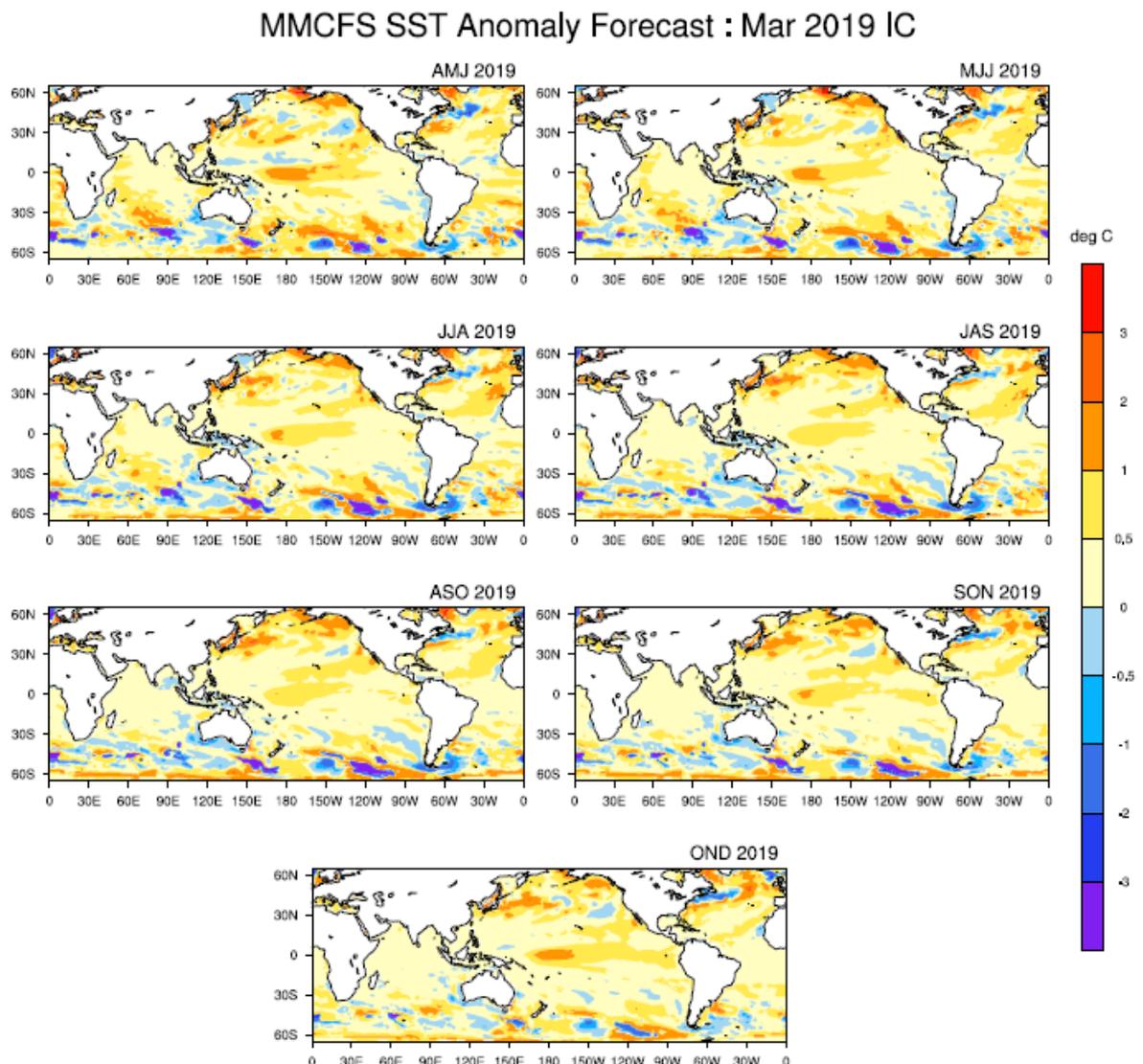
**Fig.2: (a)** Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial ( $5^{\circ}\text{S}$ - $5^{\circ}\text{N}$ ) Pacific Ocean for the month of March, 2019. **(c)** Same as (a) but for Dipole 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

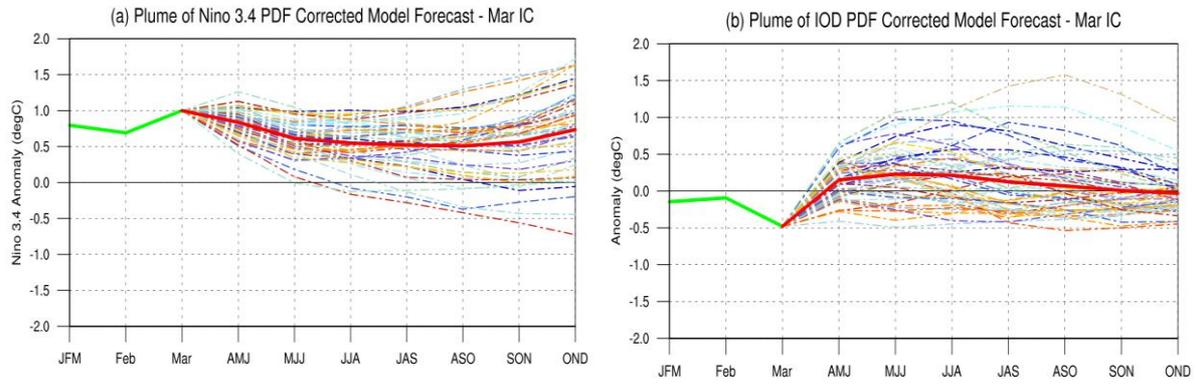
The SST forecast were prepared using the high resolution Monsoon Mission Coupled Forecast System (MMCFS) (AGCM T382L64; 38 km and OGCM 25 km in tropics) based on the 2019 March initial conditions. The initial conditions for the model runs were obtained from ESSO-INCOIS and ESSO-NCMRWF analysis. Probability 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 parts of west and central equatorial Pacific Ocean from AMJ to MJJ seasons. From JJA season onwards the strength of warming is likely to reduce till ASO season. However, from SON season, it is likely to have warmer than normal SST anomalies over parts of west central equatorial Pacific. Currently, weak El Nino conditions are prevailing over equatorial Pacific Ocean and latest MMCFS forecast indicates that these conditions are likely to weaken during summer season (Fig.4a).

In the Indian Ocean, normal SST anomalies are likely in Bay of Bengal and Arabian Sea during entire forecast period (Fig.3). Also, cooler than normal SST anomalies are likely over eastern Indian Ocean off the west coast of Australia and warmer than normal SST anomalies are likely over western Indian Ocean near east Africa coast. At present, neutral IOD conditions are present and MMCFS forecast indicates present these conditions are likely to turn into weak positive IOD conditions during coming forecasted seasons (Fig.4b).

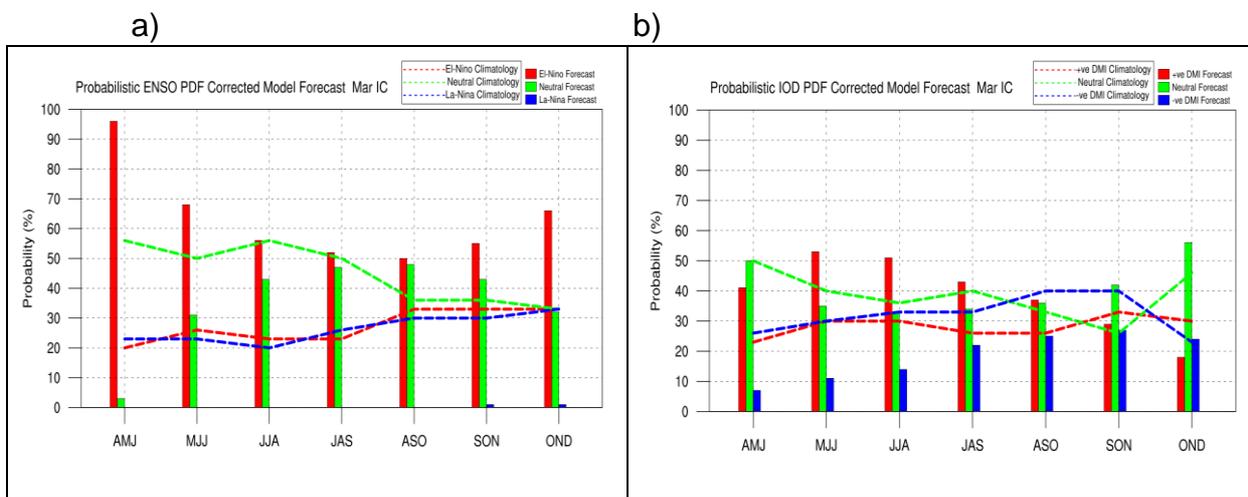


**Fig.3:** Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) April to June (AMJ), (b) May to July (MJJ), (c) June to August (JJA), (d) July to September (JAS), (e) August to October (ASO), (f) September to November (SON) and (g) October to December (OND) (Model bias correction base period: 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 56 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 maximum probability for El Niño conditions from AMJ to MJJ seasons. However, nearly equal probabilities are likely for neutral ENSO and El Niño conditions from JJA season to SON season.

The probability forecast for IOD (Fig.5b) indicates nearly equal probabilities for neutral and positive IOD conditions from during AMJ season. However, increased probability for positive IOD conditions is likely from MJJ season onwards.