



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

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

January 2019

#### Highlights:

Currently, ENSO neutral conditions are prevailing over equatorial Pacific Ocean and the latest MMCFS forecast indicates weak El Niño conditions are likely to develop in the coming months and continue for short period.

At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates present neutral IOD conditions are likely to persist for most of the forecasted seasons.

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

During December 2018, warm SST anomalies were observed over most parts of equatorial Pacific Ocean and cool SST anomalies were observed over southeast equatorial Pacific Ocean (Fig.1a). Positive SST anomalies were observed over parts of northwest Pacific Ocean as well as parts of the north and south subtropical Pacific Ocean. Also, increase in warming of SSTs is seen over the eastern parts of equatorial Pacific Ocean during December 2018. As compared to the last month, positive SST anomalies which were observed off the west coast of South America in November 2018 have slightly reduced in the December 2018 (Fig.1b). Also, warming in SSTs over central equatorial Pacific Ocean is decreased during the current month. And warming of SSTs is seen to be decreased over the northwest Pacific Ocean as compared to the last month.

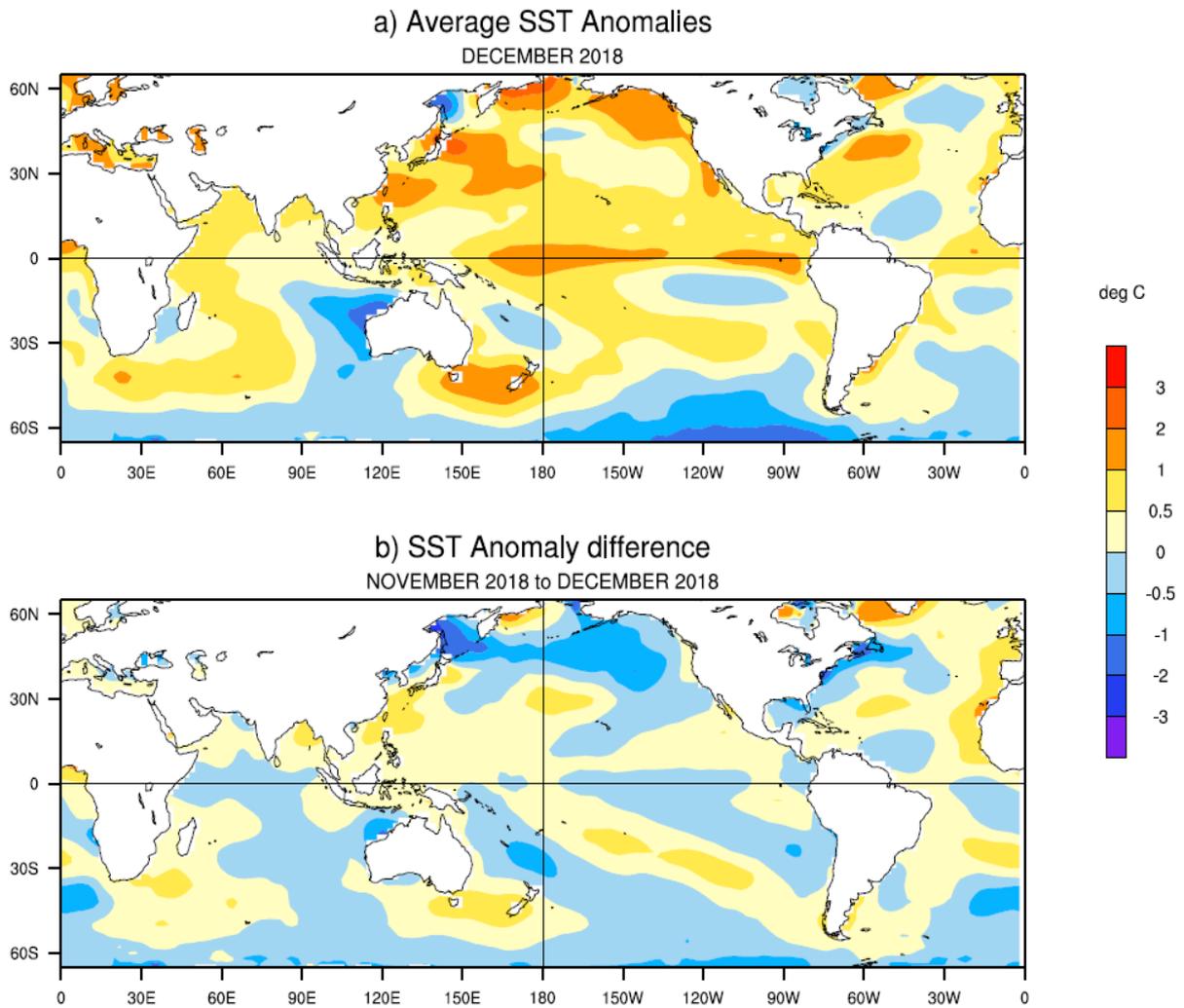
Normal to warmer than normal SST anomalies were observed over the parts of Arabian Sea and Bay of Bengal. However, positive SST anomalies were observed over parts of west and central Indian Ocean and negative SST anomalies were observed over parts of east Indian Ocean near east head Bay of Bengal and south of Maritime Continents (Fig.1a). During December, warming of SSTs was observed over most parts of the Arabian Sea and Bay of Bengal. However, cooling of SSTs was observed over and around parts of central tropical Indian Ocean (Fig.1b) as compared to the last month.

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

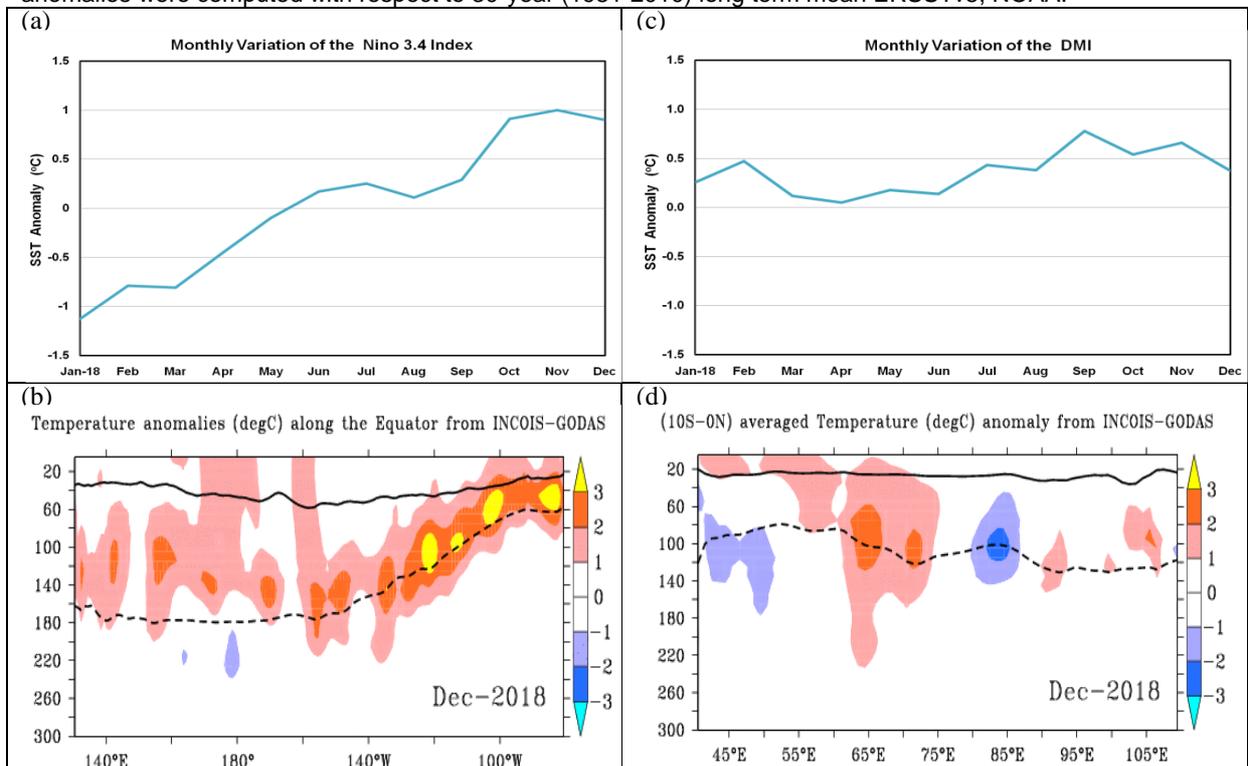
The monthly time series of Niño3.4 SST anomalies for the last 12 months i.e. from January 2018 to December 2018 (Fig.2a) suggests that La Niña conditions were prevailed till March 2018. Since April 2018, La Niña conditions turned into ENSO neutral conditions again and continued till September 2018. SST anomalies have crossed threshold value of El Niño conditions during October 2018 and continued till December 2018. Atmospheric conditions reflect ENSO-neutral pattern hence ENSO neutral conditions 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 around 120°W- 80°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 observed during January 2018, which reached to the threshold of positive IOD conditions during the month of February. Again it turned into neutral IOD conditions in March and continued up to June 2018. In July, it reached to the threshold of positive IOD conditions and continued till December 2018. Negative subsurface temperature anomalies (Fig. 2d) were seen over the parts of east-central equatorial Indian Ocean and positive subsurface temperature anomalies were seen over the parts of west-central Indian Ocean over 65°E - 75°E at around thermocline depth.



**Fig.1: (a)** Sea surface temperature (SST) anomalies ( $^{\circ}\text{C}$ ) during December, 2018 and, **(b)** changes in the SST anomalies ( $^{\circ}\text{C}$ ) from November 2018 to December 2018. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.

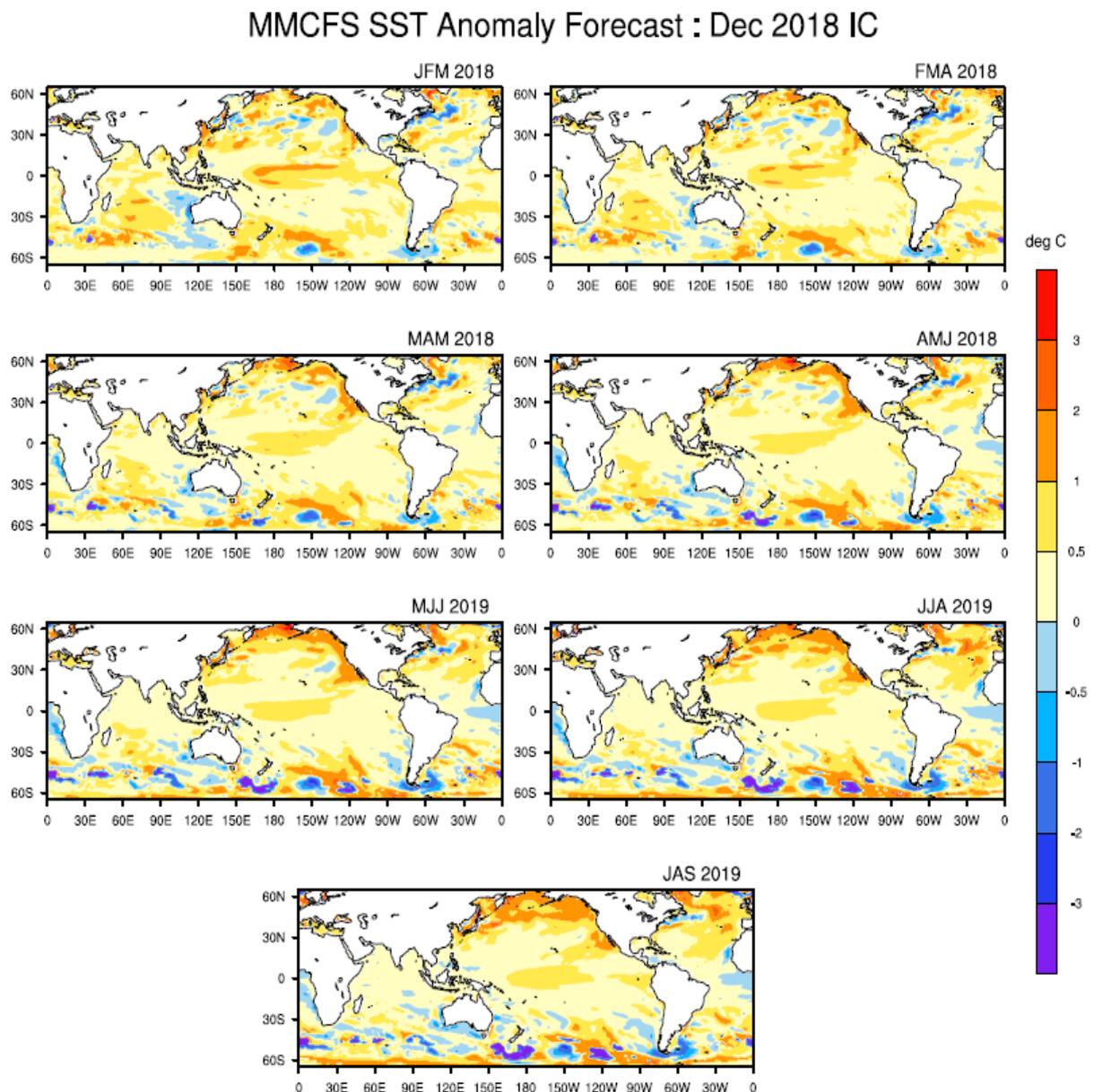


**Fig.2: (a)** Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5oS-5oN) Pacific Ocean for the month of December, 2018. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the tropical Indian Ocean (10oS-Eq). The anomalies were computed using base period of 1981-2010, Data Source:ERSSTv5, NOAA. The solid dark line is the 20oC isotherm and the dashed line is thermocline depth, Data Source: INCOIS-GODAS.

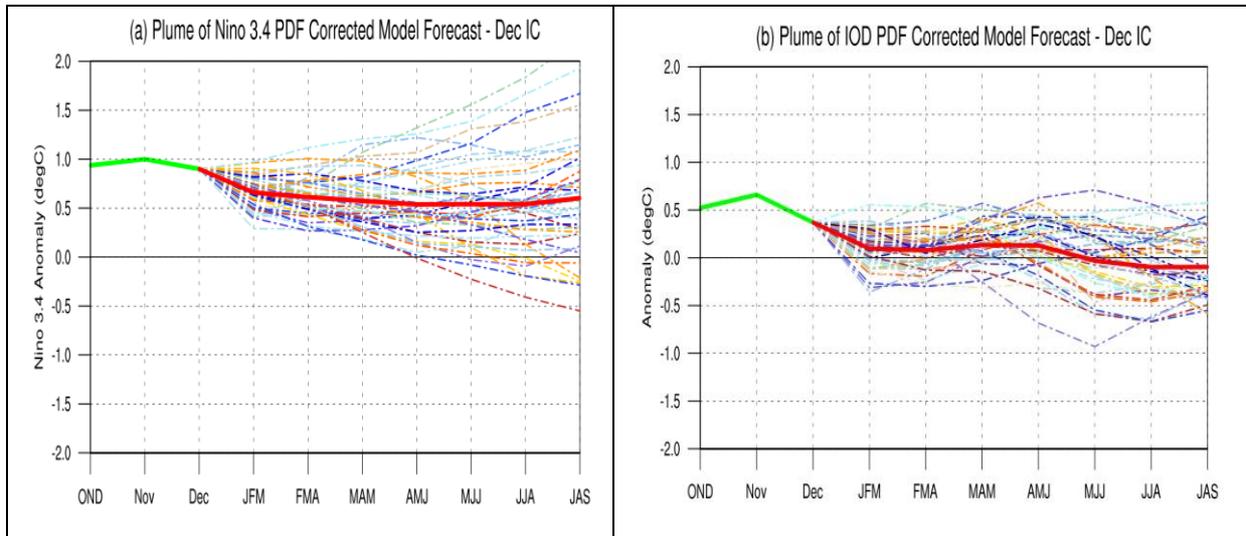
## 2. ENSO & IOD Forecast

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 2018 December 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 normal to warmer than normal SST anomalies are likely over parts of equatorial Pacific Ocean during most of the forecast period. Also, for most of the forecasted seasons above normal SSTs are likely over the parts of central Pacific Ocean. The latest MMCFS forecast indicates weakening of Niño 3.4 SST anomalies which has crossed threshold of El Niño conditions during last two months, however are likely to remain near to the threshold value during forecast period (Fig.4a). In the Indian Ocean, during most of the forecasted seasons, normal to above SST anomalies are likely in Bay of Bengal and Arabian Sea (Fig.3). Also, cool (or negative) SST anomalies are likely over eastern Indian Ocean off the west coast of Australia. MMCFS forecast indicates present neutral IOD conditions are likely to persist for coming forecasted seasons (Fig.4b).

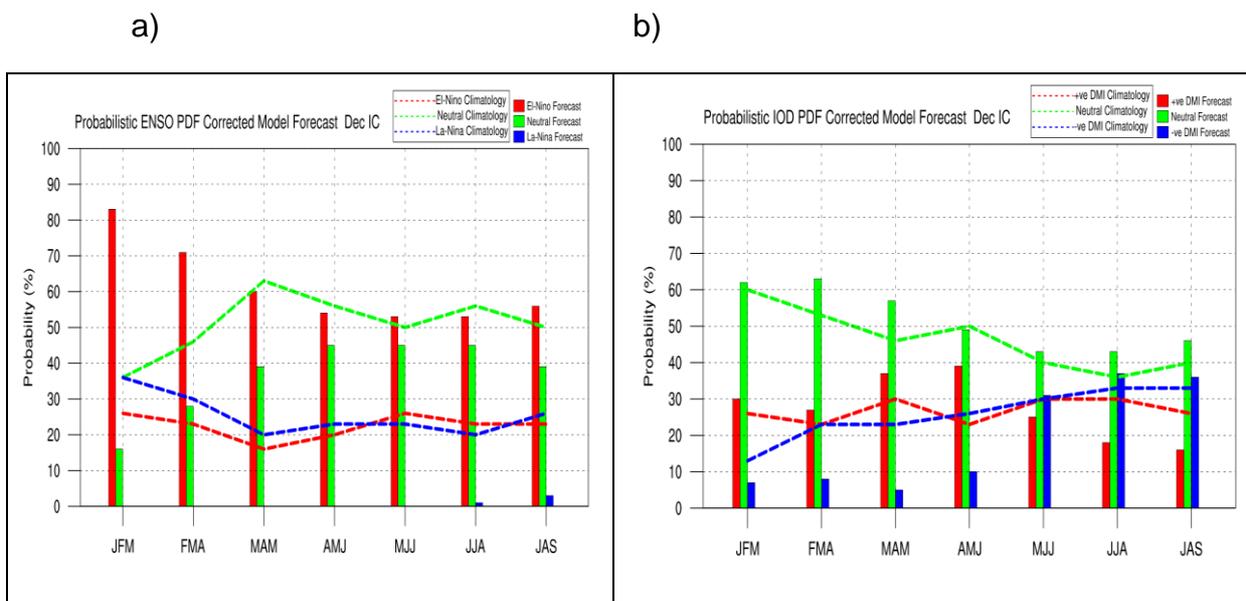


**Fig.3:** Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) January to March (JFM), (b) February to April (FMA), (c) March to May (MAM), (d) April to June (AMJ), (e) May to July (MJJ), (f) June to August (JJA) and (g) July to September (JAS) (Model bias correction base period: 1999-2010; 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 42 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 JFM to MAM seasons and it is likely to decrease thereafter.

The probability forecast for IOD (Fig.5b) indicates maximum probability for neutral IOD conditions for the coming forecasted seasons.