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

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

February 2019

Highlights:

Currently, warm ENSO neutral conditions are prevailing over equatorial Pacific Ocean and the latest MMCFS forecast indicates sea surface temperature anomalies are likely to remain near to the El Niño threshold value during FMA season. Neutral ENSO conditions are likely to prevail from MAM season onwards.

At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates present neutral IOD conditions are likely to persist up to FMA season and weak positive IOD conditions are likely to develop thereafter and continue for short period.

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

During January 2019, 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 most part of north Pacific Ocean as well as parts of the south subtropical Pacific Ocean. Also, increase in cooling of SSTs is seen over the south east parts of Pacific Ocean during January 2019. As compared to the last month, cooing of SST observed over entire equatorial Pacific Ocean (Fig.1b). Cooling of SSTs is also seen 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 Indian Ocean and negative SST anomalies were observed over parts of east Indian Ocean off the west coast of Australia (Fig.1a). During January, cooling of SSTs was observed over most parts of the Arabian Sea and head Bay of Bengal. However, warming of SSTs was also observed over east 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 February 2018 to January 2019 (Fig.2a) suggests that La Niña conditions were prevailed till March 2018. Since April 2018 La Niña conditions turned into ENSO neutral conditions and continued till September 2018. SST anomalies have crossed threshold value of El Niño conditions during October 2018 and continued till January 2019. While, atmospheric conditions reflect ENSO-neutral pattern hence (warm) ENSO neutral conditions were prevailed 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 near the date line.

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

The DMI index for the last 12 months suggests that (Fig. 2c) weak positive IOD conditions were observed during the month of February 2018. 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. It turned into neutral IOD conditions during January 2019. Negative subsurface temperature anomalies (Fig. 2d) were seen over the parts of far west equatorial Indian Ocean (weaker magnitude) and positive subsurface temperature anomalies were seen over the parts of west-central Indian Ocean over 60°E - 75°E at around thermocline depth.

a) Average SST Anomalies
JANUARY 2019

b) SST Anomaly difference
DECEMBER 2018 to JANUARY 2019
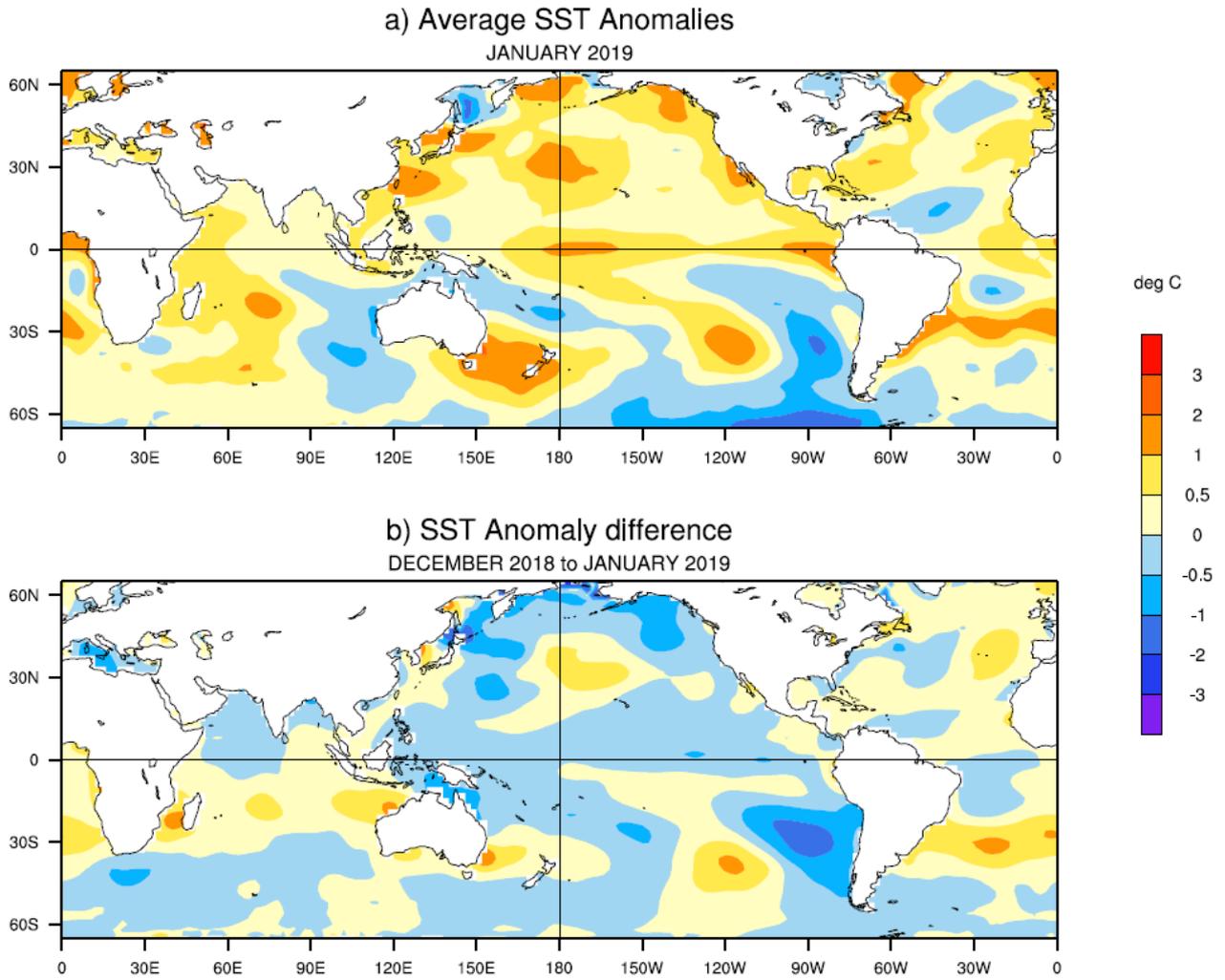
Fig.1: (a) Sea surface temperature (SST) anomalies (^{o}C) during January, 2019 and, **(b)** changes in the SST anomalies (^{o}C) from December 2018 to January 2019. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.
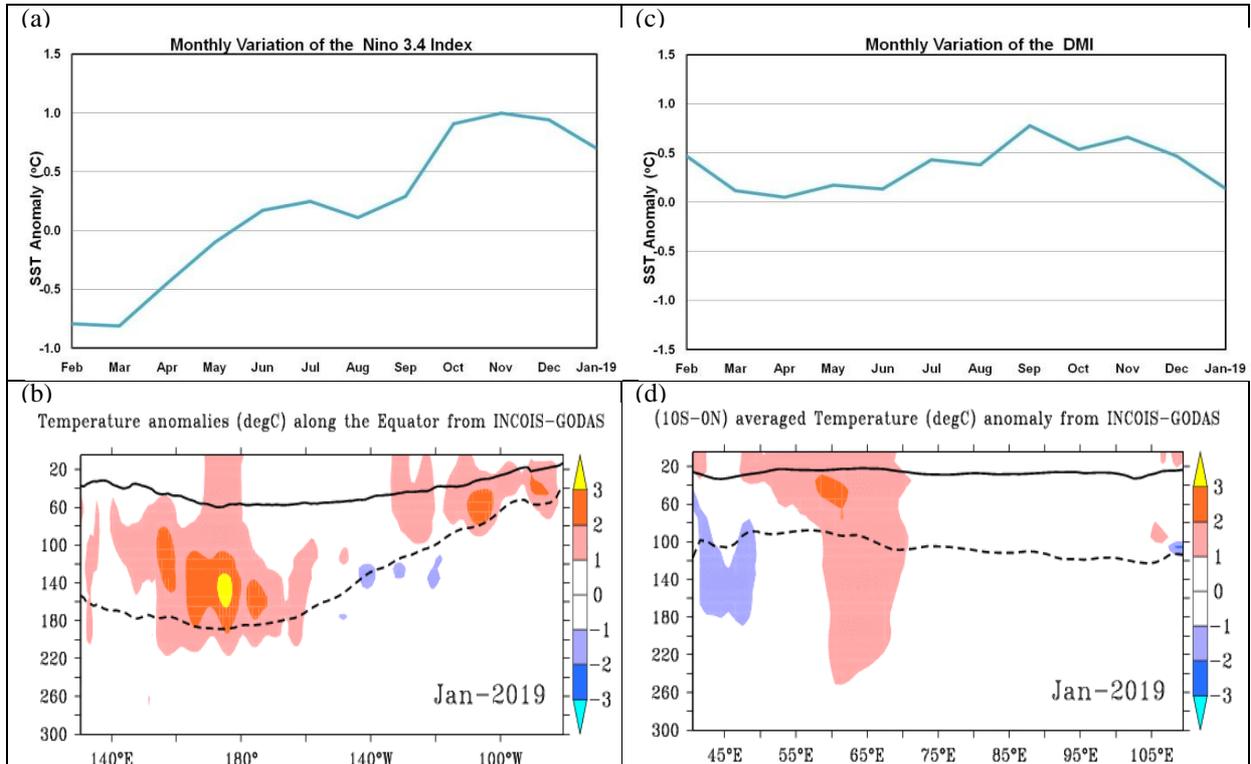

Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)**equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5^oS-5^oN) Pacific Ocean for the month of January, 2019**. (c)**Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the tropical Indian Ocean (10^oS-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 2019 January 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 during FMA and MAM seasons. However, from AMJ season onwards it likely to turn into normal SST anomalies over most parts of the equatorial Pacific Ocean. The latest MMCFS forecast indicates weakening of Niño 3.4 SST anomalies which has crossed threshold of El Niño conditions during last three months. However, SST anomalies are likely to remain near to the El Niño threshold value during FMA season and neutral ENSO conditions are likely to prevail from MAM season onwards (Fig.4a). In the Indian Ocean, during most of the forecasted seasons, normal 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 up to FMA season and weak positive IOD conditions are likely to develop thereafter and continue for short period(Fig.4b).
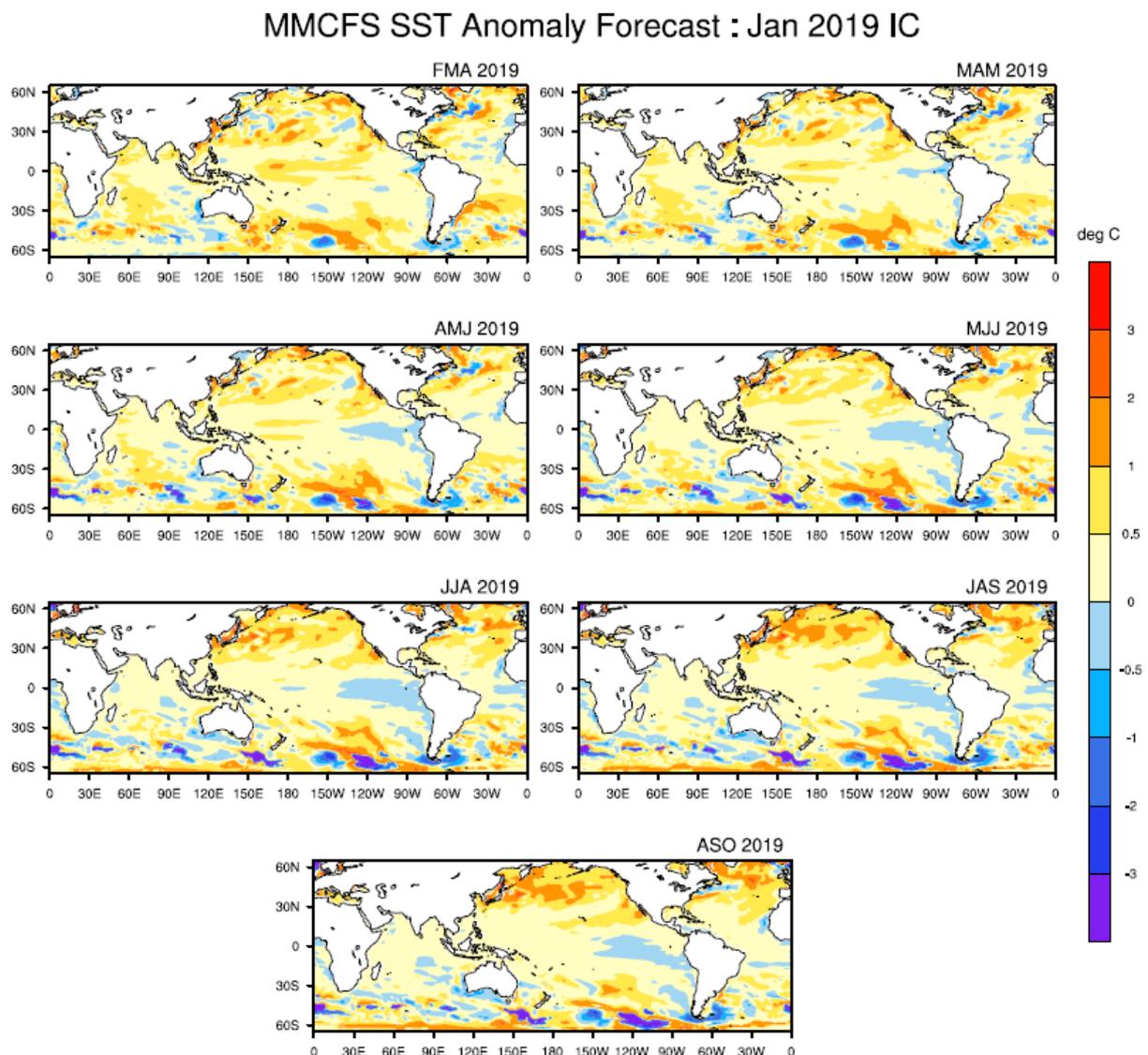

Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) February to April (FMA), (b)March to May (MAM), (c) April to June (AMJ), (d) May to July (MJJ), (e) June to August (JJA), (f) July to September (JAS) and (g) August to October (ASO) (Model bias correction base period: 1999-2010; Climatology base period:1982-2010).
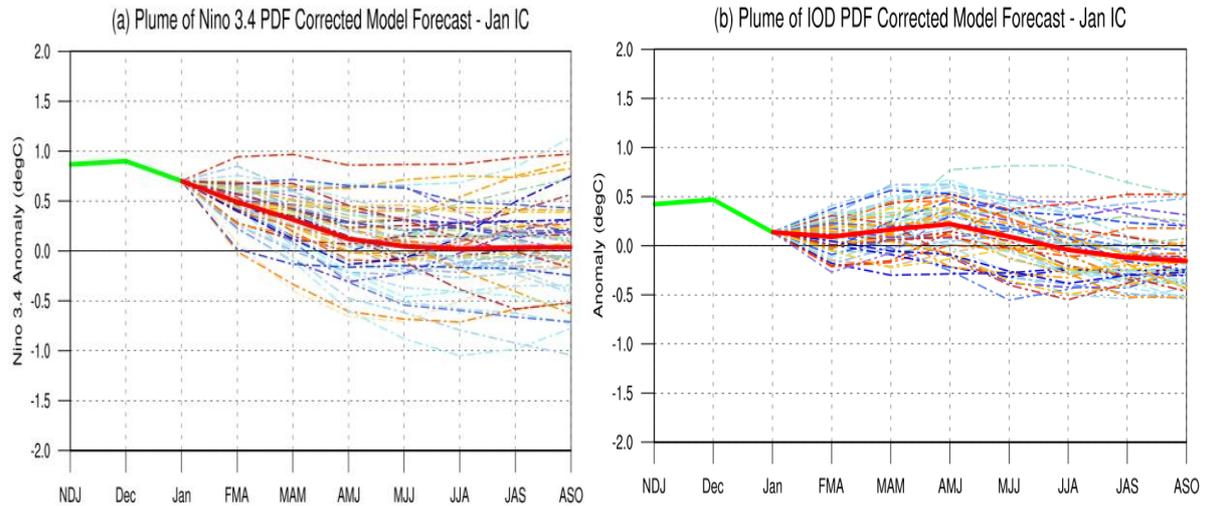
Fig.4: Plume of**(a)**Niño 3.4 SST anomalies,**(b)**Indian Ocean Dipole Mode Index forecasted by high resolutionCFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 50 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

a)   b)
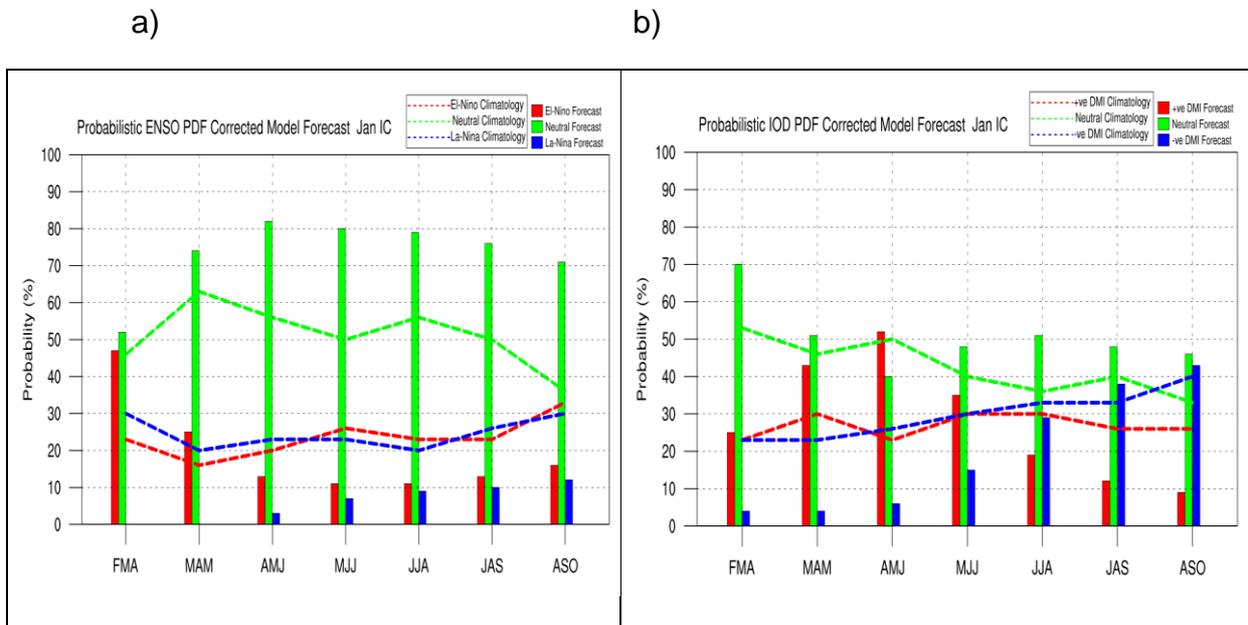
Fig.5:Probability forecast along with climatological probabilities of **(a)**Niño 3.4 and(b)Indian Ocean DipoleMode Indexfrom high resolution MMCFS.Datasource for Climatology probabilities: NOAAExtendedReconstructed SST V5.Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 to <-0.5 neutral, ≥ 0.5 El Niño. Criteria used for Probabilistic DMI Forecast: ≤ -0.2 negative DMI, >0.2 to <-0.2 neutral, ≥ 0.2 positive DMI.

The probability forecast for ENSO (Fig.5a) indicates maximum probability for El Niño conditions during FMA season. However, the probability of neutral ENSO conditions is likely to increase from MAM season till the end of the forecast period.

The probability forecast for IOD (Fig.5b) indicates maximum probability for neutral IOD conditions during the forecast period. However, increased probability for positive IOD conditions is also seen during MAM, AMJ and MJJ seasons.