



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

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

March 2019

Highlights:

Currently, weak El Niño conditions have developed over equatorial Pacific Ocean and the latest MMCFS forecast indicates that these conditions are likely to persist in early part of the summer season and likely to weaken thereafter.

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

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

During February 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 southeast equatorial Pacific Ocean (Fig.1a). Positive SST anomalies were observed over parts of north Pacific Ocean as well as parts of the south subtropical Pacific Ocean. Also, decrease in warming of SSTs is seen over the east equatorial Pacific Ocean during February 2019. As compared to the last month, cooling of SST observed near date line and parts of equatorial Pacific Ocean (Fig.1b). Cooling of SSTs is also seen over the west Pacific Ocean near Maritime Continent as compared to the last month.

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 February, 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 central Indian Ocean south of the equator (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 March 2018 to February 2019 (Fig.2a) suggests that prevailing La Niña conditions turned into ENSO neutral conditions in April 2018 and continued till September 2018. SST anomalies have crossed threshold value of El Niño conditions during October 2018 and continued till February 2019. The atmospheric conditions have also started to reflect anomalous convection and wind pattern associated with the El Niño state during end of the February 2019, indicating weak El Niño conditions have developed 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 and around 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) neutral IOD conditions from March 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 in February 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 110°E at around thermocline depth.

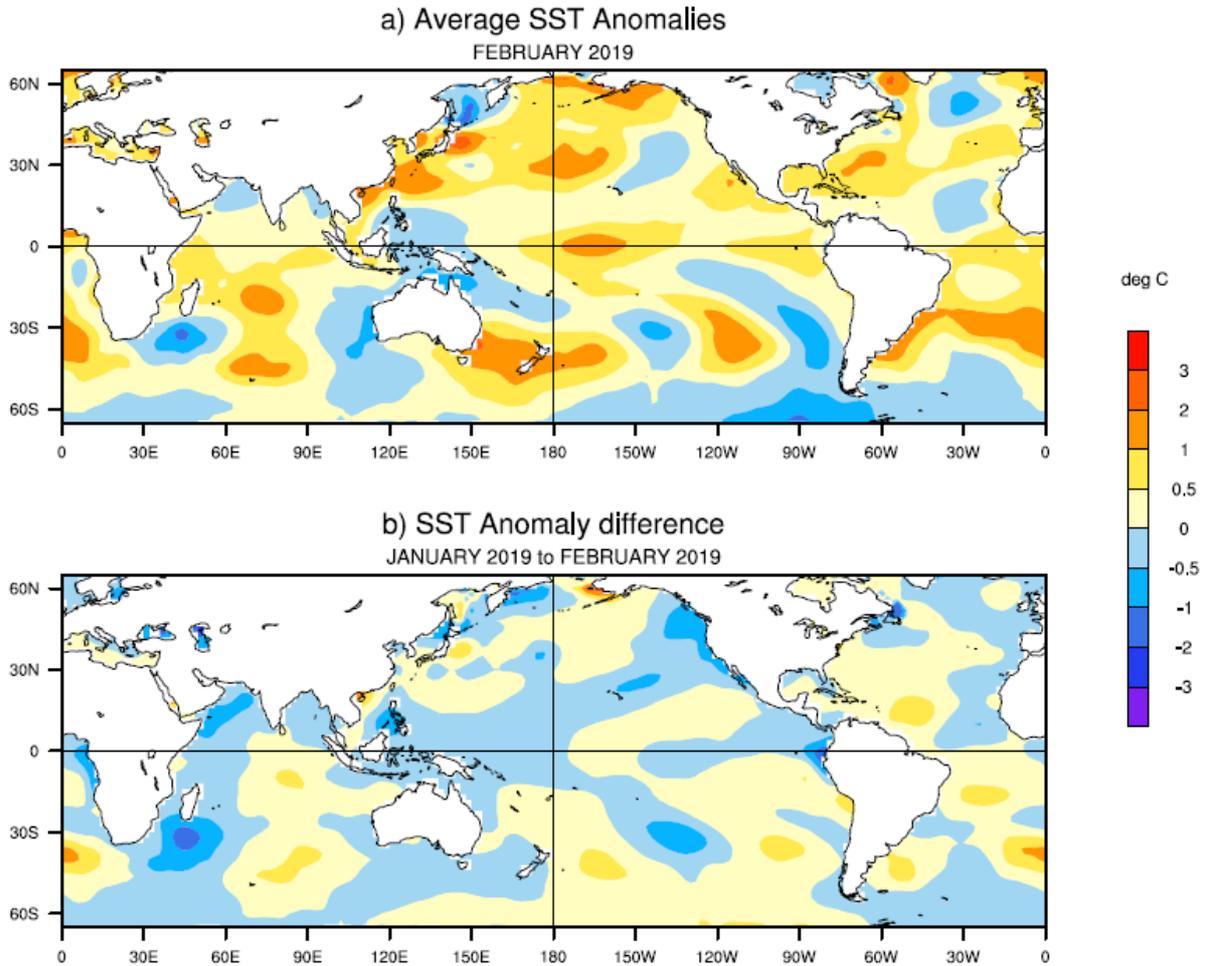


Fig.1: (a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during February, 2019 and, **(b)** changes in the SST anomalies ($^{\circ}\text{C}$) from January 2019 to February 2019. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term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

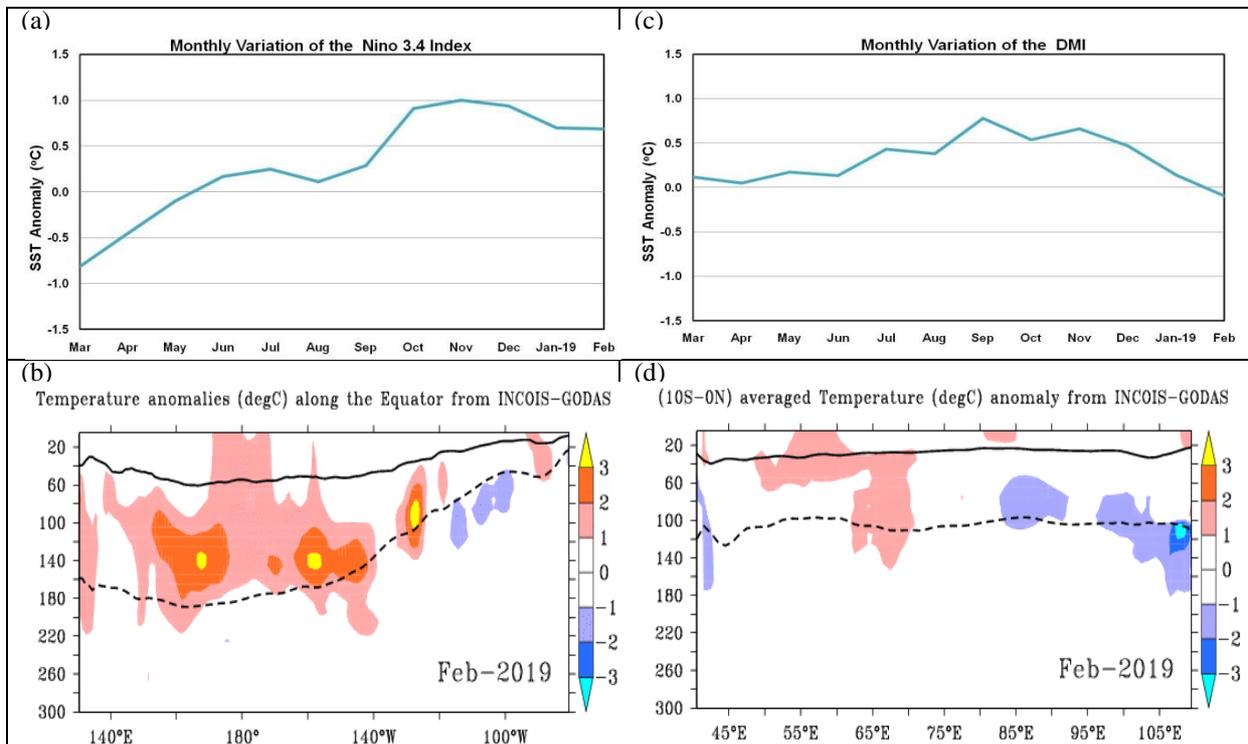


Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5°S - 5°N) Pacific Ocean for the month of February, 2019. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (b) but for the tropical Indian Ocean (10°S -Eq). The anomalies were computed using base period of 1981-2010, Data Source: ERSSTv5, NOAA. The solid dark line is the 20°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 February 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 most of the forecasted seasons. However, over parts of east equatorial Pacific it is likely to have normal SST anomalies from MAM to JAS seasons and from ASO season warmer than normal SST anomalies are likely over the region. The latest MMCFS forecast indicates these conditions are likely to persist in early part of the summer season and likely to weaken thereafter (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, 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 continue for coming forecasted seasons (Fig.4b).

MMCFS SST Anomaly Forecast : Feb 2019 IC

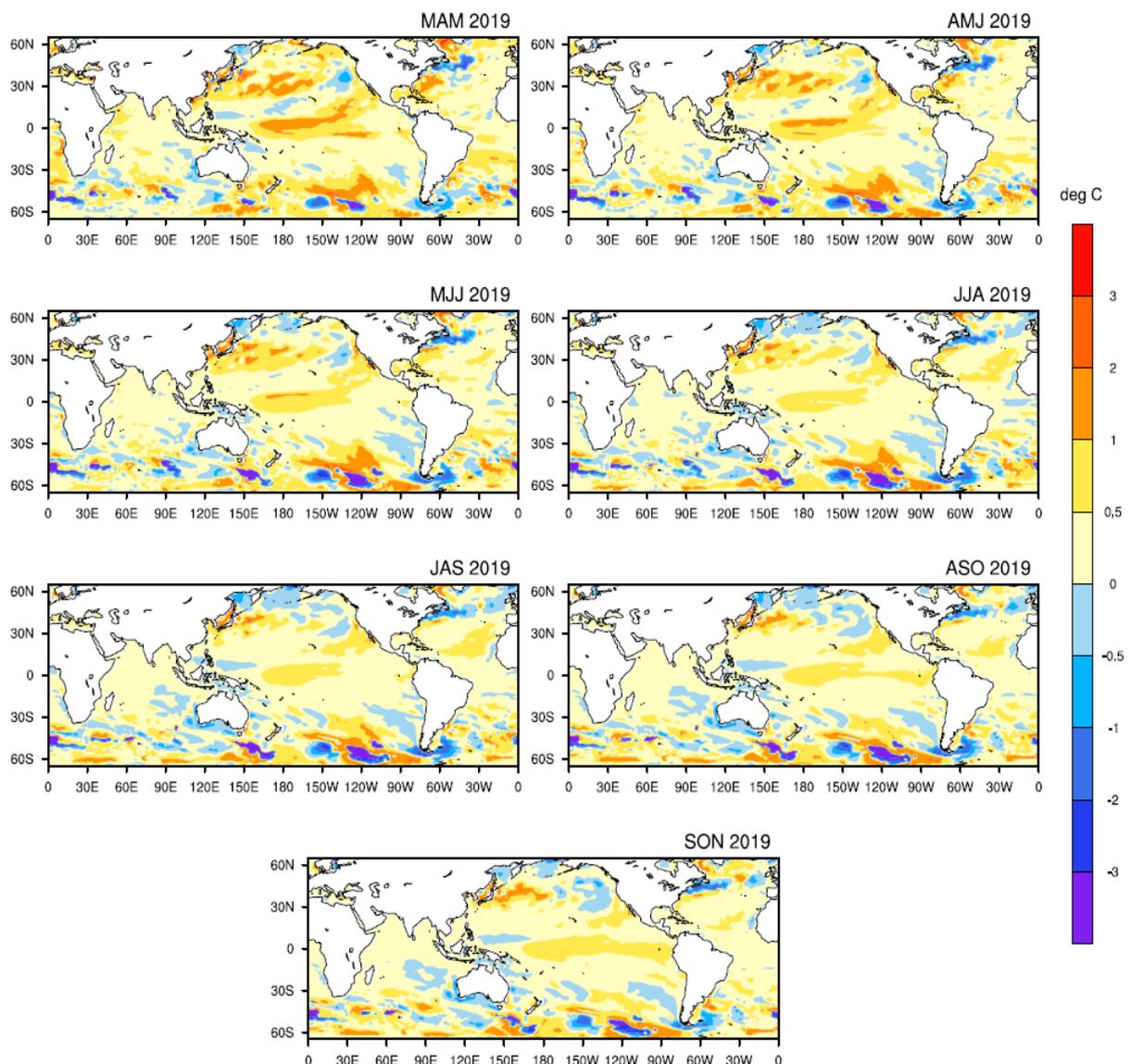


Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) March to May (MAM), (b) April to June (AMJ), (c) May to July (MJJ), (d) June to August (JJA), (e) July to September (JAS), (f) August to October (ASO) and (g) September to November (SON) (Model bias correction base period: 1999-2010; Climatology base period:1982-2010).

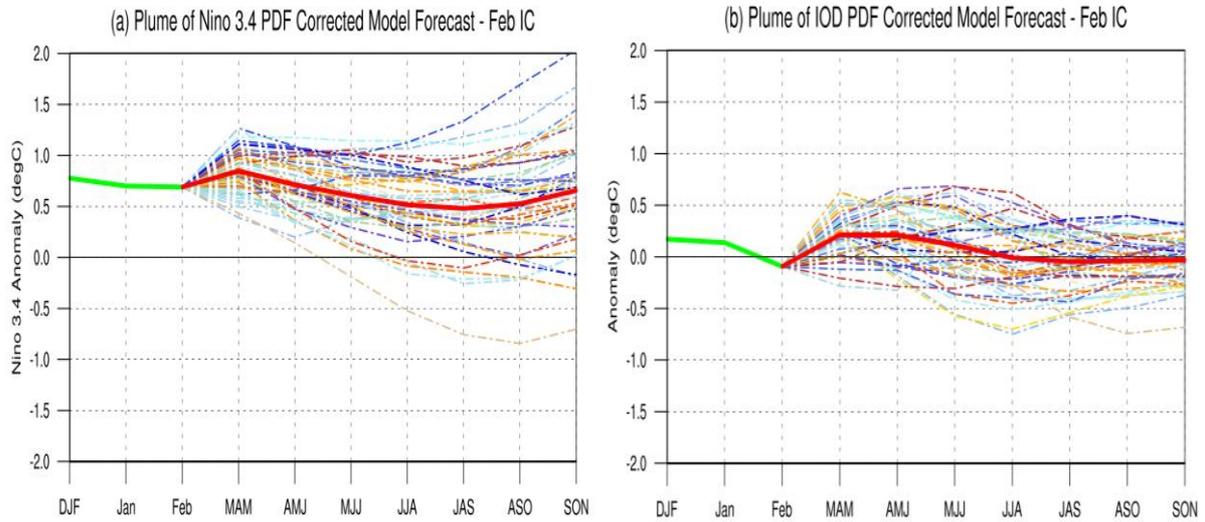


Fig.4: Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 46 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

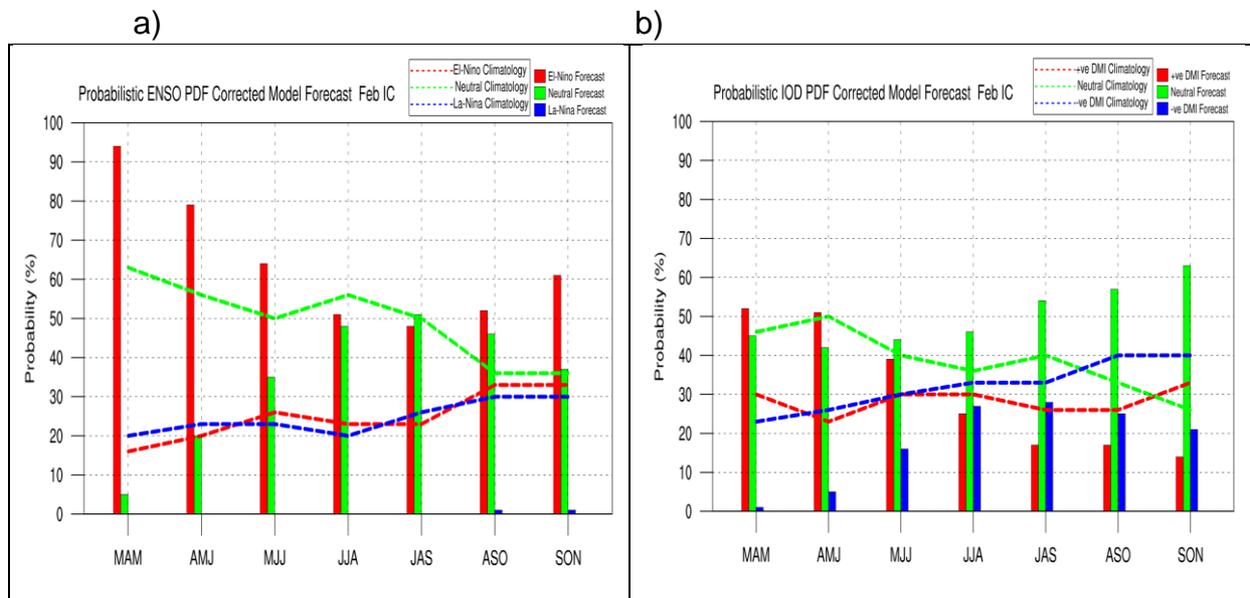


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS. Data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 to <-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 from MAM to MJJ seasons. However, nearly equal probabilities are likely for neutral ENSO and El Niño conditions from JJA season till end of the forecast period.

The probability forecast for IOD (Fig.5b) indicates nearly equal probabilities for neutral and positive IOD conditions from MAM to MJJ seasons. However, increased probability for neutral IOD conditions is seen JJA season onwards.