



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

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

December 2018

Highlights:

Currently, ENSO neutral conditions are prevailing over equatorial Pacific Ocean and the latest MMCFS forecast indicates ENSO neutral conditions are likely to continue during the forecast period.

At present, positive IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates that the present positive IOD conditions are likely to turn into neutral IOD conditions during DJF season and neutral IOD conditions are likely to persist.

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

During November 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 some parts of northwest Pacific Ocean as well as most 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 November 2018. As compared to the last month, negative SST anomalies which were observed off the west coast of South America in October 2018 have changed into positive SST anomalies in November 2018 (Fig.1b). Also, cooling in SSTs over west equatorial Pacific Ocean has increased during the current month. As compared to the last month warming of SSTs has decreased over the northwest Pacific Ocean.

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 south east Indian Ocean and near head Bay of Bengal (Fig.1a). During November, warming of SSTs was observed over most parts of the Arabian Sea and equatorial Indian Ocean. However, cooling of SSTs was observed over Bay of Bengal and most parts of south east 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 December 2017 to November 2018 (Fig.2a) suggests that La Niña conditions persisted from December 2017 till March 2018. Since April 2018, La Niña conditions turned into ENSO neutral conditions and continued till September 2018. SST anomaly value has crossed threshold of El Niño conditions during October 2018 and continued thereafter. However, atmospheric conditions still reflect ENSO-neutral pattern and currently, ENSO neutral conditions are prevailing. 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 150°E - 110°W.

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

The DMI index for the last 12 months suggests that (Fig. 2c) prevailing neutral IOD conditions continued till 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 temporarily but in subsequent month of August, it had weakened into neutral IOD conditions and during September 2018 conditions over equatorial Indian Ocean had reached to positive IOD conditions again and continued in November 2018. Negative subsurface temperature anomalies (Fig. 2d) (stronger magnitude) were seen over the parts of western equatorial

Indian Ocean and weak positive subsurface temperature anomalies were seen over the parts of central Indian Ocean over $65^{\circ}\text{E} - 80^{\circ}\text{E}$ at around thermocline depth.

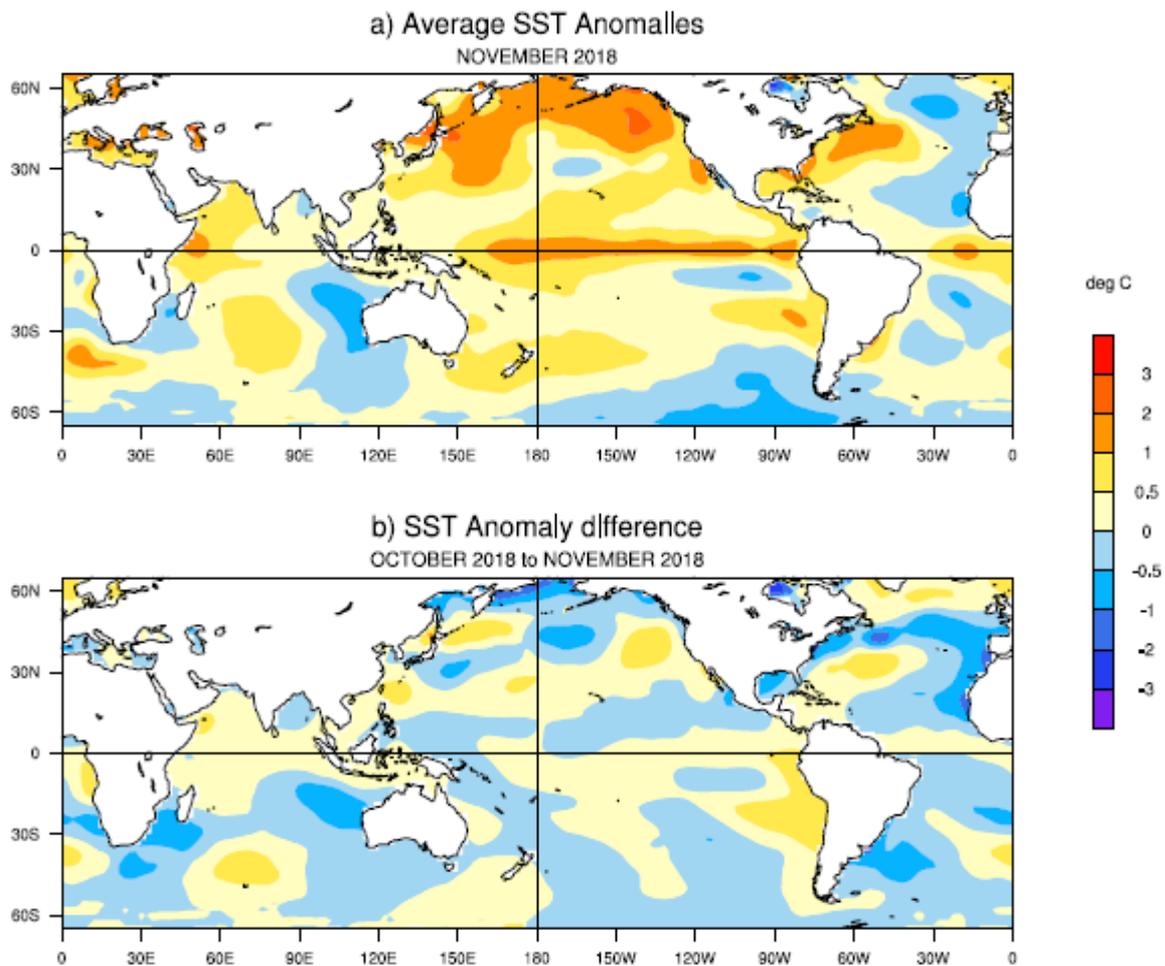


Fig.1: (a) Sea surface temperature (SST) anomalies ($^{\circ}\text{C}$) during November, 2018 and, (b) changes in the SST anomalies ($^{\circ}\text{C}$) from October 2018 to November 2018. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean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

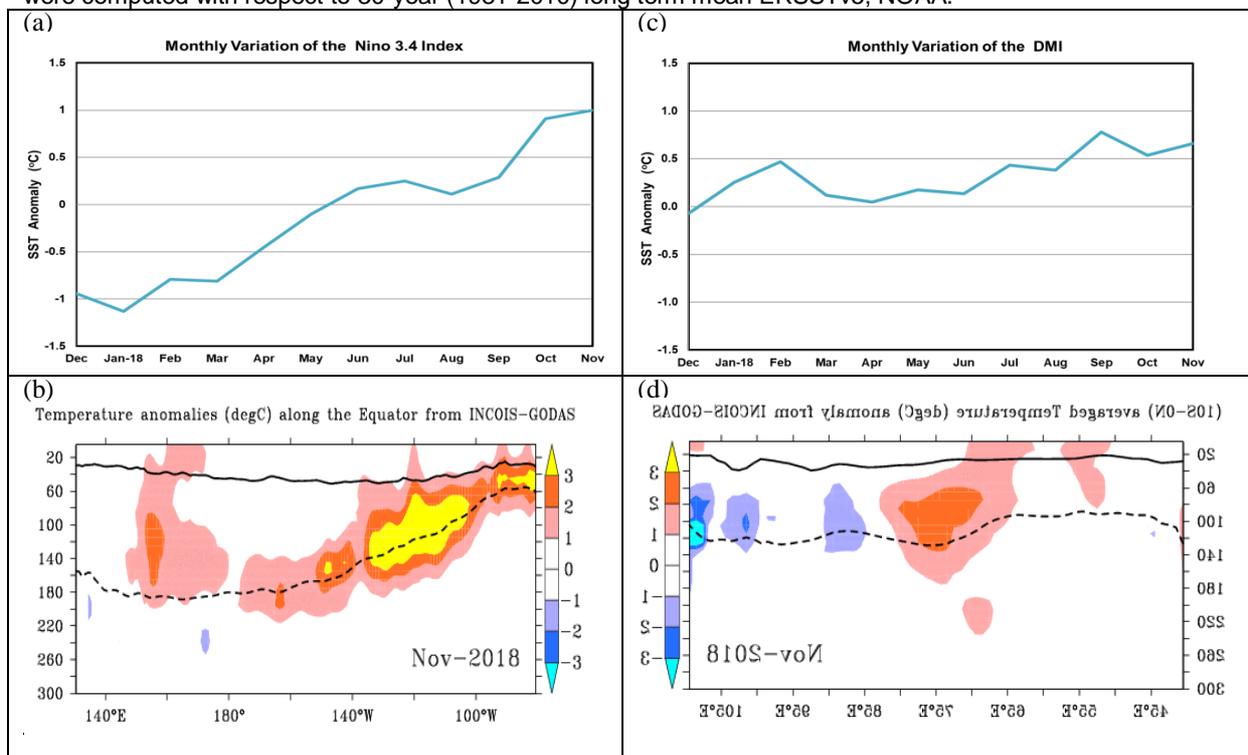


Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and (b) equatorial depth-longitude section of ocean temperature anomalies in the equatorial ($5^{\circ}\text{S}-5^{\circ}\text{N}$) Pacific Ocean for the month of November, 2018. (c) Same as (a) but for Dipole Mode Index (DMI). (d) Same as (b) but for the tropical Indian Ocean ($10^{\circ}\text{S}-\text{Eq}$). 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 was 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 November 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) indicates that warmer than normal SST anomalies are likely over most parts of equatorial Pacific Ocean and slightly cool SST anomalies are likely over just south of the central to east equatorial Pacific Ocean during DJF season. However, from JFM season onwards cool SST anomalies are likely to decrease over the central Pacific region and normal to warmer than normal SST anomalies are likely over equatorial Pacific Ocean. Also, for most of the forecasted seasons normal SSTs are likely over the most parts of north west Pacific Ocean. The latest MMCFS forecast indicates weakening of Niño 3.4 SST anomalies in subsequent months of November 2018 and likely to remain below the threshold value during forecast period (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 positive IOD conditions are likely to turn into neutral IOD conditions during DJF season and neutral IOD conditions are likely to persist (Fig.4b).

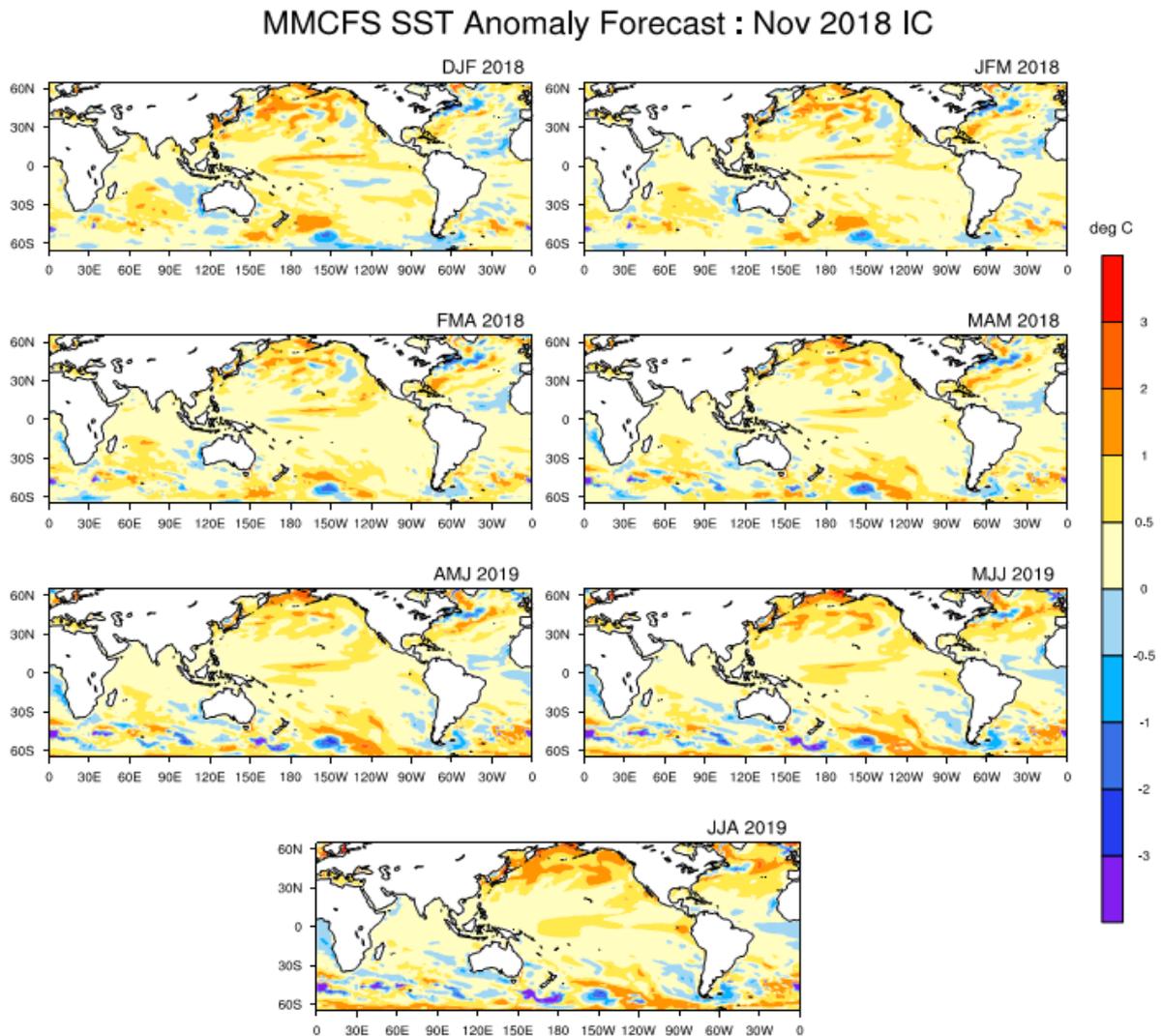


Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) December to February (DJF), (b) January to March (JFM), (c) February to April (FMA), (d) March to May (MAM), (e) April to June (AMJ), (f) May to July (MJJ) and (g) June to August (MJJ) (Model bias correction base period: 1999-2010; Climatology base period: 1982-2010).

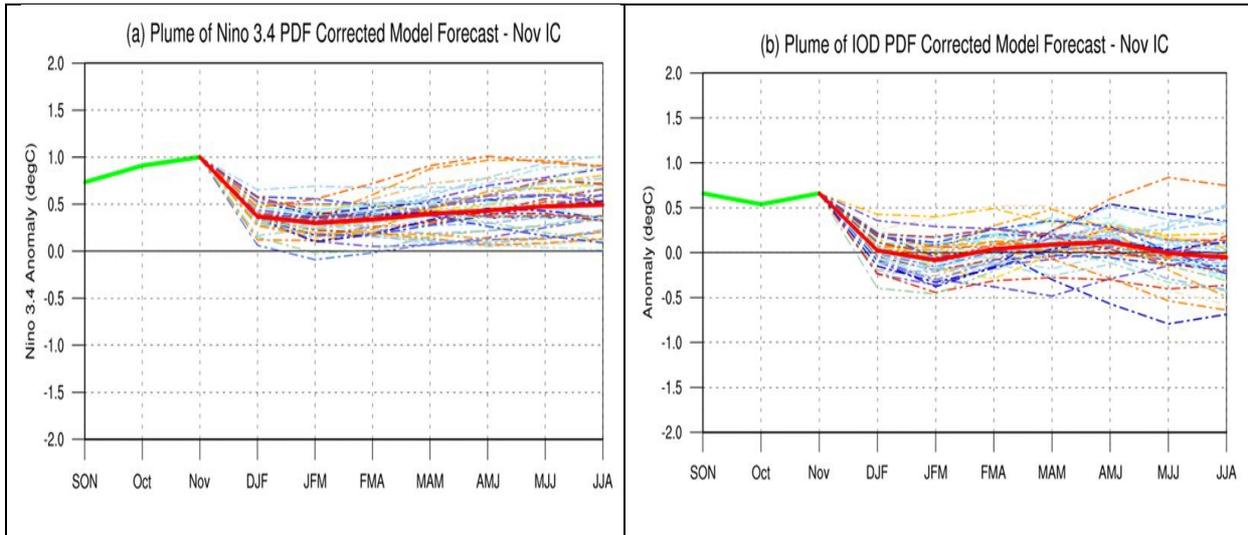


Fig.4: Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of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

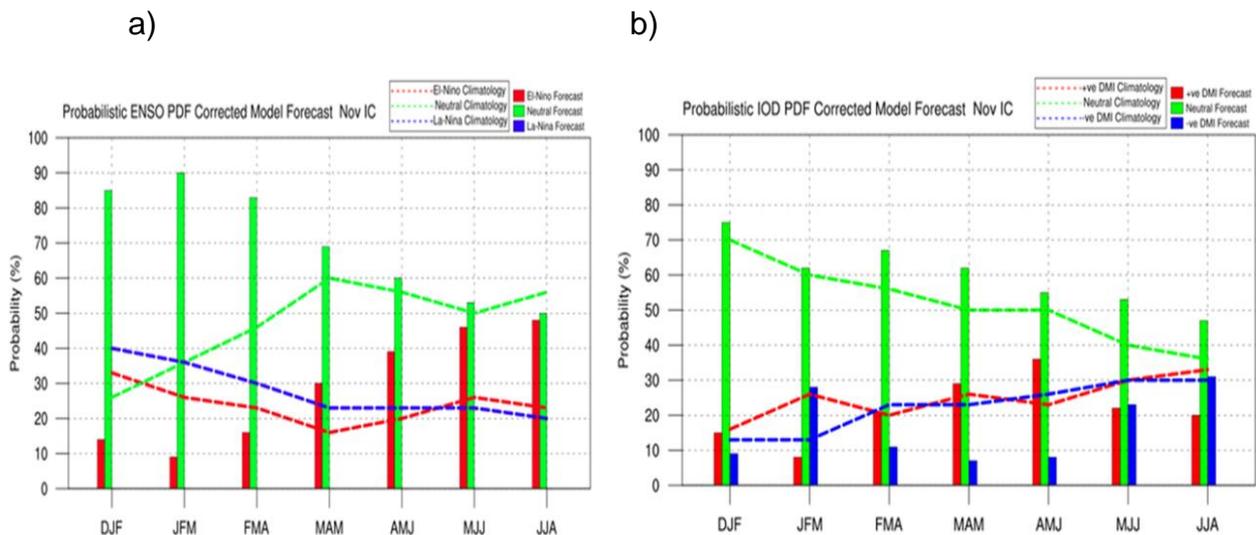


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS. Data source for Climatological probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 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 ENSO neutral conditions from DJF to FMA seasons. Thereafter, increase in probability for El Niño conditions for the remaining forecast period.

The probability forecast for IOD (Fig.5b) indicates maximum probability for neutral IOD conditions for most of the forecasted seasons. However, increase in probability for positive IOD conditions is seen from FMA to AMJ season.