Ministry of Earth Sciences
Government of India

El Niño/La Niña
Indian Ocean Dipole
February 2017

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

During January 2017, cool SST anomalies persisted along the equatorial eastern and central Pacific Ocean slightly extending west of the date line, while positive SST anomalies were observed over equatorial west Pacific Ocean and subtropical Pacific Ocean. On either side of these warm SST anomalies, negative SST anomalies were observed. As compared to the last month (December 2016), the cool SST anomaly spread over equatorial Pacific Ocean has reduced. Warming tendency over south of equatorial Pacific Ocean is seen to be increased as compared to last month. SST anomaly difference from December to January (Fig.1b) show warming of SSTs over the eastern and central equatorial Pacific Ocean and off the east coast of Australia and cooling over the northwest Pacific Ocean and around the date line.

Near normal to warm SSTs are observed during January (Fig.1a) over Arabian Sea and Bay of Bengal. Weak cool SST anomalies were seen over the equatorial Indian Ocean and relatively stronger cool anomalies were seen over south Indian Ocean of about 15^{o}S-20^{o}S along a latitudinal zone with anomalies ≤-0.5^{o}C. Warm anomalies which were observed (in December 2016) over east equatorial and south Indian Ocean off the west coast of Australia now (in January) became near normal to cool SST anomalies. The positive SST anomalies which were observed over the West Indian Ocean around 30^{o}S of latitude in December 2016 continued to exist in the current month with increased intensity. In January (Fig.1b), cooling of SSTs was observed over most parts of the equatorial Indian Ocean and south of equatorial Indian Ocean whereas warming of SSTs was observed around south-eastern Madagascar coast.

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 (Fig.2a) suggest that the border line/ weak La Niña conditions prevailed since July 2016 turned to cool neutral ENSO conditions in January 2017. Near normal subsurface temperatures were seen in the east equatorial Pacific Ocean with negative subsurface anomalies observed in the extreme east Pacific Ocean and positive subsurface anomalies were seen over west equatorial Pacific Ocean (Fig.2 b).

1.2. Indian Ocean Dipole (IOD) Conditions over Indian Ocean

The DMI index for the last 12 months suggested neutral IOD condition till April 2016 which later became negative IOD condition around June and continued till November 2016 (Fig. 2c). In December 2016, it turned into neutral IOD conditions. Currently (January 2017), neutral IOD conditions are prevailing. Strong positive subsurface (Fig. 2d) anomalies were observed in the eastern Equatorial Indian Ocean (100^{o}E). However, strong negative subsurface temperature anomalies were seen in the central and western Indian Ocean (around 50^{o}E and 70^{o}E) and positive sub surface temperature anomalies were seen in the eastern equatorial Indian Ocean in January.

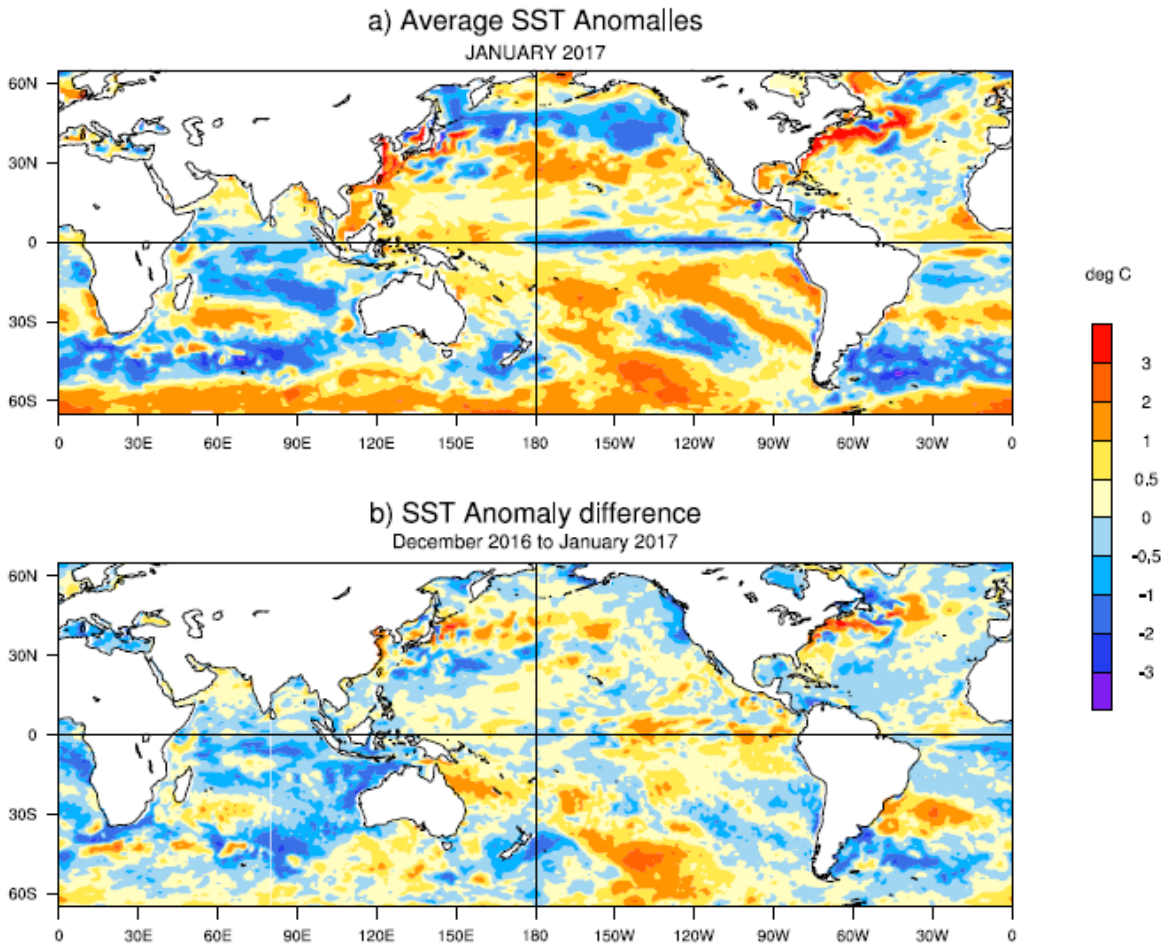

Fig.1: **(a)** Sea surface temperature (SST) anomalies (^{o}C) during January, 2017 and, **(b)** changes in the SST anomalies (^{o}C) from December 2016 to January 2017. SSTs were based on the INCOIS- GODAS analysis and anomalies were computed with respect to 30-year (1981-2010) mean NOAA OISST.

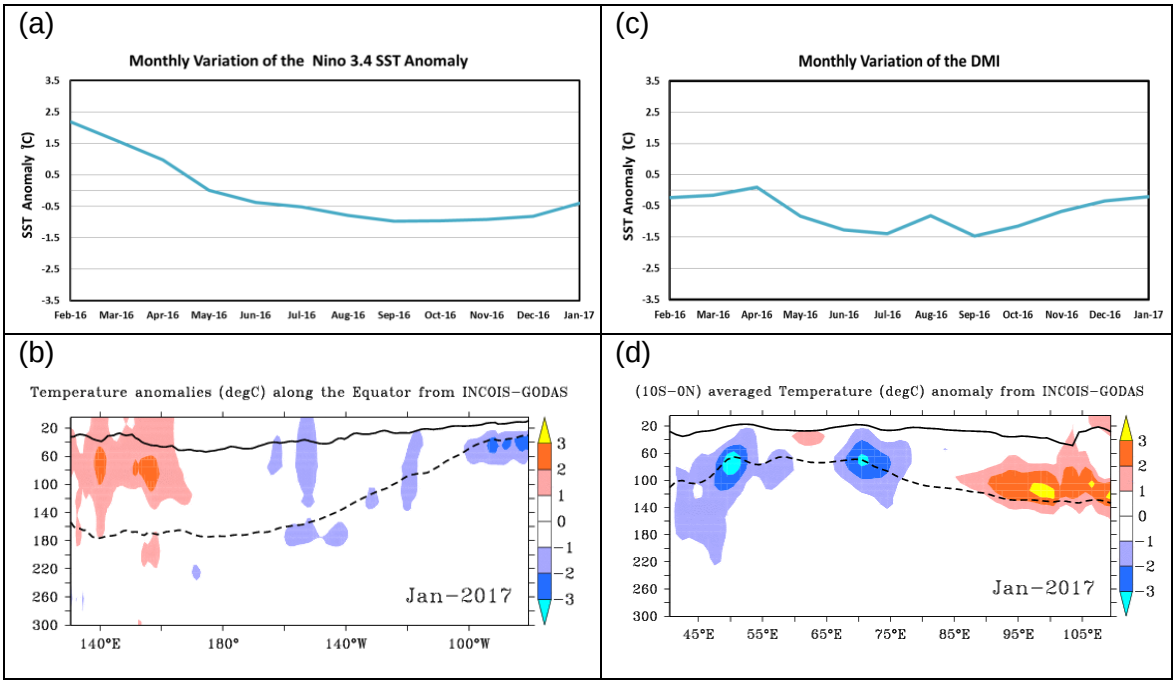

Fig.2: **(a)** Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth - longitude section of ocean temperature anomalies in the equatorial (5^{o}S - 5^{o}N) Pacific Ocean for the month of January 2017. **(c)** Same as **(a)** but for Dipole Mode Index (DMI). **(d) S**ame as **(b)** but for the tropical Indian Ocean (10^{o}S-Eq). The anomalies were computed using base period of 1981-2010. The solid dark line is the 20^{o}C isotherm and the dashed line is thermocline depth. Data Source: INCOIS-GODAS.

2. ENSO & IOD Forecast

The SST forecast were prepared using the ESSO-IMD-IITM high resolution Coupled Forecast System (AGCM T382L64; 38 km and OGCM 25km in tropics) based on the 2017January 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 1981-2010 climatology.

The forecasted 3-month season averaged SST anomalies (Fig.3) indicate cooler SST anomalies are likely in the central equatorial Pacific Ocean during FMA season which are likely to weaken thereafter. SSTs are likely to remain normal from MAM onwards. Warm SST anomalies are likely over north and south of equatorial Pacific Ocean for all the forecasted seasons. The prevailing cool neutral ENSO conditions are likely to continue in FMA season (Fig.4a) and then turn to neutral ENSO conditions. During JAS season, Niño 3.4 SST anomaly is likely to cross El Niño threshold of 0.5^{o}C. In the Indian Ocean, warm to near normal SST anomalies are likely in Arabian Sea, Bay of Bengal and equatorial Indian Ocean during all the forecasted seasons (Fig.3). The present neutral IOD conditions over Indian Ocean are likely to (Fig.4b) continue till MAM season and turn to negative IOD conditions thereafter.

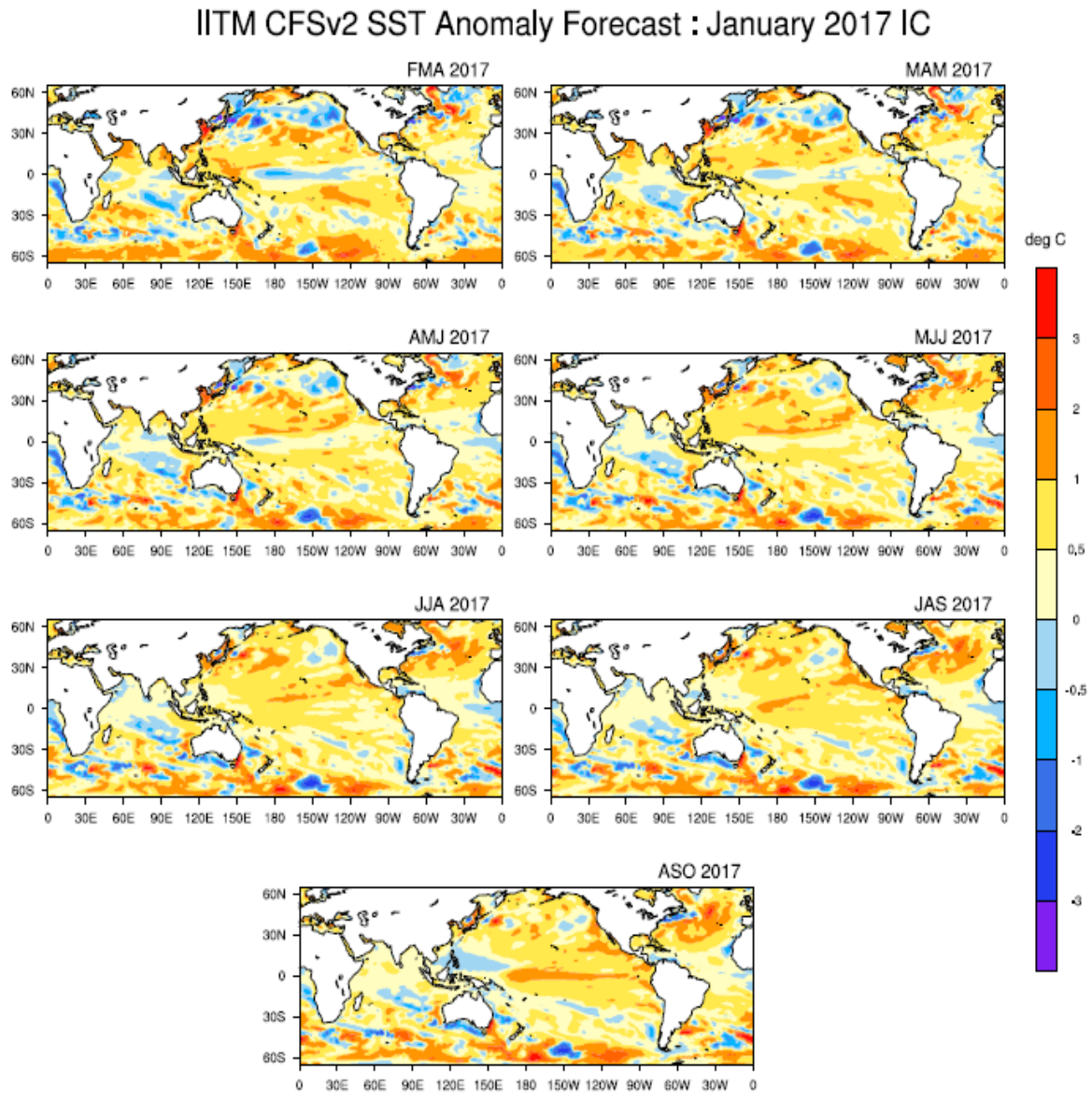

Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) February through April (FMA), (b) March through May (MAM), (c April through June (AMJ), (d) May through July (MJJ), (e) June through August (JJA), (f) July through September (JAS), and (g August through October (ASO).

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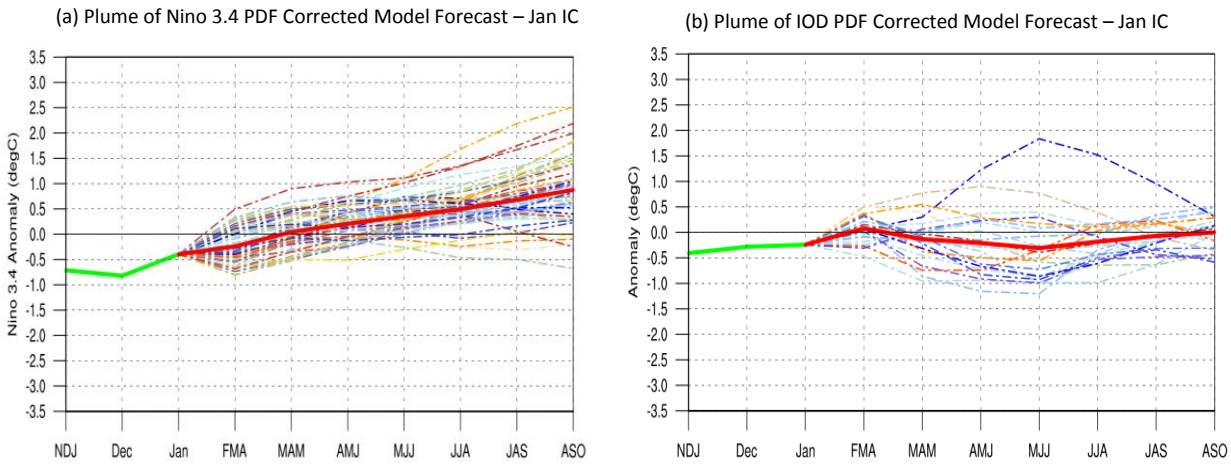

Fig.4: Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (INCOIS-GODAS) and solid red line is the ensemble SST anomaly forecast mean of 52 members (CFSv2). The individual ensemble member forecasts are shown in light dotted lines of different colours.

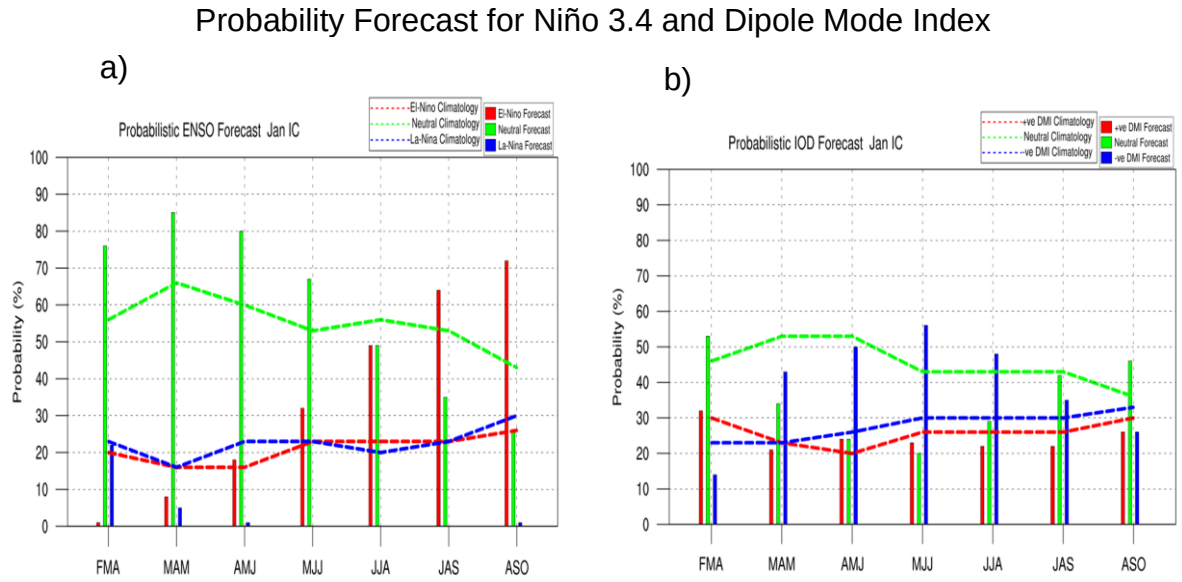

Fig.5: Probability forecast along with climatological probabilities of **(a)** Niño 3.4 and **(b)** Indian Ocean Dipole Mode Index from high resolution CFSv2. Data source for Climatology probabilities: NOAA Extended Reconstructed SST V4b. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >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 (Fig.5a) suggests high (>65%) probability of ENSO neutral conditions to continue till MJJ season. In the later forecasted seasons, probability of ENSO neutral conditions gradually decreases and probability for El Niño conditions increases. Thus there is increased probability of formation of El Niño conditions in the later part of the forecast period.

The DMI probability forecast (Fig.5b) indicates 54% probability of neutral IOD conditions to prevail during FMA. However, neutral IOD conditions are likely to turn to negative IOD conditions by MAM and will continue thereafter till around JAS. Positive DMI forecast probability is 30% in FMA season which later gradually varies between 20%-30%.