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

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

May 2019

Highlights:

Currently, weak El Niño conditions are prevailing over the equatorial Pacific Ocean and the latest MMCFS forecast indicates that these conditions are likely to continue during the monsoon season but with further reduced intensity.

At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates these conditions are likely to continue during the monsoon season.

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

During April 2019, warm SST anomalies were observed over most parts of central to eastern and northwest 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 and south subtropical Pacific Ocean. Negative SST anomalies were observed in some parts of northwest and southern Pacific Ocean. Also, decrease in warming of SSTs is seen over parts of equatorial Pacific Ocean during April 2019. As compared to the last month, cooling of SST observed in northwest, central and southeast Pacific Ocean (Fig.1b). Warming of SSTs is also seen over the parts of northeast Pacific Ocean as compared to the last month.

Normal SST anomalies were observed over the most parts of Arabian Sea and Bay of Bengal. However, warmer than normal SST anomalies were observed over northern parts of Bay of Bengal. 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 April, cooling of SSTs was observed over most parts of the East Indian Ocean. However, warming of SSTs was observed in Arabian Sea (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 May 2018 to April 2019 (Fig.2a) suggests that prevailing ENSO neutral conditions from the month May 2018 continued till the month of September 2018. During October month, SST anomalies have crossed positive threshold value of El Niño conditions and continued till April 2019. Currently, weak El Niño conditions (SST anomalies between $0.5^{o}C$ &$1.0^{o}C$) are prevailing over the equatorial Pacific. The positive subsurface anomalies were observed over parts of the east equatorial Pacific Ocean (Fig.2 b) (at around thermocline depth) with highest magnitudes spread at $90^{o}W$ and negative subsurface anomalies were observed over central equatorial Pacific Ocean with highest magnitudes spread at $180^{o}W$.

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 from May 2018 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 till April 2019. Positive subsurface temperature anomalies (Fig. 2d) were seen over the parts of west equatorial Indian Ocean and negative subsurface temperature anomalies were seen over the parts of east Indian Ocean with stronger magnitude around $110^{o}E$ at around thermocline depth.

a) Average SST Anomalies
APRIL 2019

b) SST Anomaly difference
MARCH 2019 to APRIL 2019
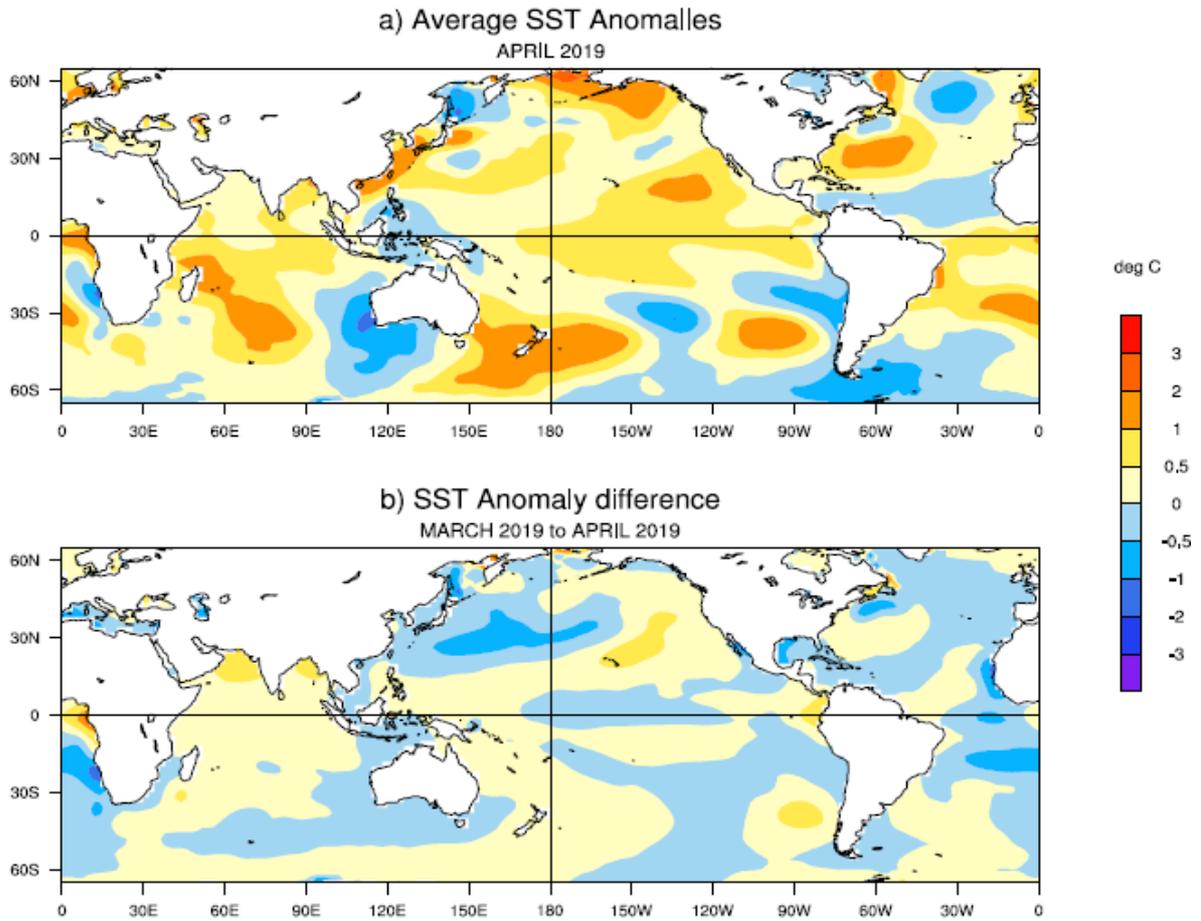
Fig.1: (a) Sea surface temperature (SST) anomalies (^oC) during April, 2019 and, **(b)** changes in the SST anomalies (^oC) from March 2019 to April 2019. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.
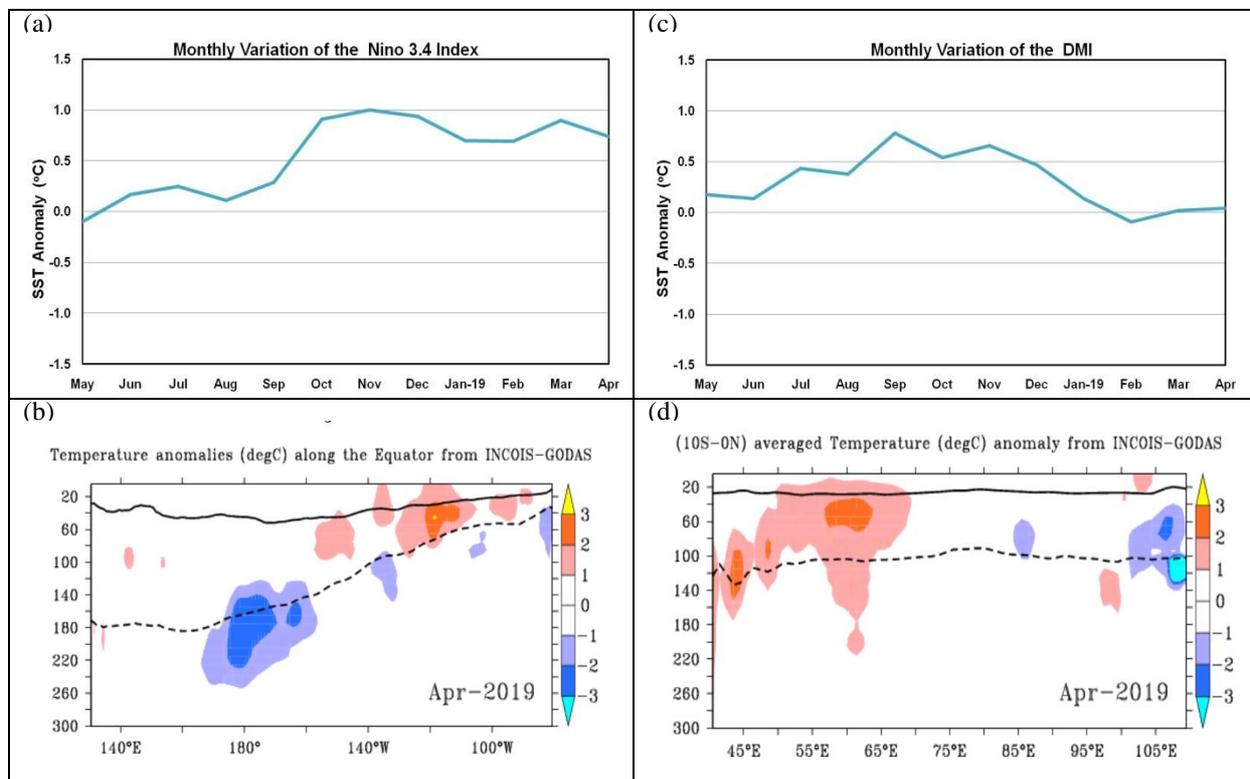

Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5^oS-5^oN) Pacific Ocean for the month of April, 2019. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same as (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 20^oC 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 April 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 from MJJ to JJA seasons. From JJA season onwards the strength of warming is likely to reduce till SON season. However, from SON season, it is likely to have slightly warmer than normal SST anomalies over parts of west central equatorial Pacific. Currently, weak El Nino conditions are prevailing over equatorial Pacific Ocean and latest MMCFS forecast indicates these conditions are likely to continue during the monsoon season but with further reduced intensity (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, cooler than normal SST anomalies are likely over eastern Indian Ocean off the west coast of Australia for most of the seasons. However, warmer than normal SST anomalies are likely over western Indian Ocean near east Africa coast during MJJ. At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates these conditions are likely to continue during the monsoon season (Fig.4b).
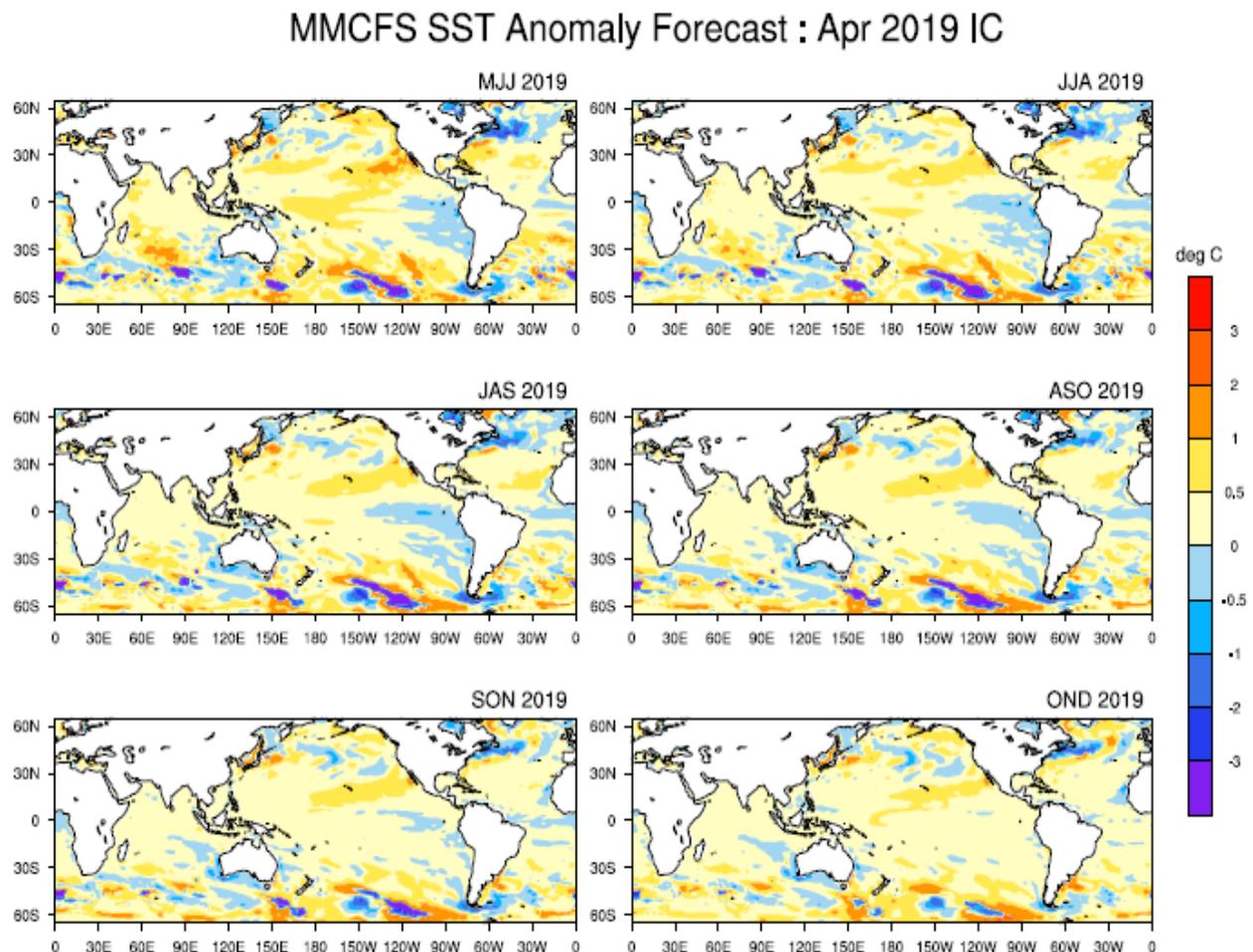

Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) May to July (MJJ), (b) June to August (JJA), (c) July to September (JAS), (d) August to October (ASO), (e) September to November (SON) and (f) October to December (OND) (Model bias correction base period: 1999-2010; Climatology base period:1982-2010).
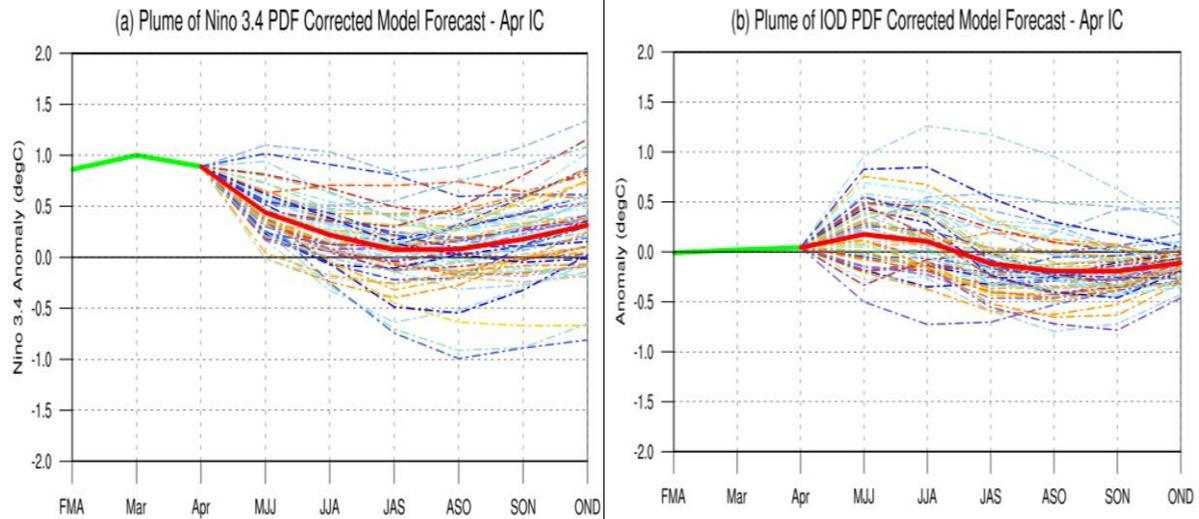
Fig.4: Plume of **(a)** Niño 3.4 SST anomalies, **(b)** Indian Ocean Dipole Mode Index forecasted by high resolutionCFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 56 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
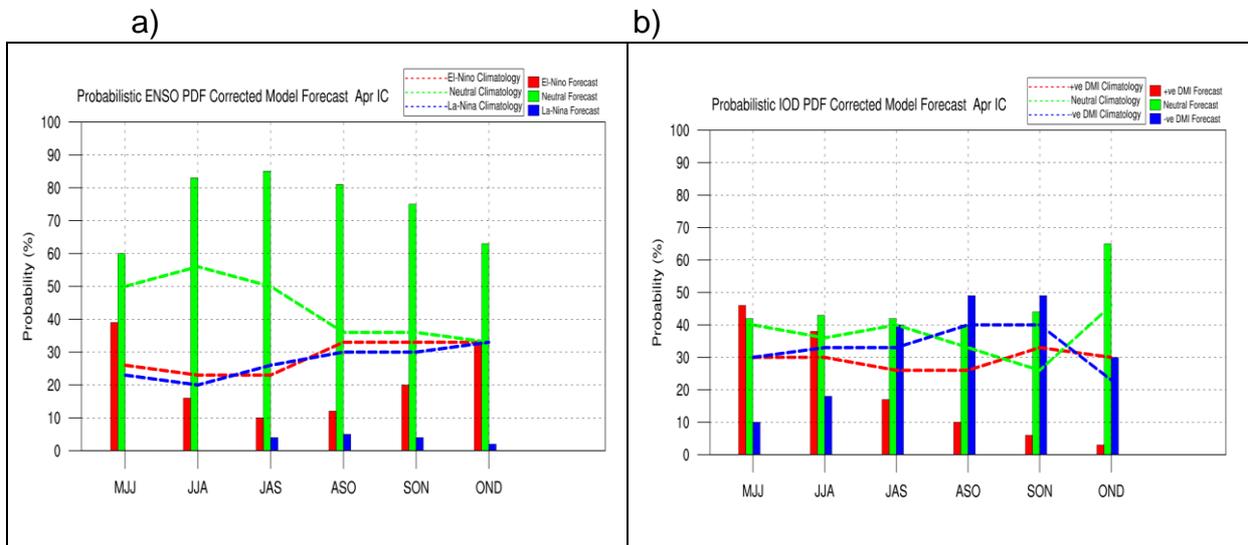
Fig.5:Probability forecast along with climatological probabilities of **(a)**Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS.Data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 to <-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 that nearly equal probabilities for neutral ENSO conditions & El Nino conditions during MJJ season. However, neutral ENSO conditions is likely have higher probability from JJA to OND seasons.

The probability forecast for IOD (Fig.5b) indicates nearly equal probabilities for neutral and positive IOD conditions during MJJ and JJA season. However, increased probability for negative IOD conditions is likely from JAS season onwards till SON season. From OND season, neutral IOD conditions is likely to have higher probability.