



**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 2020

Highlights:

Currently, ENSO-neutral conditions are prevailing over equatorial Pacific Ocean. The latest MMCFS forecast indicates ENSO-neutral conditions are likely to continue up to MJJ season and SST anomalies likely to cool further JJA season onwards. The forecast indicates enhanced probability for development of La Niña conditions during end of the forecast period. However, it may be noted that at this time of the year, ENSO predictability is limited due to spring barrier.

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

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

During February 2020, warmer than normal SSTs were observed over western parts and at and around international date line of the equatorial Pacific Ocean and cooler than normal SSTs were observed over the eastern parts (Fig.1a). Positive SST anomalies were observed over most parts of the north Pacific Ocean and central parts of south Pacific Ocean. Negative SST anomalies were observed over larger areas of eastern part of southern Pacific Ocean. As compared to the last month, cooling of SSTs is observed over most parts of equatorial Pacific Ocean and warming of SSTs is observed in some pockets of south central Pacific Ocean (Fig.1b).

Normal SSTs were observed over most parts of Arabian and Bay of Bengal with cooler than normal SSTs over northern most part of Bay of Bengal. Warmer than normal SSTs were observed over southern parts of equatorial Indian Ocean over a large region. Positive SST anomalies were observed over off the west coast of Australia, near Indonesian region and east coast of Africa and negative SST anomalies were observed over parts of south subtropical Indian Ocean around 75°E (Fig.1a). As compared to the last month, cooling of SSTs is observed over most parts of the Indian Ocean (Fig.1b).

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 from March 2019 to February 2020 is shown in Fig.2a. The figure shows that El Niño conditions from March 2019 have continued till June 2019. During July, El Niño conditions were turned into ENSO-neutral conditions and it continued thereafter. Since September there was abnormal increase in SST anomalies over the equatorial Pacific Ocean. Currently, Equatorial sea surface temperatures are near to above average across most of the Pacific Ocean. ENSO neutral conditions are prevailing over the Pacific Ocean and atmospheric conditions also indicate ENSO neutral pattern over equatorial Pacific. The positive subsurface anomalies were observed over western and eastern part of equatorial Pacific Ocean below the 20°C isotherm (Fig.2b) with strongest magnitude spread over east of 100°W (at around thermocline depth). Negative subsurface anomalies were observed over many pockets of

west and central parts of the equatorial Pacific below the thermocline depth with strongest magnitude near 130°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 since March 2019 continued till April 2019. During month of May 2019, neutral IOD conditions turned into positive IOD conditions and continued further. However, since October 2019 strength of IOD started decreasing and during December 2019 positive IOD conditions started weakening and turned into neutral IOD conditions by January 2020. During February 2020 neutral IOD conditions are prevailing over Indian Ocean. Positive subsurface temperature anomalies (Fig. 2d) were seen over the parts of west equatorial Indian Ocean with stronger magnitude over 45°E-75°E and negative subsurface temperature anomalies were seen over the parts of east Indian Ocean with stronger magnitude over 95°E-105°E in between 20°C isotherm and thermocline depth. However positive sub surface SST anomalies also observed over eastern Indian Ocean below the thermocline depth.

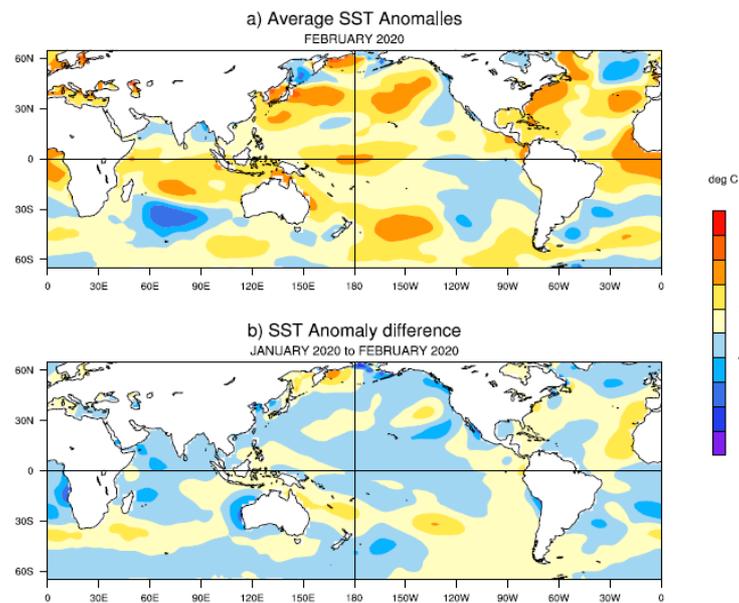


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during February, 2020 and **(b)** changes in the SST anomalies (°C) from January 2020 to February 2020. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.

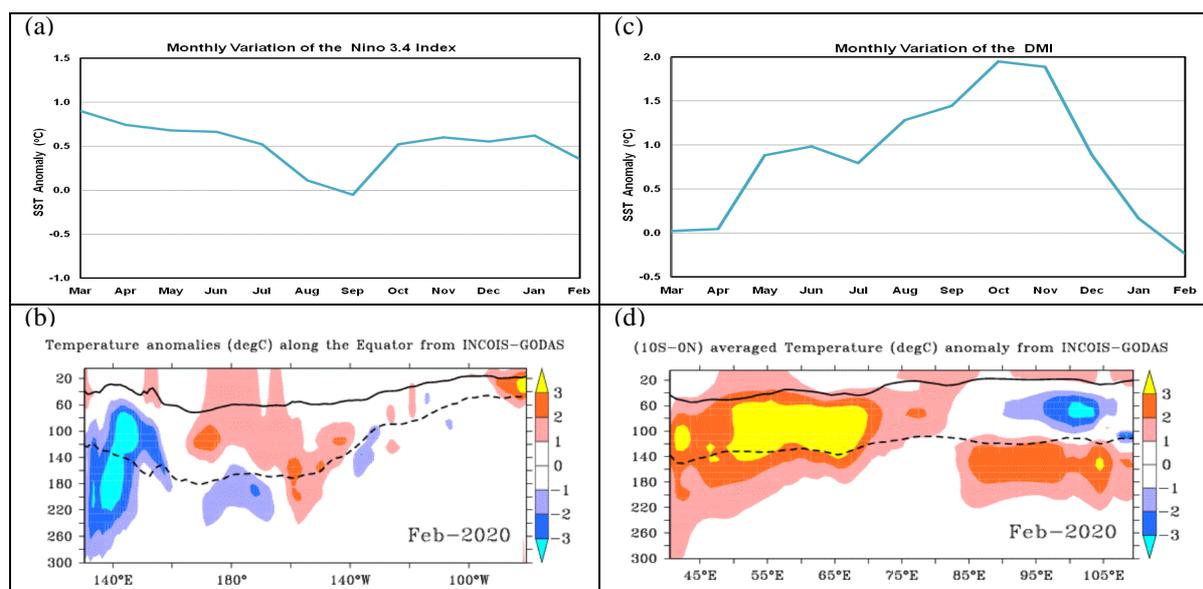


Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and **(b)** equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) Pacific Ocean for the month of February, 2020. **(c)** Same as (a) but for Dipole Mode Index (DMI). **(d)** Same 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 2020February 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 normal to warmer than normal SSTs are likely over western parts and just north of the equatorial Pacific Ocean during MAM and AMJ seasons. Cooler than normal SSTs are likely over central parts of equatorial Pacific from MJJ season onwards and these cooler SSTs are likely to extend further west and cover most parts of the equatorial Pacific till end of the forecast period. Warmer than normal SSTs are likely over north and southern parts of subtropical Pacific Ocean during all the forecasted seasons. Currently, ENSO-neutral conditions with warmer than normal SSTs over western and central part of the equatorial Pacific Ocean are observed. The latest MMCFS forecast indicates ENSO-neutral conditions are likely to continue up to MJJ season and SST anomalies likely to cool further JJA season onwards (Fig.4a). However, it may be noted that the skill of the ENSO forecast well in advance is limited during this season because of the spring barrier.

In the Indian Ocean, normal SSTs are likely in Bay of Bengal and Arabian Sea during most of the forecasted seasons (Fig.3). Normal to warmer than normal SSTs are likely over western and eastern parts of south Indian Ocean till MJJ season. Positive SSTs are likely over eastern Indian Ocean off the north coast of Australia for most of the forecasted seasons. At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates neutral IOD conditions are likely to continue for most of the forecasted seasons (Fig.4b).

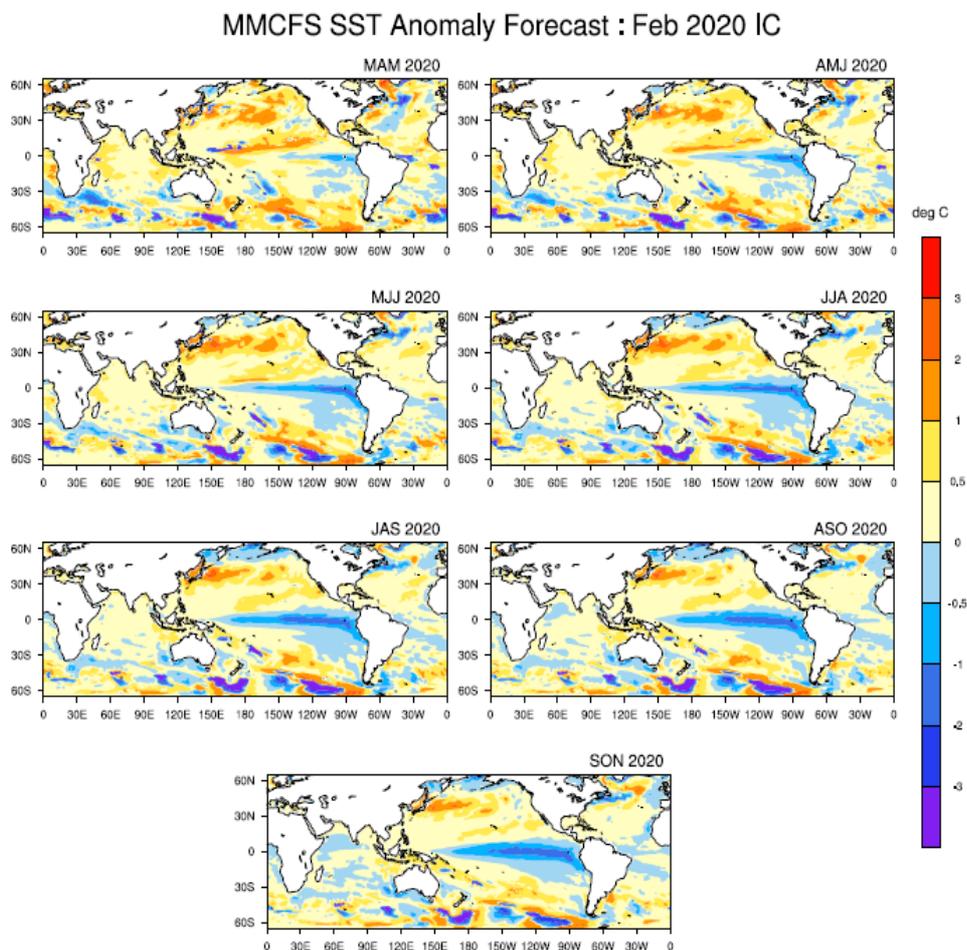


Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) March to May (MAM), (b) April to June (AMJ), (c) May to July (MJJ), (d) June to August (JJA), (e) July to September (JAS), (f) August to October (ASO) and (g) September to November (ASO) (Model bias correction base period: 1999-2008; Climatology base period:1982-2008).

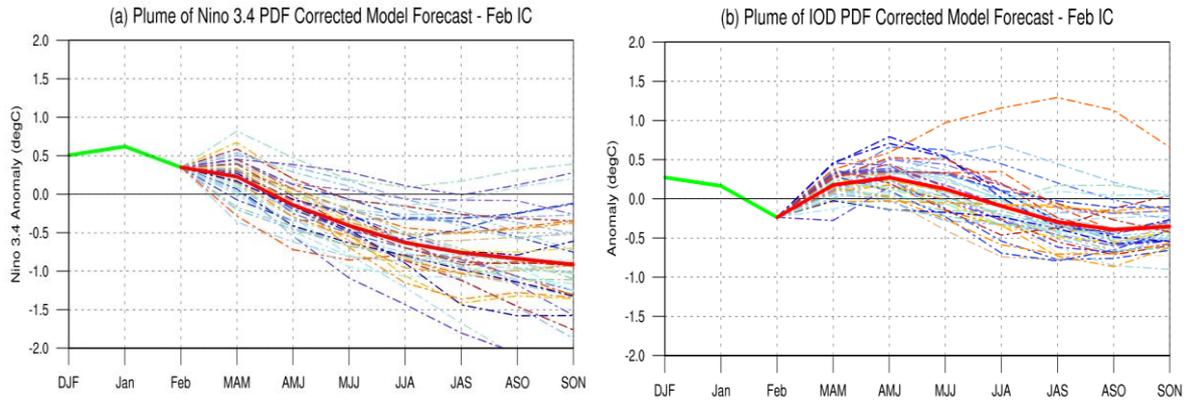


Fig.4: Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 52 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

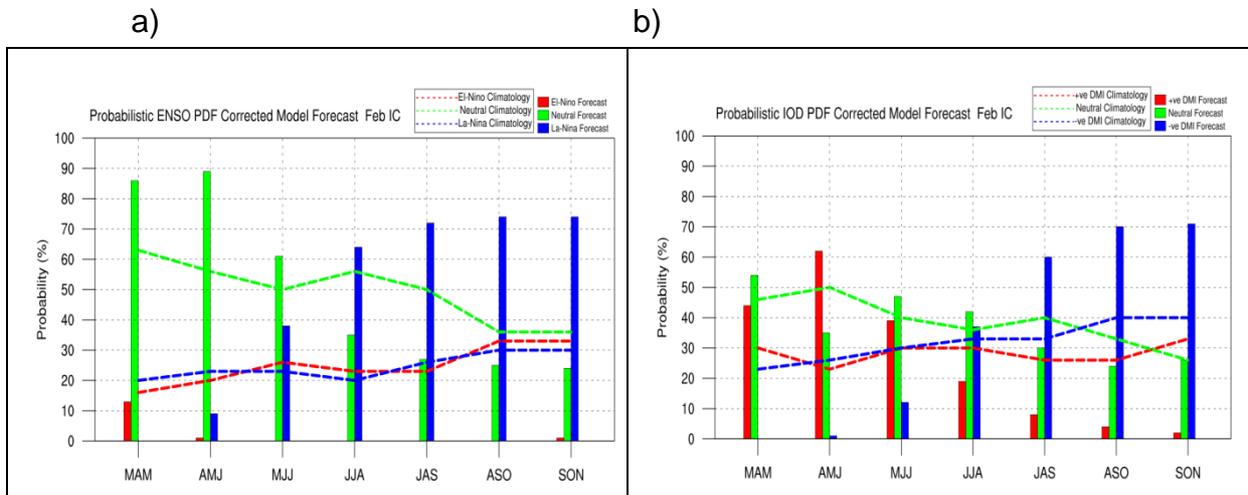


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS. Data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 to <-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 enhanced probability for neutral ENSO conditions up to MJJ season. Thereafter, enhanced probability for La Niña conditions is predicted from JJA season onwards. Thus, forecast indicates enhanced probability for development of La Niña conditions during end of the forecast period. Further, IMD will closely monitor the possible development of La Niña (or continuation of neutral ENSO) conditions.

The probability forecast for IOD (Fig.5b) indicates nearly equal probabilities for neutral and positive IOD conditions up to MJJ season and JJA season onwards enhanced probability for negative IOD conditions.