



**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 2020

Highlights:

Currently, moderate La Niña conditions are prevailing over equatorial Pacific and SSTs are below normal over central and eastern equatorial Pacific Ocean. The latest MMCFS forecast indicates cooler than normal SST anomaly will most likely to continue over the Niño 3.4 region and La Niña conditions likely to sustain during coming seasons.

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

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

During November 2020 cooler than normal SSTs were observed over central and eastern parts of the equatorial Pacific and warmer than normal SSTs were observed over most of the western equatorial Pacific Ocean (Fig.1a). Negative SST anomalies were also observed over central and eastern part of south Pacific Ocean. Positive SST anomalies were observed over most parts of the north Pacific Ocean and central parts of south Pacific Ocean. As compared to the last month, cooling of SSTs is observed over most parts of equatorial Pacific Ocean as well as some parts from North Pacific Ocean (Fig.1b). Warming of SSTs is observed over some region of the higher latitudes of central north Pacific Ocean.

Normal SSTs were observed over most parts of the Indian Ocean including Arabian Sea and Bay of Bengal except south Indian Ocean just below the equator where warmer than normal SSTs were observed. However, negative SST anomalies were observed over south of central subtropical Indian Ocean (Fig.1a). As compared to the last month, cooling of SSTs is observed over most parts of Arabian Sea and south subtropical Indian Ocean and slight warming of SSTs is observed over central parts of the south Indian Ocean. Cooling of SSTs is also observed over south east Indian Ocean near Maritime Continent. Slight warming of SSTs also observed over some parts of Bay of Bengal (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 December 2019 to November 2020 is shown in Fig.2a. Borderline/weak El Niño conditions were observed over equatorial Pacific from December 2019 till April 2020. The cooling of SST anomalies was started in the equatorial Pacific Ocean during the subsequent month of May and was enhanced during June & July months of 2020. Since then Niño 3.4 SST anomalies were near to below average over the equatorial Pacific. In the month of August, SST anomaly has shown further cooling and crossed La Niña threshold. SSTs cooled further and La Niña conditions were established during September and continued in subsequent months of October and November. Currently, moderate La Niña conditions are prevailing over the equatorial Pacific Ocean. Presently, the atmospheric circulation also indicating La Niña Pattern. Positive subsurface anomalies were observed over western Pacific Ocean with strongest magnitude spread around 140°E (between isotherm and thermocline depth) (Fig.2b).

The subsurface temperature anomalies were negative over the central and eastern Pacific Ocean with strongest magnitude observed below the thermocline depth around 150° to 100°W.

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

The DMI index for the last 12 months suggests that (Fig. 2c) positive IOD conditions were observed during month of December 2019 however turned into neutral IOD conditions by January 2020 and continued till April. During May 2020, weak positive IOD conditions were observed and started decreasing their strength during July 2020. The DMI has remained within the average and neutral IOD conditions were observed since August month and continued in subsequent months of from September to November. At present neutral IOD conditions are prevailing over Indian Ocean. Slight positive subsurface temperature anomalies (Fig. 2d) were seen over east and some parts of central equatorial Indian Ocean with stronger magnitude around 105°E in between 20°C isotherm and thermocline depth.

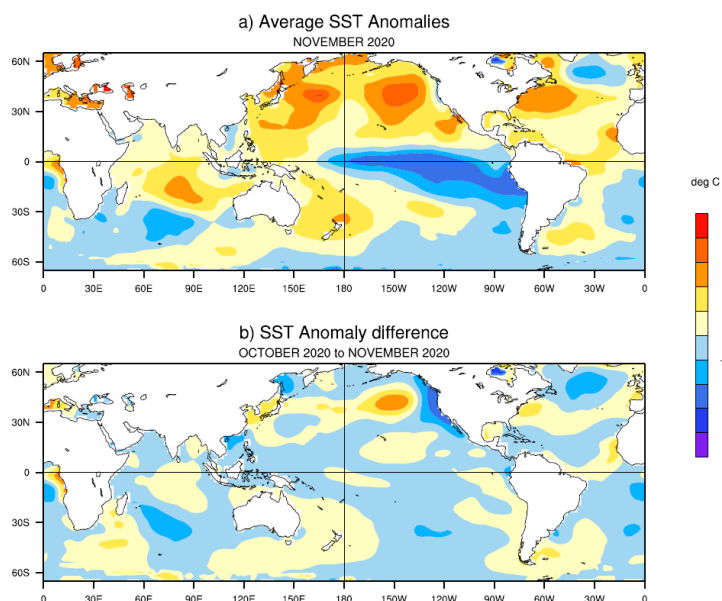


Fig.1: (a) Sea surface temperature (SST) anomalies (°C) during November, 2020 and (b) changes in the SST anomalies (°C) from October 2020 to November 2020. SSTs were based on the ERSSTv5, NOAA and anomalies were computed with respect to 30-year (1981-2010) long term mean ERSSTv5, NOAA.

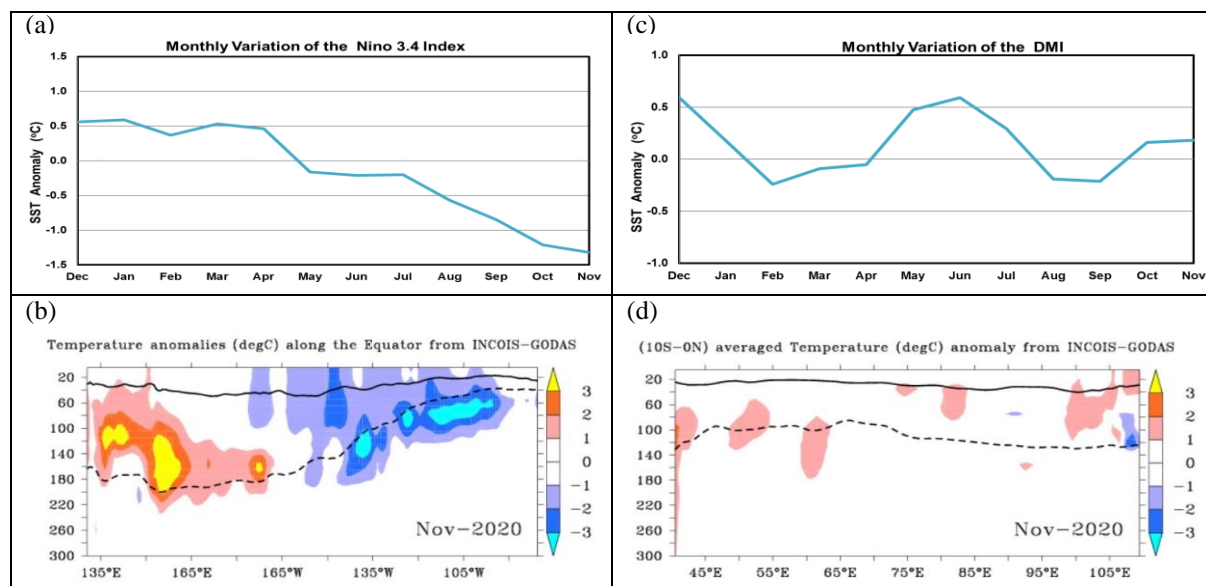


Fig.2: (a) Monthly variation of Niño 3.4 SST index anomaly for the last 12 months and (b) equatorial depth-longitude section of ocean temperature anomalies in the equatorial (5°S-5°N) Pacific Ocean for the month of November, 2020. (c) Same as (a) but for Dipole Mode Index (DMI). (d) Same as (b) but for 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 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 2020 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 below normal SSTs are likely over most parts of central and eastern equatorial Pacific Ocean for the entire forecast period. Normal to warmer than normal SSTs are likely over parts of north Pacific Ocean during most of the forecasted seasons. Currently, moderate La Niña conditions are prevailing over equatorial Pacific and SSTs are below normal over central and eastern equatorial Pacific Ocean. The latest MMCFS forecast indicates cooler than normal SST anomaly will most likely to continue over the Niño 3.4 region and La Niña conditions likely to continue during coming seasons (Fig.4a).

In the Indian Ocean, normal to warmer than normal SSTs are likely over Bay of Bengal and Arabian Sea during DJF to FMA seasons (Fig.3). At present, neutral IOD conditions are observed over Indian Ocean and the latest MMCFS forecast indicates neutral IOD conditions are likely to continue during the coming months (Fig.4b).

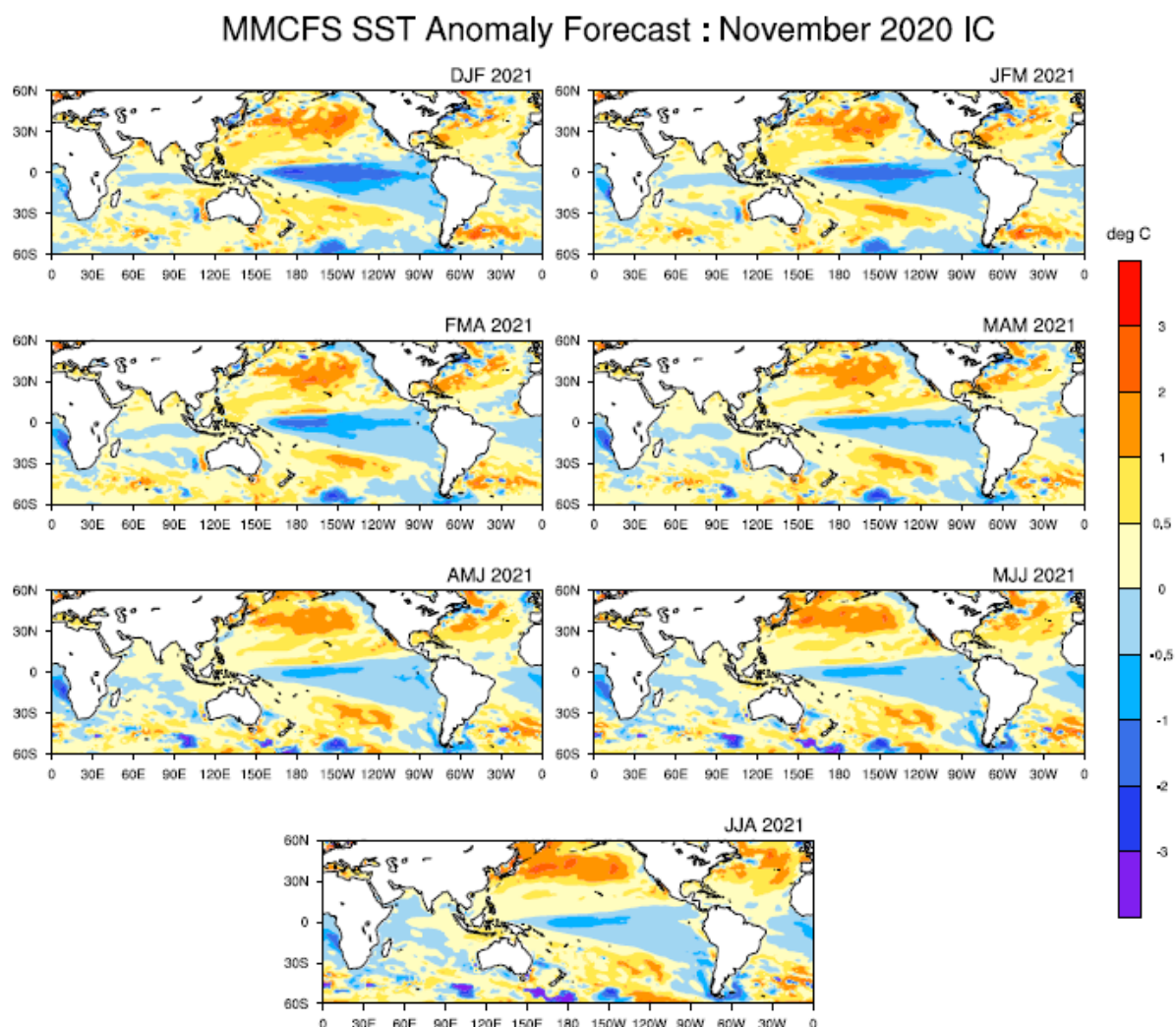


Fig.3: Forecasted Seasonal mean SST anomalies for 3 monthly seasons, (a) December to February (DJF), (b) January to March (JFM), (c) February to April (FMA), (d) March to May (MAM), (e) April to June (AMJ), (f) May to July (MJJ) and (h) June to August (JJA) (Model bias correction base period: 1999-2008; Climatology base period:1982-2008).

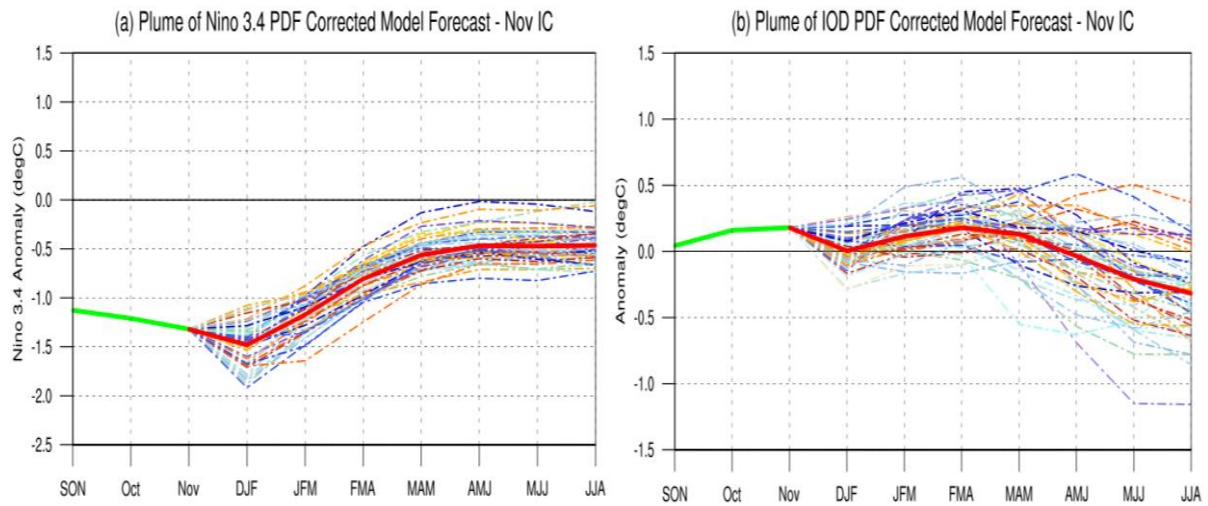


Fig.4: Plume of (a) Niño 3.4 SST anomalies, (b) Indian Ocean Dipole Mode Index forecasted by high resolution CFSv2. The forecasts were PDF corrected for bias and variance. The solid green line is the observed SST anomaly (ERSSTv5, NOAA) and solid red line is the ensemble SST anomaly forecast mean of 51 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

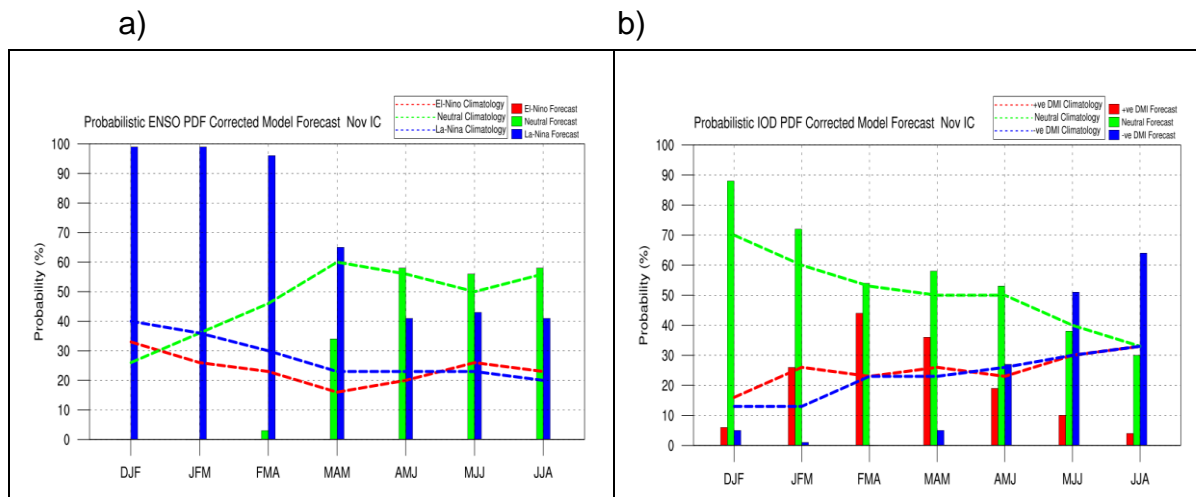


Fig.5: Probability forecast along with climatological probabilities of (a) Niño 3.4 and (b) Indian Ocean Dipole Mode Index from high resolution MMCFS. Data source for Climatology probabilities: NOAA Extended Reconstructed SST V5. Criteria used for Probabilistic ENSO Forecast: ≤ -0.5 La Niña, >0.5 to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

The probability forecast for IOD (Fig.5b) indicates enhanced probability for neutral IOD conditions during most of the forecasted seasons.