TECHNICAL NOTE
Rainfall and Temperature Forecast of Bhutan for 2019 Winter Season

BACKGROUND

The seasonal forecast is prepared using a statistical model called the Climate Predictability Tool (CPT). The rainfall and temperature forecasts for the 2019 winter season are prepared using the global observed Sea Surface Temperature (SST) data as the predictor and observed rainfall and temperature data of Bhutan as the predictants. The forecast is also based on the output/products and information from WMO's Long Range Producing Centers. The forecast also considers the forecast output from the South Asian Climate Outlook (SASCOF-15) for 2019 winter season. In addition, global-scale climate phenomena such as ENSO and IODs were considered.

ENSO AND IOD CONDITIONS AS PER WINTER SASCOF 2019

The ENSO is one of the global scale climate phenomena that have a significant influence on the year-to-year variability of the northeast monsoon rainfall as well as the surface temperatures over South Asia. The weak El Niño event of 2018-2019 started during the last quarter 2018 continued till late July 2019 and turned in to ENSO neutral conditions and these conditions continued through September. Latest forecasts indicate that neutral ENSO conditions are likely to continue during the October to December season.

In addition to ENSO conditions over the Pacific, other factors such as Indian Ocean sea surface temperatures have some influence on the climate of the region. IOD has been in the positive mode over equatorial Indian Ocean since July 2019. Recent forecasts from coupled models suggest positive IOD conditions are likely to continue during the October to December season.

There is unanimity among the experts that the prevailing ENSO neutral conditions in the equatorial Pacific Ocean and positive Indian Ocean Dipole conditions over the Indian Ocean are likely to continue during the October to December season. The relative impact of all these parameters needs to be considered to determine the expected state of the climate over the region. Careful consideration is also given to other regional and global factors as well as the intraseasonal variability of the region that can affect the rainfall and temperature patterns over the region.

WINTER SEASON OUTLOOK FROM WMO LEAD CENTERS

PRECIPITATION

Probabilistic multi-model ensemble forecast of all the GPCs (figure 1) and probabilistic multi-model ensemble forecasts of ECMWF, Seoul, Tokyo (figure 2) of WMO forecast were referred. Figures (1 & 2) show slightly above normal rainfall during DJF over Bhutan.

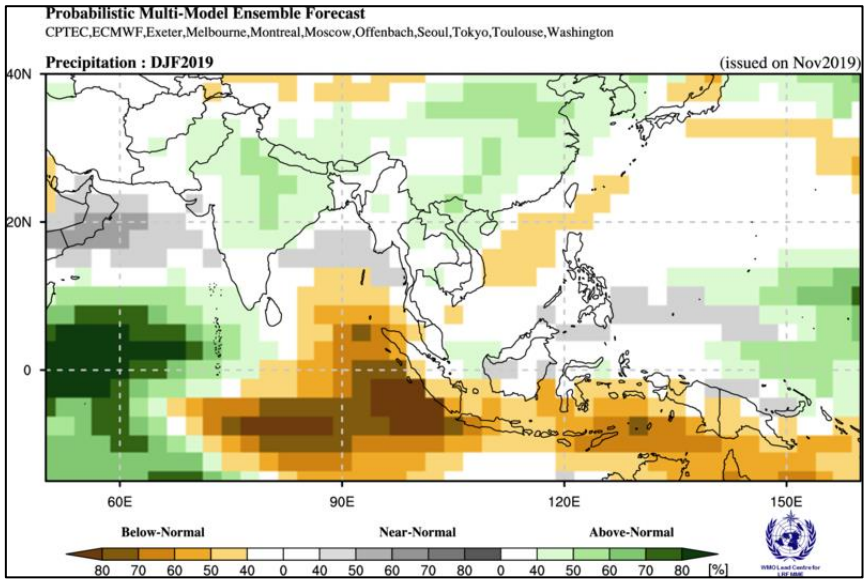


Figure 1: DJF 2019 precipitation forecast from all GPCs

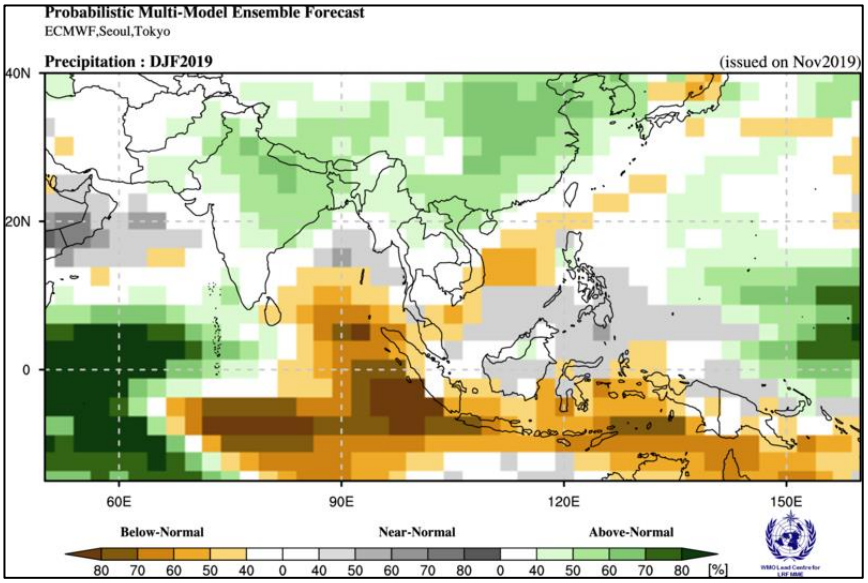
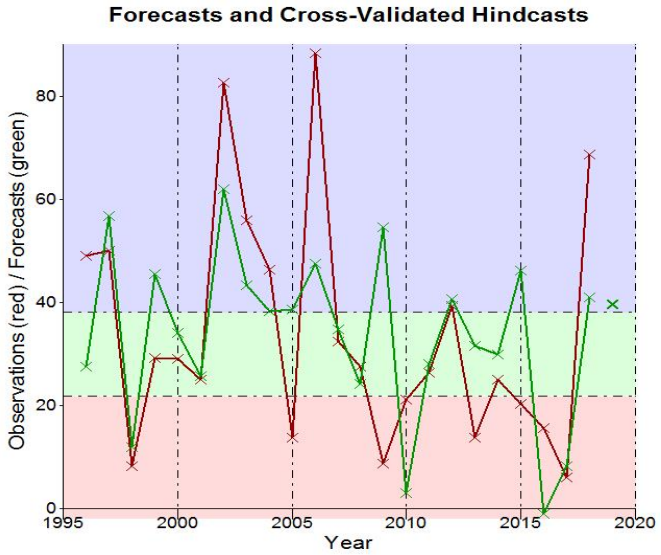


Figure 2: DJF 2019 precipitation forecast from ECMWF, Seoul and Tokyo

PRECIPITATION FORECAST BY CPT: DECEMBER 2019- FEBRUARY 2020

Precipitation forecast is prepared using the Climate Predictability Tool. The statistical model uses global sea surface temperature (SST) for October 2019 as predictor and rainfall data of Bhutan as predictand.

Figure 3 shows slightly above normal rainfall.



Probabilities:

Year	Probabilities		
	B	N	A
2019	21	26	53

Figure 3 Time series forecast for DJF precipitation using long period average rainfall data of Bhutan

WINTER SEASON OUTLOOK FROM WMO LEAD CENTERS

TEMPERATURE

Probabilistic multi-model ensemble forecast of all the GPCs (figure 1) and probabilistic multi-model ensemble forecasts of ECMWF, Seoul, Tokyo (figure 2) of WMO forecast were referred. Figures (4& 5) show below normal temperature during DJF over Bhutan.

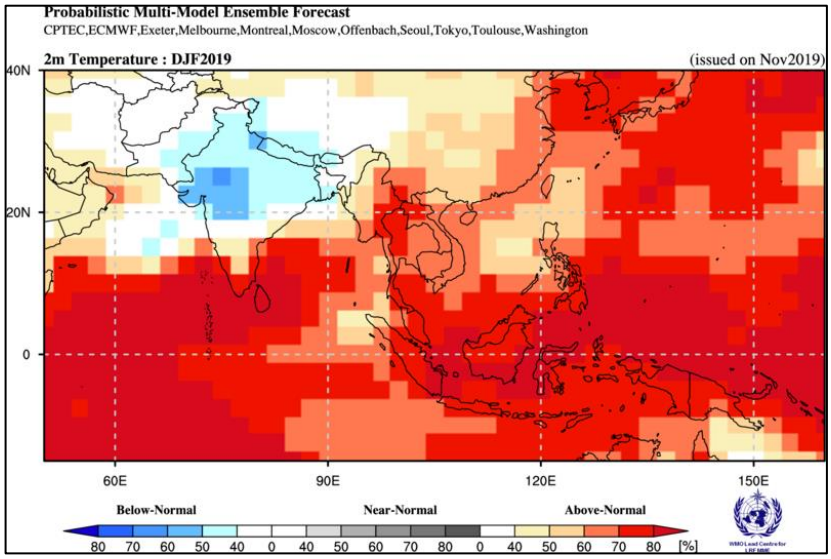


Figure 4: DJF 2019 Temperature forecast from all GPCs

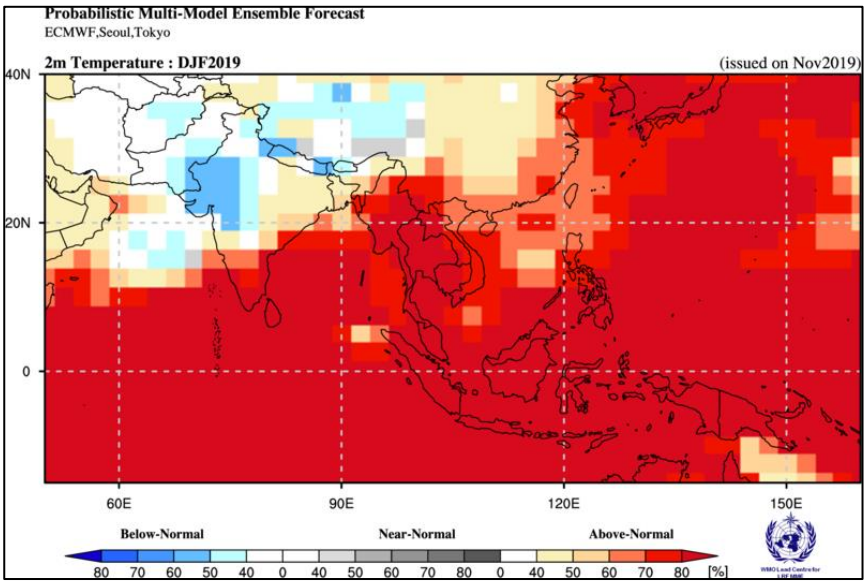
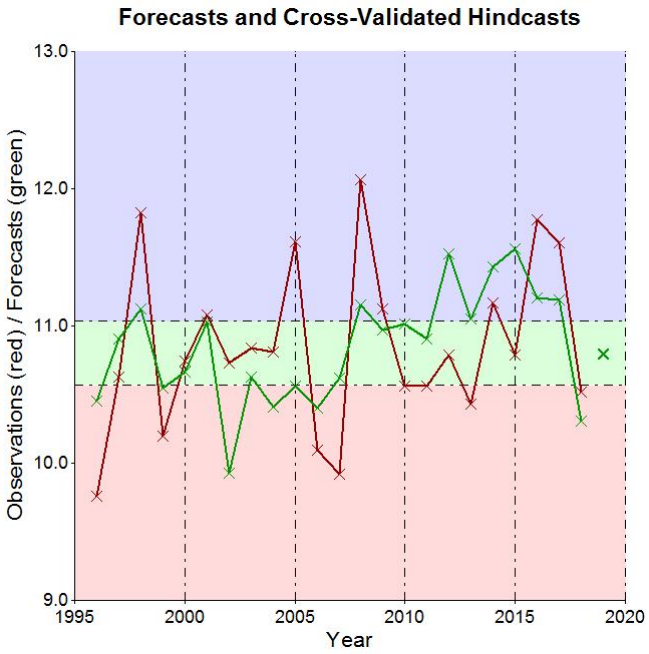


Figure 5: DJF 2019 Temperature forecast from ECMWF, Seoul and Tokyo

TEMPERATURE FORECAST BY CPT: DECEMBER 2019- FEBRUARY 2020

The temperature forecast is prepared using the Climate Predictability Tool. The statistical model uses global sea surface temperature (SST) for October 2019 as a predictor and temperature data of Bhutan as predictand. Figure 6 shows normal to slightly below normal temperature during DJF.



Probabilities:

Year	Probabilities		
	B	N	A
2019	37	28	35

Figure 6 Time series temperature forecast for DJF

SUMMARY

Based on the forecast from GPCs of WMO and the CPT, the rainfall during the 2019 winter season will most likely be normal to slightly above normal. For the temperature, both the GPCs of WMO and CPT forecast slightly below normal during the winter season. It is to be noted that the forecast is provided as an average across the country and therefore, slight deviations in the forecast are expected from the point or station wise forecasts.

References:

i. India Meteorological Department WMO Regional Climate Centre (2019). *Consensus Statement on the Forecast for the October-December 2019. Precipitation and Temperatures over South Asia*, Pune, India.

ii. WMO Lead Center for Long-Range Forecast Multi-Model Ensemble. (2019). Retrieved from https://www.wmolc.org/seasonPmmeUI/plot_PMME.

Date:25 November 2019

Precipitation and Temperature Outlook for 2019 Winter Season

The National Center for Hydrology and Meteorology releases the outlook for precipitation and temperature for 2019 winter season, for the months of December 2019 to February 2020. The forecast was prepared using a statistical model (Climate Predictability Tool) with inputs such as the Global Sea Surface Temperature and Observed Data (Rainfall and Temperature) of Bhutan. For the temperature, the average of the maximum and minimum temperature was used. In addition, the outputs from the South Asian Seasonal Climate Outlook Forum (SASCOF), winter season 2019 and the seasonal probabilistic multi-model ensemble of WMO Lead Centre for Long-Range Forecast were used.

Rainfall Forecast for 2019 Winter Season

Normal is the average rainfall for winter (DJF) of Bhutan from 1996 to 2018. The winter rainfall for Bhutan during 2019 will mostly likely to be normal to slightly above normal.

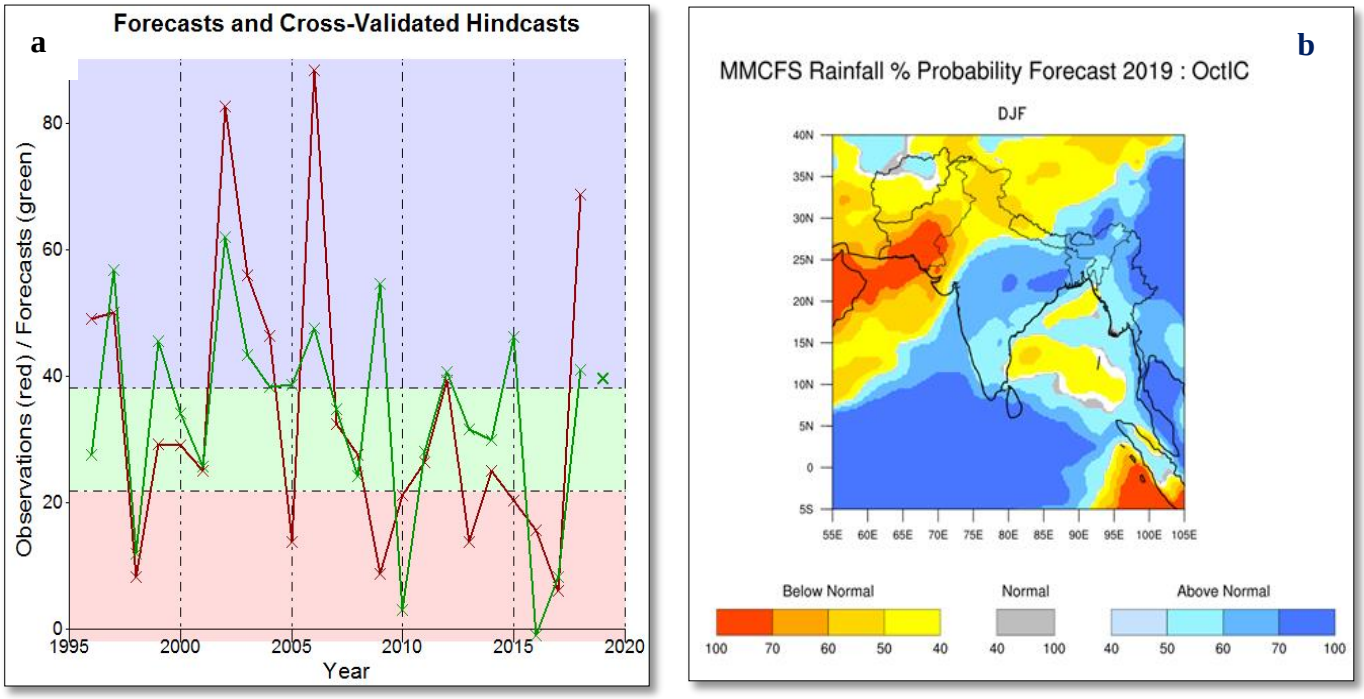


Figure (a)Time series forecast for DJF precipitation using long period average rainfall data of Bhutan;(b) Seasonal probability (%) forecasts of precipitation for DJF based on Initial conditions of October 2019.
Source(b): India Meteorological Department, 2019

Temperature Forecast for 2019 Winter Season

The temperature forecast for Bhutan 2019 winter season will most likely to be below normal.