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WEATHER AND CLIMATE SERVICES DIVISION
NATIONAL CENTER FOR HYDROLOGY AND METEOROLOGY
THIMPHU: BHUTAN



TECHNICAL NOTE

Rainfall and Temperature Forecast of Bhutan for 2017 Winter Season

Background

The seasonal forecast is prepared using a statistical model called Climate Predictability Tool (CPT). The rainfall and temperature forecasts for the 2017 winter season is prepared using the global observed Sea Surface Temperature (SST) data as a predictor and observed rainfall data of Bhutan as predictant. The forecast is also based on the output/products and information from WMO's Long Range Producing Centers or usually called WMO's Lead Center. The forecast also considers the forecast output from the South Asian Climate Outlook (SASCOF) for 2017 winter season. In addition, global scale climate phenomena such as ENSO and IODs were considered.

ENSO and IOD Conditions as per India Meteorological Department

The El Niño/Southern Oscillation (ENSO) is one of the global scale climate phenomena having a significant influence on the year-to-year variability of the winter precipitation as well as the surface temperatures over South Asia. The strong El Nino event of 2015-2016 after peaking in December 2015 started to weaken thereafter. In March 2016, conditions became warm neutral and further cooling of SSTs over equatorial Pacific thereafter resulted in the establishment of cool neutral ENSO conditions in June. Currently, the SST conditions over equatorial Pacific suggest borderline La Nina conditions. However, some of the atmospheric conditions are indicating neutral ENSO conditions. The latest forecasts from global climate models indicate strong probability of cool neutral ENSO conditions to prevail during the winter season (DJF).

Currently, the SST conditions over the equatorial Indian Ocean suggest negative Indian Ocean Dipole (IOD) conditions. The forecast from global climate models indicate strong probability of neutral IOD conditions to establish during the winter season (DJF).

There is unanimity among the experts that the prevailing borderline La Nina conditions are likely to weaken and cool neutral ENSO conditions is likely to prevail over equatorial Pacific during the coming winter season. Therefore, SST anomaly conditions over Pacific may not have much impact on the climate of the region that is generally influenced by the strong day to day atmospheric variability observed in the region. The day to day atmospheric variability over the northern part of the region is caused by the western disturbances and that over the southern part is caused by the eastern waves. Therefore, it is recognized that there is large uncertainty in the prediction of winter precipitation over the region. It was also recognized that SSTs over Pacific is not the only factor that decides the performance of winter monsoon over the region. Other relevant climate drivers such as the state of the Indian Ocean Dipole (IOD), the Tropical Atlantic SST etc. are also important. The relative impact of all these parameters needs to be considered to determine the rainfall over the region. However, the impact of El Nino on the winter season precipitation over northern Part of the South Asia is not very clear, particularly due to strong day to day atmospheric variability over the region.



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Winter Season Outlook for South Asia

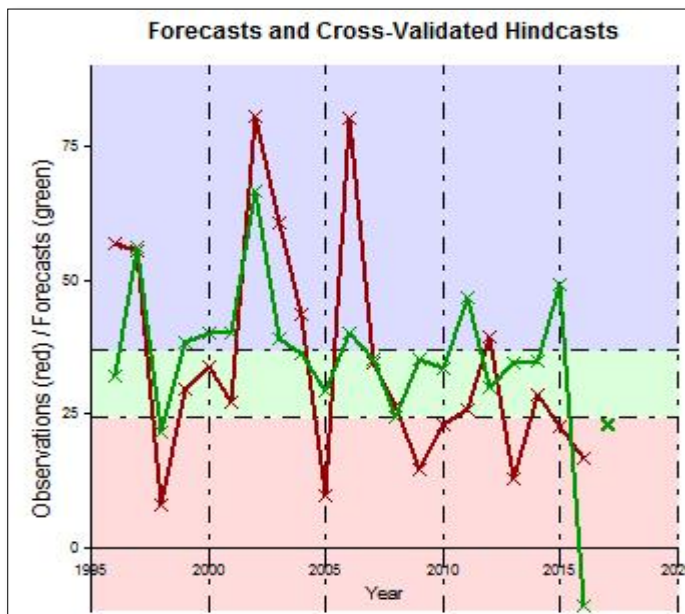
Below normal precipitation is likely during the Winter Season (December 2016 to February 2017) over northernmost parts of the South Asia, Maldives and neighbouring Lakshadweep, and northeastern parts of South Asia including northeast India, east Nepal, Bhutan, and northern parts of Myanmar. Normal precipitation is likely over the remaining parts of the region. During the season, normal to above normal temperatures are likely, over most parts of the region.

2017 Winter Season Rainfall/ Precipitation Forecast

Probabilities:				Forecast ranges:			
Year	Probabilities			Year	Forecast	Lower	Upper
	B	N	A				
2017	53	20	27	2017	22.908	-0.159	45.975

Figure (a): Graphical outputs from CPT

The winter rainfall for Bhutan during 2017 will most likely be below normal or slightly on the negative side of normal.



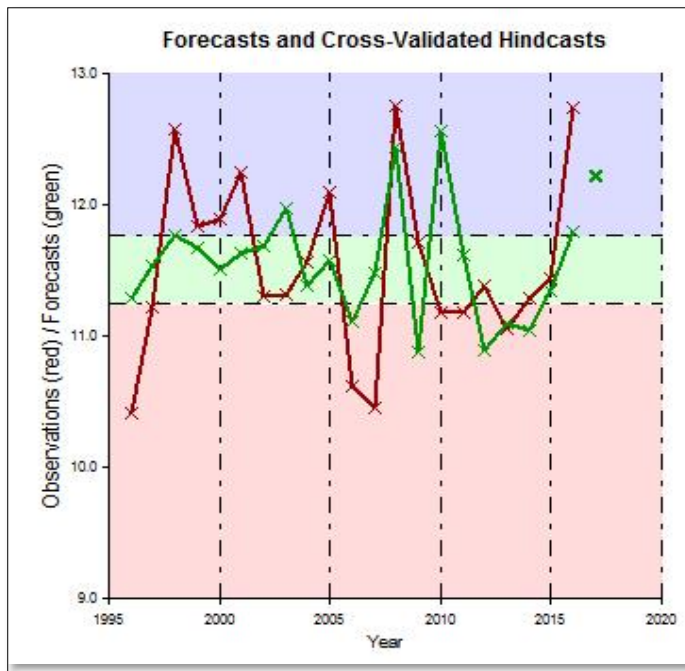
2017 Winter Season Temperature Forecast

The temperature forecast for the winter is issued for the first time. The average of **Maximum** and **Minimum Temperatures** from 1996 to 2016 for the winter season was calculated. For simplicity and to start with, separate forecasts for maximum temperature and minimum temperature were not prepared. For the temperature forecasts, the SST of October month was taken as a predictor. The forecast was compared with the forecast output of the 2017 winter season of South Asia.



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Probabilities:			
Year	Probabilities		
	B	N	A
2017	12	17	71

Forecast ranges:			
Year	Forecast	Lower	Upper
2017	12.213	11.416	13.009

Figure (b): Graphical outputs from CPT

The temperature forecast for Bhutan 2017 winter season will most likely be above normal or slightly towards the positive side of normal.

Summary

In conclusion, the rainfall in 2017 winter season will most likely be below normal or slightly towards the negative side of normal. For the temperature, it will most likely be above normal or slightly towards the positive side of normal.

References:

- i. India Meteorological Department WMO Regional Climate Centre (Demonstration Phase) 2017, Consensus Statement on the Forecast for the Winter Season (December 2016 –February 2017) Precipitation and Temperature over South Asia, Pune, India.
- ii. WMO Lead Center for Long Range Forecast Multi-Model Ensemble 2017, <https://www.wmolc.org/modules/data/plot/plot_PMME.php?tm_id=1&cdepth=3&upnum=6&ca_id=101&s1=3&s2=1&t1=4#>

Rainfall and Temperature Forecasts for 2017 Winter Season

The National Center for Hydrology and Meteorology releases the outlook for precipitation and temperature for 2017 winter season, for the months of December 2017, January and February 2018. 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



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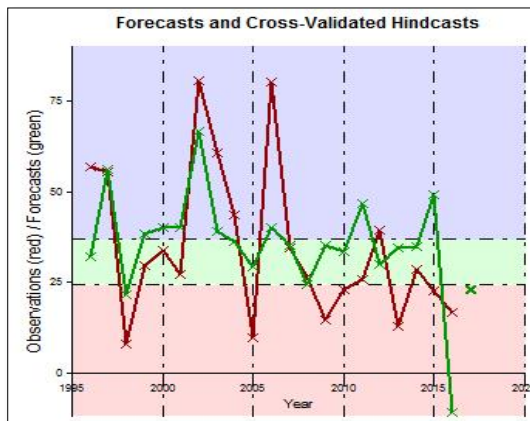


temperature was used. In addition, the outputs from the South Asian Seasonal Climate Outlook Forum (SASCOF), winter season 2017 and the seasonal probabilistic multi-model ensemble of WMO Lead Centre for Long Range Forecast were used.

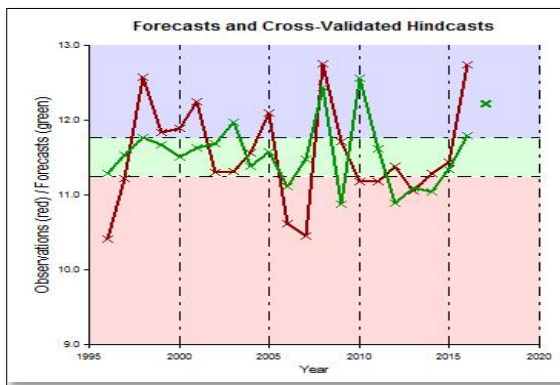
Rainfall Forecast for 2017 Winter Season

Normal is the average rainfall for winter (DJF) of Bhutan from 1996 to 2016. The winter rainfall for Bhutan during 2017 will likely be below normal.

Figure 1: Model output for rainfall forecast



Temperature Forecast for 2017 Winter Season



The temperature forecast for Bhutan 2017 winter season will most likely be above normal.

Figure 2: Model output for temperature forecast