



**Rainfall and Temperature Forecast of Bhutan
for
Summer Monsoon
(June – September 2022)**

**Weather and Climate Services Division
National Centre for Hydrology and Meteorology
Royal Government of Bhutan
2022**

Acknowledgement

“Rainfall and Temperature Forecast of Bhutan for Summer Monsoon (June – September 2022)” was prepared after the completion of the 8th session of National Climate Outlook Forum (NCOF-8) held on 27th May, 2022. The event was carried as part of the **Project Title: Supporting Climate Resilience and Transformational Change in the Agriculture Sector in Bhutan** funded by Green Climate Fund (GCF).

1. Background

Seasonal forecasting and climate predictions are important adaptation measures to climate variability and change. Regional Climate Outlook Forums (RCOFs) were created to bring together countries having common climatological characteristics and to produce a joint assessment of the state of the regional climate. Thus, South Asian Climate Outlook Forum (SASCOF) came into existence in 2010 with specific focus on the information needs of countries affected by the monsoon climate in South Asia.

Seasonal forecasts generally consist of an outlook of precipitation and temperature for a particular region. The seasonal forecast of Bhutan is prepared with inputs from global and regional prediction centres, and national climate data. The final outlook is also based on the consensus outlook of the South Asian Climate Outlook Forum (SASCOF), products from World Meteorological Organization (WMO) Global Producing Centres (GPCs) of Long-Range Forecast, various other international sources and the prevailing global climate conditions such as El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) affecting the monsoon. The summer monsoon outlook has to be used and interpreted along with the extended, medium, daily weather forecasts and other advisories released by the Centre.

2. SASCOF-22 consensus on prevailing conditions

2.1 ENSO Conditions over the Pacific Ocean

The El Niño/Southern Oscillation (ENSO) is a global climate conditions having significant influence on the variability of the monsoon precipitation and the surface temperatures over South Asia. La Niña conditions (colder than normal SSTs over the equatorial Pacific) strengthen in December 2021 and it gradually weakened in January and February 2022. However, the La Niña conditions slightly strengthened in March 2022 and currently, La Niña conditions are prevailing over the Pacific region. The latest global model forecasts indicate La Niña conditions to continue during this monsoon season.

2.2 Conditions over the Indian Ocean

The Sea Surface Temperature (SSTs) of the Indian Ocean also influence the monsoon of the region. A positive (negative) Indian Ocean Dipole (IOD) is associated with a stronger (weaker) than normal monsoon. Currently, neutral IOD conditions are prevailing over the region and the latest global model indicate the development of a negative IOD during this monsoon season.

2.3 Snow Cover over the Northern Hemisphere

The Northern Hemisphere and Eurasia snow-covered area was near normal during December 2021 and January to March 2022. The Northern Hemisphere snow cover areas during February and March 2022 were 29th and 25th lowest respectively and the Eurasian snow cover area was 32th and 24th respectively in the last 55 years. Generally, winter and spring snow cover extent has an inverse relationship with the summer monsoon rainfall of Asia.

3. Regional Outlook for 2022 Southwest Monsoon over South Asia (SASCOF-22 outlook for JJAS 2022)

A regional climate outlook for the 2022 Southwest monsoon over South Asia was prepared based on assessment of the prevailing large-scale climate indicators, experimental models developed during capacity-building workshops of previous SASCOF sessions, statistical and dynamical long-range forecasts of NMHSs in the region and various other climate centres of the world. Factors such as ENSO, IOD, tropical Atlantic Sea surface temperatures, Eurasian land heating etc. are considered for the SASCOF outlook.

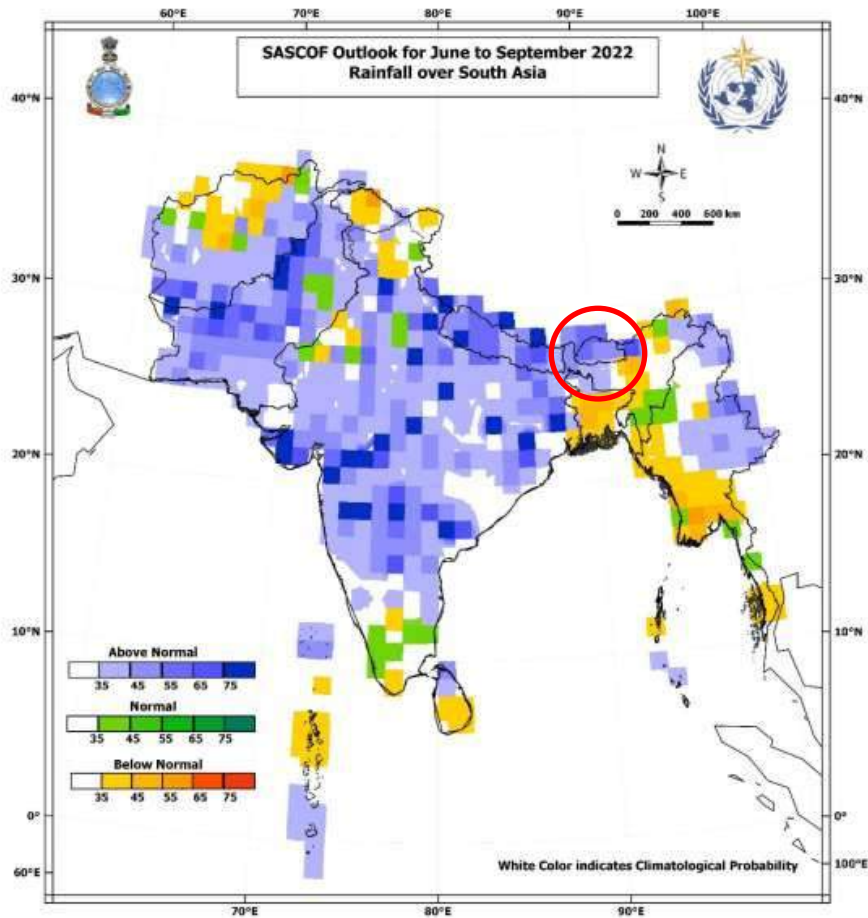


Figure 1: Outlook for JJAS 2022 rainfall over South Asia

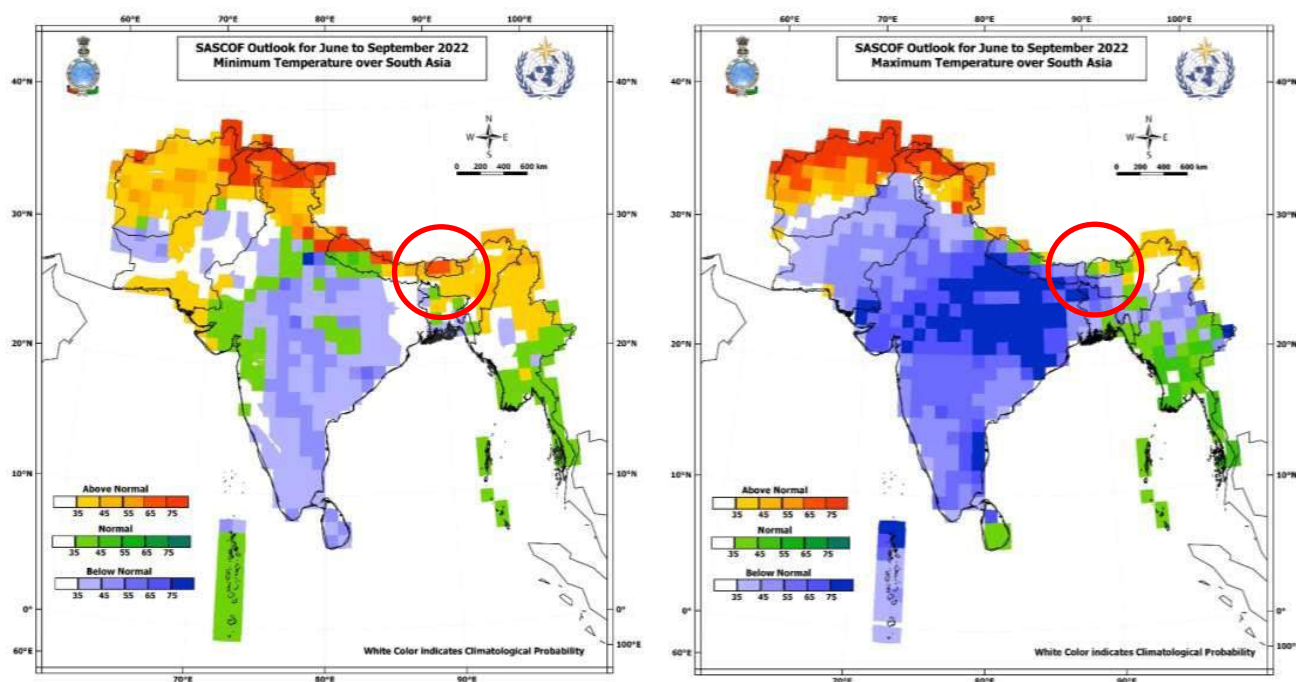


Figure 2: Outlook for JJAS 2022 minimum (left) and maximum temperature (right) over South Asia

The Figure shows grid wise most likely tercile probability category for each 1x1 degree grids. As depicted in Figure 1, the outlook indicates that during the summer season JJAS 2022, the rainfall is most likely to be normal to above normal over most parts of South Asia and below normal rainfall over the extreme north, northwestern, south and southeastern parts of the South Asia. However, the remaining region is likely to be normal or of climatological probabilities.

Above normal minimum temperatures for JJAS 2022 season are likely over the foothills of Himalayas northern, northwestern and northeastern parts of the South Asia. While, the minimum temperature are most likely to be below normal to normal over central, southern and southeastern areas of the region and the remaining regions are expected to have climatological probabilities.

The outlook on maximum temperatures for JJAS 2022 is likely to be normal to below normal over most of the region. Climatological probabilities are expected over the rest of the remaining regions.

Since the rainfall and temperature during the southwest monsoon season depicts strong intra-seasonal variability, it is recommended to follow the extended and medium range forecast besides seasonal forecast for better planning.

4. Summer Seasonal Outlook from International and Regional Climate Centres

4.1 WMO Lead Centres

Probabilistic multi-model ensemble forecast of all the GPCs of WMO forecast show above normal rainfall and above normal temperature during JJAS 2022 over Bhutan.

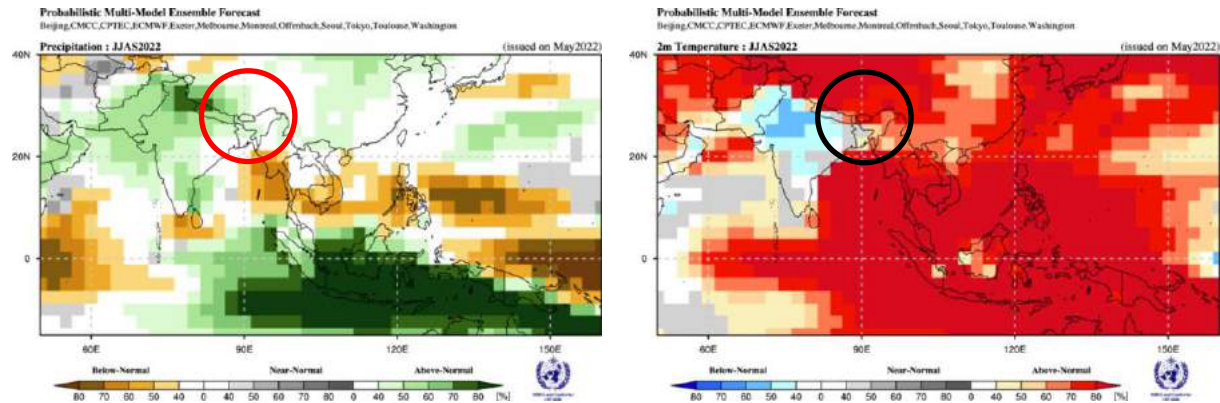


Figure 3: JJAS 2022 precipitation (left) and temperature (right) forecast from WMO GPCs

4.2 International Research Institute for Climate and Society (IRI)

The IRI forecast indicates above normal rainfall over most of the areas and above normal temperature during JJAS 2022 over Bhutan.

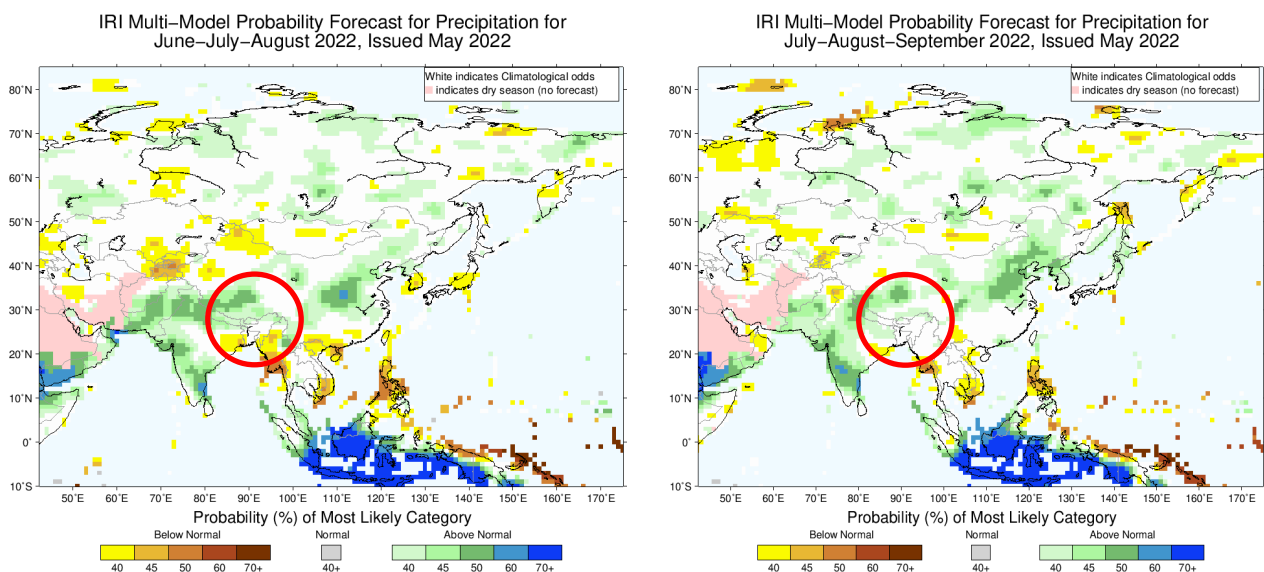


Figure 4: 2022 precipitation (left) and JAS (right) forecast from IRI

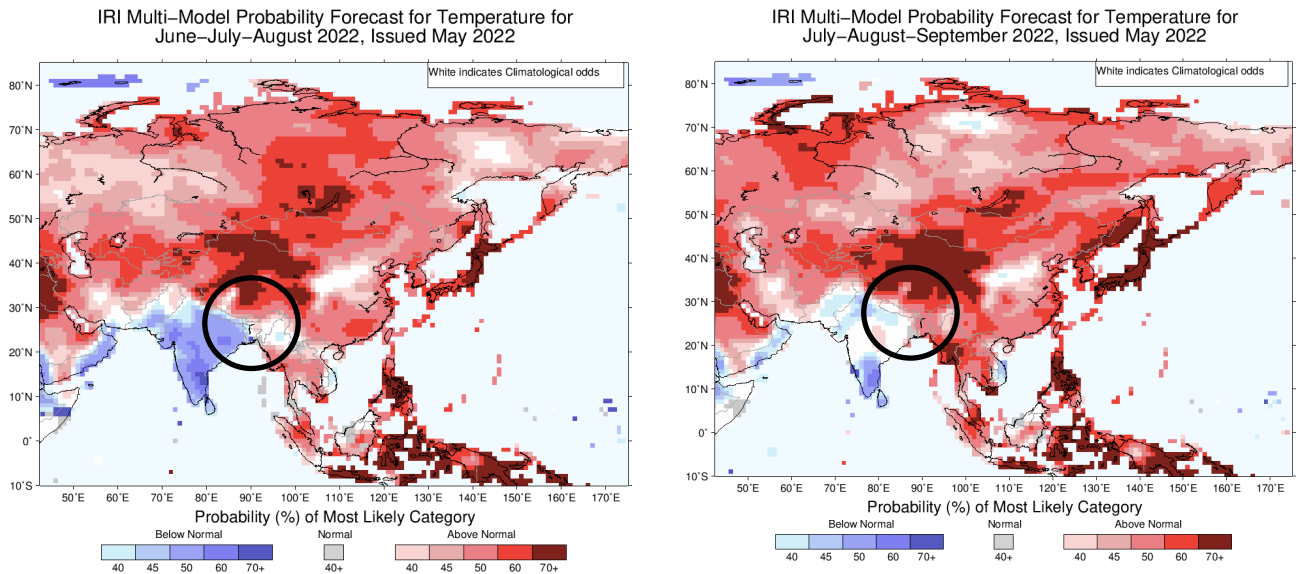


Figure 5: 2022 temperature for JJA (left) and JAS (right) forecast from IRI

4.3 APEC Climate Center (APCC)

The APCC forecast indicates climatological probability for rainfall and above normal temperature during JJA 2022 over Bhutan.

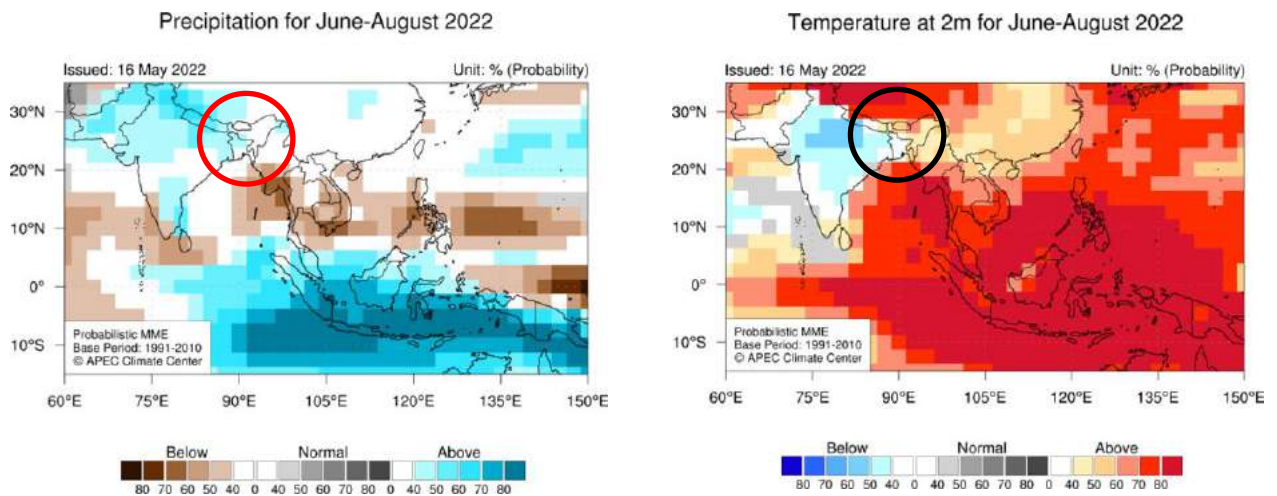


Figure 6: JJA 2022 precipitation (left) and temperature (right) forecast from APCC

4.4 UK Met office

According to UK Met office forecast, there is high probability of above normal rainfall and above normal temperature during JJAS 2022 over Bhutan.

Probability of tercile categories Jun/Jul/Aug Issued May 2022

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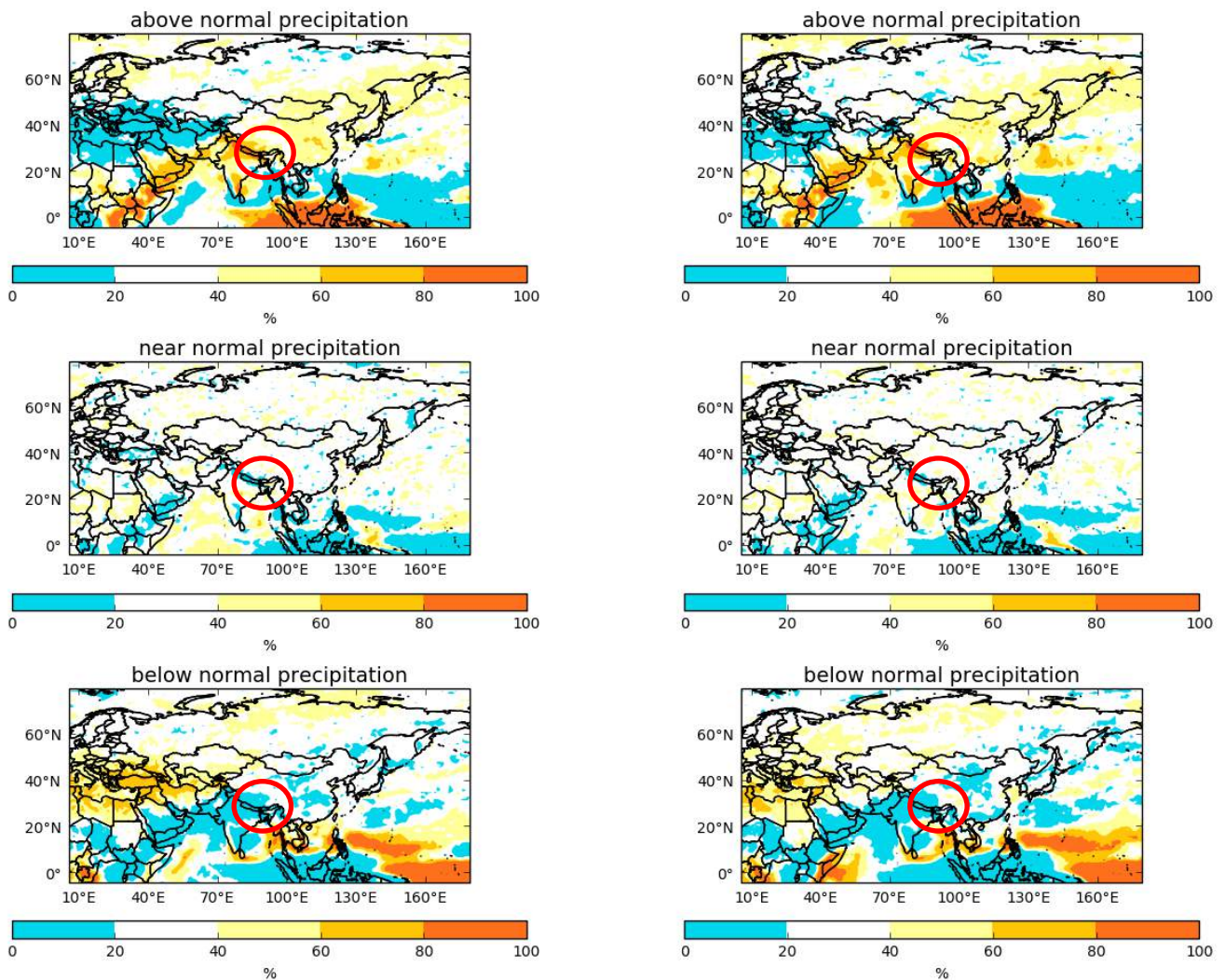


Figure 7: 2022 precipitation for JJA (left) and JAS (right) forecast from UK Met office

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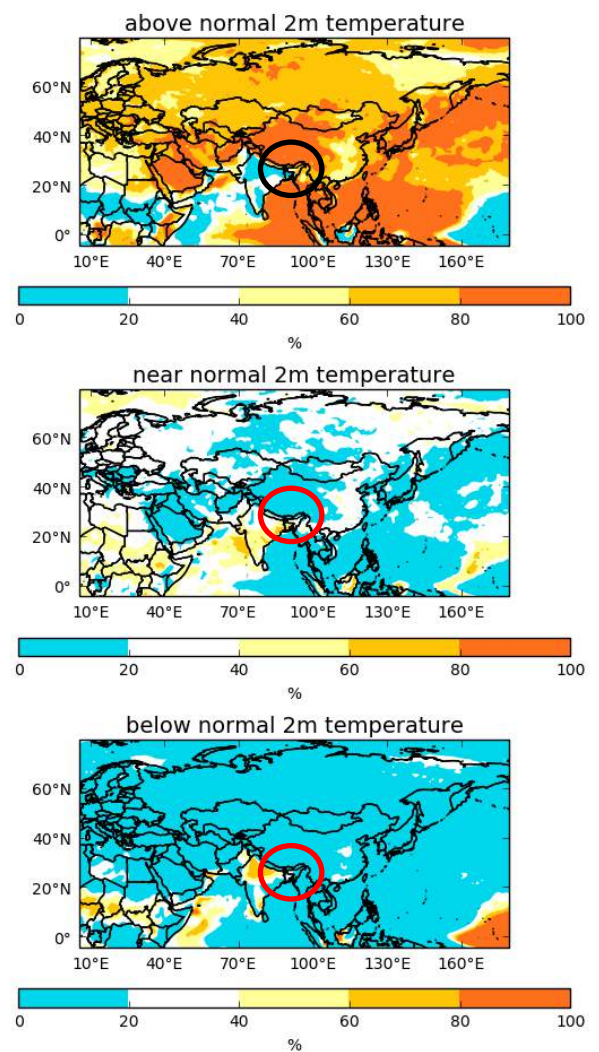
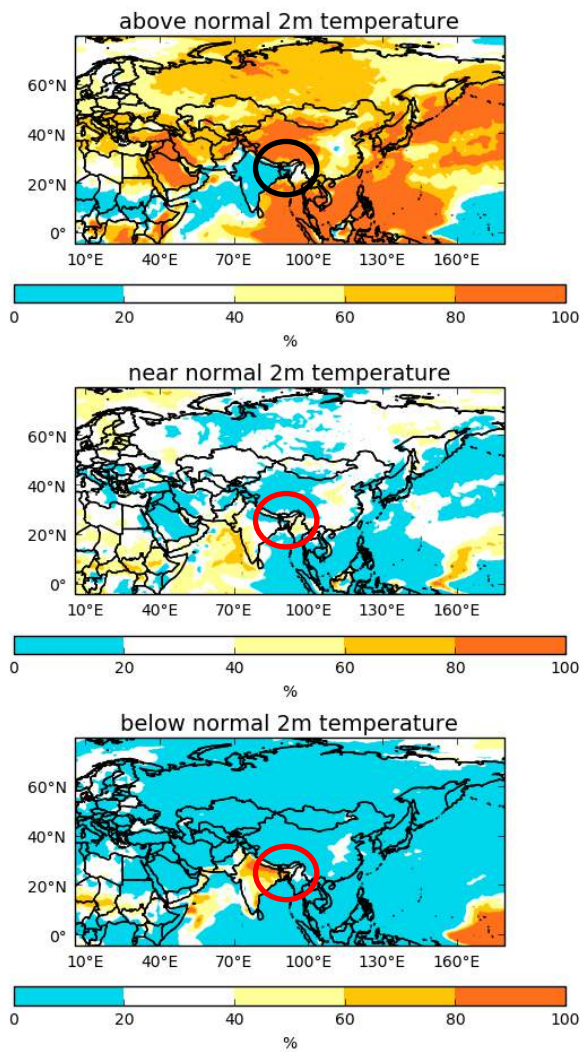
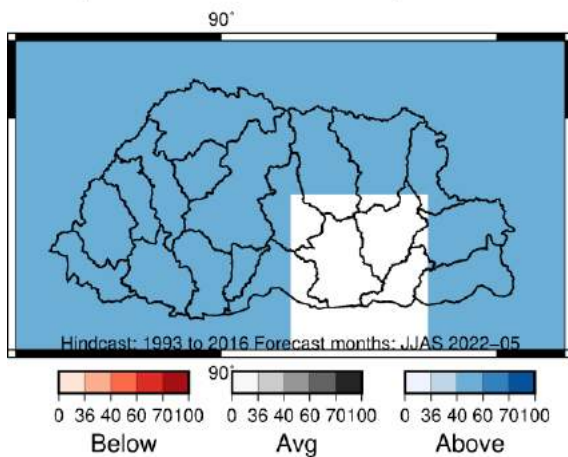


Figure 8: 2022 temperature for JJA (left) and JAS (right) forecast from UK Met office

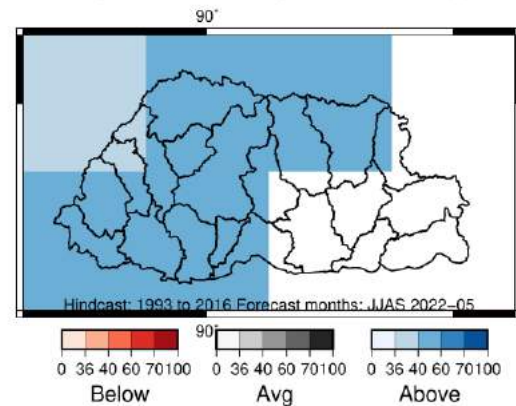
4.5 FOCUS probability forecast, RIMES

The forecast from the FOCUS tool is calculated on the probability forecast methods viz; simple mean and skilled weighted average. According to FOCUS, there is high probability of above normal rainfall during JJAS 22 over Bhutan for both ECMWF Re-analysis (ERA) and Climate Hazards Group Infrared Precipitation with Station data (CHIRPS) observation.

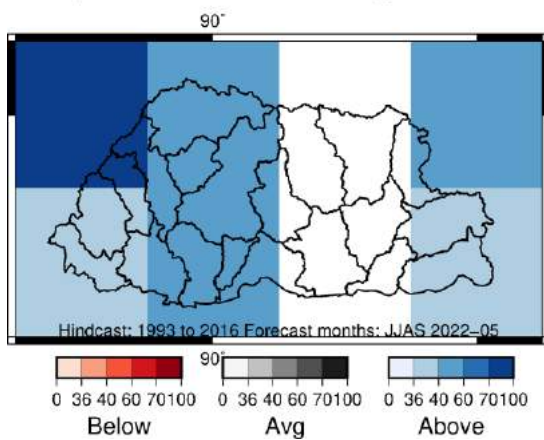
Simple Mean Probability Forecast



Skilled Weighted Average Probability Forecast



Simple Mean Probability Forecast



Skilled Weighted Average Probability Forecast

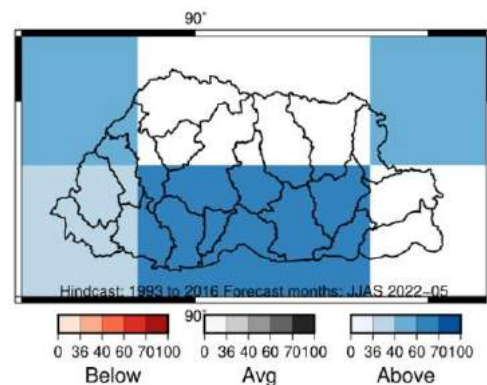


Figure 9: JJAS 2022 precipitation forecast based on CHIRPS (top) and ERA (bottom)

4.6 Forecast from NCHM using Climate Predictability Tool (CPT)

The CPT forecast indicate near normal to slightly above normal rainfall during JJAS 2022.

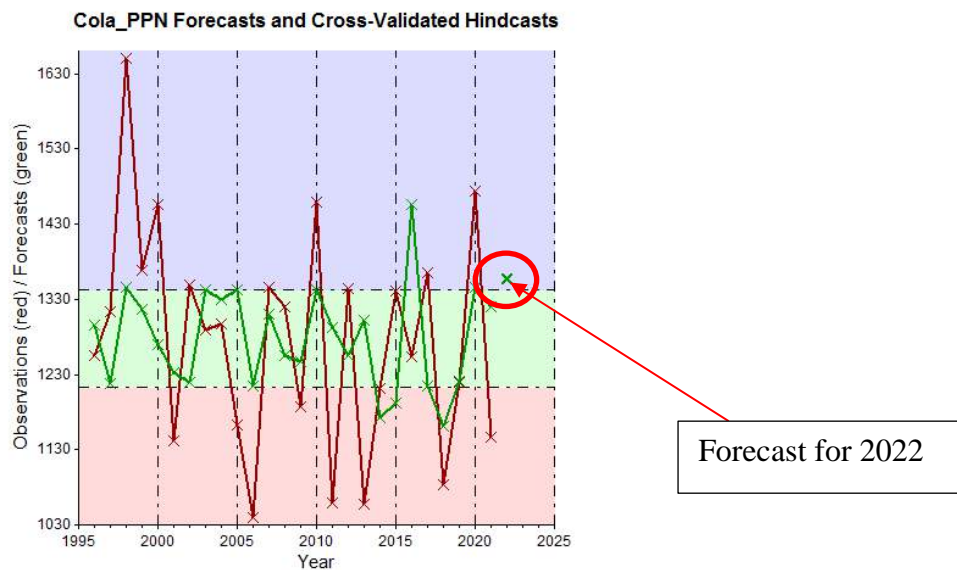


Figure 10: JJAS 2022 Precipitation forecast from CPT

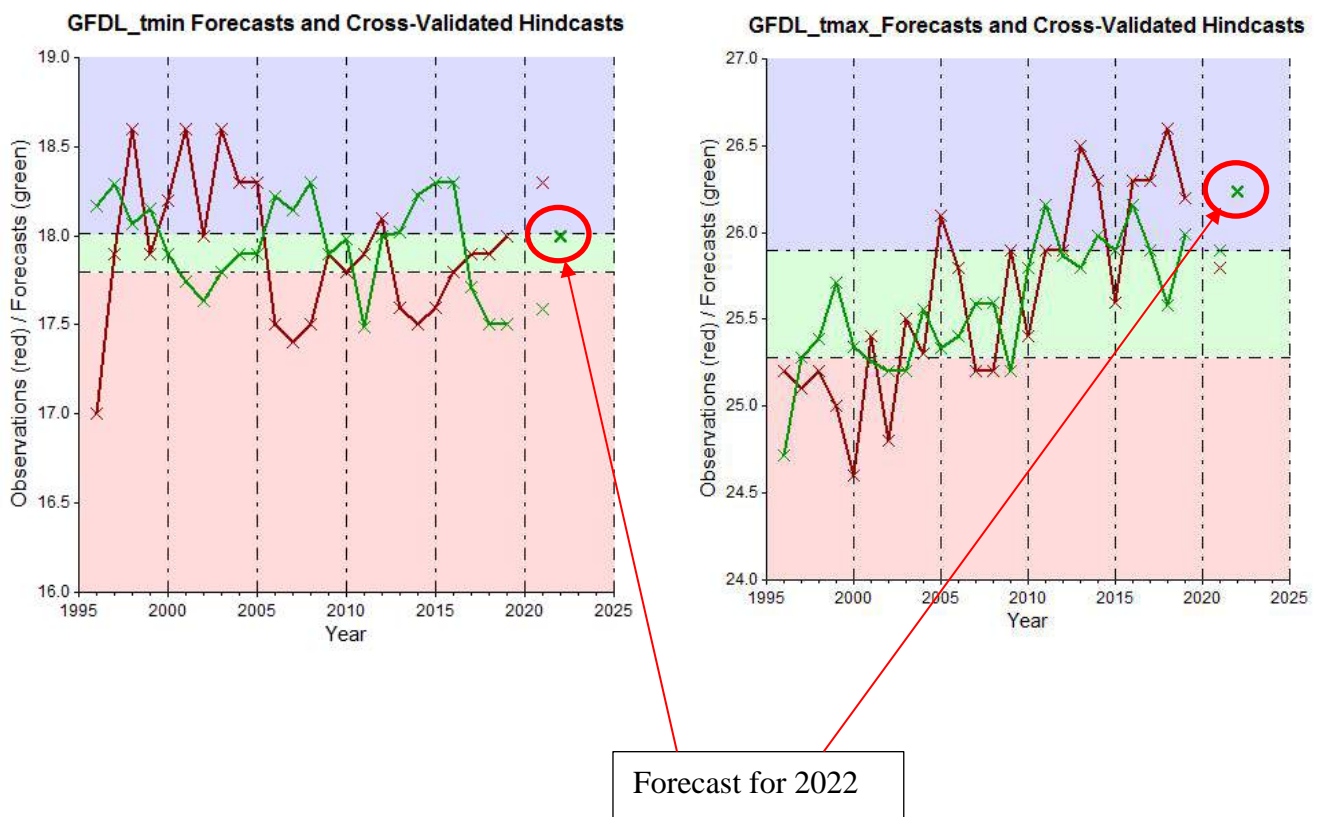


Figure 11: JJAS 2022 minimum (left) and maximum temperature (right) forecast from CPT

5. Summer Seasonal Monsoon outlook JJAS 2022 for Bhutan

ENSO La Nina and negative IOD conditions are likely to prevail during this season. The final outlook of summer season over Bhutan is based on the forecast products from various sources.

Table 1: Summary of results from various sources

SI No.	Indicators	Precipitation	Maximum Temperature	Minimum Temperature
1	CPT	Slightly above normal	Above normal	Normal to slightly above
2	FOCUS	Slightly above normal	N/A	
3	GPCs	Above normal	Above normal	
4	IRI	Above normal	Slightly above normal over most regions	
5	APEC	Climatology Probability	Above normal	
6	UK Met	Above normal	Above normal	
7	SASCOF	Above normal	Normal to slightly above	Above normal

Consensus forecast

Rainfall Forecast for 2022 Summer Season

The summer rainfall for Bhutan during the 2022 JJAS monsoon season is most likely to be slightly above normal. Normal is the average rainfall for the summer season (JJAS) of Bhutan from 1996 to 2021.

Temperature Forecast for 2022 Summer Season

The maximum and minimum temperature in Bhutan during the 2022 JJAS monsoon season is likely to be slightly above normal. Normal is the average temperature (maximum and minimum) for the summer season (JJAS) of Bhutan from 1996 to 2021.

References:

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27 May, 2022

Press Release

Precipitation and Temperature Outlook for Southwest Summer Monsoon (June – September, 2022)

The National Centre for Hydrology and Meteorology releases the outlook for precipitation and temperature for the 2022 summer season, for the months of June to September 2022. The 8th National Climate Outlook Forum (NCOF-8) was held on 27 May 2022. The presentation of the outlook was made to all the stakeholders and media. The forecast was prepared with inputs from global and regional prediction centres, and national climate data. The final outlook is also based on the consensus outlook of the South Asian Climate Outlook Forum (SASCOF-22) held from 26 – 28th April, 2022, outlook from WMO GPCs and various other international sources. The summer monsoon outlook has to be used and interpreted along with the extended, medium, daily weather forecasts and other advisories released by the Centre. Stakeholders and users are advised to follow the NCHM website and Facebook pages for advisories and updates.

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