Rainfall and Temperature Forecast of Bhutan
for
Summer Monsoon
(June – September 2024)

Meteorological Services Division
National Centre for Hydrology and Meteorology
Royal Government of Bhutan
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Acknowledgement

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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 must be used and interpreted along with the extended, medium, daily weather forecasts and other advisories released by the Centre.

2. SASCOF-28 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. Currently, ENSO neutral condition is prevailing over the Pacific region. The latest global model forecasts indicate La Nina conditions to develop during second half of 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 positive IOD during this monsoon season.

2.3 Snow Cover over the Northern Hemisphere

The Northern Hemisphere snow cover areas during January to March 2024 were below normal. and the Eurasian snow cover area was 5th lowest during the March 2023 in the last 57 years. The snow cover area during February and March were 8th and 7th lowest ever recorded during the past 58 years respectively. Generally, winter and spring snow cover extent has an inverse relationship with the summer monsoon rainfall of Asia.

3. SASCOF-28 Outlook for JJAS 2024 Southwest Monsoon over South Asia

A regional climate outlook for the 2024 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.

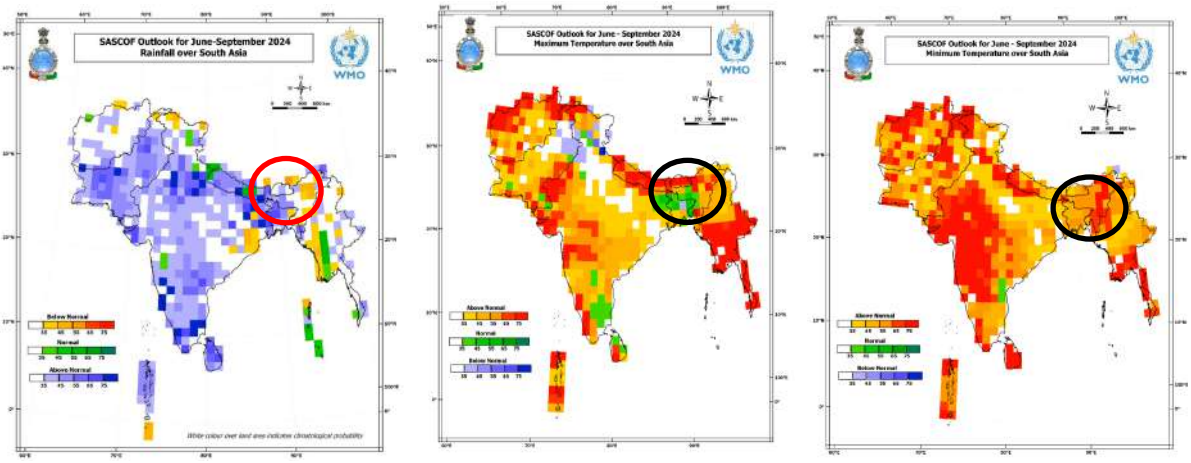


Figure 1: Outlook for JJAS 2024 rainfall over South Asia (left), maximum temperature (middle) and minimum temperature (right) over South Asia

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 2024, the rainfall is most likely to be above normal over most parts of South Asia. The below normal rainfall is expected over the isolated parts of extreme north and eastern region of South Asia. The remaining regions are likely to experience climatological probabilities.

The outlook on maximum temperatures for JJAS 2024 is likely to be normal to above normal over most of the South Asia region except some parts of the northern India. The outlook on minimum temperatures for JJAS 2024 is likely to be above normal over most of the region of South Asia. 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 JJAS 2024 from International and Regional Climate Centres

4.1 WMO Lead Centres

Probabilistic multi-model ensemble forecast of all the GPCs of WMO forecast show slightly above normal rainfall and above normal temperature during JJAS 2024 over Bhutan.

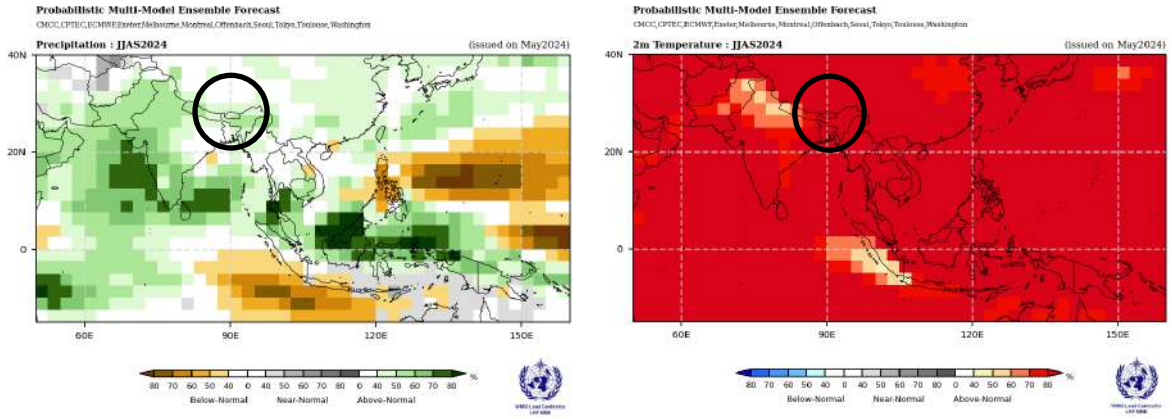


Figure 2: JJAS 2024 precipitation (left) and temperature (right) forecast from WMO GPCs

4.2 International Research Institute for Climate and Society (IRI)

The IRI forecast indicates climatological probability over the regions. The temperature is likely to be above normal during JJA 2024 over Bhutan.

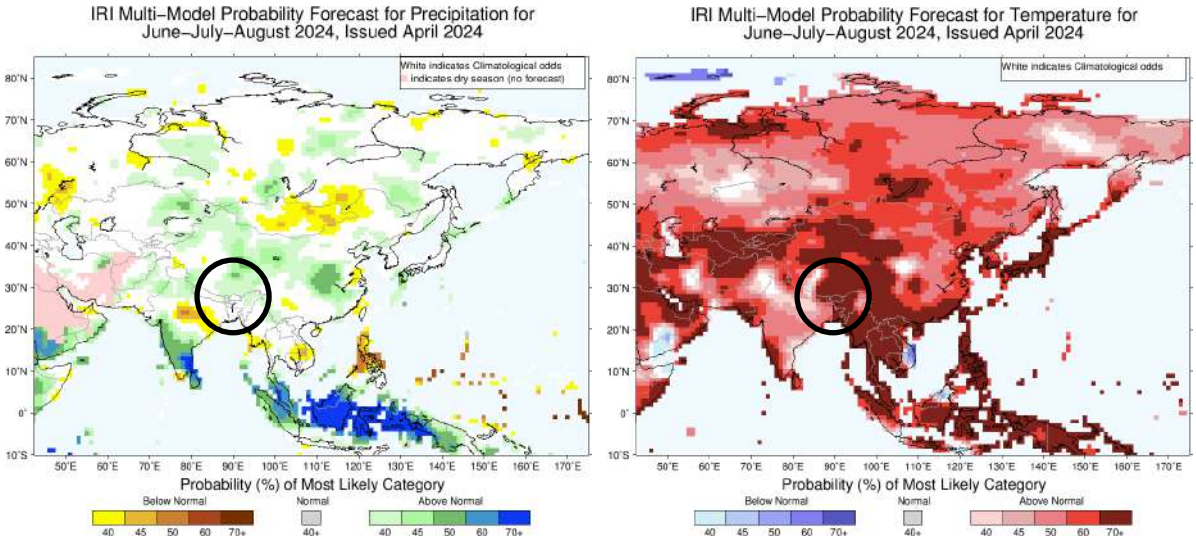


Figure 3: JJA 2024 precipitation (left) and temperature (right) forecast from IRI

4.3 APEC Climate Center (APCC)

The APCC forecast indicates above normal for rainfall and above normal temperature during JJA 2024 over Bhutan.

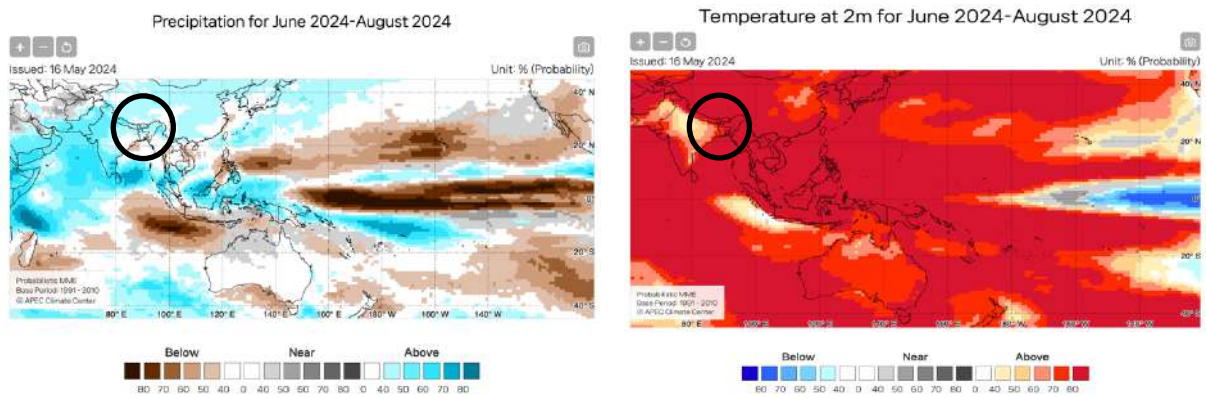


Figure 4: JJA 2023 precipitation (left) and temperature (right) forecast from APCC

4.4 Copernicus Climate Change Service (C3S)

According to C3S forecast, there is forecast of below normal rainfall in the northern part and above normal rainfall in the southern parts of the country. The temperature is likely to be above normal during JJA 2024 over Bhutan.

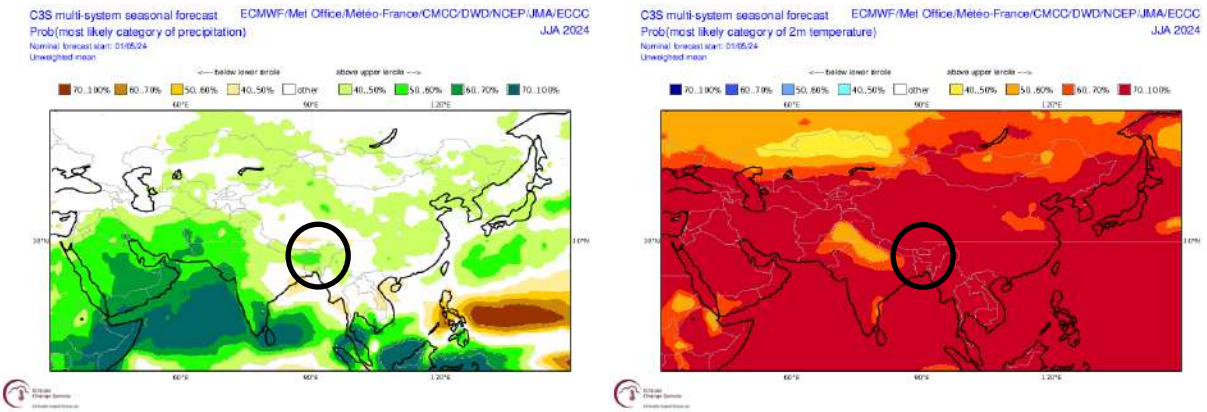


Figure 5: JJA 2024 precipitation (left) and temperature (right) forecast from C3S

4.5 Japan Meteorological Agency (JMA) forecast

The JMA forecast indicates slightly above normal for rainfall and above normal temperature during JJA 2024 over Bhutan.

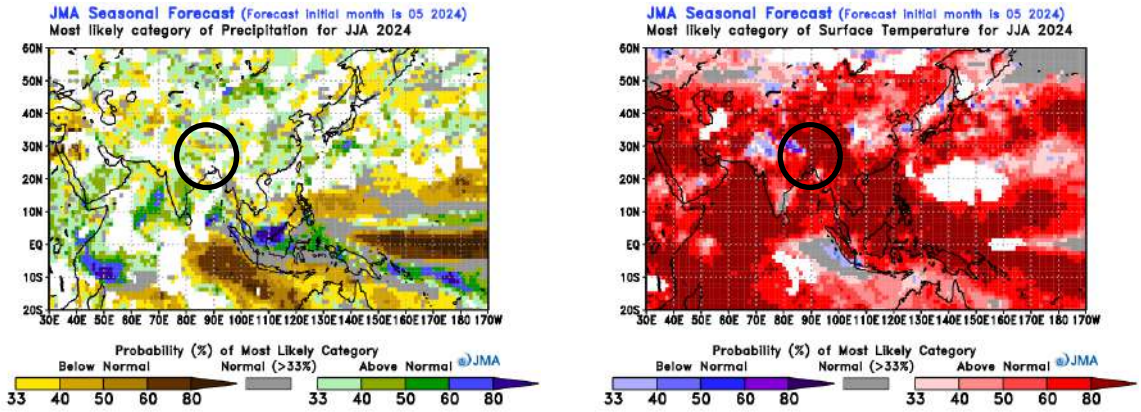


Figure 6: JJA 2024 precipitation (left) and temperature (right) forecast from JMA

4.6 FOCUS 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 2024 over Bhutan for ECMWF Re-analysis (ERA) observation.

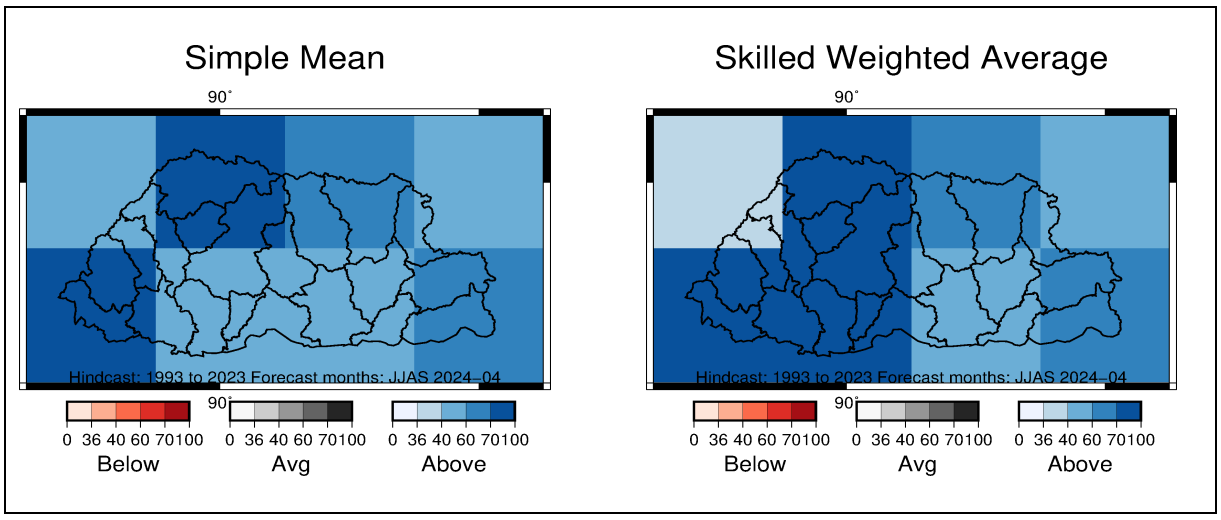


Figure 7: JJAS 2024 precipitation forecast based on ERA5 data

4.7 Forecast from NCHM using Climate Predictability Tool (CPT)

The CPT forecast indicate slightly above normal rainfall, above normal maximum temperature and slightly above normal minimum temperature during JJAS 2024.

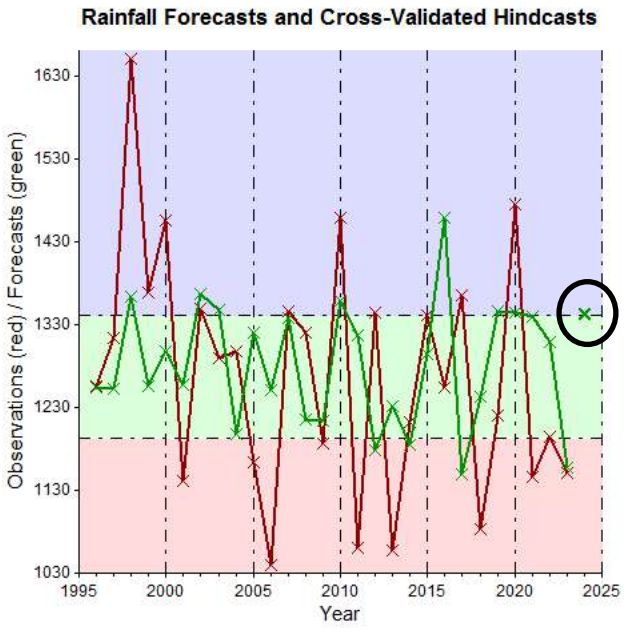


Figure 8: JJAS 2024 Precipitation forecast from CPT

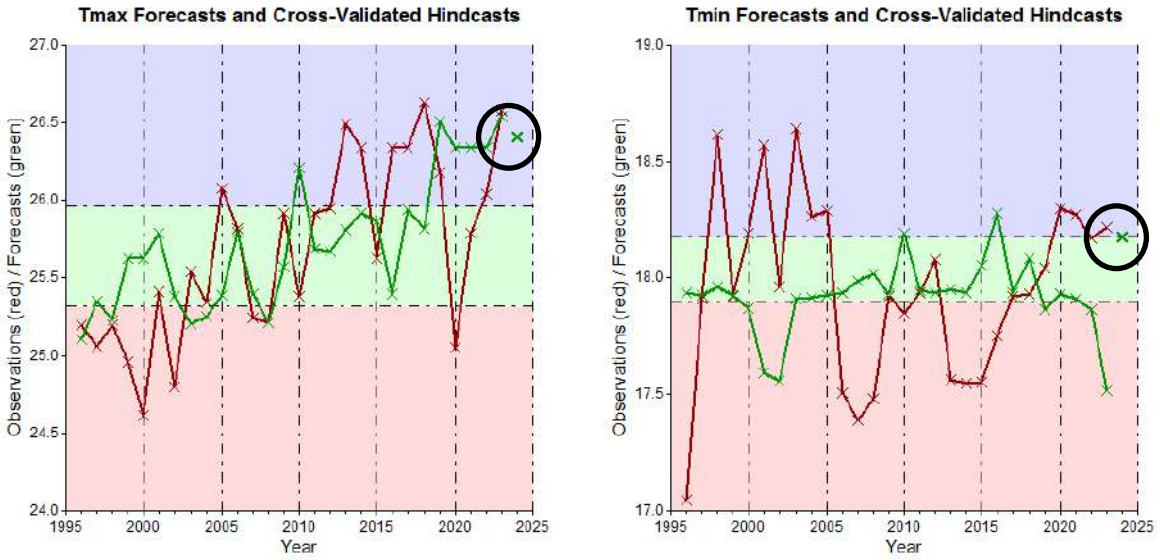


Figure 9: JJAS 2024 maximum (left) and minimum temperature (right) forecast from CPT

5. ENSO and IOD outlook JJAS 2023

ENSO Neutral to La Nina and positive IOD conditions are likely to prevail during this season.

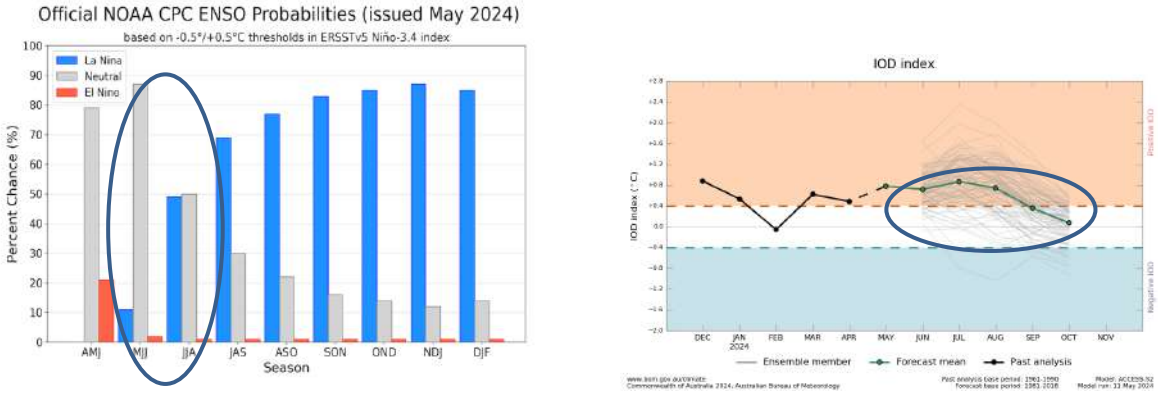


Figure 10: El Nino condition (left) and IOD condition (right)

The final outlook of summer season JJAS 2024 over Bhutan is based on the forecast products from various sources.

Sl No.	Indicators	Precipitation	Maximum Temperature	Minimum Temperature
1	CPT	Slightly above normal	Above normal	Normal to slightly above normal
2	FOCUS	Above normal		
3	GPCs	Slightly above normal	Above normal	
4	IRI	Climatology Probability	Above normal	
5	APEC	Above normal	Above normal	
6	C3S	Above Normal for south, Below normal for north	Above normal	
7	JMA	Slightly above normal	Above normal	
8	SASCOF	Normal to slightly above normal	Above normal	Above normal
9	ENSO	Neutral to La Nina		
10	IOD	Positive		

Table 1: Summary of results from various sources

6. Consensus Monsoon outlook JJAS 2024 for Bhutan

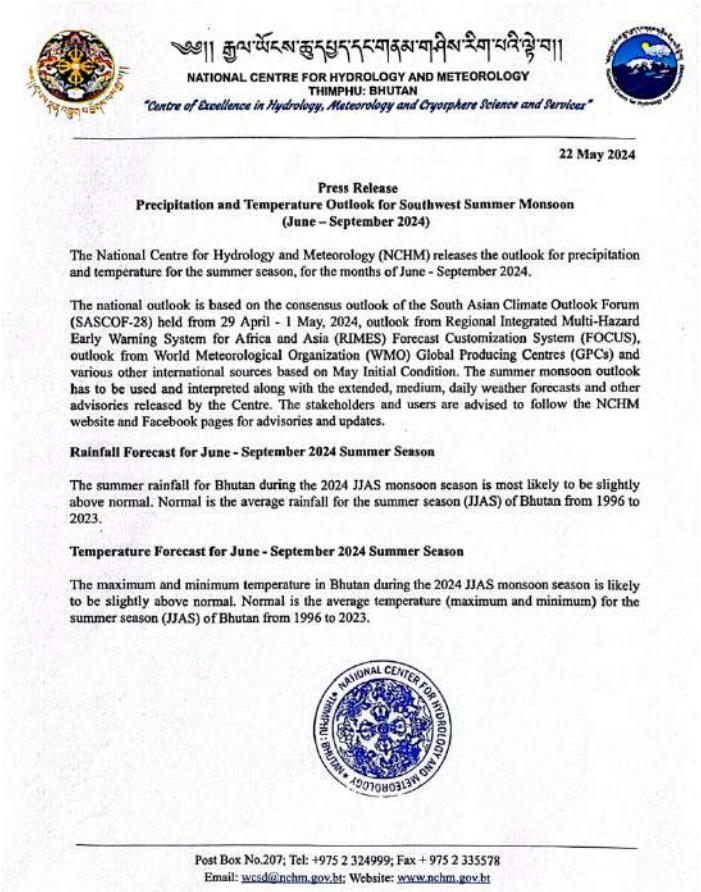
The National Centre for Hydrology and Meteorology release the outlook for precipitation and temperature for the 2024 summer season, for the months of June to September 2023. The consensus forecast was prepared with inputs from global and regional prediction centres, and national climate data. The final outlook is also based on the consensus outlook of the South Asian Climate Outlook Forum (SASCOF-28) held from 29 April to 1st May, 2024, outlook from WMO GPCs and various other international sources. The summer monsoon outlook must be used and interpreted along with the extended, medium, daily weather forecasts and other advisories released by the Centre.

a. Rainfall Forecast for 2024 Summer Season

The summer rainfall for Bhutan during the 2024 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 2023.

b. Temperature Forecast for 2024 Summer Season

The maximum and minimum temperature in Bhutan during the 2024 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 2023.



NATIONAL CENTRE FOR HYDROLOGY AND METEOROLOGY
THIMPHU: BHUTAN
"Centre of Excellence in Hydrology, Meteorology and Cryosphere Science and Services"

22 May 2024

Press Release
Precipitation and Temperature Outlook for Southwest Summer Monsoon
(June – September 2024)

The National Centre for Hydrology and Meteorology (NCHM) releases the outlook for precipitation and temperature for the summer season, for the months of June - September 2024.

The national outlook is based on the consensus outlook of the South Asian Climate Outlook Forum (SASCOF-28) held from 29 April - 1 May, 2024, outlook from Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) Forecast Customization System (FOCUS), outlook from World Meteorological Organization (WMO) Global Producing Centres (GPCs) and various other international sources based on May Initial Condition. 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. The stakeholders and users are advised to follow the NCHM website and Facebook pages for advisories and updates.

Rainfall Forecast for June - September 2024 Summer Season

The summer rainfall for Bhutan during the 2024 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 2023.

Temperature Forecast for June - September 2024 Summer Season

The maximum and minimum temperature in Bhutan during the 2024 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 2023.

NATIONAL CENTER FOR HYDROLOGY AND METEOROLOGY THIMPHU BHUTAN

Post Box No.207; Tel: +975 2 324999; Fax + 975 2 335578
Email: wcsd@nchm.gov.bt; Website: www.nchm.gov.bt

Figure 11: Press release issued by Centre for JJAS 2024 Outlook