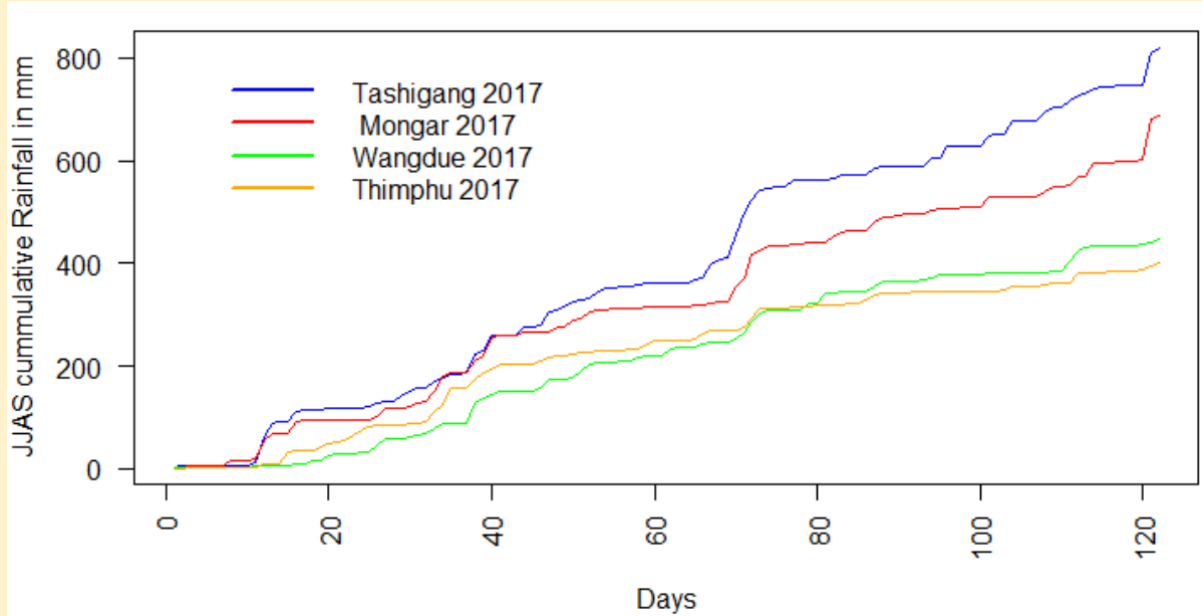


# Bhutan State of the Climate 2017



2017



National Center for Hydrology and Meteorology  
Royal Government of Bhutan





# **Bhutan State of the Climate**

# **2017**

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# About this Report

The Bhutan State of the Climate report is an annual climate monitoring report that provides a summary of observations of the country's climate. As the first of this series, this maiden issue contains a summary of only 2017 climate in the country. All computations contained in this report are based on Class A (Agrometeorological) stations owned and operated by National Center for Hydrology and Meteorology, Royal Government of Bhutan. While policy makers will require the best information about the past, current and the future climate for effective decision making, this report intends to provide the status of recent climatic conditions. This report contains only the basic climate indicators like temperature and rainfall and its pattern in 2017 compared to the long-term average.

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# Message

The National Center for Hydrology and Meteorology (NCHM) is mandated to provide meteorology, hydrology and cryosphere related information and services. Weather and climate affects all aspects of our lives, society and the economy. Changes in climate and its variation presents both risks and opportunities. NCHM strives to deepen scientific understanding of weather and climate, deliver climate services from national to local scales extending from seasons to years and decades to improve public information about the impacts of a changing climate. NCHM will continue to provide a seamless suite of weather and climate services and facilitate efforts to identify and address the climate-related needs of planners and decision makers. Climate information to support decision making has become increasingly important for countries like Bhutan. The need for climate information is urgent to manage the risks and uncertainties of a changing climate across all public and private sectors that will help build resilience in protection of the environment, protection against disasters, water resource management among many others.

The State of the Climate, Bhutan 2017 provides a brief update on the country's climate indicators for the previous year. This will be an annual publication henceforth. We hope that the content of this report will be useful for decision makers and other users.

**Karma Dupchu**

**Director**

National Center for Hydrology and Meteorology (NCHM)  
Permanent Representative (PR) of Bhutan with World Meteorological Organization

## **MAJOR FACTORS INFLUENCING CLIMATE VARIABILITIES IN BHUTAN**

### **Monsoon**

A monsoon is a consistent wind pattern generated by a large weather system that lasts for a period of months and affects large areas. There are two monsoon seasons in the country: Southwest Monsoon and Northeast Monsoon. southwest usually means wet conditions in the country from June to September. It usually brings significant amount of rainfall that triggers rise in water levels, flooding and landslides. Northeast Monsoon features cool and dry breeze with prolonged periods of successive cold days. It affects the country from November to February.

### **ENSO**

El Niño Southern Oscillation (ENSO) refers to the ocean component (El Niño) and the atmospheric component (southern oscillation) of a naturally occurring phenomenon that originates in the Pacific Ocean. El Niño and La Niña refer to the pattern of above or below average sea surface temperatures in the central and eastern Pacific that leads to a major shift in weather patterns across the Pacific. ENSO is the one sources of inter-annual variability of Bhutan climate.

### **Western Disturbance (WD)**

WD is an extratropical storm and a non-monsoonal precipitation pattern driven by the westerlies originating in the Mediterranean region. The moisture in these storms usually originates over the sea and the Atlantic Ocean. Extratropical storms are a global phenomenon with moisture usually carried in the upper atmosphere, unlike their tropical counterparts where the moisture is carried in the lower atmosphere. In the case of the subcontinent, moisture is sometimes shed as rain and snow when the storm system encounters the Himalayas. Heavy winter snowfall in Bhutan is largely associated with WD.

### **Tropical Cyclones**

Tropical Cyclone(TC) is the general term for a cyclone that originates over the tropical oceans. TCs are low pressure systems in which winds spin inward in a circularly symmetric spiral, bringing with it intense rain and winds. While Bhutan does not experience any direct impact of the Tropical cyclones, tropical cyclones in the North Indian Ocean and Bay of Bengal with severe windstorm brings peripheral impacts like Cyclone Aila in 2009.

## WHAT HAPPENED IN 2017?

### Annual rainfall

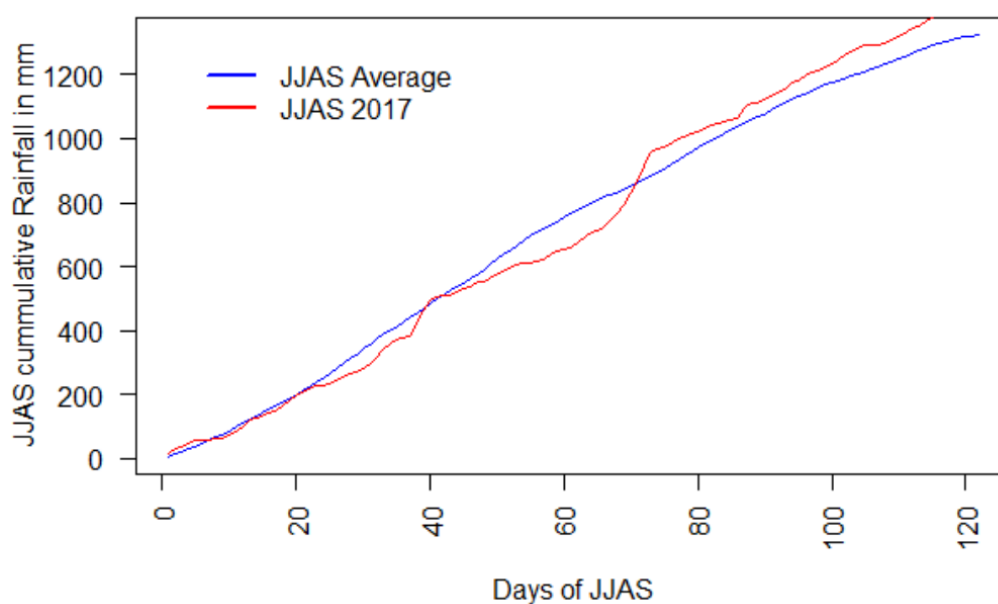
The annual average rainfall for Bhutan (area average) was 1916.29 mm in 2017. Bhutan received slightly above normal rainfall with most regions receiving rainfall above the average. The highest 24-hour rainfall was recorded at Phuntsholing with 285.4mm. Gasa experienced the highest number of rainy days with 217 days (with rainfall greater than or equal to 0.1mm). However, highest annual rainfall was recorded at Sarpang followed by Samtse, Phuntsholing and Samdrupjonkhar. It is to be noted that more number of rainy days doesn't translate to more rain.

### Maximum and minimum temperature

The annual average maximum temperature was 23.1 Degree Celsius and the annual average minimum temperature was 11.6 Degree Celsius. The highest temperature was recorded at Tangmachu with 36.5 degree Celsius and the lowest was recorded at Haa with -11 Degree Celsius. Haa experienced more number of days with minimum temperature below zero compared to other regions with 129 days.

### Monsoon 2017

Monsoon in Bhutan is comprised of months from June through September. In 2017, Bhutan received slightly above normal monsoon. Most stations observed above normal rainfall for these months.



**Figure 1: JJAS cumulative rainfall**



## **EXPLANATORY NOTES**

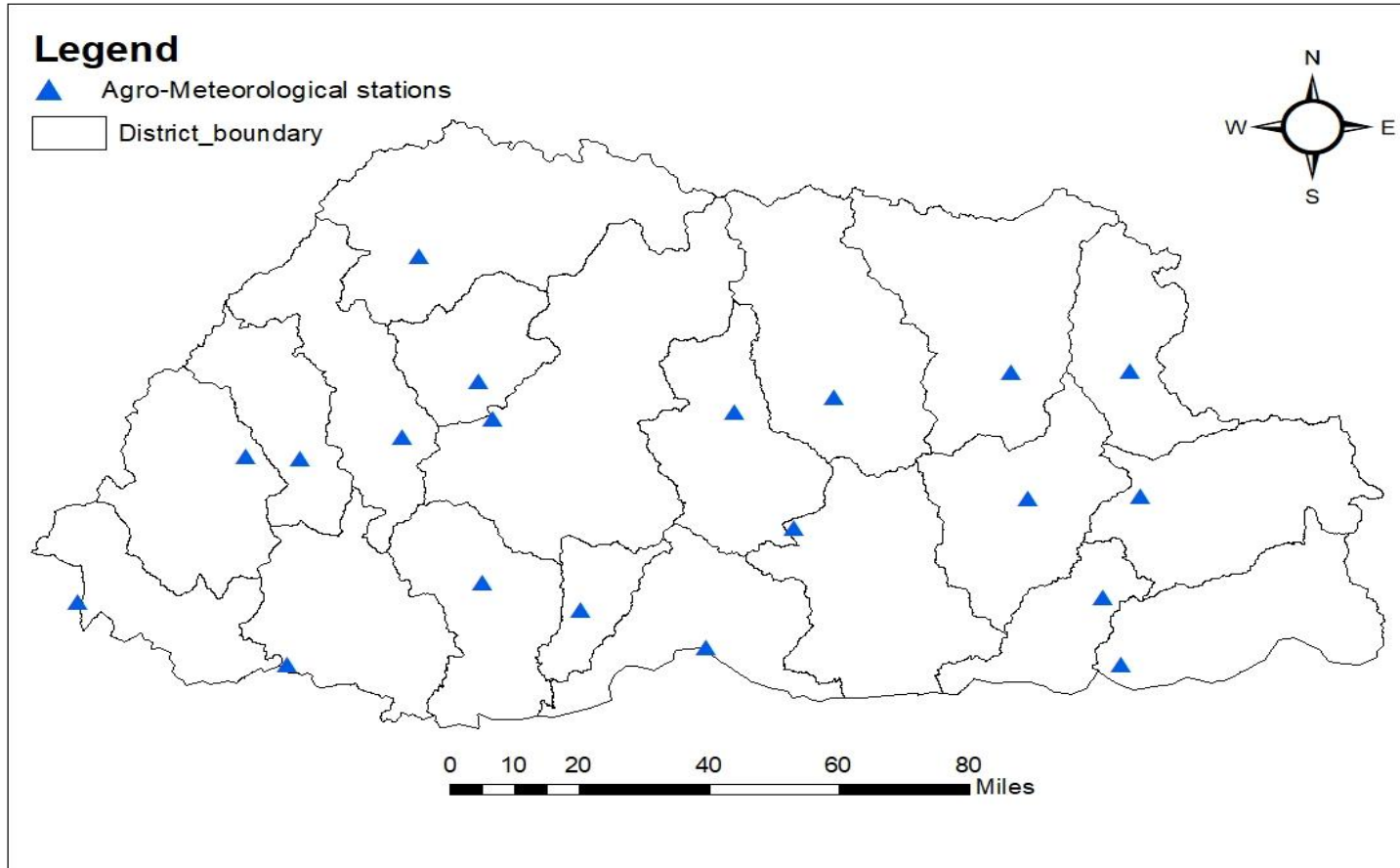
### **Temperature maps:**

The existing network of stations does not portray a realistic pattern of temperature in Bhutan due to complex topography. To overcome this limitation, a regression-based method was adopted to map the monthly temperatures considering elevation, latitude and longitude as the covariates. The mean monthly temperatures were computed by averaging the monthly maximum and minimum temperatures.

### **Average/Normal rainfall and temperature:**

The Normal/average in the report is referred to long-term average through 1996-2016 for temperature and rainfall.

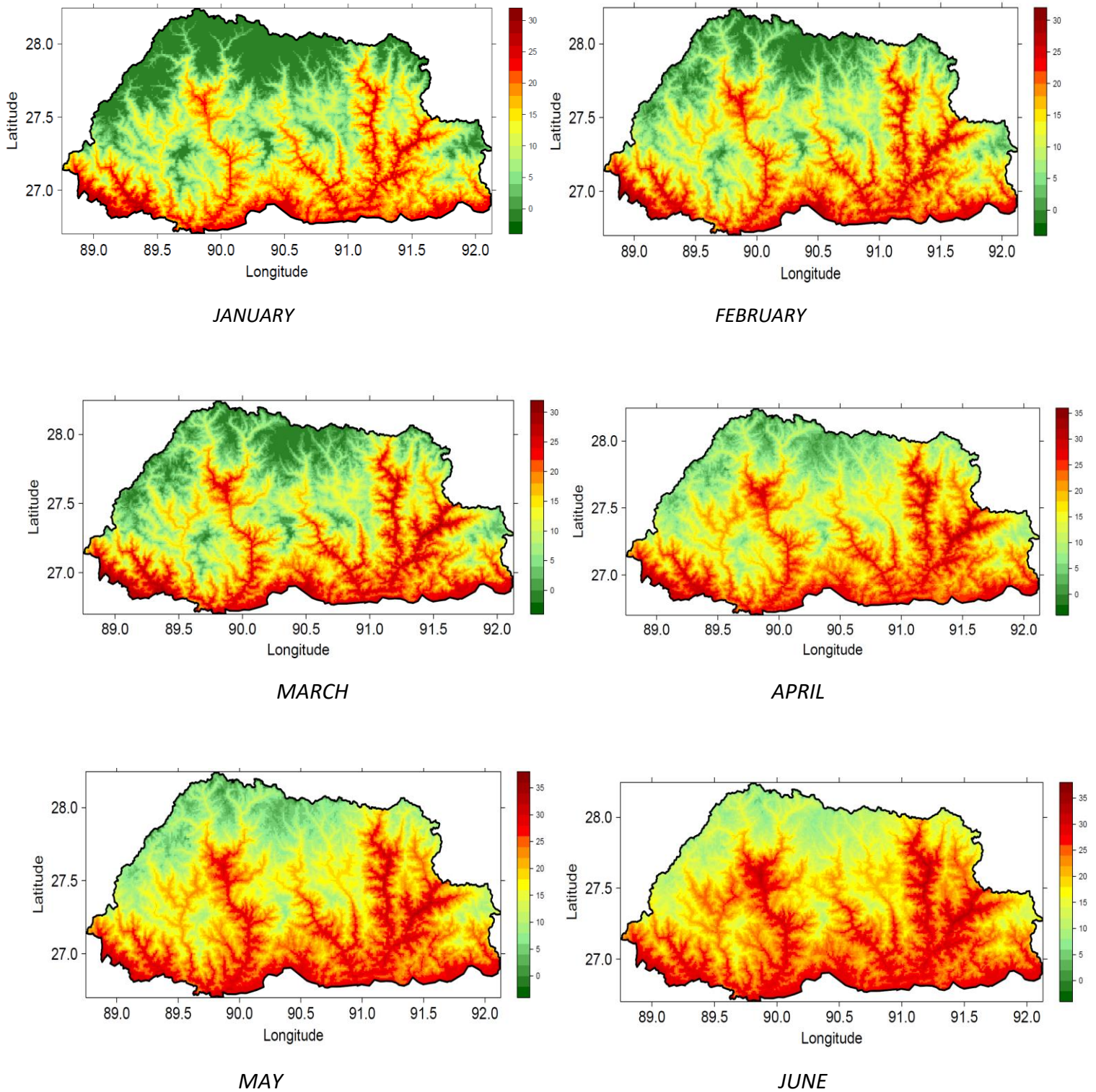
## LOCATION MAP OF AGROMETEOROLOGICAL SATTIONS



*Figure 2: Location of Agrometeorological stations*

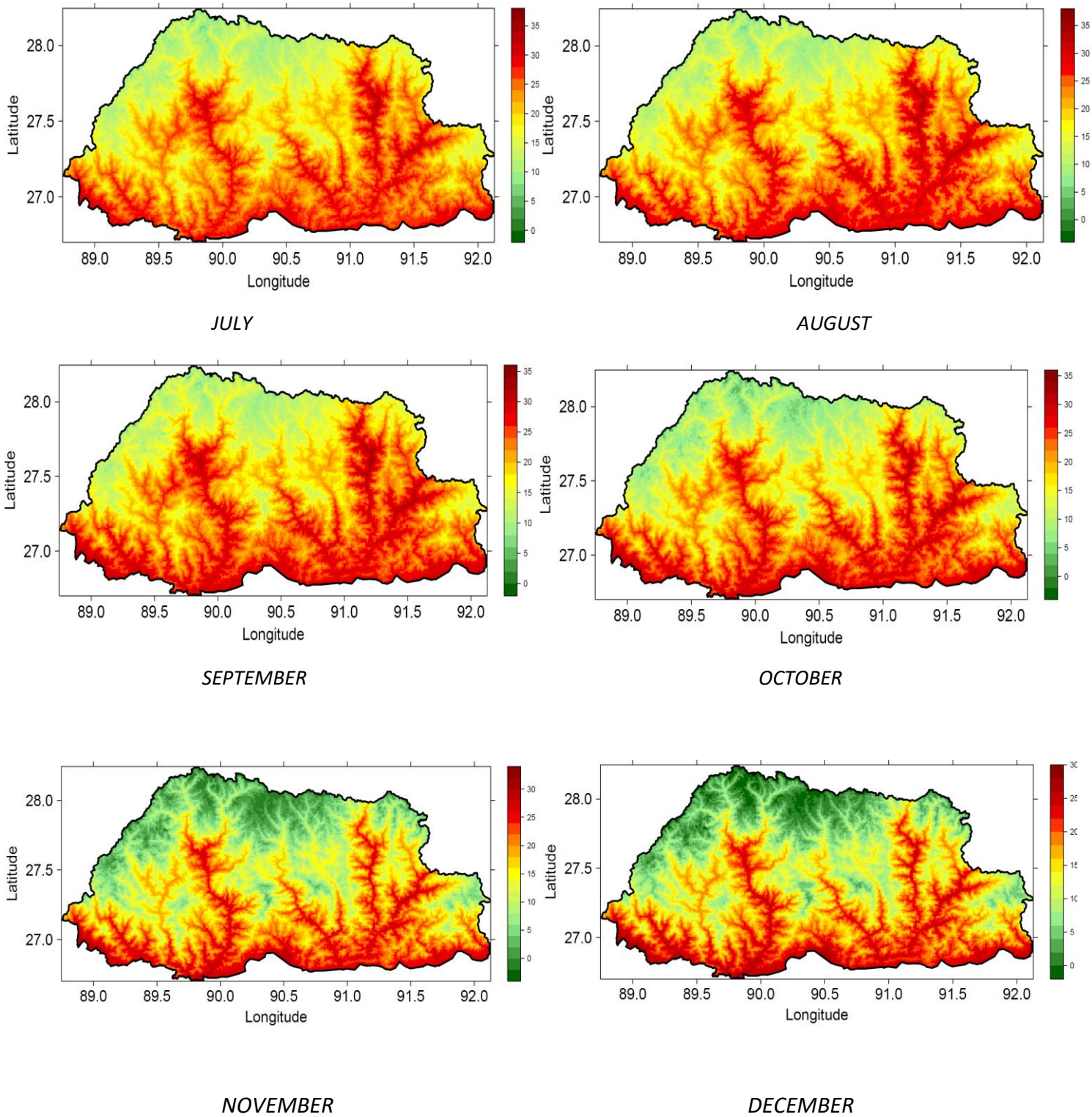
## MONTHLY MEAN MAXIMUM TEMPERATURE 2017

Figure 3 (a). Monthly mean maximum temperature (Jan-June)



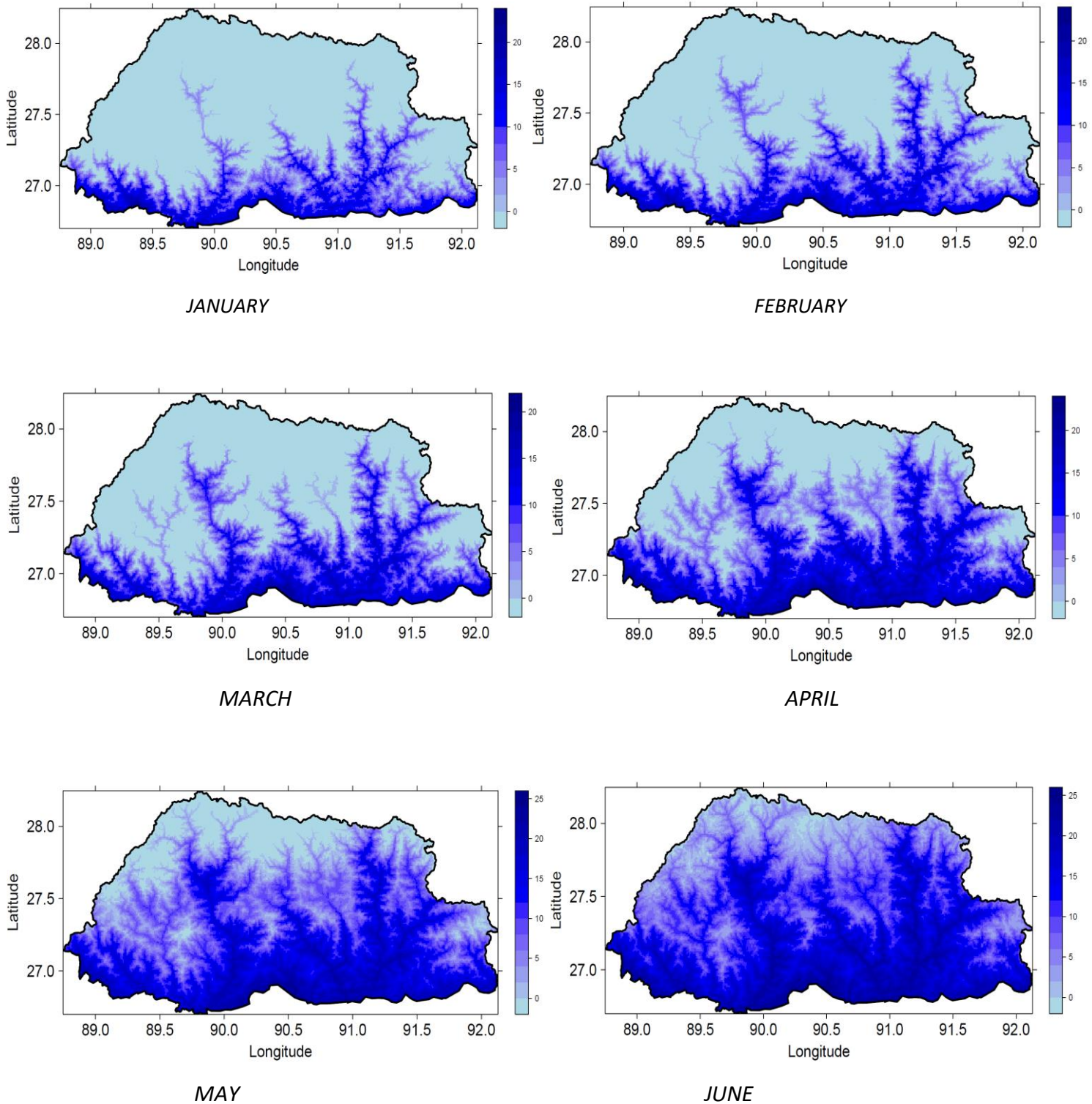
## MONTHLY MEAN MAXIMUM TEMPERATURE 2017

*Figure 3 (b). Monthly mean maximum temperature (July-December)*



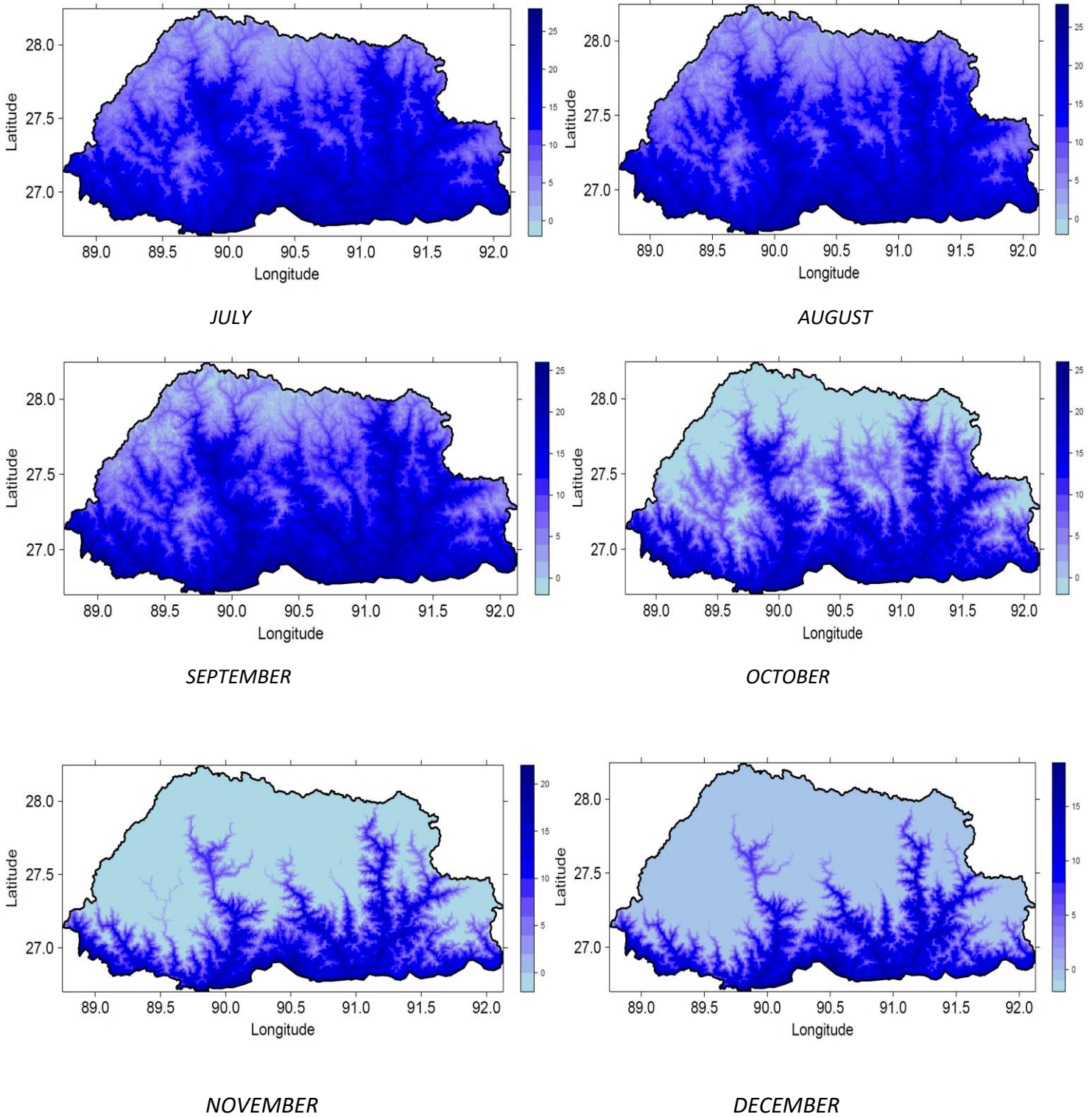
## MONTHLY MEAN MINIMUM TEMPERATURE 2017

**Figure 4 (a).** Monthly mean minimum temperature (January-June)



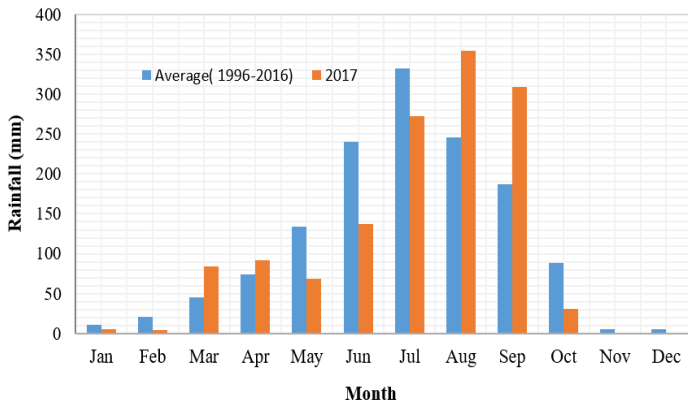
# MONTHLY MEAN MINIMUM TEMPERATURE 2017

Figure 4(b). Monthly mean minimum temperature (July-December)

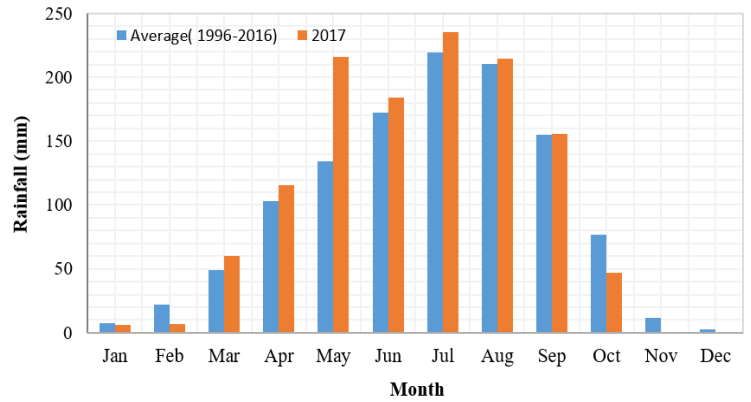


## STATIONWISE 2017 MONTHLY RAINFALL WITH AVERAGE RAINFALL

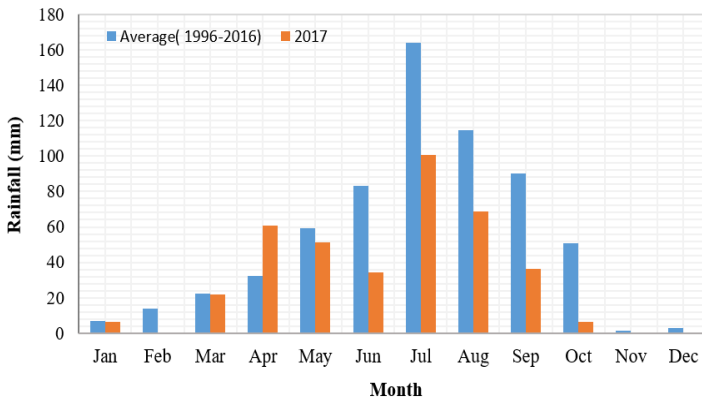
**Figure 6 (a): Station wise 2017 rainfall**



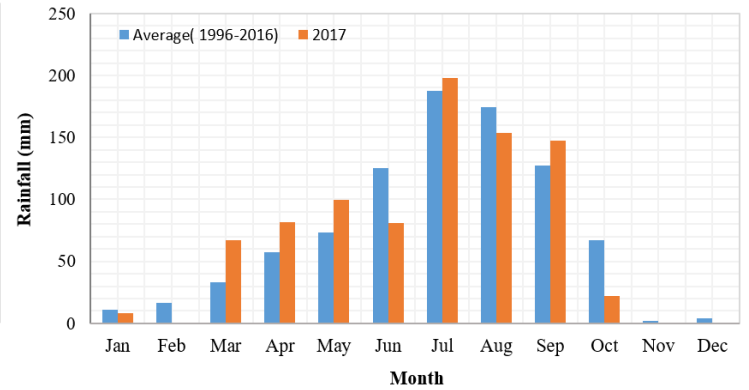
**ZHEMGANG**



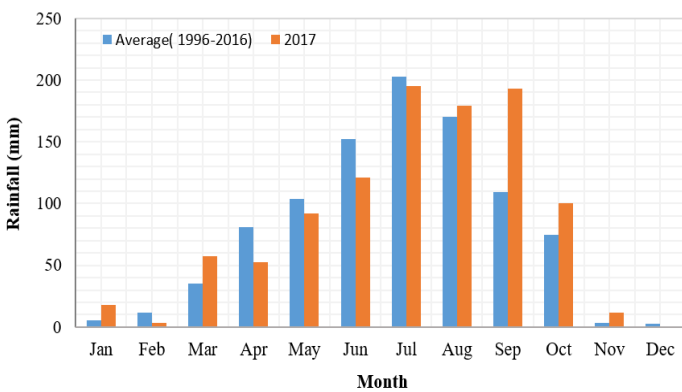
**TASHI YANGTSE**



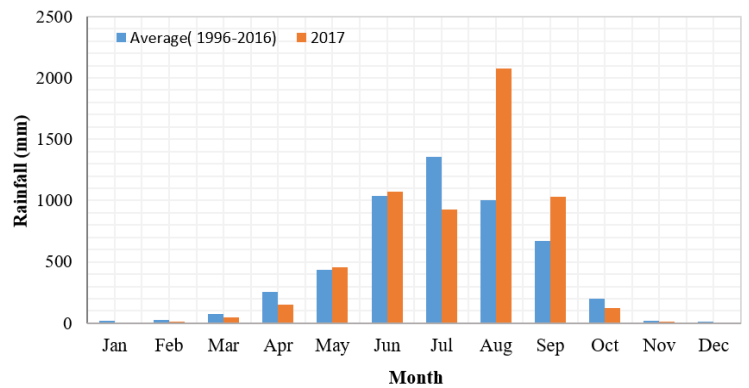
**PARO**



**HAA**



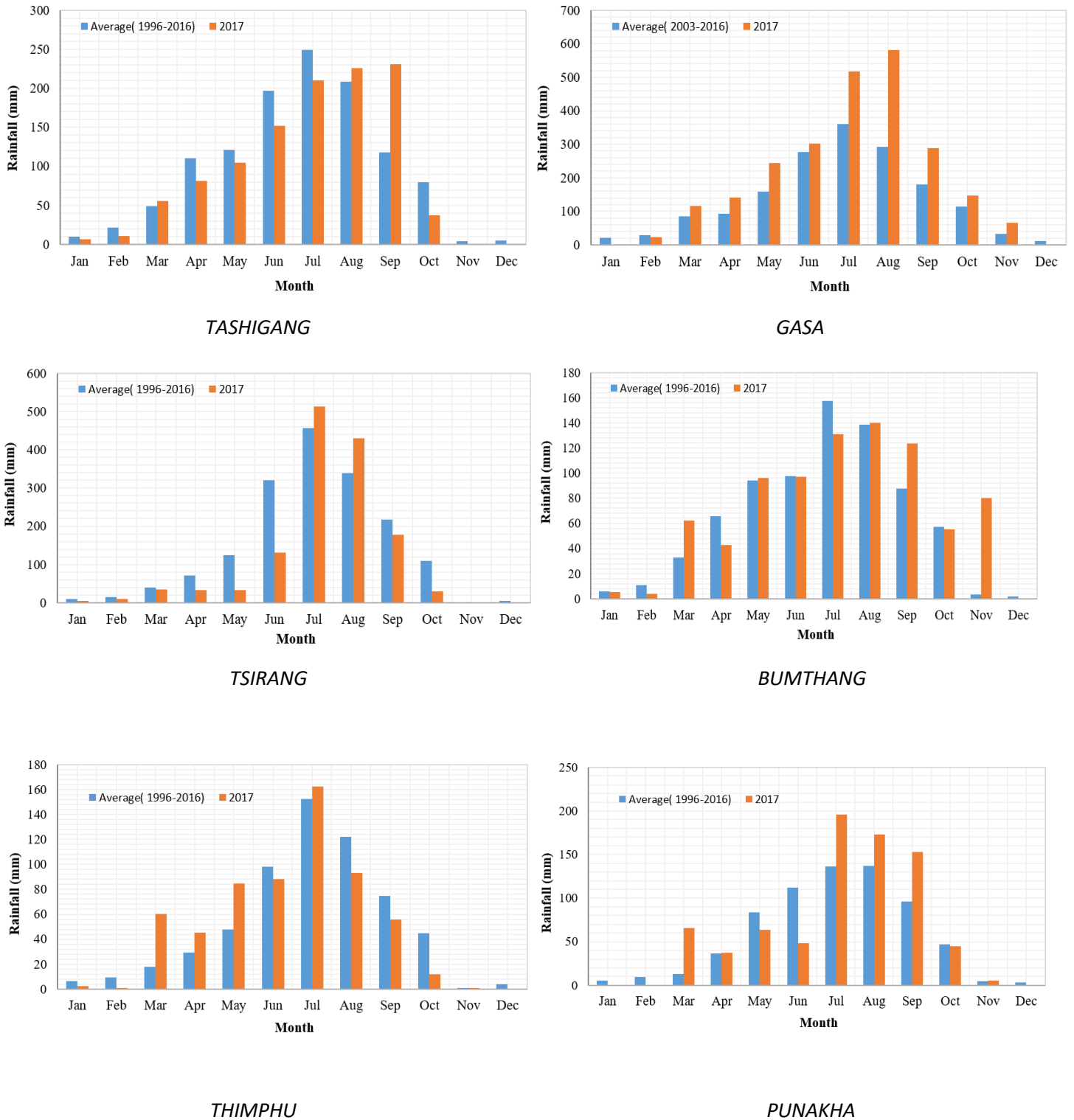
**MONGAR**



**SARPANG**

## STATIONWISE 2017 MONTHLY RAINFALL WITH AVERAGE RAINFALL

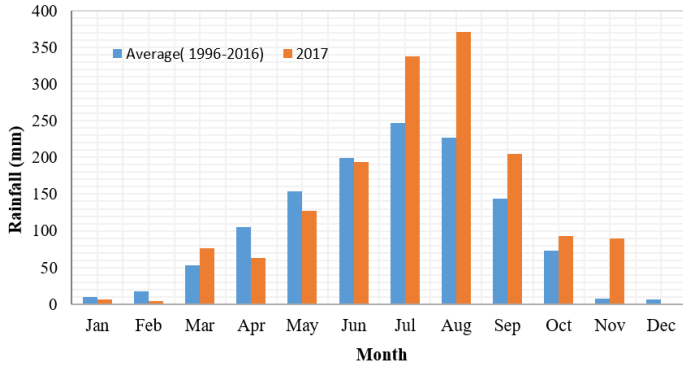
**Figure 6 (b): Station wise 2017 rainfall**



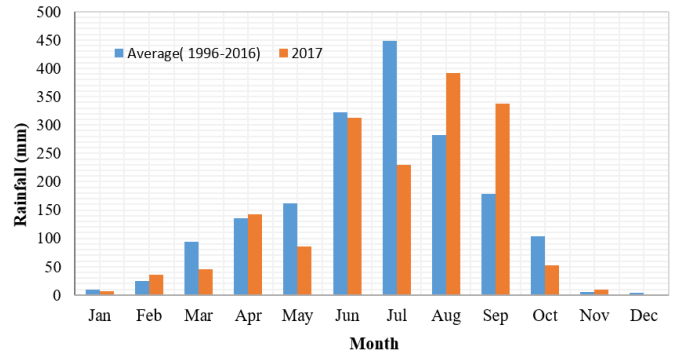


## STATIONWISE 2017 MONTHLY RAINFALL WITH AVERAGE RAINFALL

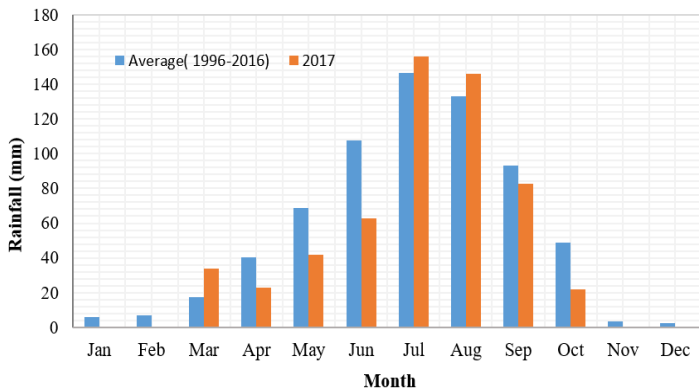
**Figure 6 (c): Station wise 2017 rainfall**



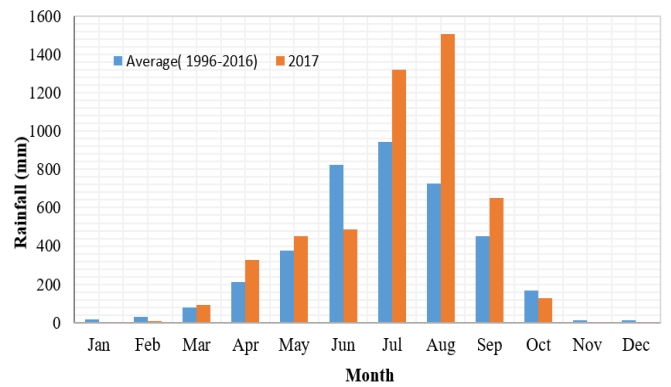
**TRONGSA**



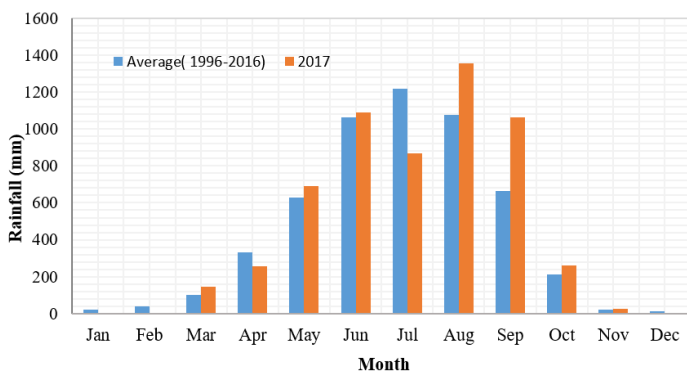
**PEMAGATSHEL**



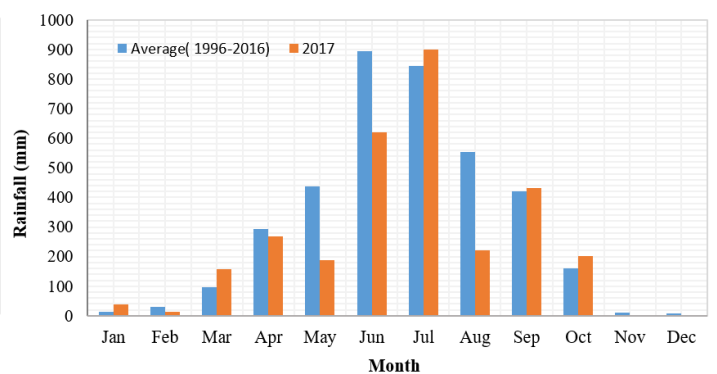
**WANGDUE**



**PHUNTSHOLING**



**SAMTSE**



**SAMDRUPJONGKHAR**

### STATION WISE TEMPERATURE AND RAINFALL EXTREMES IN 2017

Sl. No	Station	Min Temp	Date	Max Temp	Date	24 hr Rainfall (mm)	Date
1	Gelephu Bhur	11	1/14/17	35	7/19/17	258.2	8/8/17
2	Bumthang Chamkhar	-10	1/15/17, 1/16/17	26.5	8/4/2017	37	11/27/17
3	Dagana	-1.5	1/14/17	30	5/13/17, 7/18/17, 9/17/17	93	8.11.2017
4	Tsirang Dampfu	2.5	1/13/17, 1/14/17	28.5	7/18/17	141.2	7/8/17
5	S/Jongkhar Deothang	8	1/14/17	33	7/18/17	167	6/13/17
6	Gasa Khatay	-6	1/14/17	23	19/7/17, 6/8/17	71	8/10/17
7	Haa Namjeyling	-11	1/14/17, 1/15/17	25	7/18/17, 8/6/17	23.9	8/11/17
8	Tashigang Kanglung	0	1/14/17	31	8/26/17	62.2	9/29/17
9	Mongar	3	1/14/17	32	7/18/17	78.2	9/29/17
10	Paro	-7	1/12/17, 1/14/17	30	9/16/17	37.2	4/1/17
11	Pemagatshel	2.5	11 to 18/01/17	31	7/18/17	94.2	8/9/17
12	Phuntsholing	11.5	12/30/17	35	5/29/17, 6/7/17, 7/18/2017	285.4	8/12/17
13	Punakha	1.5	12/28/17	35	6/7/17, 7/7/17	48.4	7/17/17
14	Samtse Sipsu	9	1/14/17	34.5	10/6/17	158.4	6/5/17
15	Thimphu Simtokha	-7	7/1/17	31.5	5/8/17, 6/23/17, 6/24/17	37	11/3/17
16	Lhuentse Tangmachu	2.5	14 to 17/01/17	36.5	7/18/17	60	5/26/17
17	Tashiyangtse	-4	1/14/17, 1/15/17	30.5	4/17/17	56.2	7/8/17
18	Trongsa sherubling	-3	1/14/17, 1/15/17	27.5	7/18/17, 9/16/17	85	11/27/17
19	Wangdue Bajo	1	1/16/17, 1/18/17, 12/3/17	36	5/30/17	36.6	7/18/17
20	Zhemgang	3.5	3/13/17, 3/21/17	29.5	7/18/17	93.6	9/22/17

### STATION WISE ANNUAL AVERAGES 2017

Region/station	Annual average maximum temp	annual average minimum temp	Annual total rainfall (mm)	Number of days with Tmax>=30	No. of days with Tmin<=0	Number of days with rainfall>=0.1mm
Paro	20.2	6.2	386.8	1	92	109
Wangdue Bajo	26.9	14.1	569.6	116	0	108
Thimphu simtokha	23	7	606.7	24	89	121
Punakha	29	15.2	786.6	181	0	116
Bumthang chamkhar	18.3	6.8	837.8	0	85	163
Haa Namjeyling	16	4.6	858.4	0	121	159
Lhuentse tangmachu	28	7	943.5	156	0	177
Mongar	22.6	13.4	1024.8	19	0	136
Kanglung	24.2	10.3	1115.6	20	1	155
Dagana	21.6	10.4	1147.5	3	7	139
Tashiyangtse	22.2	9.6	1240.1	1	29	173
Zhemgang	20.6	11.6	1358.8	0	0	149
Tsirang Damphu	21.1	13.6	1438.4	0	0	111
Trongsa Sherubling	19.3	9.3	1567	0	16	187
Pemagatshel	22.1	13.11	1649.6	1	0	144
Gasa Khatey	15.7	5	2428.4	0	97	217
Deothang	26	16.7	3693.3	44	0	150
Chukha Phuntsholing	29	19.3	4979.4	146	0	171
Sipsoo	29.1	18.3	5763.2	167	0	188
Bhur	27.6	20.6	5930.3	83	0	171



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**For more information, contact:**  
National Center for Hydrology and Meteorology  
Post Box 207, Thimphu, Bhutan  
[www.hydromet.gov.bt](http://www.hydromet.gov.bt)  
Tel: + 975 2 323703  
Fax: + 975 2 335578

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