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Government of India
पृथ्वी विज्ञान मंत्रालय (एम. ओ. ई. एस.)
Ministry of Earth Sciences (MoES)
भारत मौसम विज्ञान विभाग
INDIA METEOROLOGICAL DEPARTMENT
Climate Research and Services (CRS)

Climate Summary for the month of June 2023

1. Monthly Rainfall Scenario (01 to 30 June, 2023)

During June 2023, country as a whole received 148.6 mm rainfall, which is 10% less than its Long Period Average (LPA) of 165.3 mm based on data of 1971-2020. Rainfall over homogeneous region of south peninsular India (88.6 mm) was lowest since 1901.The previous lowest rainfall value was 90.7mm observed in the year 1976. Daily variation of the rainfall over the country as a whole during the month of June 2023 with normal (1971-2020) and All India rainfall expressed in percentage departure from normal for June during 1901-2023 is shown in the figure 1(a) and 1(b) respectively.

The time series of actual rainfall since 1901 for South Peninsular India is given in Fig. 2.

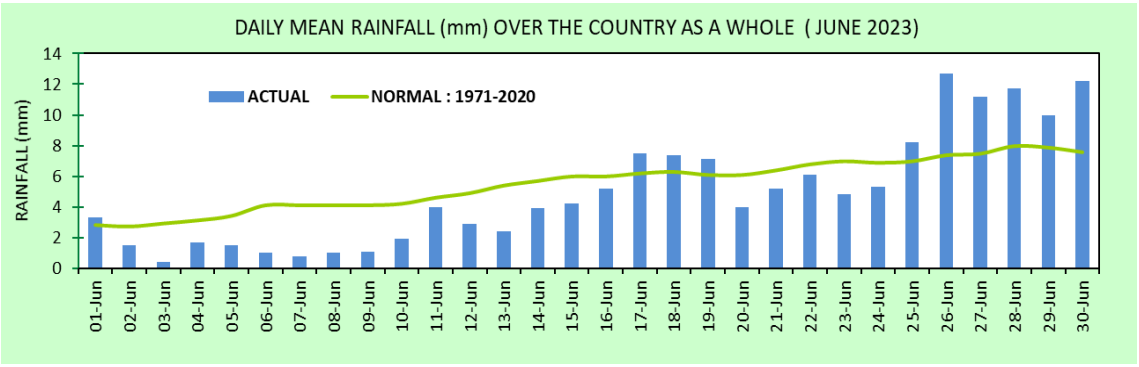


Fig.1 (a): Daily variation of rainfall over the country as a whole during June 2023.

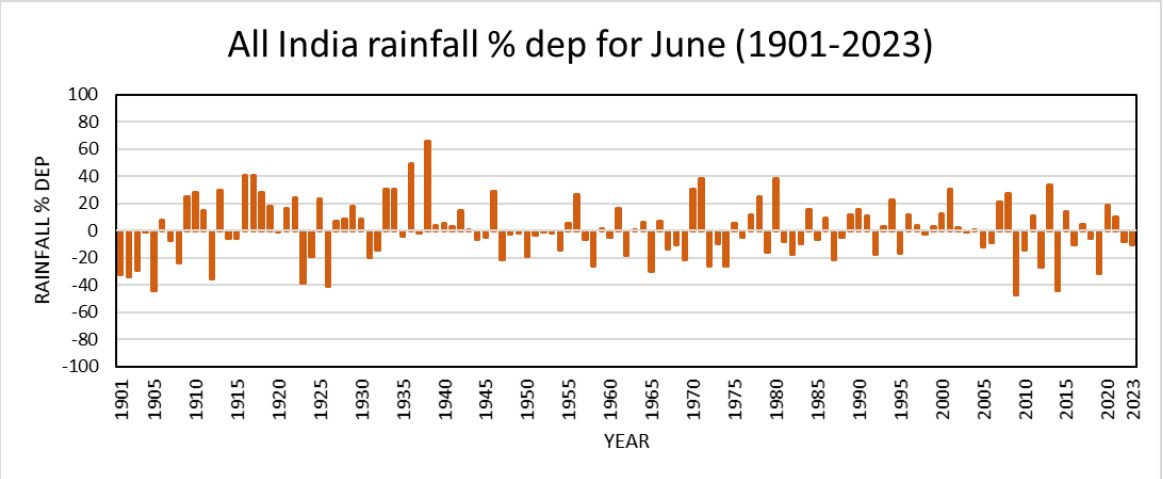


Fig 1(b). All India monthly rainfall percentage departure from normal (1971-2020) for June from 1901-2023.

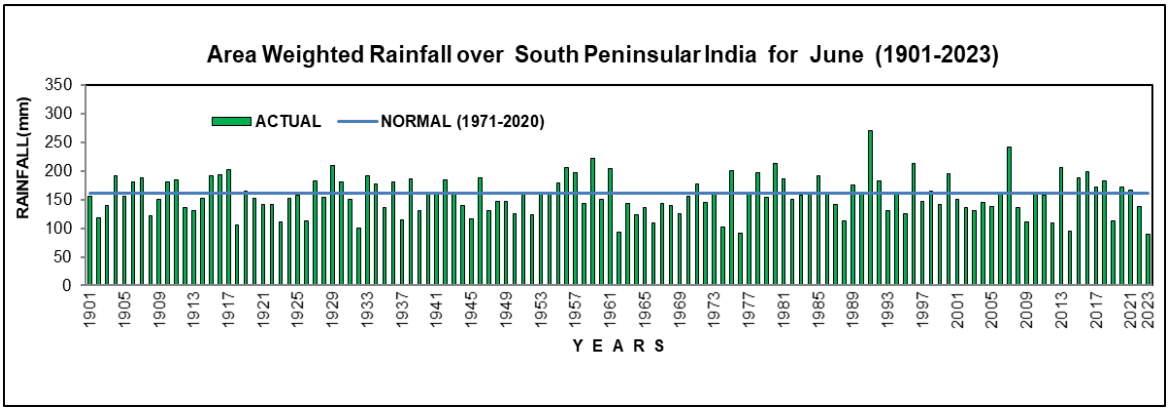


Fig.2: Time series of area weighted rainfall over South Peninsular India for June (1901 -2023)

The monthly rainfall of the country as a whole and four homogeneous zones for June 2023 is given in the table below:

Regions	Actual Rainfall (mm)	Normal Rainfall (mm)	% Departure from LPA
Country as a whole	**148.6**	**165.3**	**-10.0**
Northwest India	**111.1**	**78.1**	**42.0**
Central India	**160.4**	**170.3**	**-6.0**
South Peninsula India	**88.6**	**161.0**	**-45.0**
East & northeast India	**269.9**	**328.4**	**-18.0**

During this month, 3 sub division received large excess, 7 excess, 7 normal, 17deficient and 2 received large deficient rainfall. The rainfall distribution expressed in percentage departure is given in Fig.3.

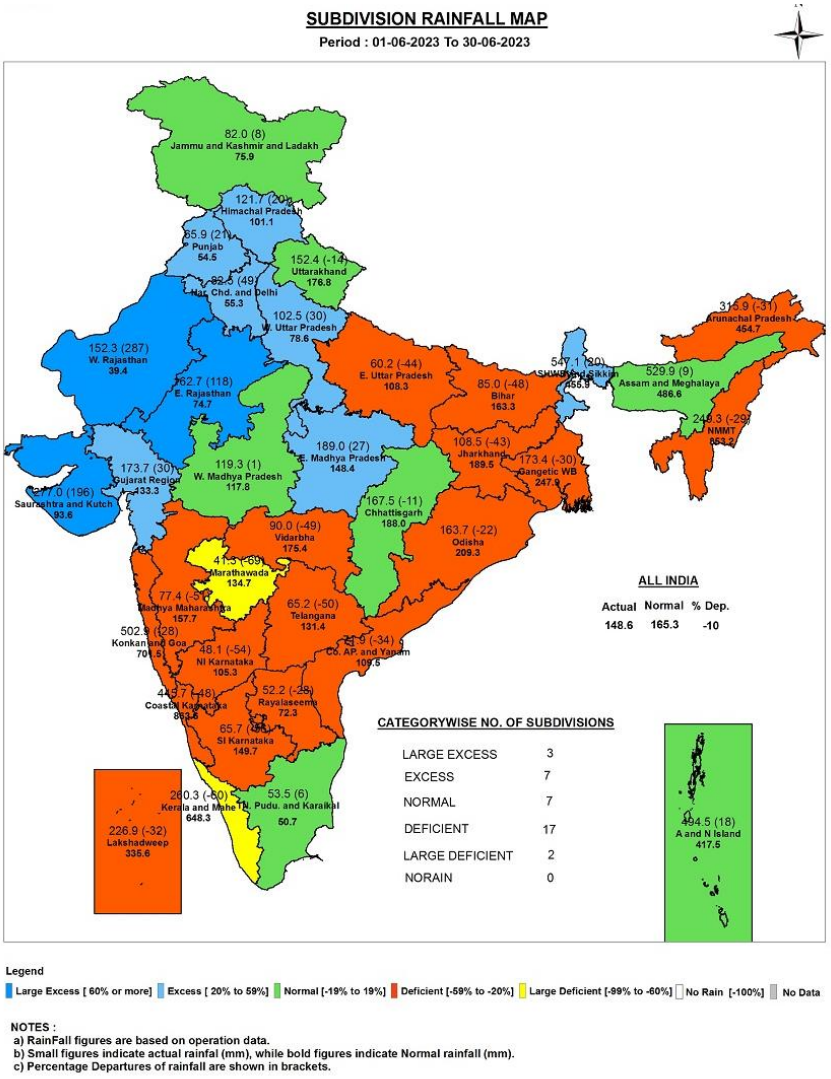


Fig 3: Subdivision-wise rainfall distribution for June 2023.

The observed spatial distribution of rainfall during June 2023, normal rainfall based on data of 1971 to 2020 and rainfall departures from normal during June 2023 are given in Fig.4.

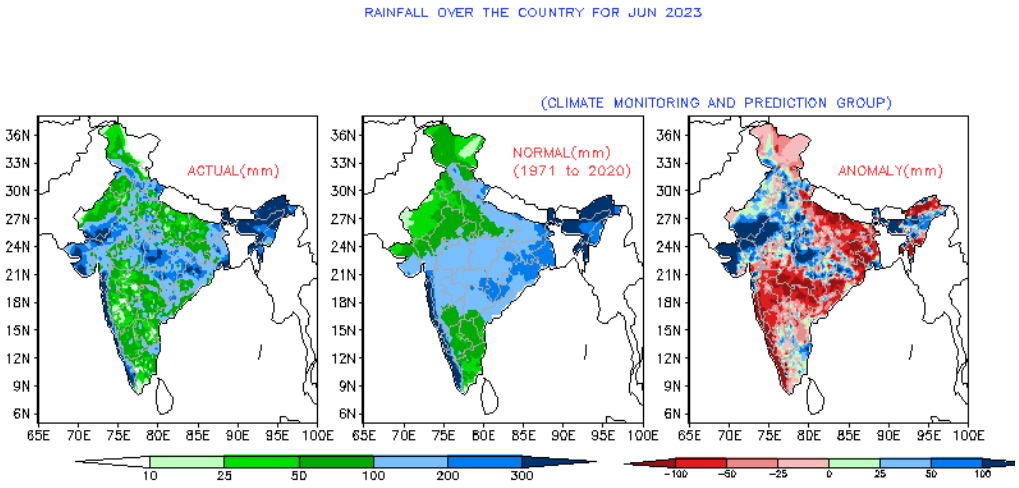


Fig 4: Observed spatial Rainfall pattern for the month of June 2023 over India and their departure from normal (1971 to 2020 period).

2. Advance of southwest monsoon over the country

The southwest monsoon advanced into Andaman Sea and southern parts of Bay of Bengal on 19th May against the normal date of 22nd May. The southwest monsoon set in over south Kerala and south Tamil Nadu on 08th June 2023 against the normal date of 1st June. Covered most parts of the country except over some parts of north Rajasthan and adjoining areas of southwest Haryana and Punjab by 28th June. The southwest Monsoon gradually advanced thereafter and it has covered the entire country on 2nd July 2023, against the normal date of 8th July (6 days before the normal date of covering the entire India). The normal date of onset of monsoon and actual date of onset in 2023 is shown in Fig.5. There was a delay in advance of monsoon by 7 to 12 days over Peninsula and adjoining central India compared to its normal date and over northeast India, it was by 5 days. But, the advance over northwest India was earlier than its normal by 4-6 days.

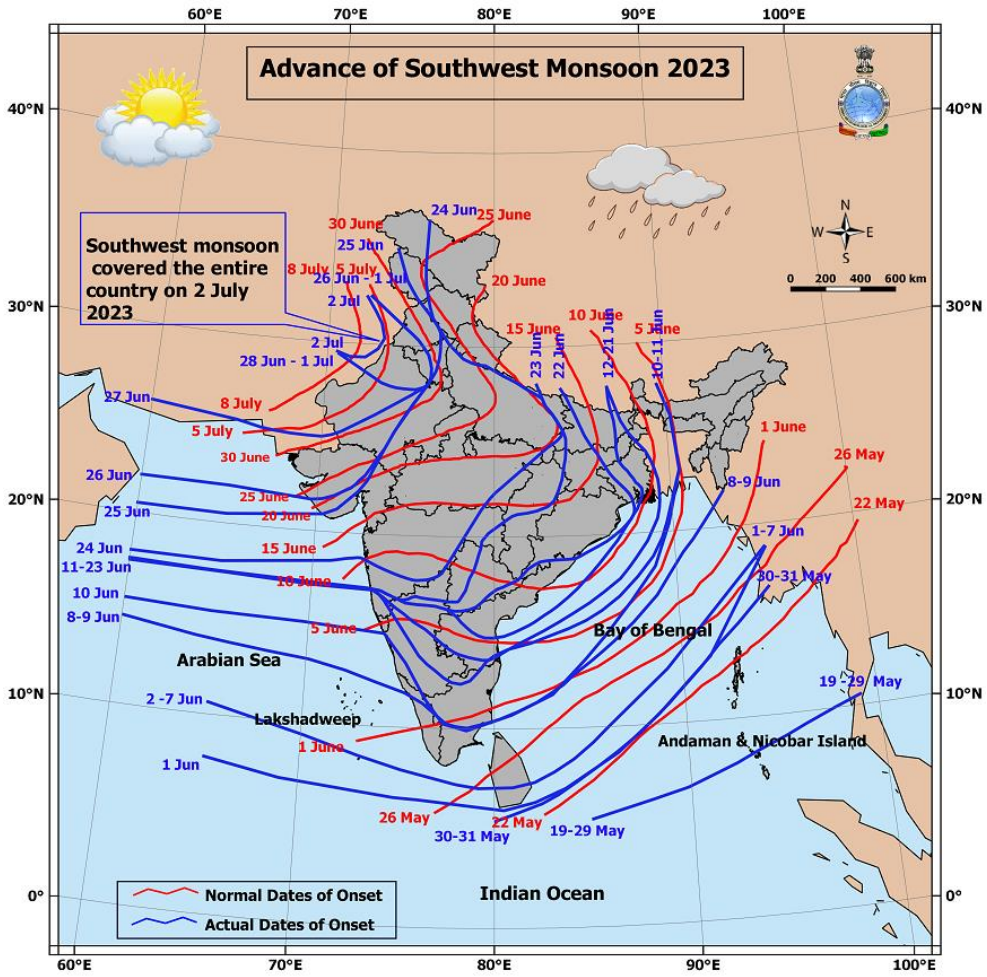


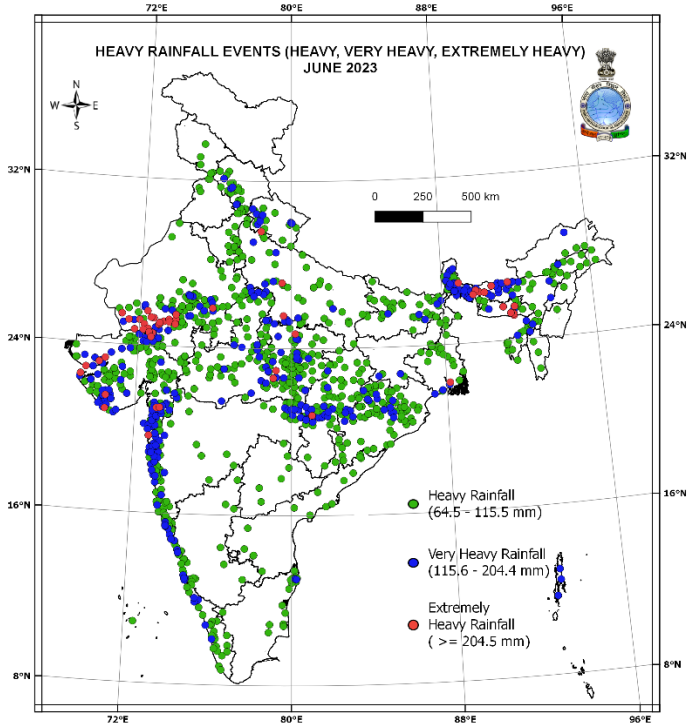
Fig.5. Onset of Southwest Monsoon 2023.

3. Frequency of Heavy Rainfall events

The June 2023 witnessed extremely heavy rainfall events (> 204.4 mm of rainfall) mainly over Assam & Meghalaya, Sub Himalayan West Bengal & Sikkim, South Rajasthan, Gujarat, West Uttar Pradesh, East Madhya Pradesh, Chhattisgarh and

Konkan Goa. The location of occurrences of heavy and very heavy rainfall events is shown in the Figure 6.

Out of total 1064 stations, 53 station reported extremely heavy rainfall (> 204.4 mm), 284 station reported very heavy rainfall (115.6 to 204.4 mm) and 727 stations reported heavy rainfall (64.5 to 115.5 mm of rainfall) during this month.



(Only highest category of rainfall event considered for a station)

Fig 6: The location of occurrences of heavy rainfall events in the month June 2023.

Some stations received record rainfall (24 hour). The table below shows stations received 24-hour record rainfall and its previous record.

STATION	24 HOUR RECORD RAINFALL IN June 2023(mm)#	DATE	PREVIOUS RAINFALL RECORD (mm)	DATE	STATE
ANGUL	170.0	26	161.2	15-06-1990	Odisha
NAJIBABAD	205.0	25	93.5	12-06-1984	Uttar Pradesh
SRIGANGANAGAR	109.0	26	99.1	14-06-1938	Rajasthan
ERINPURA/JAWAI DAM	239.0	19	78.3	25-06-1977	Rajasthan
NARSINGHPUR	218.0	28	217.6	27-06-1977	Madhya Pradesh
MAHUVA	225.0	30	179.6	30-06-1959	Gujarat
OKHA	228.1	17	190	30-06-1980	Gujarat
UDGIR	66.0	25	65.4	18-06-2012	Maharashtra

based on real time available data

Chief Synoptic weather features observed during June 2023.

During June 2023, one extremely severe cyclonic storm “BIPARJOY” formed over Arabian Sea during 6 – 19 June. Track of this system is shown in figure 7.

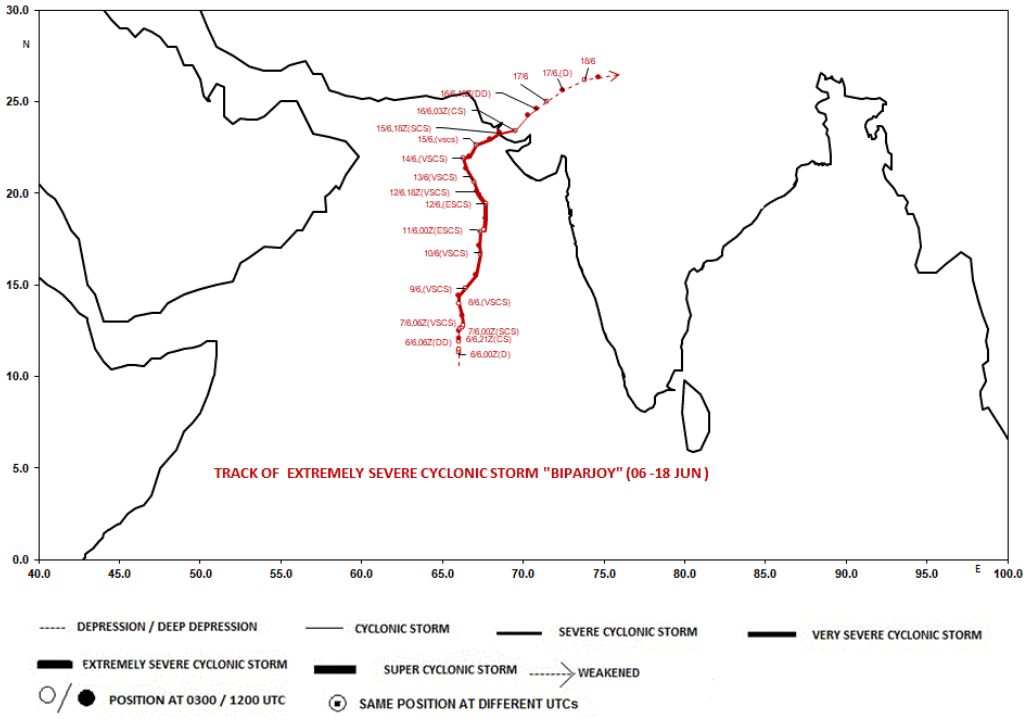


Fig 7: Track of extremely severe cyclonic storm BIPARJAY formed during June 2023.

Besides this extremely severe cyclonic storm, two well marked low pressure areas formed over Bay of Bengal during (9 – 11 June) and (25 – 30) June. Also, the remnant of Cyclonic Storm ‘Biparjoy’ continued as a well-marked low pressure area/low pressure area and moved slowly from central parts of east Rajasthan to central parts of Uttar Pradesh across northwest Madhya Pradesh during 20-25 June which helped establishment of the easterly/southeasterly winds across north India**.** All these low-pressure systems during the monsoon season contributed heavy and very heavy rainfall with isolated extremely heavy rainfall. Development and persistence of the Off-Shore trough along west coast and cyclonic circulation at middle atmospheric level over northeast Arabian Sea off Gujarat coast, also enhanced rainfall along west coast, Gujarat and Rajasthan during 23-30 June 2023. Western Disturbance (WD) activities over northwest India during June 2023, were near normal with 4 WDs(1-7, 5-10, 9-16 and 27-30 June) affecting the region. It was the 1st half of the month, when northwest India was dominated by WDs activities.

5. Characteristics of Temperatures for the month of June 2023

The average maximum, average minimum and mean temperature for the country as a whole during June 2023 are 34.60 ºC, 25.39 ºC and 29.99 ºC respectively, against the normal of 33.73 ºC, 24.76 ºC and 29.25 ºC based on period 1981-2010. Thus, the average maximum temperature, average minimum temperature and mean temperature were above normal by 0.87 ºC, 0.62 ºC and 0.75 ºC respectively for the country as a

whole. The climatological data based on the period of 1981 to 2010 are used to calculate the normal and hence the anomaly (Actual average temperature in 2023 - normal temperature based on data of 1981-2010). The daily variation of maximum and minimum temperature anomaly over the country as a whole for June 2023 is shown in the figure 8(a) and (b). It shows that warmer than normal temperatures (both for maximum and minimum temperatures) were observed over the country as a whole during many days in June 2023 and it was mainly during 5-24 June 2023

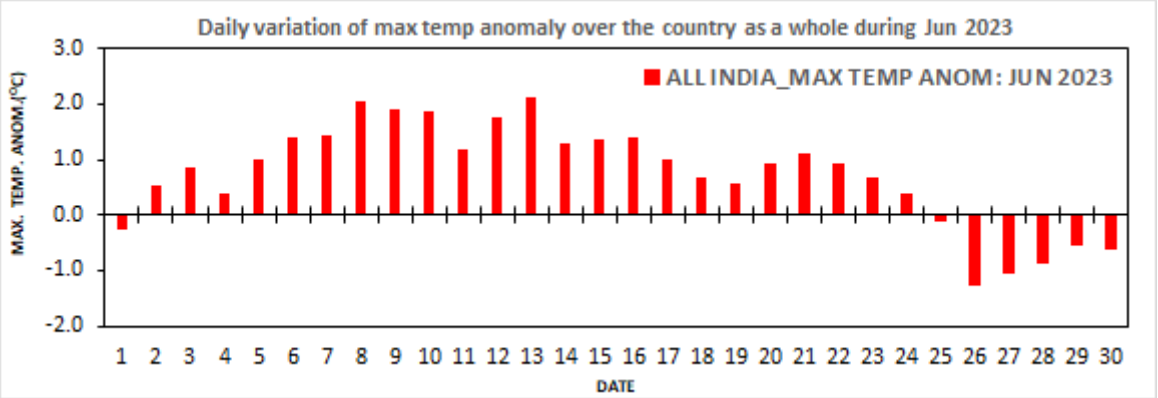


Fig 8(a): Daily variation of maximum temperature anomaly over the country as a whole for June 2023.

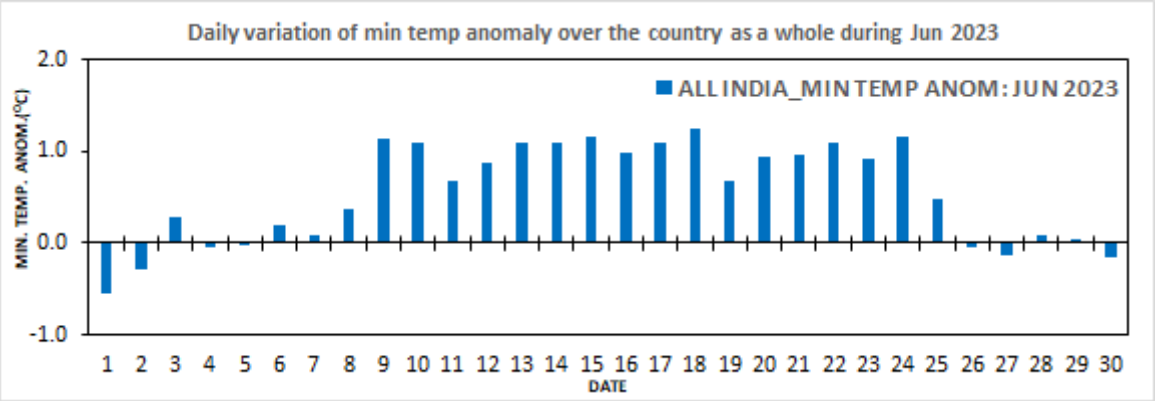


Fig 8(b): Daily variation of minimum temperature anomaly over the country as a whole for June 2023.

Figure 9 shows time series of monthly average maximum, average minimum and mean temperature over the country as a whole for the month of June 1901-2023. Over the country during June, the average maximum temperature is the tenth highest (34.60 ºC with an anomaly of 0.87 ºC) while the average minimum temperature is the eighth highest (25.39 ºC with an anomaly of 0.62 ºC) since 1901. Over all India during June, the mean temperature is the seventh highest (29.99 ºC with an anomaly of 0.75 ºC) since 1901.

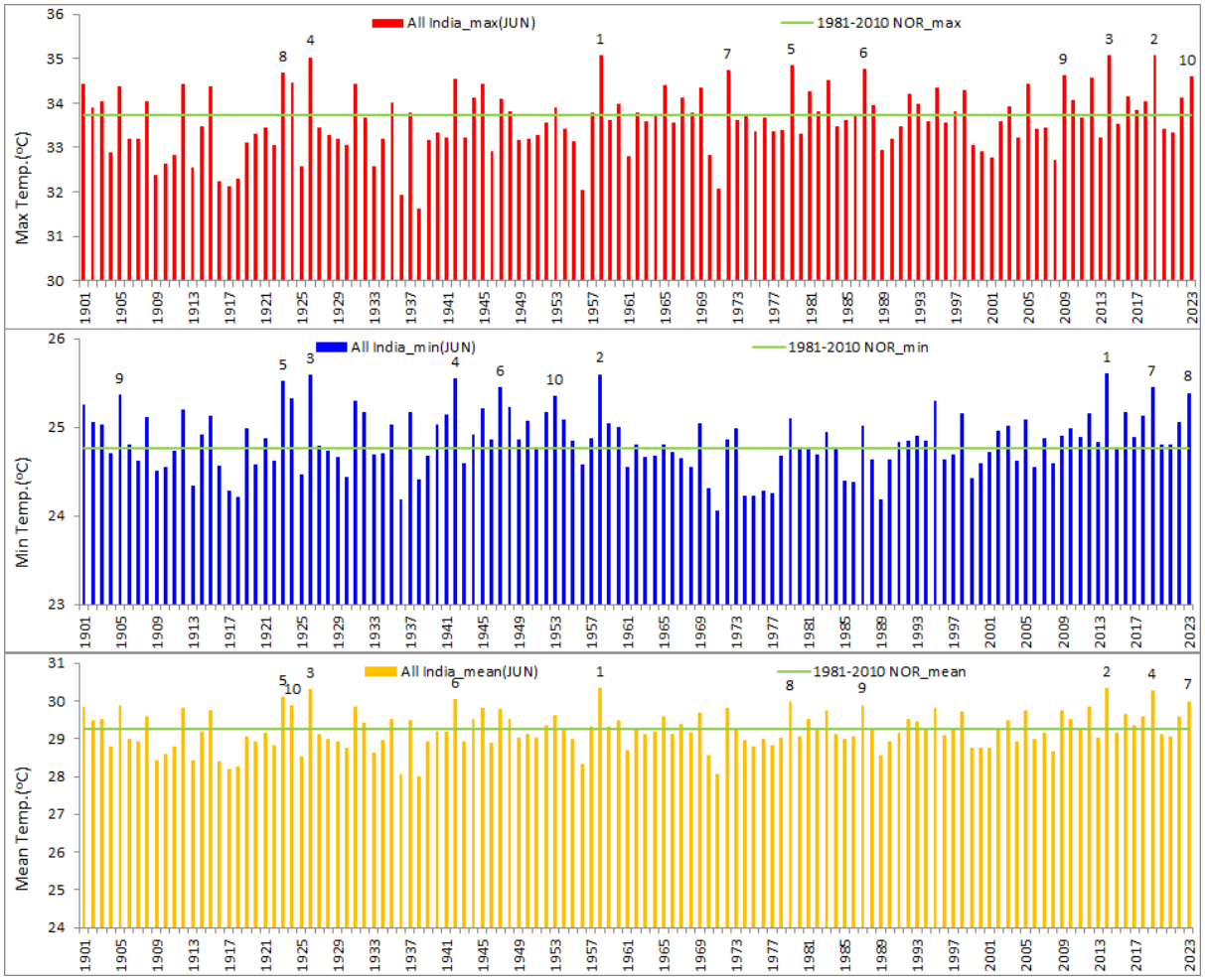


Fig 9: Time series of monthly average maximum, average minimum and mean temperature over the country as a whole for the month of June 1901-2023.

Figure 10 shows time series of monthly average maximum, average minimum and mean temperature over the East & Northeast India for the month of June 1901-2023. Over East & Northeast India during June, the average maximum temperature is the third highest (33.87 ºC with an anomaly of 1.73 ºC) after the years 1979 (34.47 °C), 1958 (34.26 °C) since 1901. The average minimum temperature is the second highest (25.11 ºC with an anomaly of 1.00 ºC) after the year 1958 (25.14 °C) since 1901. The mean temperature is the third highest (29.49 ºC with an anomaly of 1.37 ºC) after the years 1958 (29.70 °C), 1979 (29.53 °C) since 1901.

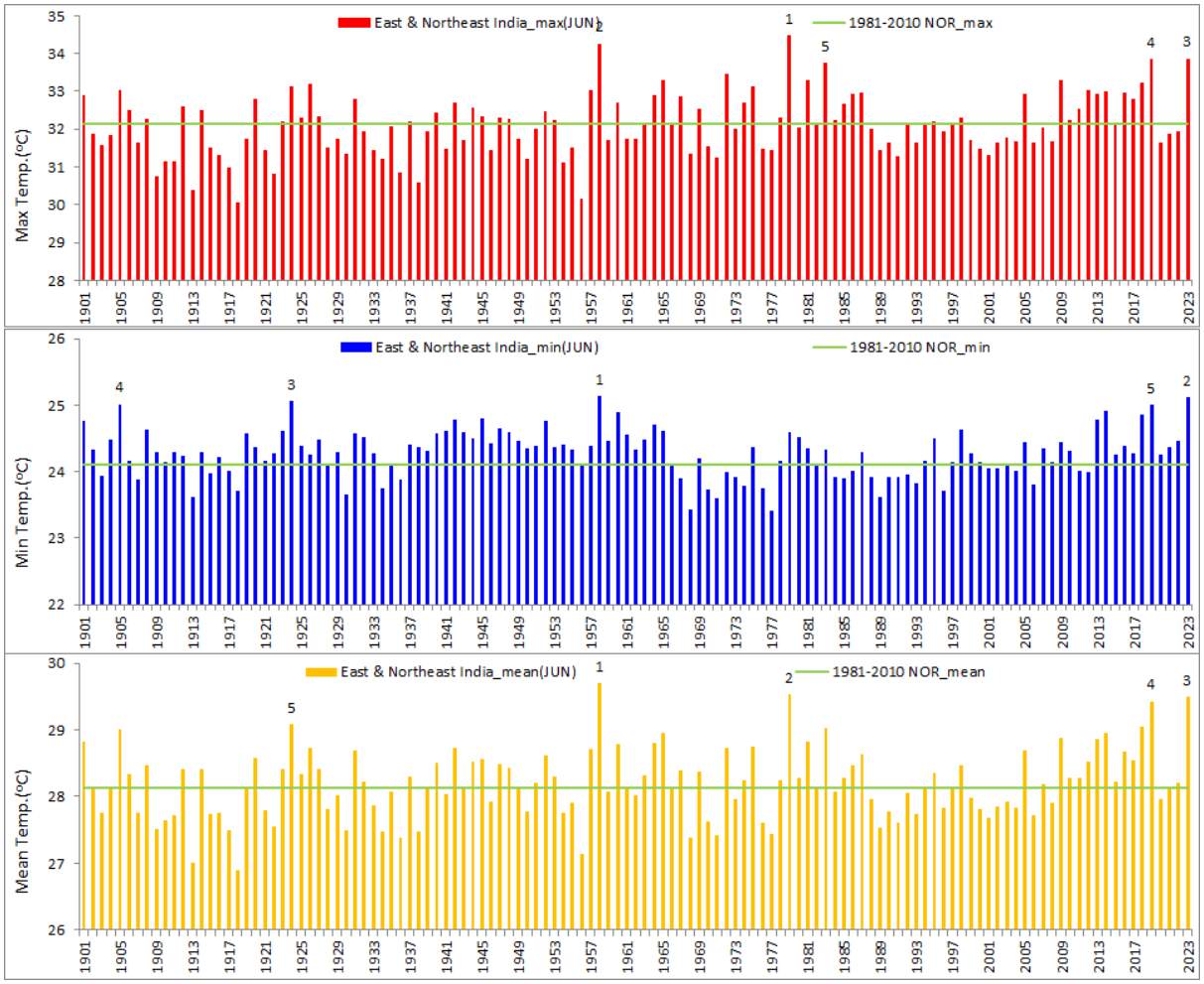


Fig 10: Time series of monthly average maximum, average minimum and mean temperature over East & Northeast India for the month of June 1901-2023.

Figure 11 shows time series of monthly average maximum, average minimum and mean temperature over South Peninsular India for the month of June 1901-2023. Over South Peninsular India during June, the average maximum temperature is ever highest at 34.05 ºC since 1901 and it has broken the earlier ever-highest record of 33.74 ºC that was in 2014 for the month of June for the same period. The average minimum temperature is the third highest (26.04 ºC with an anomaly of 0.87 ºC) after the years 2014 (26.23 °C), 1926 (26.11 °C) since 1901. The mean temperature is ever highest at 30.05 ºC since 1901 and it has broken the earlier ever-highest record of 29.98 ºC that was in 2014 for the month of June for the same period.

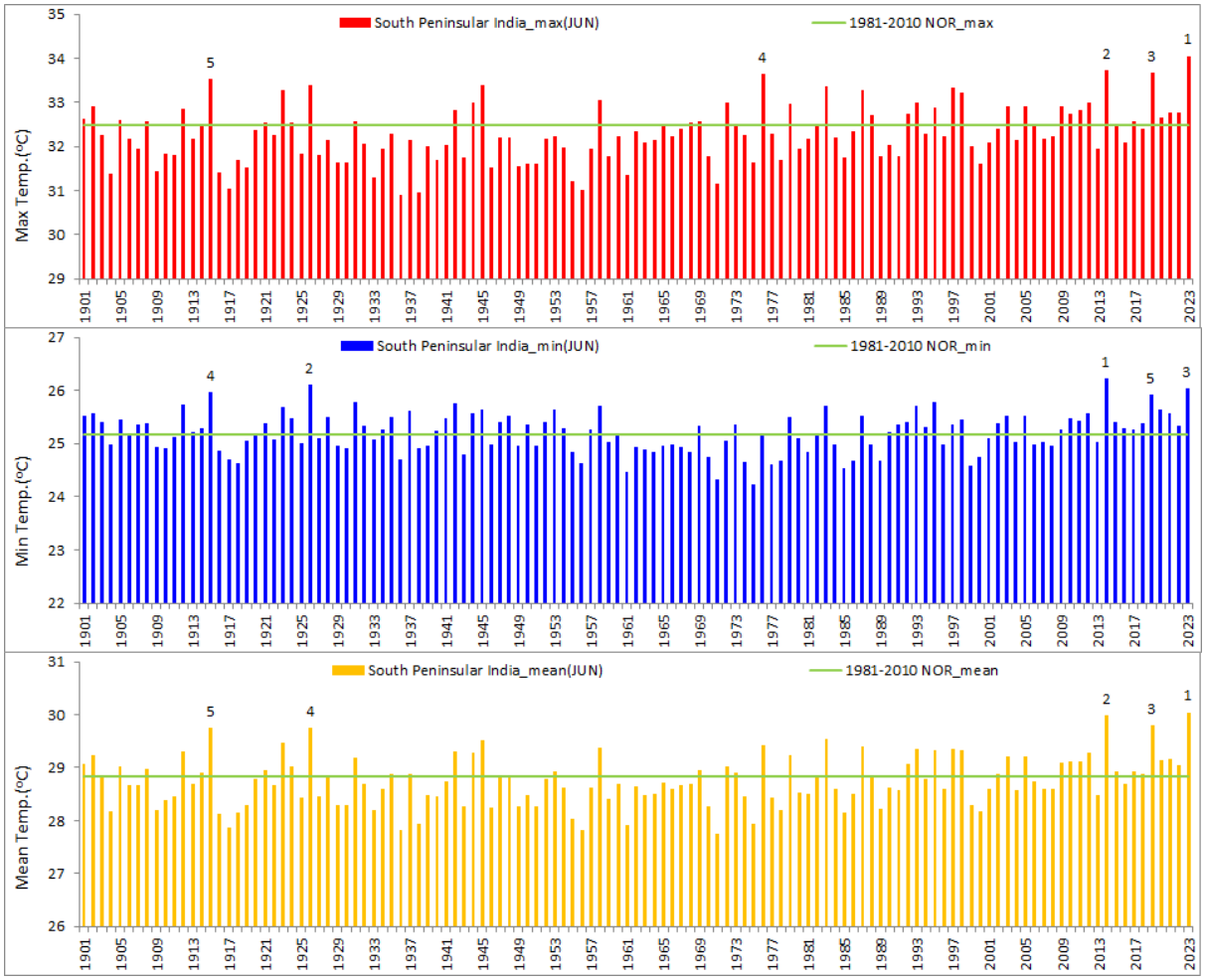


Fig 11: Time series of monthly average maximum, average minimum and mean temperature over South Peninsular India for the month of June 1901-2023.

The Temperatures during June 2023 for all India and homogeneous regions with its top ranks since 1901 are given bellow;

JUN 2023		Max Temp (^{0}C)	Min Temp (^{0}C)	Mean Temp (^{0}C)
ALL INDIA	**ACTUAL**	**34.60**	**25.39**	**29.99**
	NORMAL	33.73	24.76	29.25
	ANOMALY	0.87	0.62	0.75
	Rank from Top	**10**	**8**	**7**
NORTHWEST INDIA	**ACTUAL**	**34.93**	**23.52**	**29.22**
	NORMAL	35.78	23.45	29.61
	ANOMALY	-0.85	0.07	-0.39
	Rank from Top	**102**	**68**	**91**
EAST & NORTHEAST INDIA	**ACTUAL**	**33.87**	**25.11**	**29.49**
	NORMAL	32.14	24.11	28.13
	ANOMALY	1.73	1.00	1.37
	Rank from Top	**3**	**2**	**3**
CENTRAL INDIA	**ACTUAL**	**35.62**	**26.40**	**31.01**
	NORMAL	34.81	25.93	30.37
	ANOMALY	0.81	0.47	0.64
	Rank from Top	**25**	**24**	**22**
SOUTH PENNINSULAR INDIA	**ACTUAL**	**34.05**	**26.04**	**30.05**
	NORMAL	32.47	25.18	28.82
	ANOMALY	1.58	0.868	1.22
	Rank from Top	**1**	**3**	**1**

Note: Values are rounded off to nearest two decimal

The five highest temperature records with corresponding ranks since 1901 along with year of occurrence for East & Northeast India and South Peninsular India (TMax, TMin, TMean) are given in the table below;

East & Northeast India (June 2023)				
Year	TMax	Normal	Anomaly	Top Rank
1979	34.47	32.14	2.33	1
1958	34.26		2.12	2
2023	**33.87**		**1.73**	**3**
2019	33.86		1.72	4
1983	33.74		1.60	5

South Peninsular India (June 2023)				
Year	TMax	Normal	Anomaly	Top Rank
2023	**34.05**	**32.47**	**1.58**	**1**
2014	33.74		1.26	2
2019	33.67		1.19	3
1976	33.63		1.16	4
1915	33.54		1.06	5

East & Northeast India (June 2023)				
Year	TMin	Normal	Anomaly	Top Rank
1958	25.14	24.11	1.03	1
2023	**25.11**		**1.00**	**2**
1924	25.06		0.95	3
1905	25.01		0.90	4
2019	25.00		0.89	5

South Peninsular India (June 2023)				
Year	TMin	Normal	Anomaly	Top Rank
2014	26.23	25.18	1.06	1
1926	26.11		0.93	2
2023	**26.04**		**0.87**	**3**
1915	25.96		0.79	4
2019	25.92		0.74	5

East & Northeast India (June 2023)				
Year	TMean	Normal	Anomaly	Top Rank
1958	29.70	28.13	1.58	1
1979	29.53		1.40	2
2023	**29.49**		**1.37**	**3**
2019	29.43		1.30	4
1924	29.09		0.96	5

South Peninsular India (June 2023)				
Year	TMean	Normal	Anomaly	Top Rank
2023	**30.05**	**28.82**	**1.22**	**1**
2014	29.98		1.16	2
2019	29.79		0.97	3
1926	29.75		0.92	4
1915	29.75		0.92	5

Maximum temperature was above normal by 4.4 ºC mainly over most parts of East & Northeast India, South Peninsular India, some parts Northwest India and Central India. Figure 12 shows the stations with number of days, which were above normal (>4.4 ºC) maximum temperatures.

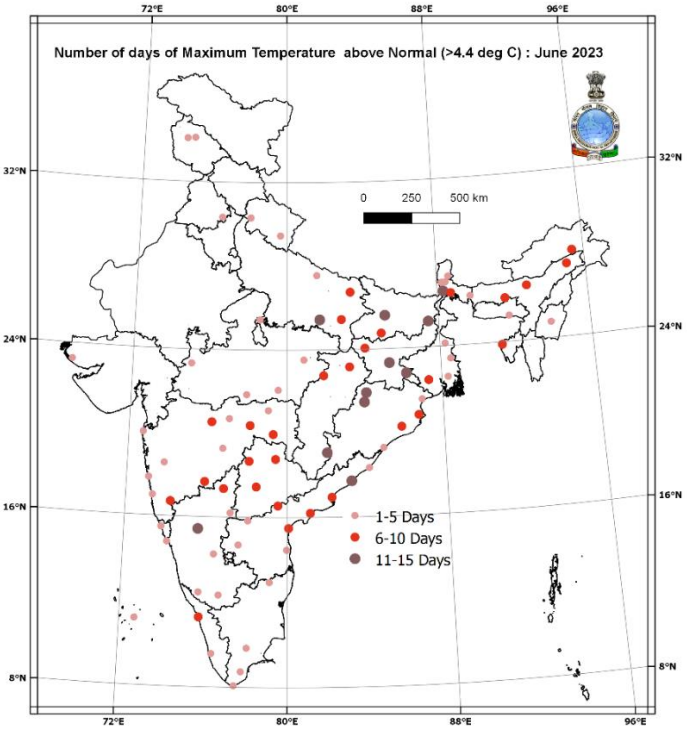


Fig 12: Number of days with maximum temperature above normal (>4.4 ºC) over the country for June 2023.

The observed spatial temperature pattern of monthly average maximum, average minimum and mean temperature over India and their departures from normal (1981 to 2010 period) for the month of June 2023 is given in Figure 13.

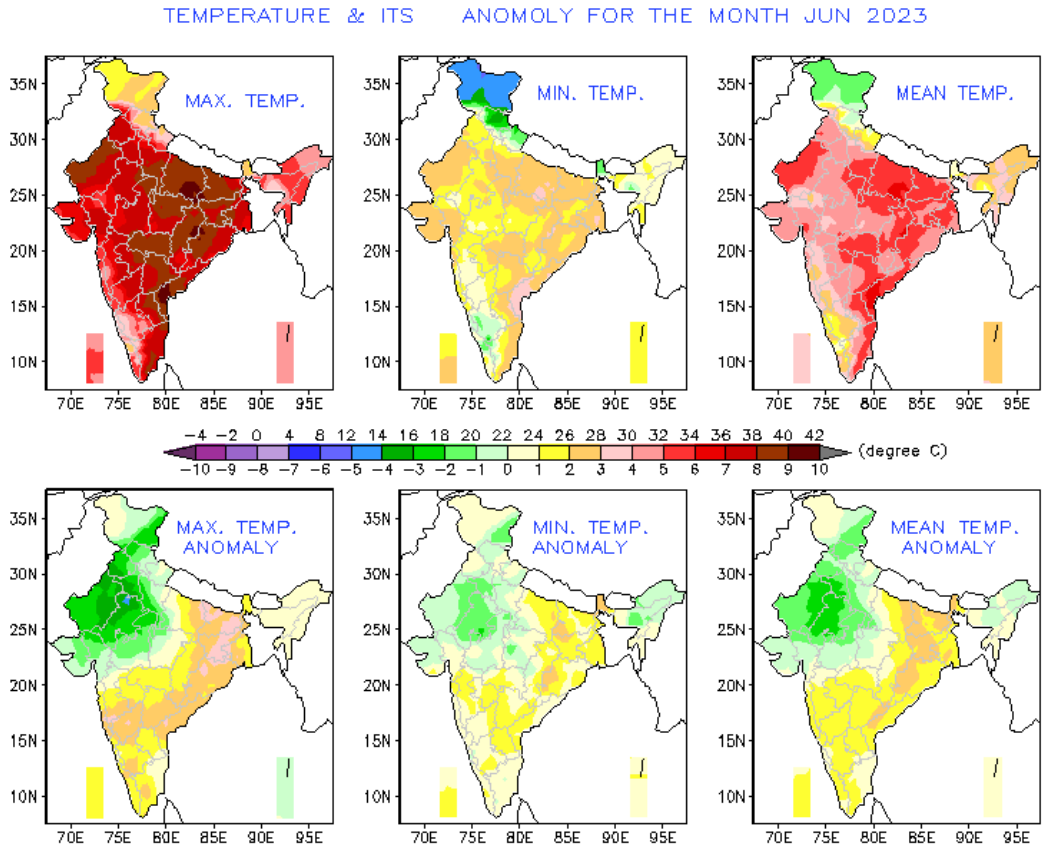


Fig 13: Observed spatial temperature pattern of monthly average maximum, average minimum, and mean temperature over India (top three from left to right) and their departure from normal (1981 to 2010 period) for June 2023 (lower three from left to right).

Heat wave conditions in June 2023: The observed meteorological sub-division based total heat wave days (which also included severe heat wave days) as reported in the month of June 2023 and their Climatological average days for the month, based upon long period data of 1961-2010, is given in Figure 14(a, b). It shows that eastern parts of India was worst affected in June, with significantly higher than the normal heat wave days observed over the region. It was of 11-19 days (normals are 2-4 days) observed over some areas mainly covering West Bengal, Odisha, Bihar, east Uttar Pradesh, Jharkhand, Chhattisgarh, Coastal Andhra Pradesh, Telangana followed by 7-9 days over adjoining central parts of India which covered East Madhya Pradesh, Vidarbha. Heat wave to severe heat wave was observed in almost all dates for the period of 1 June to 22 June over Bihar, 1 June to 18 June over West Bengal, 12 to 21 June over East Uttar Pradesh. But over northwest and adjoining central parts of India, it was lower than normal with almost no occurrences of any heat wave conditions over Rajasthan, Punjab, Haryana, Chandigarh and Delhi and Gujarat state.

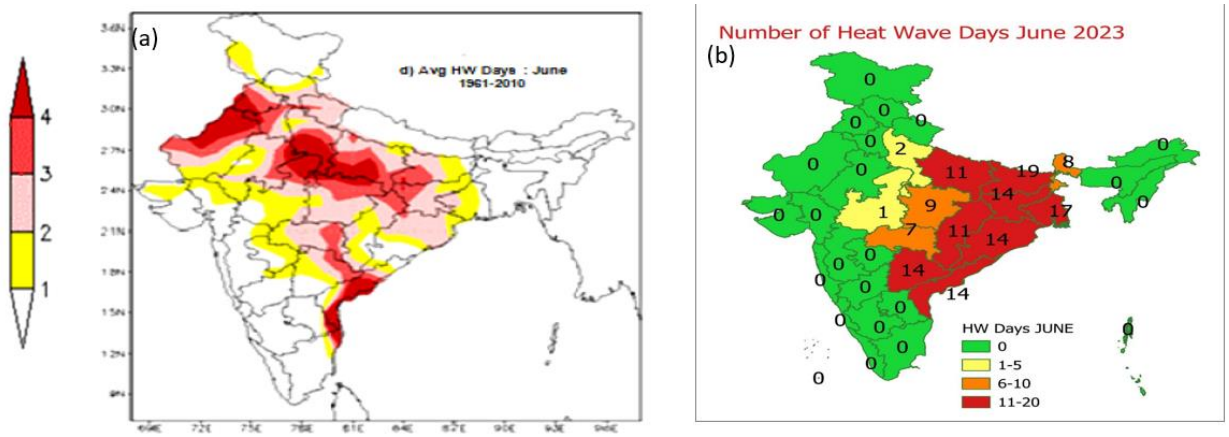


Fig 14: Heat Wave Days in June (a) Climatology (1961-2010) (b) Year 2023