

Letters to the Editor

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A STUDY ON VARIATION OF MAXIMUM AND MINIMUM TEMPERATURE OVER PATNA AIRPORT

1. Patna (25° 36' N, 85° 06' E) is east west elongated and linear city situated between the river the Ganges in the north and Punpun in the south. Climatologically, the lowest minimum temperature is recorded as 2.2° C on 25 December 1961 and the highest maximum temperature is 46.6° C on 9 June 1966 (I. M.D., 1999). Generally, maximum temperature exceeding 45° C is observed in the month of May and June and lowest minimum temperature is observed in January. Rise and fall of maximum temperature is controlled by thunderstorm activity during summer and that of minimum temperature by the passage of western disturbance in winter.

A number of studies related to maximum/minimum temperature at various places have been made in India (Lal 1993; Manral 1983; Suresh 1999; Attri *et al.*, 1995 and Dubey and Balakrishnan, 1989). As no study appears to have been made for maximum and minimum temperature at Patna airport, the objective of this paper is to investigate the characteristics of maximum temperature during April, May and June and minimum temperature during December, January and February.

2. Maximum temperature for the month of April, May and June and minimum temperature for the month of December, January and February at Patna airport have been collected from Met. Office, Patna for the year 1980 – 2005. Frequency distributions of the temperature have been worked out in the class intervals 1 - 5, 5 - 10, 10 - 15, 15 - 20, 20 - 25, 25 - 30, 30 - 35, 35 - 40, 40 - 45 and 45 - 50° C for each month. Day to day change in the maximum and minimum temperature have been analyzed according to meteorological operational practices, *viz.*, No change/no significant change ($\pm 1^\circ$ C), slight rise/fall ($\pm 2, \pm 3^\circ$ C), significant rise/fall ($\pm 4, \pm 5, \pm 6^\circ$ C) and large rise/fall ($\pm 7^\circ$ C or more).

Similarly, departure from pentad normal has been classified according to meteorological practices such as normal/nearly normal ($\pm 1^\circ$ C), above/below normal ($\pm 2^\circ$ C), appreciably above/below normal ($\pm 3, \pm 4^\circ$ C), markedly above/below normal ($\pm 5, \pm 6^\circ$ C) and largely above/below normal ($\pm 7^\circ$ C or more). With a view to study persistence, the change of temperature has been

TABLE 1(a)

Month wise cumulative frequency of maximum temperature, Patna, April-June, 1980-2005

Temperature (°C)	April	May	June	Total
25- 30	15	21	28	64
30-35	157	174	225	556
35-40	463	398	401	1262
40-45	150	212	123	485
45-50	0	1	3	4

TABLE 1(b)

Month wise cumulative frequency of minimum temperature, Patna, December-February, 1980-2005

Temperature (°C)	December	January	February	Total
01- 05	2	38	0	40
05-10	342	498	180	1020
10-15	405	250	441	1096
15-20	29	20	114	163

classified into three categories namely no change, rise and fall. Rise (fall) includes the cases where the next day value is higher (lower) than that of previous day by 2° C or more. The number of days for which one type of continuous change occurred is counted as unit accordingly classification has been made and percentage frequencies calculated for 1, 2 , , 6 days.

3. *Frequency distribution of maximum and minimum temperature* – Table 1(a) shows the frequencies of maximum temperature during April - June for different class intervals. The modal class is 35-40° C. In 40-45° C range, the cumulative frequency is the highest during May followed by April. Due to the northward movement of the Sun (from equator during vernal equinox to tropic of cancer during summer solstice), the insolation increases over central and adjoining north India. When temperature exceeds 40° C, a trough of low-pressure area generally forms from west Rajasthan to Nagaland, Mizoram, Manipur and Tripura with embedded vortices observed in the lower level either over Uttar Pradesh or Bihar up to 0.9 km above sea level generally. Due to intense heating of land and supply of moisture from the Bay of Bengal, thunder activity starts over central India. The thunderstorm, squally winds and rain bring down the temperature to the range 35-40° C. The frequency in the range 45-50° C was found to be 3 in the month of June

TABLE 2(a)

Percentage frequencies of 24 hours change of maximum temperature, Patna, April-June, 1980-2005

Month	Large rise (+7° C or more)	Significant rise (+4, +5, +6° C)	Slight rise (+2, +3° C)	No change/No significant change ($\pm 1^\circ$ C)	Slight fall (-2, -3° C)	Significant fall (-4, -5, -6° C)	Large fall (-7° C or more)
April	0.0	3.7	17.3	59.6	15.7	3.4	0.3
May	0.3	5.2	23.9	45.8	15.8	7.1	1.9
June	0.0	4.4	16.7	54.4	17.3	5.6	1.6

TABLE 2(b)

Percentage frequencies of 24 hours change of minimum temperature, Patna, December-February, 1980-2005

Month	Large rise (+7° C or more)	Significant rise (+4, +5, +6° C)	Slight rise (+2, +3° C)	No change/No significant change ($\pm 1^\circ$ C)	Slight fall (-2, -3° C)	Significant fall (-4, -5, -6° C)	Large fall (-7° C or more)
Dec	0.0	1.9	7.7	78.5	10.0	1.9	0.0
Jan	0.3	5.2	18.4	54.5	15.5	6.1	0.0
Feb	0.0	6.0	14.8	59.1	16.3	3.8	0.0

TABLE 3(a)

Percentage frequencies of departure of maximum temperature from normal, Patna, April-June, 1980-2005

Month	Largely above normal (+7° C or more)	Markedly above normal (+5, +6° C)	Appr. above normal (+3, +4° C)	Above normal (+2° C)	Normal/Nearly normal ($\pm 1^\circ$ C)	Below normal (-2° C)	Appr . below normal (-3, -4° C)	Markedly below normal (-5, -6° C)	Largely below normal (-7° C or more)
Apr	0.0	1.0	11.3	9.0	36.0	11.7	18.0	10.3	2.7
May	0.3	2.3	8.7	4.8	24.9	10.0	20.3	14.8	13.9
Jun	3.3	6.3	9.6	9.0	32.6	11.7	14.3	9.7	3.3

TABLE 3(b)

Percentage frequencies of departure of minimum temperature from normal, Patna, December-February, 1980-2005

Month	Largely above normal (+7° C or more)	Markedly above normal (+5, +6° C)	Appr. above normal (+3, +4° C)	Above normal (+2° C)	Normal/ Nearly normal ($\pm 1^\circ$ C)	Below normal (-2° C)	Appr . below normal (-3, -4° C)	Markedly below normal (-5, -6° C)	Largely below normal (-7° C or more)
Dec	0.3	2.9	8.4	16.1	51.9	11.3	8.1	1.0	0.0
Jan	1.0	3.2	7.1	5.8	36.4	16.5	20.0	7.7	2.3
Feb	0.4	3.2	16.6	11.3	45.5	8.8	12.4	1.8	0.0

and only one in the month of May during the period of study. The highest maximum temperatures recorded were 46.1, 45.2 and 45.0° C on 15 June 1995, 7 June 1998 and 3 June 2005 respectively while 45.6° C was reported on 29 May 2005.

Table 1(b) shows the frequency distribution of minimum temperature under various classes in the month of December, January and February. Though the modal class is 10 - 15° C, the frequency in the class 5 - 10° C is almost closed to that of the modal class. The frequency of

lowest minimum temperature in the range 1 - 5° C was highest (38) during January while it was 2 during December and nil during February. Northwesterly cold wind generally prevails over Bihar during winter. Air becomes saturated and fog forms. In foggy condition change in temperature is not significant. Under the influence of western disturbance, induced low/cyclonic circulation forms over Madhya Pradesh and adjoining areas. When the disturbance moves towards Bihar, rise in minimum temperature has been observed due to perpetual clouding as high as 7 oktas. When the system passes

TABLE 4(a)

Persistence of no change, rise and fall of Maximum temperature
(Percentage frequencies), Patna, April-June, 1980-2005

	No. of Days					
	1	2	3	4	5	6
No Change ($\pm 1^\circ \text{C}$)						
Apr	13.0	5.3	4.0	0.0		
May	11.6	2.6	2.9	0.0		
Jun	14.7	4.0	3.0	0.0		
Rise ($\geq 2^\circ \text{C}$)						
Apr	16.0	16.0	8.0	0.0	0.0	0.0
May	13.5	15.5	9.7	7.7	0.0	1.9
Jun	15.3	11.3	11.0	4.0	0.0	0.0
Fall ($\leq 2^\circ \text{C}$)						
Apr	16.7	14.0	3.0	4.0	0.0	
May	14.8	10.3	6.8	2.6	0.0	
Jun	16.0	13.3	6.0	1.3	0.0	

away, the sky becomes clear resulting in abrupt fall in temperature. The lowest minimum temperature are recorded 4.0, 2.3 and 5.1 $^\circ \text{C}$ on 28th December 1998, 15 January 2003 and 4 February 2001 respectively.

4. *Change of maximum and minimum temperature* – Table 2(a) shows percentage frequencies of 24 hr change of maximum temperature during April, May and June. No change/no significant change is found 60, 46 and 54 % in all the three respective months. Slight rise is largest in the month of May and slight fall is largest in the month of June. While significant rise and fall vary around 4 - 7 % of total number of cases in all the three months, large rise is negligible and large fall is insignificant. Further analysis revealed that the maximum temperature is modulated by the prevailing wind, cloud coverage and rain.

Table 2(b) shows percentage frequencies of 24 hr change of minimum temperature for the month of December, January and February. No change/no significant change is found 79, 55 and 59 % in all the three respective months. Large rise and fall of temperature are negligible in all the three winter months. Slight and significant rise/fall are associated with the approach and passage of western disturbances.

5. *Departure of maximum and minimum temperature* - Tables 3(a&b) present monthly percentage frequencies of departure of maximum and minimum temperature from pentad normal respectively. It can be seen that the frequencies of negative departures are greater than that of positive departures in respect of maximum

TABLE 4(b)

Persistence of no change, rise and fall of minimum temperature
(Percentage frequencies), Patna, December-February, 1980-2005

	No. of Days					
	1	2	3	4	5	6
No Change ($\pm 1^\circ \text{C}$)						
Dec	14.5	8.4	5.8	2.6	1.6	1.9
Jan	11.6	5.8	1.0	1.3	0.0	0.0
Feb	14.8	5.7	1.1	0.0	0.0	0.0
Rise ($\geq 2^\circ \text{C}$)						
Dec	18.7	3.9	5.8	1.3	1.6	0.0
Jan	16.8	15.4	3.9	3.9	1.6	0.0
Feb	15.5	12.0	11.7	2.8	0.0	2.1
Fall ($\leq 2^\circ \text{C}$)						
Dec	14.2	12.9	6.8	0.0	0.0	
Jan	19.0	11.6	6.8	1.3	0.0	
Feb	11.3	14.8	5.3	2.8	0.0	

temperature. The largest negative departure found during May may be attributed to frequent thunder activity over the station. In regard to minimum temperature, negative departure from normal is more than that of positive departure during January. The location, movement and passage of western disturbance may be the cause for cold wave condition over Patna during January.

6. *Persistence of maximum and minimum temperature* - Table 4(a) shows the percentage frequencies of maximum temperature under the class no change ($\pm 1^\circ \text{C}$), rise $\geq 2^\circ \text{C}$ and fall $\leq 2^\circ \text{C}$ continuously during April, May and June. It can be seen that while 'no change' lasts only for 3 days, 'rise' may continue as long as 6 days and 'fall' may last upto 4 days.

Table 4(b) shows the percentage frequencies of persistence of minimum temperature under the different classes as above during December, January and February. 'No change' may persist up to 6 days during December whereas it is confined to 4 days during January and 3 days during February while 'fall' is confined to 4 days, rise may last up to 6 days.

7. Following conclusions can be drawn from the study:

(i) The modal class of maximum temperature is 35-40 $^\circ \text{C}$ during April, May and June.

(ii) Though the modal class of minimum temperature is 10 - 15 $^\circ \text{C}$, good chance prevails for the range 5 - 10 $^\circ \text{C}$ as well during winter over Patna.

(iii) While pre-monsoon thunderstorm activity modulates the maximum temperature during May and June, the location, approach and passage of western disturbance modulates minimum temperature during January and February over Patna.

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