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Letters to the Editor

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A STUDY ON THE VARIATIONS OF PRESSURE AND TEMPERATURE DURING PRE-MONSOON THUNDERSQUALLS AT GAYA

1. Ghosh and Singh (1988) studied the pre-monsoon thundersqualls at Gaya based upon data of 1976-1986 with respect to its speed, direction, time of occurrence pressure and temperature and some extreme cases. In this study the variation of surface pressure and temperature in association with thundersqualls have been made.

Similar study has been carried out by Padmanabhamurty and Choudhury (1967) based upon norwester's data of 1963 to 1966 of Calcutta airport (Dum Dum). They got a set of data where both variables were dichtomous and calculated tetrachoric correlation coefficient RT=—0.32 for Dum Dum.

Bhattacharya and Basu (1983) studied the variations of temperature and pressure associated with norwester's at Dum Dum airport based upon data of 1974-1980. They got a set of data where both the variables were not dichtomous.

2. The dates of occurrence of thundersqualls have been collected from the current weather registers of Gaya for the period 1976-1986. The relevant autographic charts such as anemogram, thermogram, barogram, hygrogram and hyetogram of each date have been taken into account. Thundersqualls occurred on 59 days. Variations of pressure and temperature during thundersqualls have been depicted in Table 1. On six days there were two thundersqualls at certain interval of time and variations of pressure, temperature, humidity, direction and speed associated with rain or no rain have been depicted in Table 2.

3. *Examples are given below to illustrate typical cases*

3.1. *Case I—Pressure and temperature rise on 7 May 1977* (Fig. 1) — A thundersquall hit the station from northwest direction at 1540 IST on 6 May 1977. After an interval of 9 hrs, another squall from northwest direction hit the station with a speed of 58 kmph at 0115 IST on 7 May 1977. Prior to that the wind was westnorthwesterly. Pressure rose by 2 mb and temperature rose by 1.1°C from 24°C. Thereafter, rain started and temperature dropped by 0.5°C from 24°C line. The relative humidity rose from 64 to 70%. The rainfall was 1.6 mm.

The air in the lower layer was already at its lowest temperatue and maximum saturation because of an earlier squall and subsequent nocturnal cooling. Downdraft from the second squall arrived at the station at higher temperature resulting in rise of temperature and pressure. The temperature started falling as the rainfall started.

3.2. *Case II—Pressure and temperature fall on 7 April 1977* (Fig. 2)—The squally weather started at 1530 IST. The squall hit the station from northwest direction with a peak speed of 72 kmph and lasted for two minutes. Initially the wind was westerly and temperature was 36.5°C. The pressure fell by 0.4 mb and temperature by 8.0°C. The rainfall was trace.

3.3. *Case III—Pressure rise and temperature fall on 16 May 1976* (Fig. 3)—In a majority of cases, the pressure rises and temperature falls during squall. On 16 May 1976 at about 0430 IST, the wind was southeasterly. The squall hit the station from northwest direction at about 0445 IST and lasted for roughly 20 minutes. The peak speed was 108 kmph. The pressure rose by 4.5 mb and temperature fell by 6.6°C. The rainfall during the squall was 0.6 mm. Such abnormal rise of pressure was due to tremendous speed of the downdrafts 108 kmph.

3.4. *Case IV—No change in pressure but fall in temperature on 8 May 1977* (Fig. 4)—The wind was northeasterly prior to squall on 8 May 1977. The thunderstorm started at 2300 IST and hailstorm occurred between 2302 and 2309 IST. After the hailstorm, two squalls hit the station at an interval of 10 minutes.

The first squall hit the station from northeasterly direction with a peak speed of 48 kmph at about 2325 IST and lasted for 3 minutes. There was no change in pressure but temperature dropped by 4.5°C, relative humidity also rose from 56% to 73%.

Another squall hit the station from easterly direction with peak speed of 52 kmph and lasted for 2 minutes. There was no change in pressure level but temperature dropped by 0.5°C. Relative humidity remained at 73%. The total rainfall was 4.1 mm.

4. Table 2 shows that on six occasions two squalls occurred on the same day. On 20/21 April 1977 and 6/7 May 1977 (dates changed due to counting of time in IST

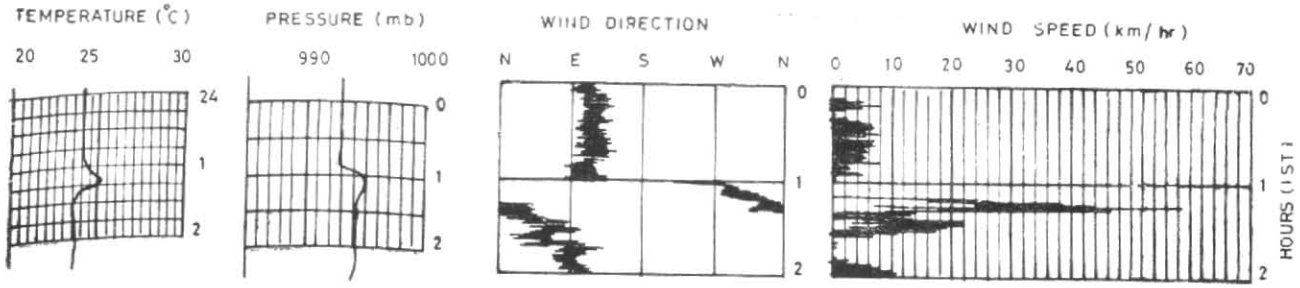

Fig. 1. (Station)— Gaya, 7 May 1977)

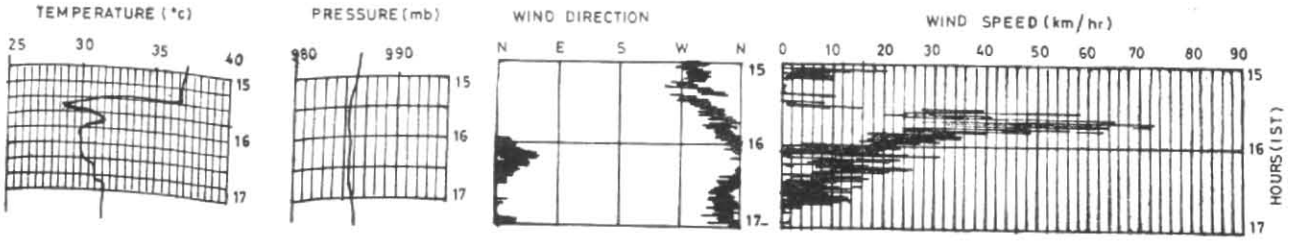

Fig. 2

TABLE 1

Variation of pressure and temperature associated with premonsoon thundersqualls over Gaya (1976-1986)

Associated		Total of occasions	Percentage frequency
Pressure	Temperature		
Rise	Fall	42	66.66
Rise	Rise	7	11.11
Fall	Fall	5	7.93
Fall	Rise	0	0
No change	Fall	8	12.69
No change	Rise	1	1.50
Rise	No change	0	0
Fall	No change	0	0
No change	No change	0	0
Total		63	100.00

Note : Thundersqualls days = 59
Thundersquall including two squalls on the same day =63

from midnight to midnight). The time lag between two squalls on four occasions varied from 1 hr to 9 hr 37 minutes only two occasions the time lag was 10-15 minutes.

On 8 May 1977 both the squalls hit the station at the interval of 10 minutes, the first from northeast direction and the second from east respectively. In the first squall the rainfall was 2.4 mm and in the second 1.7 mm. It can be assumed that both the squalls originated from the same cumulonimbus cloud and the cloud has moved from northeast to east. There was no change of pressure and temperatures fell 4.5°C and 0.5°C during 1st and 2nd squall respectively. Hailstorm also occurred prior to 1st squall at 2302 IST.

Asnani (1961) theoretically suggested that severe hailstorms may sometimes be accompanied by pressure fall. Occurrence of hailstorms and no change in pressure during both the squalls confirmed Asnani's finding.

On 6 May 1977 the first squall reached the peak speed of 48 kmph from northwest direction. The pressure rose by +1.2 mb, temperature fell by —10°C, humidity rose from 28 to 54% and rainfall was 3.5 mm. The second squall with peak 76 kmph hit the station from northwest direction. There was no change in pressure, temperature rose by 2.5°C, humidity fell from 54% to 51% and there was no rainfall.

Byers and Braham (1949) have observed that if the relative humidity dip had occurred after temperature had reached the lowest point, a temperature rise of 2° to 3°C or even more was to accompany the relative humidity dip. The humidity dip resulted from desiccation from a relatively dry downdraft. The above result tallies with Byers and Braham findings.

5. From Tables 1 & 2 it may be observed that in most of the cases squall was associated with a fall in temperature. In 87 per cent cases, the temperatue fell, in 79 per cent cases, the fall of temperature was associated with either rise of pressure or no change in pressure. In 67 per cent cases the fall of temperature was associated with only rise of pressure. In 11 per cent cases the rise in temperature was associated with rise in pressure.

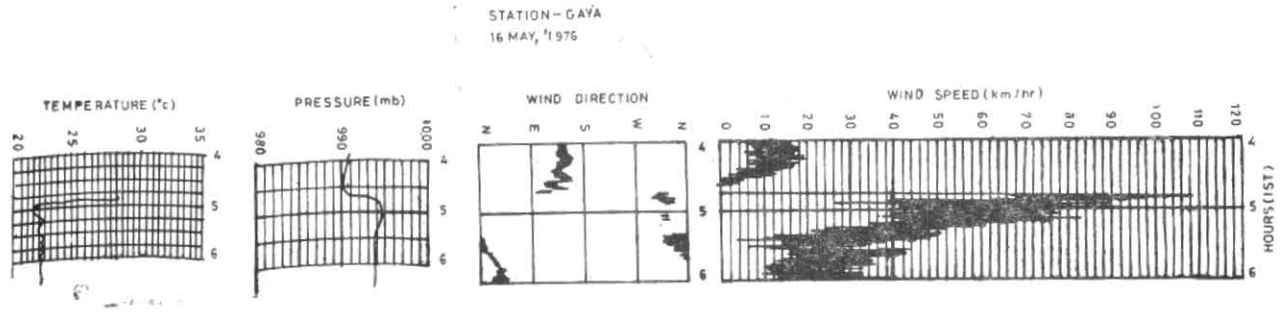

Fig. 3

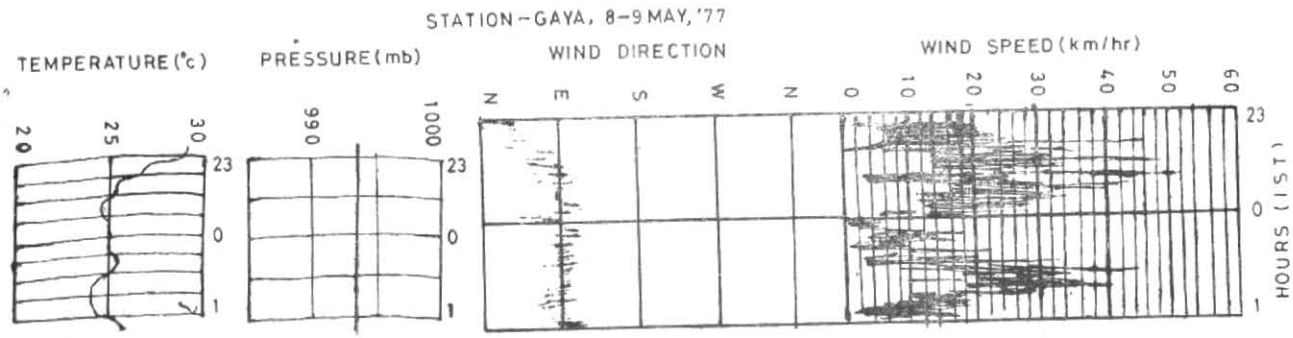

Fig. 4

TABLE 2

Variations of meteorological elements in connection with two squalls on the same day

S. No.	Date	Time of squall (IST)	Duration (min)	Direction	Speed (kmph)	Rainfall during squalls weather (mm)	Corresponding rise (+)/ fall (—) temp. (°C)	Pressure (mb)	Relative humidity (%) Prior to squall	Relative humidity (%) After squall	Direction of wind prior to squall	
1	20 Apr 77	1717	4	SW	59	0.3	—6.0	+0.2	27	53	WSW	
	21 Apr 77	0055	5	NW	88	10.2	—6.0	+1.4	65	75	SW	
	8 May 77	2325	3	NE	48	2.4	—4.5	No change	56	73	NE	2302
												2309
2	Hailstorm 8 May 77	2355	2	E	52	1.7	—0.5	No change	56	73	NE	
3	6 May 77	1538	5	NW	52	0.0	—11.2	+1.8	31	62	W	
	7 May 77	0115	2	NW	58	1.6	+1.1	+1.9	64	70	WNW	
4	16 May 77	1810	2	NW	48	3.5	—10.0	+1.2	28	54	W	
	16 May 77	1825	3	NW	76	0.0	+2.5	No change	54	51	NW	
5	17 May 80	1255	5	SW	86	1.0	—9.5	—0.2	37	44	NW	
	17 May 80	1355	5	WNW	80	2.0	—8.2	+1.4	39	55	SE	
6	10 May 81	1735	5	SW	61	Trace	—6.1	+0.5	29	55	NNW	
	10 May 81	2045	5	W	74	Trace	—3.0	+0.7	57	65	SW	

TABLE 3

Rainfall and relative humidity during squall

No. of occasions when rainfall was measurable	No. of occasions when no rainfall/trace	No. of occasions when R.H. rose during squall	No. of occasions when R.H. fell during squall
38 (60%)	25 (40%)	56 (89%)	7 (11%)

There was no case of temperature rise and pressure fall at Gaya, although Padamanabhamurty and Choudhury (1967) and Bhattacharya and Basu (1983) reported 3 such cases for Calcutta Airport based upon their data of 1963-1966 (66 squalls) and 1976-1980 (86 squalls) respectively. Rise in temperature associated with the secondary squall is favoured during night or in the early morning. Such cases are common at Calcutta but rare at Gaya.

6. On the basis of 63 squalls (59 squally days) during the pre-monsoon period 1976-86 :

(*i*) In 87 per cent of the cases, the surface temperature falls with the onset of the squall,

(*ii*) The most preferred combination of variation of pressure rise and temperature fall, *i.e.*, 67 per cent of cases.

(*iii*) In 60 per cent cases the squall is associated with measurable rainfall but in 40 per cent cases either trace or no rainfall have been observed.

(*iv*) Majority of the squalls (95 percent cases) have been associated with rise in relative humidity.

(*v*) In majority of cases rise in temperature associated with squall has been observed when two squalls or more hit the station either at night or during early morning. Adiabatic heating during downdraft is the most important factor for temperature rise.

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