551.553·6 (543)

A study of Squalls at Ahmedabad airfield

S. P. SAXENA and R. NATARAJAN

Meteorological Office, Ahmedabad

(*Received 26 April 1965*)

ABSTRACT. A study of squalls at Ahmedabad has been made from the analysis of autographic records of the observatory at Ahmedabad for the period 1954 to 1963 and their statistical features discussed in this paper.

1. Introduction

A study of the various features of the surface squalls at Ahmedabad has been undertaken in this paper. Statistical analysis of monthly frequency, diurnal variation, maximum speed recorded etc, together with changes in pressure and temperature associated with the incidence of squalls has been made, based on the data for the years 1954 to 1963.

2. Data

For the purpose of this study, a squall has been taken to mean a sudden increase in wind speed by at least three stages on B.F. Scale reaching 44 km/hr or more and lasting for at least one minute. Autographic records of anemograph, barograph and thermograph for the period 1954 to 1963 have been examined for this analysis. There were 87 occasions of squalls during the period of this study. Results of the analysis are summarised and discussed below.

3. Results and discussions

Monthly frequency of squalls — Monthly frequencies of squalls for different years are shown in Table 1. The data relating to maximum number of days of squalls in different months, average number of days of squall and the percentage frequency of squalls, with reference to annual total is also given in the same table. It will be seen that (*i*) the period December to February is free from squalls, for which reason, these months have not been included in the table, (*ii*) maximum number of squalls occur in the month of June and (*iii*) 57 per cent of the squalls in the year occur during the period June to July.

Diurnal distribution — Table 2 shows the distribution of squalls, month-wise, during different three-hour periods of the day. The above frequency expressed as percentage of the total occurring in each month is also given in bracket. It will be seen that (*i*) the period 0900 to 1200 IST is completely free from squalls, (*ii*) maximum frequency of occurrence of squalls is during the period 1500 to 1800 IST taking the year as a whole, (*iii*) 78 per cent of the squalls occur during the period 1500 to 2100 IST taking the year as a whole.

Maximum gust speed — Table 3 gives the frequencies of maximum gust speed (percentage shown in brackets) in various specified limits for various months of the year. The chief features shown by this table are (*i*) 75 per cent of the squalls in the year do not reach a peak speed of 75 km/hr, (*ii*) only 25 per cent of the squalls in the year have peak speed 75 km/hr or more, (*iii*) only 11 per cent of the squalls in the whole year reach peak speed of 85 km/hr or more — all in April, May and June and (*iv*) 80 per cent of the squalls occurring in May reach a peak speed of 75 km/hr or more. The highest speed recorded during the years of study was 130 km/hr on 13 May 1963. These severe squalls are generally associated with afternoon heat thunderstorms.

Pressure changes — Out of 87 occasions of squalls during the period of study, values of pressure changes on two occasions are not available. Therefore, only 85 occasions of squall have been studied in relation to pressure changes. Pressure changes in association with the passage of squalls together with the percentages, in bracket, of the total number in each of the groups of months March to May, June to September and October to November are given in Table 4. It will be seen from this table that (*i*) taking the year as a whole 50 per cent of the squalls are associated with the pressure rise of 0·5 mb or less, (*ii*) during the months March-May 42 per cent of the squalls and during the period June to September 54 per cent of the squalls are associated with pressure of only 0·5 mb or less whereas during the months October to November 50 per cent of the squalls are associated with a pressure rise of 1·0 to 1·9 mb.

TABLE 1

Frequency of occurrence of squalls

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total for the year
1954	2 (on same day)			3	1		2 (on same day)			8
1955			1	4				1		6
1956				1	2	6 (in four days)	1	1		11
1957			1	2	2	4			2	11
1958	1	1		2	5 (in three days)	3				12
1959		1		4 (in three days)	1					6
1960				5	4		2			11
1961			2	4						6
1962	1			1	3 (in two days)	1	3 (in two days)			9
1963		1	1	5 (in four days)						7
Total	4	3	5	31	18	14	8	2	2	87
Max. No. of days of squalls	1	1	2	5	4	4	2	1	2	
Average No. of days of squalls	0·3	0·3	0·5	2·9	1·5	1·2	0·6	0·2	0·2	
Percentage of squalls in different months to the year as a whole	5	3	6	36	21	16	9	2	2	

TABLE 2

Diurnal distribution of squalls

	00—03	03—06	06—09	09—12	12—15	15—18	18—21	21—24 (IST)	Total
					Number (Percentage)				
Mar	—	—	—	—	—	1 (25)	3 (75)	—	4
Apr	—	—	—	—	—	1 (33)	2 (66)	—	3
May	—	—	—	—	—	3 (60)	2 (40)	—	5
Jun	2 (7)	2 (7)	1 (3)	—	—	14 (45)	9 (29)	3 (10)	31
Jul	—	1 (6)	—	—	3 (17)	8 (44)	3 (17)	3 (17)	18
Aug	—	1 (7)	—	—	1 (7)	6 (43)	5 (36)	1 (7)	14
Sep	—	—	—	—	—	3 (37)	5 (63)	—	8
Oct	—	—	—	—	—	2 (100)	—	—	2
Nov	—	—	—	—	—	—	1 (50)	1 (50)	2
Total for the year	2 (2)	4 (4)	1 (1)	—	4 (4)	38 (44)	30 (34)	8 (9)	87

TABLE 3

Maximum gust speed of winds

	Peak speed (km/hr)							Highest speed recorded	Date of record of highest speed	Total No. of squalls
	44	45—54	55—64	65—74	75—84	85—94	95 or more			
					Number (Percentage)					
Mar	—	—	2 (50)	1 (25)	1 (25)	—	—	82	15-3-62	4
Apr	—	1 (33)	—	—	—	1 (33)	1 (33)	118	5-4-63	3
May	—	1 (20)	—	—	2 (40)	—	2 (40)	130	13-5-63	5
Jun	—	4 (13)	7 (23)	10 (32)	5 (16)	3 (10)	2 (6)	110	24-6-59	31
Jul	1 (5)	10 (55)	1 (5)	3 (17)	3 (17)	—	—	80	23-7-58	18
Aug	—	6 (43)	5 (35)	3 (21)	—	—	—	70	23-8-57 24-8-57	14
Sep	2 (25)	5 (63)	1 (13)	—	—	—	—	67	25-9-60	8
Oct	—	—	1 (50)	—	1 (50)	—	—	77	1-10-55	2
Nov	—	1 (50)	—	1 (50)	—	—	—	70	15-11-57	2
Total for the year	3 (3)	28 (32)	17 (19)	18 (21)	12 (14)	4 (5)	5 (6)			87

TABLE 4

Pressure changes in squalls

	Pressure rise (mb)						Pressure decrease by 1 mb or more	Total No. of squalls
	0·5 or less	0·5—0·9	1·0—1·9	2·0—2·9	3·0—3·9	4·0 or more		
	Number (Percentage)							
Mar to May	5	—	2	3	1	—	1	12
	(42)		(17)	(25)	(8)		(8)	
Jun to Sep	37	9	17	4	—	2	—	69
	(54)	(13)	(25)	(6)		(3)		
Oct to Nov	1	—	2	1	—	—	—	4
	(25)		(50)	(25)				
Total for the year	43	9	21	8	1	2	1	85
	(50)	(11)	(25)	(9)	(1)	(2)	(1)	

The data on examination does not reveal any dependence between maximum wind speed reached in squalls and the associated pressure rise. Even feeble squalls were found to be associated with relatively large rises of pressure. The peak speed of 130 km/hr was associated with a pressure rise of only 1·5 mb whereas a pressure rise of 4·0 mb had resulted only in a peak speed as little as 59 km/hr. There was one occasion during the whole period of study when pressure had fallen by 1·0 mb in association with the squall — the peak speed recorded being 111 km/hr. Mull and Rao (1950) have shown that such instances are a dynamical possibility.

Temperature changes — As in case of pressure, temperature data are available only for 85 out of 87 occasions of squall during the period of study. Table 5 gives the frequencies of the fall of dry bulb temperature of different order of magnitude associated with the occurrence of squalls in different months, together with their percentages within brackets. It will be seen that (*i*) 48 per cent of the squalls, taking the year as a whole, are associated with a fall of temperature of more than 6°C, (*ii*) 80 per cent of the squalls occurring in May are associated with temperature fall of more than 8°C. On a study of the data, it is also revealed that, in general, the greater the peak speed of the squall the greater is the temperature fall. The maximum fall of temperature of 18°C was recorded in association with a severe squall with peak speed of 130 km/hr on 13 May 1963.

Direction of squalls — Direction of squall has been taken as the direction corresponding to the peak speed of the squall. Table 6 gives the actual number as well as percentage frequencies, in brackets, of squalls occurring from different directions in eight points of compass. It will be seen that (*i*) 75 per cent of the squalls in March and 66 per cent of the squalls in April are from the directions S to W through SW, (*ii*) Squalls of May do not favour any particular direction, (*iii*) 74 per cent of the squalls in June are from N to S through east, (*iv*) 61 per cent of the squalls occurring in July and 64 per cent of the squalls occurring in August are from the direction S to NW through west, (*v*) 63 per cent of the squalls occurring in September are from the direction N to SE through east, (*vi*) During October 50 per cent of the squalls are from a northerly direction and 50 per cent from a southeasterly direction, (*vii*) During November 50 per cent of the squalls are from a northeasterly direction and 50 per cent from a westerly direction.

With a view to correlate the direction of the squalls with the direction of the upper winds, the upper wind data of Ahmedabad for the period 1957 to 1963* have been examined. During the period 1957 to 1963 there were 62 occasions of squalls. Out of these 62 occasions, 54 squalls which have occurred after 0530 IST have been examined in relation to 0530 IST upper wind data of the day of occurrence of squall. Out of 54 occasions, data for 3

*Upper wind data for the years 1954 to 1957 were not readily available to the authors and so these years have not been included for this study

TABLE 5

Temperature falls in squalls

	Temperature range (°C)						Largest fall (°C)	Total No. of squalls
	1·0 or less	1·1—2·0	2·1—4·0	4·1—6·0	6·1—8·0	>8·0		
	Number (Percentage)							
Mar	2 (51)	—	—	—	2 (50)	—	7	4
Apr	1 (33)	—	—	—	—	2 (66)	11	3
May	—	—	1 (20)	—	—	4 (80)	18	5
Jun	—	3 (10)	6 (19)	—	9 (29)	13 (42)	14·5	31
Jul	2 (12)	3 (19)	4 (25)	3 (19)	2 (12)	2 (12)	8·5	16
Aug	—	1 (7)	7 (50)	4 (28)	2 (14)	—	7	14
Sep	1 (13)	3 (37)	—	2 (25)	—	2 (25)	12	8
Oct	—	—	1 (50)	—	—	1 (50)	11·2	2
Nov	—	—	—	—	2 (100)	—	7·7	2
Total for the year	6 (7)	10 (12)	19 (22)	9 (11)	17 (20)	24 (28)		85

TABLE 6

Direction of squalls

	N	NE	E	SE	S	SW	W	NW	Total
	Number (Percentage)								
Mar	—	—	—	1 (25)	1 (25)	2 (50)	—	—	4
Apr	1 (33)	—	—	—	—	1 (33)	1 (33)	—	3
May	—	1 (20)	—	1 (20)	1 (20)	1 (20)	—	1 (20)	5
Jun	5 (16)	4 (13)	8 (26)	2 (6)	4 (13)	2 (6)	—	6 (19)	31
Jul	2 (11)	3 (17)	1 (5)	1 (5)	3 (17)	4 (22)	3 (17)	1 (5)	18
Aug	3 (21)	1 (7)	1 (7)	—	—	5 (36)	1 (7)	3 (21)	14
Sep	3 (37)	—	1 (13)	1 (13)	—	1 (13)	—	2 (25)	8
Oct	1 (50)	—	—	1 (50)	—	—	—	—	2
Nov	—	1 (50)	—	—	—	—	1 (50)	—	2
Total for the year	15 (17)	10 (11)	11 (13)	7 (8)	9 (10)	16 (18)	6 (7)	13 (15)	87

or 2·1-km level were available for 35 occasions only. (For 30 occasions data for 3-km level, and for five occasions data for 2·1-km level have been utilised as data for 3-km were not available). The remaining 19 occasions could not be studied as the upper wind data even for 2·1-km level were not available. It has been noticed that out of 35 squalls, on 26 occasions (74 per cent) the direction of the squall was either same as the direction of the upper wind at 3 km/2·1km or it differed only by one point of compass (considering 8 points of compass in all) and for remaining nine occasions (26 per cent) it differed by two points of compass or more.

Other features — There were occasions during the period of study when squalls were recorded twice on the same day with peak speed of comparable magnitude in most cases. In eight of the above cases, the direction of both squalls was same or differed by 45° only, whereas in the remaining two cases the direction of squalls differed by 90°.

4. Conclusion

The above study brings out the following important features about surface squalls occurring at Ahmedabad airfield — (*i*) Highest frequency of squalls is in the month of June, (*ii*) The period 0900 to 1200 IST is completely free from squalls. Maximum frequency of squalls is during the period 1500 to 1800 IST, (*iii*) Most severe squalls associated with heat thunderstorms occur in May, 80 per cent of them reaching a peak speed of 75 km/hr or more, (*iv*) The peak speed reached in squalls is not significantly dependent on the pressure changes, (*v*) The higher the peak speed of squall, the higher is the fall of temperature in association with the squall. Maximum fall of temperature in association with squalls occurs in May and (*vi*) On most cases the direction of squalls corresponds reasonably well with the direction of upper wind between 2·1 and 3-km level prior to the occurrence of squalls.

REFERENCE

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