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Squalls at Cochin

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1. Introduction

Cochin (lat. 09° 57′N, long. 76° 16′E) is an important aerodrome, and one where adverse flying weather is more frequent than at many other aerodromes (Ramakrishnan and Ramakrishnan—see reference). Features of the ground wind there, particularly (*i*) about winds exceeding some 15 mph or so and (*ii*) squalls based on anemograph records are, therefore, of considerable utility. A Dines' anemograph has been installed at the aerodrome meteorological office (under Indian Navy) in January 1956. It will be a few years before enough records from this anemograph accumulate.

A Dines' anemograph (recording both direction and velocity) has, however, been maintained by the Cochin Port Trust at the Port Office, Willingdon Island, about 2 miles from the aerodrome from 1939. The height of the anemometer head above ground was 42 feet. It was, therefore, thought desirable to study the charts of this with a view to get as much information as possible about surface winds at Cochin. The anemograms were kindly placed at the author's disposal by the Chief Engineer of the Port Trust. The squalls that occurred at Cochin, as revealed by the anemograms, are studied in this paper. An analysis and discussion of the general features of the ground wind at the station will form the subject matter of another paper.

2. The data

The anemograms for the ten-year period, 1943-1952, were examined and particulars of all squalls that occurred were tabulated. These formed the basis for the present study. It may be mentioned here that no other autographic meteorological instrument, like barograph or thermograph, functioned at the same site; and therefore, no information about the pressure or temperature changes that attended the squalls is available.

3. Frequency of occurrence

The numbers of days on which at least one squall occurred, in each month, in each of the ten years and the mean per year, are given in Table 1.

It will be seen that, on the average, squalls occur on some 46 days each year, 32 of which are in the southwest monsoon months June, July and August. The largest number of squally days, 14, occur in June. It may be mentioned here that June is also the month having the largest number of days, 15, with adverse flying weather conditions *vide* Table 2 (Ramakrishnan and Ramakrishnan—see reference).

From an examination of individual days in some of the years, it is seen that in pre-monsoon months, March, April and May, a very high percentage of the squalls are associated with thunderstorms; whereas in June and later months, only a very few of them are so associated.

It was a striking feature of Cochin that several distinct squalls occurred on many of the above days (Ramakrishnan and Gopinatha Rao 1954). The numbers of squalls which occurred in each month in each of the ten years, as well as the mean per year, are given in Table 3.

In the 46 days in the year on which squalls occur, there were on the average 71 squalls. In the 14 squally days of June, there occurred about 24 squalls. There have been instances (23 August 1946 and 14 August 1952) when as many as seven distinct squalls occurred on a single day.

TABLE 1

Number of days with squall at Cochin

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1943	1	1		3	9	20	14	3	7	1	1		60
1944			2	1	6	12	11	3	1	1	1		38
1945				1	1	11	14	10	4	1			42
1946			3	5	3	17	13	19	5	4		2	71
1947		1		3	1	12	9	15	5				46
1948			1	4	2	15	8	8	2	2	2	1	45
1949				2	10	11	6	7	7	1	1		45
1950					5	12	12	5	6	1	2		43
1951			2		2	20	9	3	2	5			43
1952				2	6	9	4	5		1			27
Mean per year	0·1	0·2	0·8	2·1	4·5	13·9	10·0	7·8	3·9	1·7	0·7	0·3	46·0

TABLE 2

Frequency of days in each month with at least a part under M 5 conditions at Cochin

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	6	12	12	15	11	7	4	8	4	2

TABLE 3

Number of squalls at Cochin

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1943	1	1		3	14	31	37	4	11	1	1		104
1944			2	1	6	17	20	5	1	1	1		54
1945				1	1	16	25	16	4	1			64
1946			3	6	3	36	23	27	5	4		2	109
1947		1		3	1	24	10	25	5				69
1948			1	4	3	23	9	10	2	2	2	1	57
1949				2	14	17	10	10	7	2	1		63
1950			1		5	26	21	7	15	1	2		78
1951			2		2	40	13	3	3	6			69
1952				2	7	13	5	13		1			41
Mean per year	0·1	0·2	0·9	2·2	5·6	24·3	17·3	12·0	5·3	1·9	0·7	0·3	70·8

TABLE 4

Distribution of squalls at Cochin according to time of commencement, hour by hour

	Jun to Sep	Oct to May	Year
0001 to 0100	19	4	23
0101 to 0200	28	4	32
0201 to 0300	32	4	36
0301 to 0400	14	2	16
0401 to 0500	18	2	20
0501 to 0600	20		20
0601 to 0700	9	3	12
0701 to 0800	17	3	20
0801 to 0900	17		17
0901 to 1000	16		16
1001 to 1100	24	3	27
1101 to 1200	21	2	23
1201 to 1300	29	5	34
1301 to 1400	32	3	35
1401 to 1500	33	5	38
1501 to 1600	37	7	44
1601 to 1700	35	10	45
1701 to 1800	24	16	40
1801 to 1900	26	12	38
1901 to 2000	39	12	51
2001 to 2100	30	11	41
2101 to 2200	22	7	29
2201 to 2300	19	2	21
2301 to 2400	24	7	31

TABLE 6

Distribution of squalls at Cochin according to duration (1943-1952)

(hr)	Jun to Sep	Oct to May	Year
$\frac{1}{4}$	80	13	93
	(13)	(12)	(13)
$\frac{1}{4} - \frac{1}{2}$	107	31	138
	(18)	(28)	(19)
$\frac{1}{2} - \frac{3}{4}$	105	16	121
	(17)	(15)	(17)
$\frac{3}{4} - 1$	84	13	97
	(14)	(12)	(14)
$1 - 1\frac{1}{4}$	55	7	62
	(9)	(6)	(9)
$1\frac{1}{4} - 1\frac{1}{2}$	41	8	49
	(7)	(7)	(7)
$1\frac{1}{2} - 1\frac{3}{4}$	32	3	35
	(5)	(3)	(5)
$1\frac{3}{4} - 2$	23	4	27
	(4)	(4)	(4)
$2 - 2\frac{1}{2}$	34	4	38
	(6)	(4)	(5)
$2\frac{1}{2} - 3$	14	5	19
	(2)	(5)	(3)
$3 - 3\frac{1}{2}$	5	1	6
	(1)	(1)	(1)
$3\frac{1}{2} - 4$	8		8
	(1)		(1)
>4	14	4	18
	(2)	(4)	(3)
Total	602	109	711

The figures in brackets are percentages of total of season or year

TABLE 5

Distribution of squalls at Cochin according to time of commencement in three-hour intervals

	0001 to 0300	0301 to 0600	0601 to 0900	0901 to 1200	1201 to 1500	1501 to 1800	1801 to 2100	2101 to 2400	Total
June to September	79	52	43	61	94	96	95	65	585
	(13)	(9)	(7)	(11)	(16)	(16)	(16)	(11)	
October to May	12	4	6	5	13	33	35	16	124
	(10)	(3)	(5)	(4)	(11)	(27)	(28)	(13)	
Year	91	56	49	66	107	129	130	81	709
	(13)	(8)	(7)	(9)	(15)	(18)	(18)	(11)	

The figures in brackets are percentages of the total in the season or year

4. Usual times of occurrence

The distribution of the squalls according to time of commencement, in two seasons, *viz.*, June—September and October—May, and the whole year, is shown, hour by hour in Table 4 and in three-hour intervals in Table 5.

One sees that 48 per cent of squalls occur in the nine hours from 1201 to 2100 IST in the season June to September; in the season October to May, 55 per cent occur in the six hours 1501 to 2100 IST. Thus the time of occurrence lies in a narrower band in the season October—May. The period with minimum squalls is 0601—0900 IST in June—September and 0301—0600 IST in October—May.

5. Duration of squalls

The distribution according to duration, in steps of quarter hour upto 2 hours, in half-hour steps from 2 to 4 hours and in a single group when more than 4 hours, is shown in Table 6.

About 60 to 65 per cent of squalls exhaust themselves within an hour of start. In the matter of duration, there is no striking difference between squalls in the two seasons.

6. Maximum speed

The distribution according to maximum gust speed is shown in Table 7.

It will be seen that 85 per cent of squalls attain a maximum speed of less than 40 mph and that the number falls off steeply with increasing speed. Though Cochin gets more squalls than most other stations in the country, destructive ones are much less common there. In the ten-year period studied in this paper there has been no instance when speed reached 60 mph*. It is interesting that of the various stations, squalls of which have been studied by the author (Ramakrishnan and Gopinatha Rao 1954), Bombay and Kodaikanal share this feature with Cochin.

TABLE 7

Distribution of squalls according to maximum gust speed at Cochin

	30–39 (mph)	40–49 (mph)	50–59 (mph)	60 mph or more	Total
Jun to Sep	511 (86)	71 (12)	10 (2)	..	592
Oct to May	98 (81)	18 (15)	5 (4)	..	121
Year	609 (85)	89 (12)	15 (2)	..	713

The figures in brackets are percentages of total of season

7. Direction of squalls

The numbers of squalls which came from different directions and the association of squalls from different directions with the wind directions before the squalls are shown in the form of correlation tables in Tables 8 and 9.

Table 8 relates to squalls of the season June–September and Table 9 to those of the season October–May. In the former season, squalls are practically absent from the semi-circle to the right of the north-south line. The quadrant from west to northnorthwest takes 424 out of the total of 584 squalls (or 73 per cent) of the season. In arranging protection from squalls, therefore, particular attention should be paid to this quadrant.

In the latter season, the scatter is too wide for any useful inference to be drawn. Squalls may come from any direction in this season.

8. Typical squalls

Portions of anemograms of a few typical squalls are reproduced in Figs. 1–8.

*It may be mentioned here that the wind speed did touch the 70 mph mark in a gust in a 6-hour stretch of steadily rising wind, in association with a severe cyclonic storm in the Arabian Sea on 26 May 1941

TABLE 8
Direction of squalls at Cochin (1943-52)
(June to September)

Direction before squall	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Var.
N														2	3	6	2
NNE	1	1												1	4	3	2
NE											1	1		3	3	1	4
ENE	2																2
E	2														3	2	2
ESE	1										1	1	4	4	1		1
SE											1	1		2	4	1	4
SSE												3		2			2
S										1	1	3		3	1		
SSW										1	2	2	4	1	1	1	2
SW											3	2	9	5	5	3	11
WSW		1									2	2	11	14	9	2	9
W	1											2	9	15	21	6	9
WNW	4											1	10	41	37	33	11
NW	2												7	15	17	10	17
NNW													2	7	10	3	6
Var.	1										1		2	8	8	3	12
Calm	3											4	7	12	14	9	9
Total	17	2								2	12	22	65	135	141	83	105

TABLE 9
Direction of squalls at Cochin (1943-52)
(October to May)

Direction before squall	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Var.
N																	
NNE																	
NE														1		1	1
ENE																	
E																	
ESE										1							
SE											1						2
SSE										3	1						
S											1						
SSW							1					2	1		1		
SW						1	1				1		2	1		1	7
WSW	1	1	2						1		1		2		1		3
W			1			3	1		1			1	1	2	2		9
WNW			2		1			1	1				2	2	2	2	8
NW		1		1	3		2			2			1	2	2	2	5
NNW																	2
Var.	1				1							1				1	5
Calm								1									
Total	2	2	5	1	5	4	5	2	2	6	5	4	9	8	8	7	42

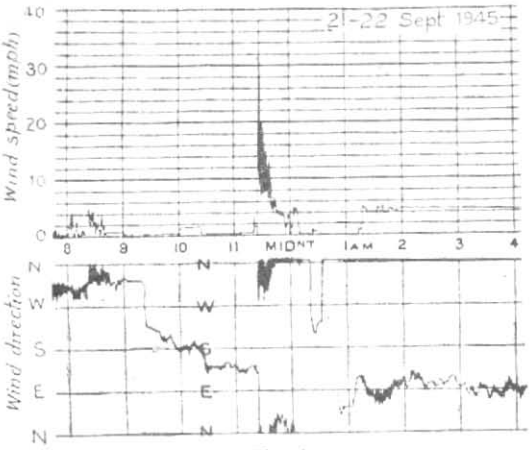

Fig. 1

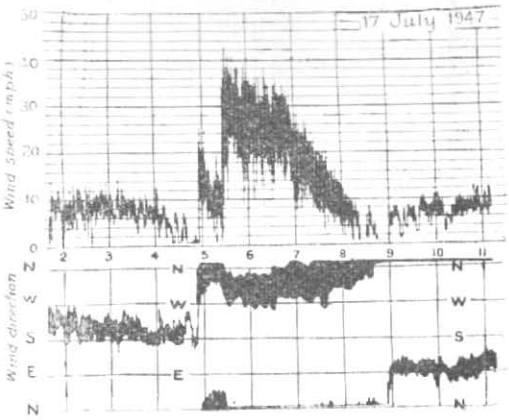

Fig. 2

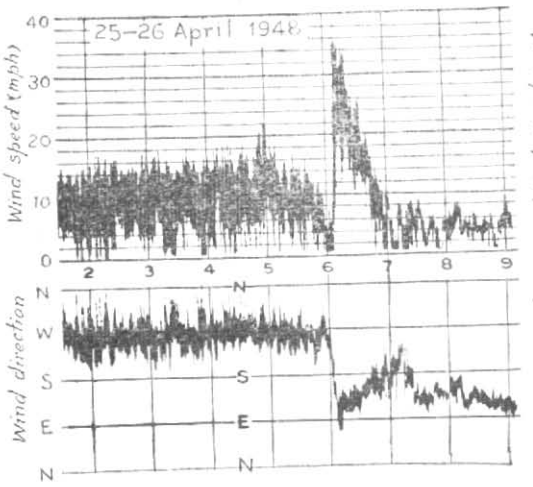

Fig. 3

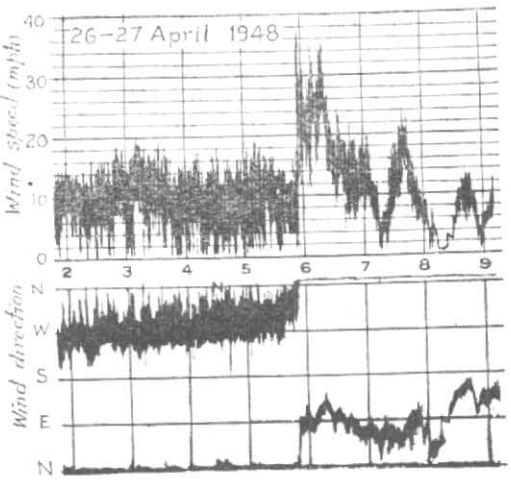

Fig. 4

9. Acknowledgement

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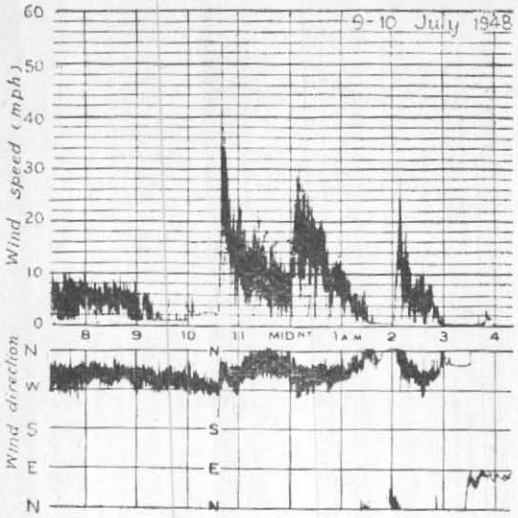

Fig. 5

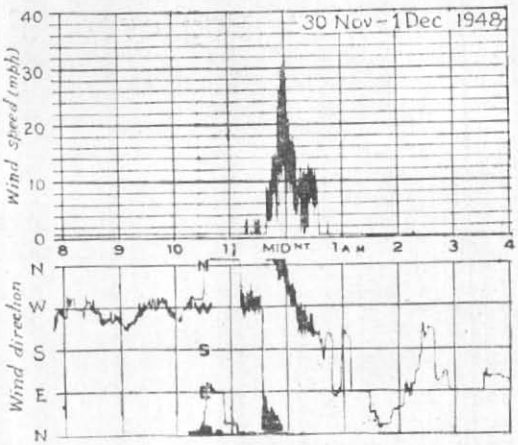

Fig. 6

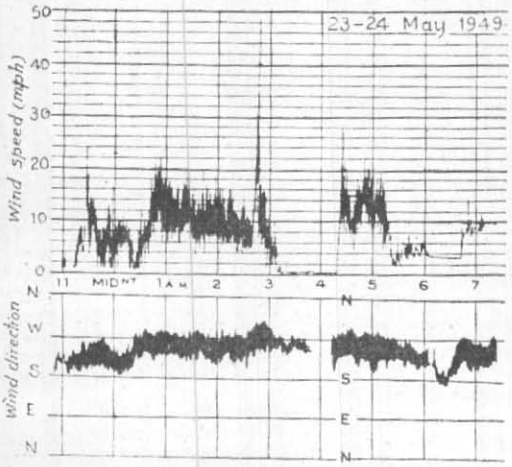

Fig. 7

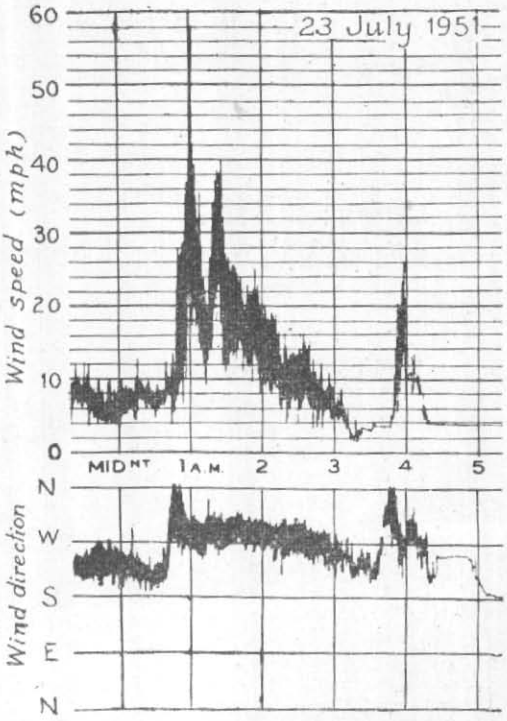

Fig. 8

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