Indian J. Met. Hydrol. Geophys. (1976), **27**, 1, 15-22

551.58 (213)

A study of the climatology of the equatorial region between 10°N and 10°S and 40°E to 115°E*

C. V. V. S. RAO

Meteorological Office, Bombay Airport, Bombay

(*Received 23 September 1970*)

ABSTRACT. A detailed examination of the INOSHAC charts during the period 1967-1969 has been made to derive monthly mean climatic conditions in the equatorial region between 10°N-10°S and 40°E-115°E based mainly on ships' observations. The parameters examined are wind, cloudiness and weather.

1. Introduction

The South Indian Ocean area is vast and relatively data are sparse and so location of storms and depressions in the equatorial trough was difficult earlier, but recently the satellite pictures helped in locating the storms and depressions somewhat accurately. Gray (1969) indicates that satellite information shows that the majority of the location of initial disturbances in the Northwest Atlantic (where data have been especially scarce) should be relocated in the Cape Verde island or over West Central Africa. Asnani (1968) made some theoretical study regarding equatorial clouding wherein he gives an equatorial cell separating the classical two Hadley cells from each other. In this cell the air approaching the equator in the lower layers and receding from it aloft suffers subsidence. This is, perhaps, the cause of lack of cloudiness observed at the equator in the oceans (Fletcher 1945 and Rossby 1949). In this paper an attempt is made to give certain climatological features in the near equatorial region between Long. 40°E and 110°E and Lat. 10°N and 10°S. The author made use of the Indian Ocean and Southern Hemispheric Analysis Centre (INOSHAC) charts for the period 1967-1969, the automatic picture transmission (APT) picutres for the period October 1966 to November 1969 and also a few publications of the Meteorological Service of Re-Union Islands.

2. Storms and Depressions

In Fig. 1 the tracks of the storms and depressions of the southern hemisphere in the Indian Ocean are represented for the storm season 1965-66 and 1966-67 wherein no APT picture data are used. It would appear from this, that east of 75°E in the equatorial region very little development takes place.

In Fig. 2 the tracks of storms and depressions for the storm season 1967-68 and 1968-69 are represented in which APT pictures data also are used. It shows more number of disturbances have their origin east of 75°E. The development area of southern hemisphere disturbances as revealed by satellite pictures seems to be slightly east of position known earlier.

3. Cloudiness

The extent of clouding over the equator and adjoining regions is also examined. In the cloud pictures, extensive clouding is seen on many days over the equator, but there are many other days when the equator has been completely free from the clouding. Sadler (1968) has prepared mean monthly charts over equator and adjoining regions and his results show considerable clouding over equator during certain months. Recent studies of Rao and Raghavendra (1969) show the clouding over equatorial region is not different from the adjoining regions. The satellite pictures available in INOSHAC have been examined for clouding in this region from 60°E to 100°E and 5°N to 5°S. 5°-squares have been taken and for each day numbers from 8 to 1 are assigned as indices for clouding. 8 represents cloudiness of 75 per cent or more of this area and 1 represents practically no clouding over this region. It may be mentioned here that there was no day on which the entire region was completely covered with clouds without gaps. The daily pictures from October 1966 to November 1969, have been examined.

*Paper presented at the Scientific Session of the Forecasting Officers' Conference, 1969 held at Poona.

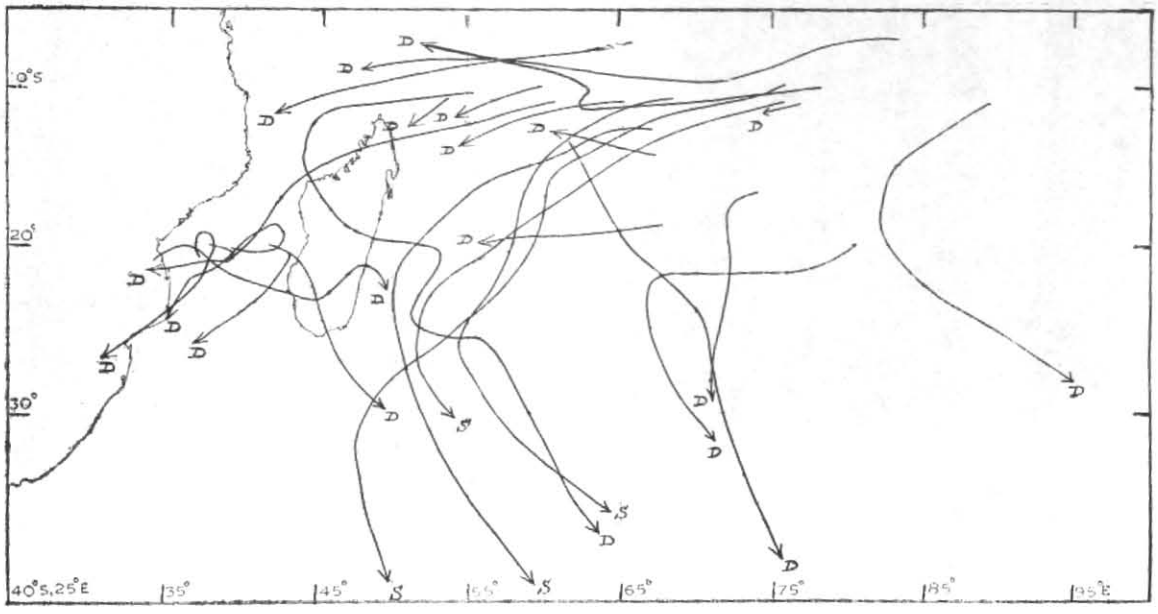


Fig. 1. Tracks of the storms (S) and depressions (D) during 1965-1967 (without APT data)

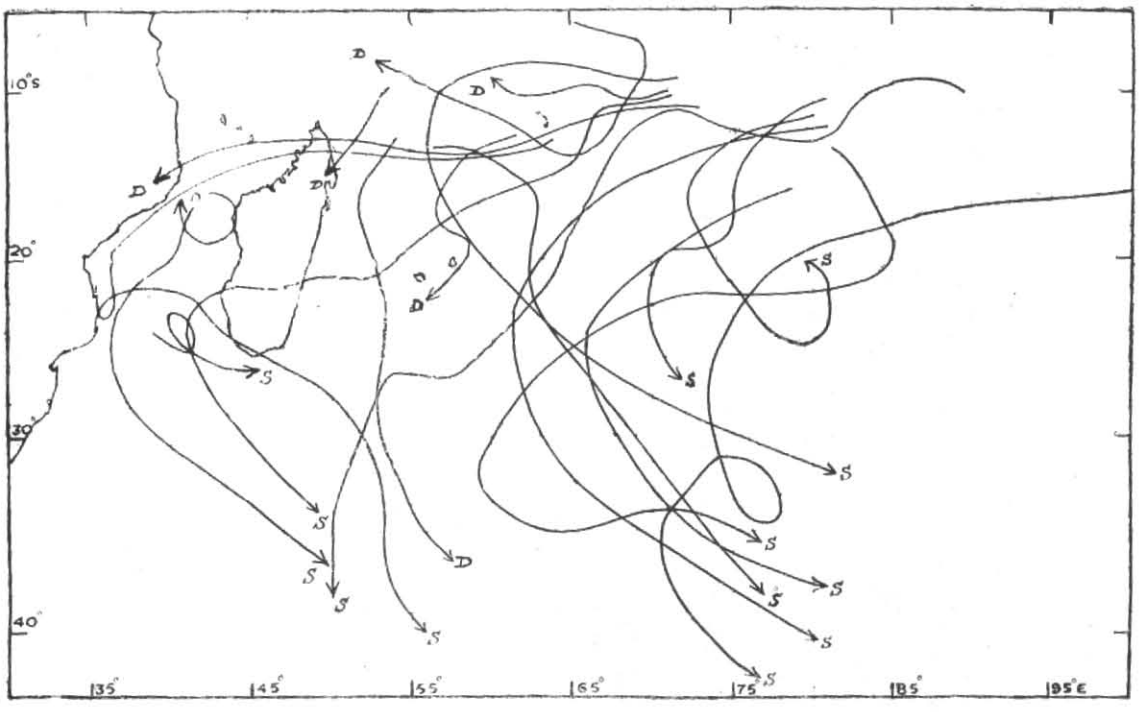


Fig. 2. Tracks of the storms (S) and depressions (D) during 1967-1969 (with APT data)

Table 1 shows that there is more clouding between September and January than February and August. It is seen that in most of the months the number of days of the clouding, under assinged No. 4, was the highest. In order to see how the number of days of heavy clouding and little clouding varied from month to month, we added cases of 8 and 6 for each month as representing heavy clouding and 1 and 2 representing little clouding and plotted them on a graph (Fig. 3). The graph shows some interesting results. There is a strong variation from year to year, for example, in 1967 the number of cloudy days over the equator was considerable throughout when compared to other years except in the months of March and April, particularly in the months of June and July in 1967. Though the low pressure area south of Gan Islands is a seasonal feature throughout the year, during this period in 1967 it was active. The year 1969 on the other hand shows minimum clouding over the equator during most of the months. From this we cannot conclude anything else except that there is a general increase in clouding over equator during the period September to January.

Table 2 gives the region of clouding with respect to the trough axis in March, April and May on certain days when the southern hemisphere trough had well marked low pressure areas on the surface charts. The table shows that clouding occurs predominantly north of the trough axis in March and April while in May the clouding has occurred on both sides of the trough axis in 50 per cent of the cases. In southern hemisphere the mean charts show a quasipermanent low west of Sumatra near about 9°S and 95°E from October to April and another one south of Gan Islands throughout the year and another over NE of Madagascar from September to April. From the examination of the APT pictures the clouding is observed in most of the days from 90°E to 100°E and from 60°E to 70°E over the equator which shows there is a preferential region for the clouding.

4. Ships' data

All the ships' observations in the region under study, available in INOSHAC charts during the year 1968-1969 are also examined. From these observations statistics of weather, clouding and wind in various sections of 5° square have been derived, the total number of ships' observations examined being about 10000. Only 4 charts representing the conditions of 4 typical months, *viz.*, April, July and October of 1968 and January 1969 are given (in Tables 3 to 6). The bold figures indicate actual number of observations in

TABLE 1

Clouding between 5°N to 5°S and 60°E to 110°E

	Year	Number assigned					
		8	6	4	2	1	Free
Jan	1967	1	11	13	6	..	..
	1968	..	4	13	10	4	..
	1969	..	..	11	17	3	..
Feb	1967	1	7	17	3	..	..
	1968	..	1	4	17	7	..
	1969	..	..	..	6	22	..
Mar	1967	..	1	10	17	3	..
	1968	2	10	16	..	3	..
	1969	..	..	..	11	20	..
Apr	1967	..	2	11	14	3	..
	1968	..	..	2	18	10	..
	1969	..	..	..	14	16	..
May	1967	1	7	14	9	..	..
	1968	..	1	7	20	3	..
	1969	..	..	..	14	17	..
Jun	1967	..	11	12	7	..	..
	1968	..	3	7	6	14	..
	1969	..	..	..	14	16	..
Jul	1967	5	7	10	9	..	..
	1968	..	..	12	16	3	..
	1969	..	..	..	9	22	..
Aug	1967	..	8	16	7	..	..
	1968	..	..	1	23	7	..
	1969	..	2	7	16	6	..
Sep	1967	1	6	13	9	1	..
	1968	..	3	13	6	8	..
	1969	..	..	4	22	4	..
Oct	1966	..	10	17	4	..	..
	1967	2	12	15	2	..	..
	1968	..	4	10	16	1	
	1969	1	1	15	9	5	..
Nov	1966	1	15	13	1	..	..
	1967	2	12	14	2	..	..
	1968	..	2	6	14	8	..
	1969	..	3	9	14	4	..
Dec	1966	..	7	14	9	1	..
	1967	..	11	16	4	..	..
	1968	2	7	4	14	4	..
	1969						

TABLE 2

Frequency of southern hemisphere clouding with respect to trough axis

	March	April	May
Days examined	15	12	16
North of the trough axis	12	8	7
South of the trough axis	..	..	1
Both sides of the trough axis	3	4	8

TABLE 3

Statistics of different weather phenomena in various Sections of 5° square during January 1969

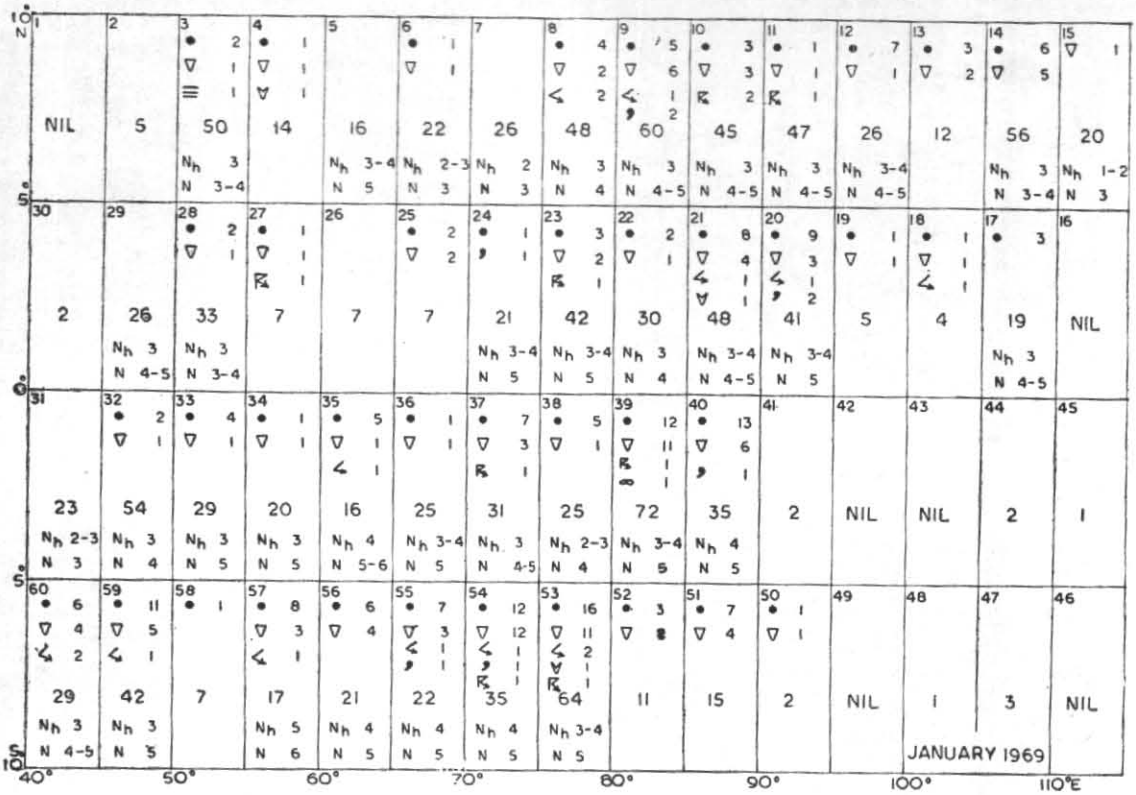


TABLE 4

April 1968

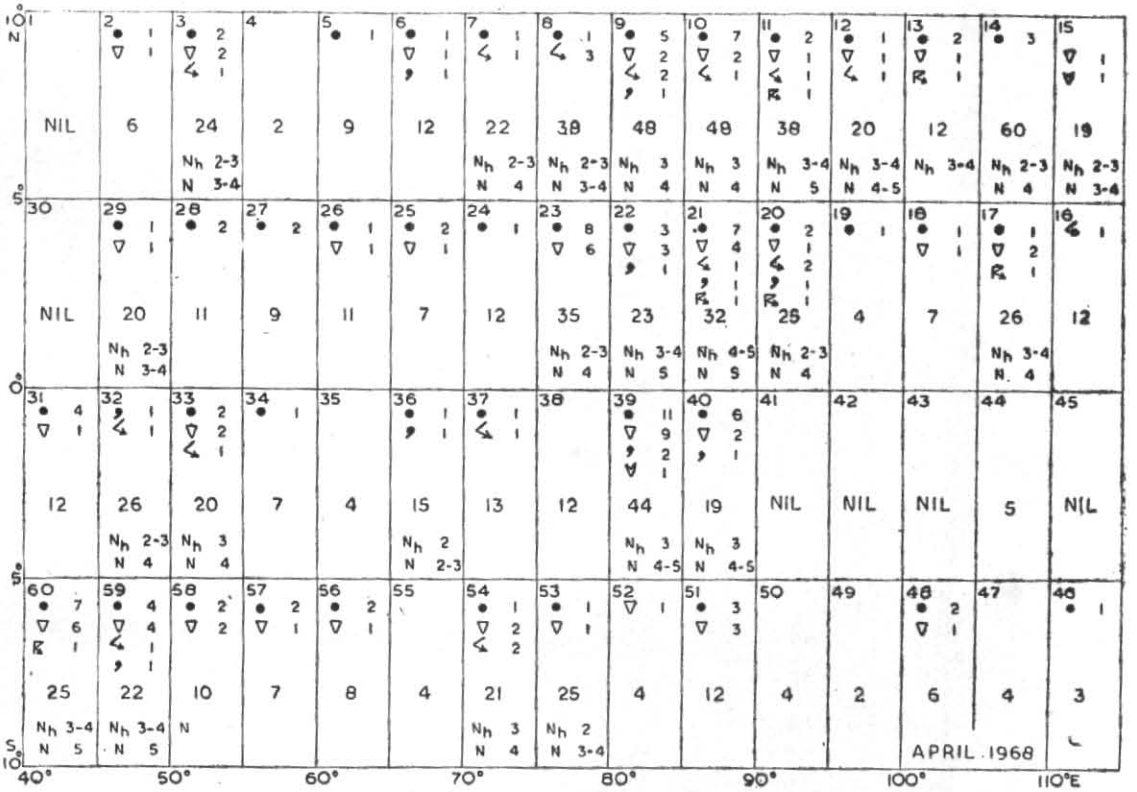


TABLE 5

Statistics of different weather phenomena in various sections of 5° square during July 1968

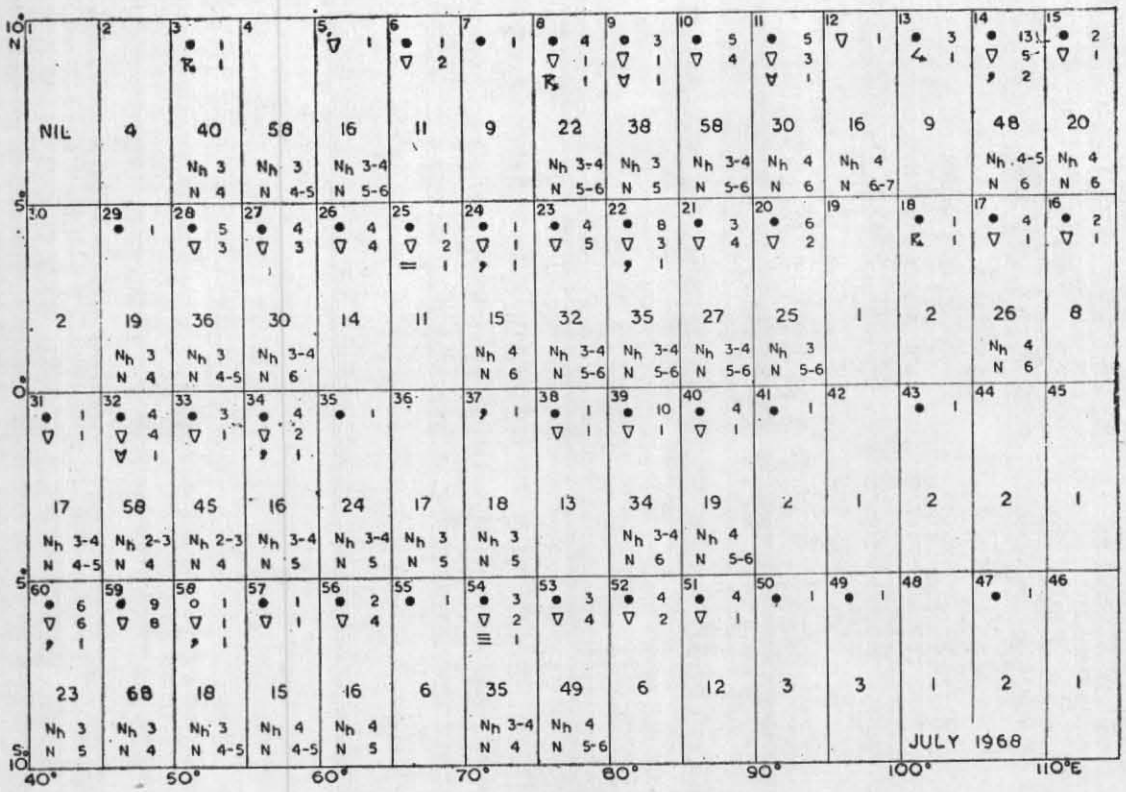
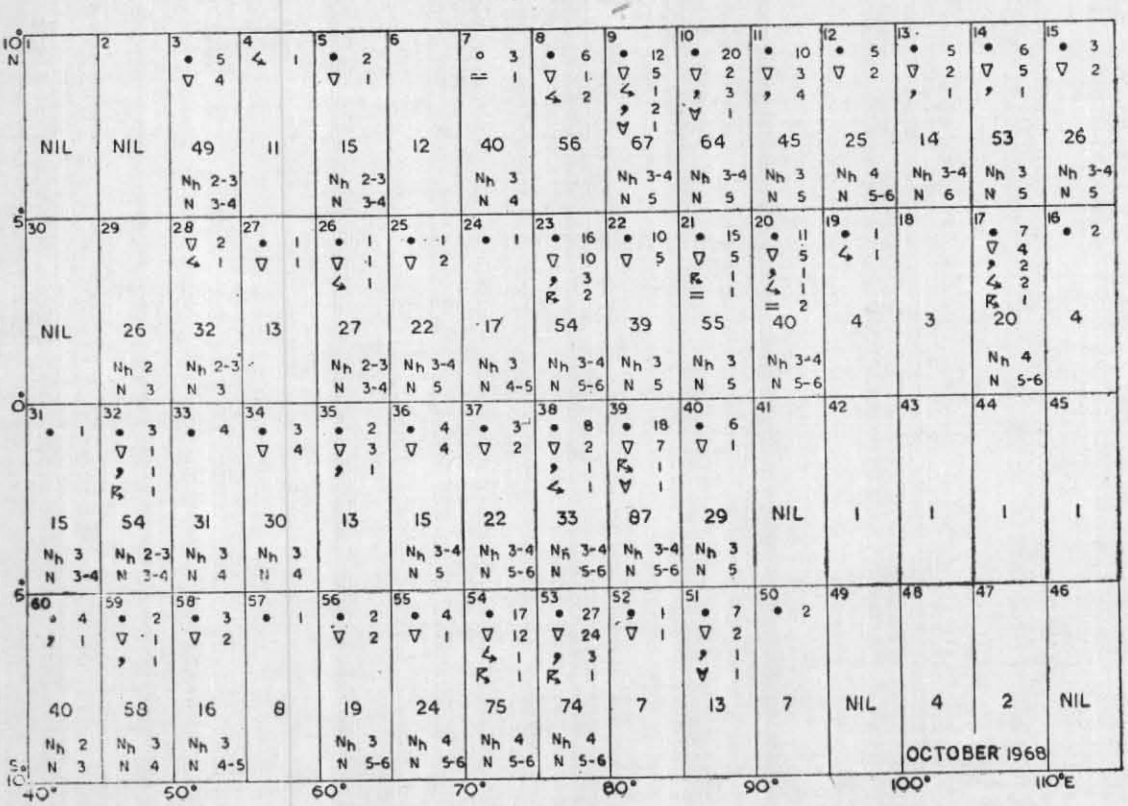


TABLE 6

October 1968



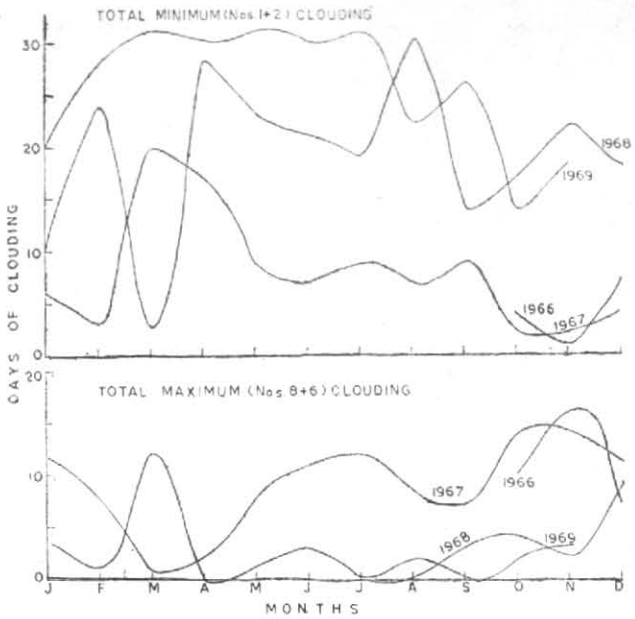


Fig. 3. Cloudiness in different months

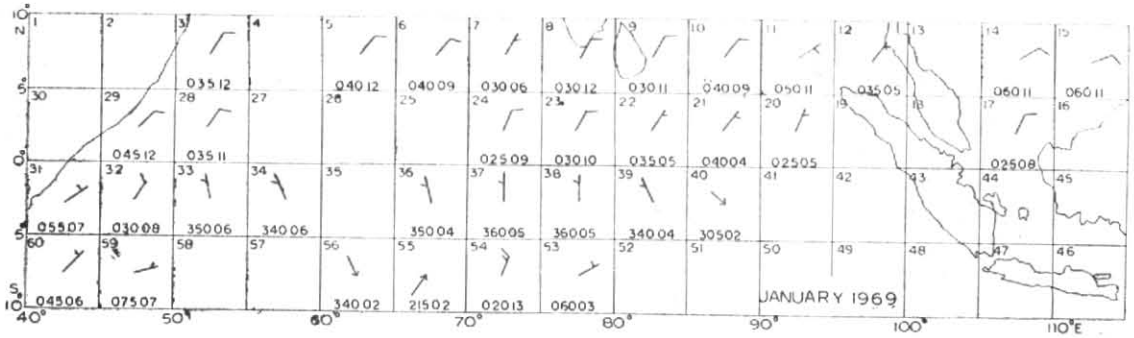


Fig. 4. Mean wind field from Ships' data — January 1969

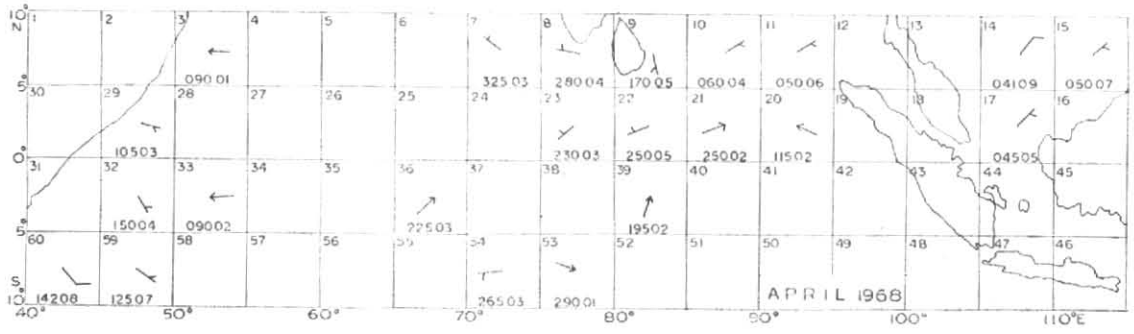


Fig. 5. Mean wind field from ships' data — April 1968

each box. Actual number of observations of rain, thunderstorm, shower and lightning has been put. For the boxes where the observations are more than 15, the mean cloud amount and mean wind have been derived. From the Tables 3 to 6 it will be seen that there is a wide variation of ships' observations in the various boxes but conclusions may be drawn by considering the percentage number of occasions, when rain, showers, or thunderstorms were reported (Table 7). It shows that the region between 5°S and 10°S and 45°E to 90° E in January 1969 shows more than 40 percentage of occasions of such phenomena. Fig. 4 gives the mean wind field. In the northern hemisphere such a region of greater frequency than the neighbourhood is not clearly seen just north of

TABLE 7

Percentage frequencies of rain, shower and thunderstorm (put together) in various boxes shown in Table 3 to 6

Box No.	January	April	July	October	Box No.	January	April	July	October
1	..	..	..	..	31	..	25	12	7
2	..	33	..	..	32	6	4	14	11
3	6	16	5	18	33	17	20	9	13
4	14	..	..	..	34	10	14	44	23
5	..	11	6	20	35	36	..	4	48
6	9	25	27	..	36	8	14	..	53
7	..	9	11	10	37	35	8	6	23
8	13	6	27	13	38	25	..	15	33
9	20	17	11	28	39	33	50	33	33
10	16	18	24	40	40	60	49	26	25
11	7	10	27	38	41	..	..	50	..
12	32	10	6	28	42	..	..	..	..
13	40	33	33	57	43	..	..	50	..
14	20	5	42	23	44	..	..	..	..
15	5	5	15	19	45	..	..	..	..
16	..	..	40	50	46	..	33	..	..
17	5	11	20	60	47	..	..	50	..
18	50	30	100	..	48	..	50	..	..
19	40	25	..	25	49	..	..	33	..
20	33	20	33	43	50	100	..	33	31
21	27	40	25	38	51	77	50	40	80
22	10	30	33	38	52	451	25	100	30
23	14	40	28	58	53	43	8	14	71
24	10	9	20	6	54	77	14	14	40
25	56	40	27	14	55	50	..	17	21
26	..	19	57	8	56	48	40	38	31
27	42	22	23	15	57	66	40	13	13
28	9	18	45	6	58	14	40	17	30
29	..	10	6	..	59	40	40	25	7
30	..	..	..	..	60	34	56	60	13

the equatorial trough between 85°E and 105°E. Incidently this is the region where a wind trough is seen in the mean. In Table 4 for the month of April 1968 the number of ships observations are comparatively less but the percentage number of occasions when rain or showers was reported is more on either side of the equator, between the longitude belt 80 to 85°E. Fig. 5 gives the mean wind field.

Table 5 gives the number of ships' observations for the month of July 1968 which are fairly good except in a very few sections, but the percentage number of occasions when rain or showers occurred was more than 40 percentage only in very few boxes here and there. The wind field of south-southeasterlies after crossing equator becoming southwesterlies in the northern hemisphere which is a well known fact, is seen in the mean picture at Fig. 6.

Table 6 gives for the month of October when the number of ships' observations is quite satisfactory but only few boxes show clouding on more than 40 per cent of the occasions. When the wind field is examined (Fig. 7), the clouding is in the region where the wind trough in the southern hemisphere is identifiable.

5. Conclusions

The author could not complete all the aspects planned for this study because of the involvement of physical labour in going through many charts. Also, some aspects of the quasi-stationary lows

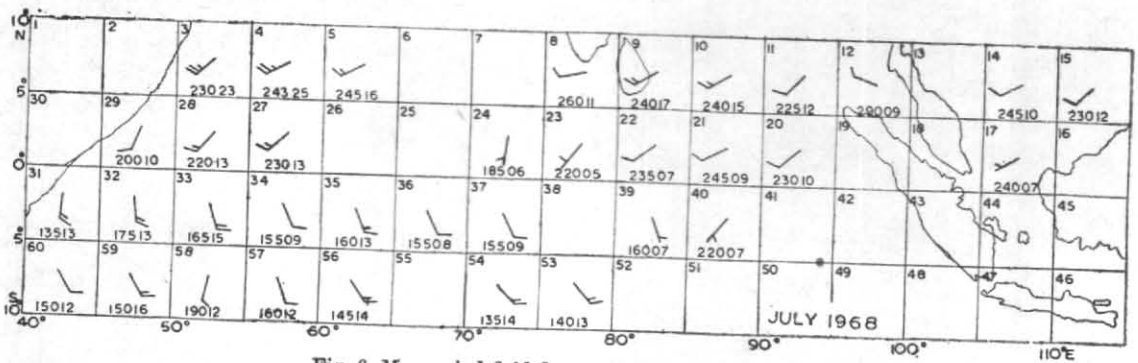


Fig. 6. Mean wind field from ships' data — July 1968

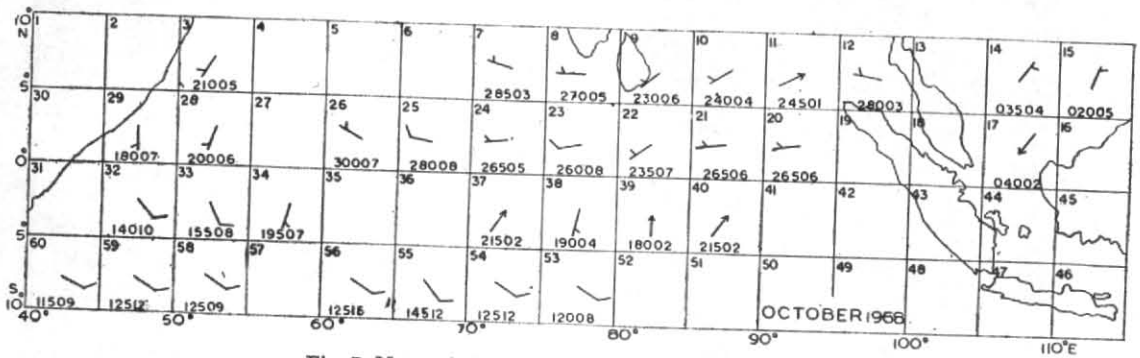


Fig. 7. Mean wind field from ships' data — October 1968

in the southern hemisphere require examination; the ships' observations of clouding and the APT pictures data for every day are to be compared and then only we can have further light on the equatorial clouding. The relation between the activity in the southern hemisphere trough and northern hemisphere trough during the months when they are near the equator requires examination.

Acknowledgements

I wish to thank Dr. A.S. Ramanathan, Meteorologist, INOSHAC, for his encouragement during this study.

REFERENCES

Asnani, G. C. 1968 *J. atmos. Sci.*, **25**, pp. 133-134.

Fletcher, R. D. 1945 *J. Met.*, **2**, pp. 167-174.

Gray William, M. 1969 *Mon. Weath. Rev.*, **96**, 10.

Rao, Y.P. and Raghavendra, V. K. 1969 Variation of pressure, wind, cloudiness and rainfall across equator in the Indian Ocean, Symp. Indian Ocean, 1011-1014.

Rossby, C. G. 1949 'On the nature of general circulation of the lower atmosphere', *Atmospheres of the earth and planets*, Univ. Chicago Press, pp. 16-48.

Sadler, J. C. 1968 Average cloudiness in the tropics from satellite observations, IIOE Met. Monograph, 2.