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Letters to the Editor

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A CLIMATOLOGICAL STUDY OF THE HEIGHTS OF RADAR CLOUD TOPS

Several studies have been made on the heights of radar cloud tops over different parts of our country. Kulshrestha (1962) studied the heights of *Cb* cloud tops over north India. Seshadri (1963) reported a study on the heights of tops of *Cb* clouds around New Delhi. Bhattacharya and De (1966) studied the radar cloud tops in the Gangetic valley of West Bengal. A similar study for Madras and neighbourhood has been attempted and the results are presented in the paper. Earlier Lakshmanaswamy and Rao (1974) had reported a climatological study of the radar echoes over Madras and neighbourhood. There, only the areal distribution of the radar echoes around Madras Airport has been studied in great detail and the present paper attempts to study the climatological aspects of the height distribution of the radar echoes. The authors have also attempted to find out the possible relationship between radar echo heights and the corresponding rainfall over Madras and neighbourhood. The object of this study is to see whether the clouds, when they grow vertically higher, will systematically give rise to larger amounts of precipitation. The results of this study will be presented in a future communication.

2. The present study is based on observations taken with a 3 cm Decca radar installed at Madras Airport (Meenambakkam). The maximum range of the radar is 250 km. The available radar data during the period 1965-69 have been analysed and presented.

3. The heights of the radar echoes were subdivided into six height intervals (as shown in Table 1 a).

In order to study the diurnal variation of the heights of cloud tops the data are again subdivided into five broad periods as shown in Table 1(b).

The echo heights distribution is also studied during the four different seasons shown in Table 2 (a).

Table 1 gives the percentage mean frequency distribution of the echoes (a) for different height ranges, and (b) for different periods of the day. Tables 2 (a) & (b) give the mean seasonal distribution of radar echoes for different height ranges and during different periods of the day.

4. It is seen from the frequency distribution for different heights that during the month of October the maximum number of radar echoes are observed, the least being in the month of February. Also most of the echo tops are below 5 km heights. Only during April and May the echo tops reach beyond 13 km. During monsoon season and especially during July and August the tops do not reach beyond 12 km and during winter season the echoes are less in number and do not go beyond 10 km. From the frequency distribution of the echoes during different parts of the day it is seen that most of the echoes occur only during the afternoon, *i.e.*, between 1230 & 1730 IST, which is the period of maximum convective activity. It is further noticed that the maximum number of occurrence of radar echoes (the percentage being 44 per cent) is seen during the monsoon season and during the winter season it is the least being only 4 per cent. During the post monsoon season during which period Madras gets the major amount of rainfall, the percentage of occurrence is 41 per cent.

Thus it is seen that though the post monsoon season gives the major amount of rainfall over Madras city, the number of echoes are more during the monsoon season and the echo tops are higher during the pre-monsoon season.

5. From the frequency distribution it is seen that 40 per cent of the rainfall is due to the echoes which fall in the height range of 15,000 to 20,000 feet. 30 per cent is between 25,000 & 30,000 feet. Incidentally it may be mentioned that the maximum number of occasions of rainfall occurs when the echo heights are just above the freezing level (*viz.*, 16,000 feet over Madras).

TABLE 1 (a)

Monthly mean frequency distribution of radar echoes for different height (km) ranges

	⩽5 km	5.1 to 7 km	7.1 to 9 km	9.1 to 11 km	11.1 to 13 km	>13 km	Total (echoes)
January	49	1	1	0	0	0	51
February	10	4	1	0	0	0	15
March	20	15	10	5	1	0	51
April	39	30	24	9	2	1	105
May	39	53	40	16	5	1	154
June	105	94	33	6	1	0	239
July	132	69	13	1	0	0	215
August	218	104	25	2	0	0	349
September	161	77	13	2	1	0	254
October	297	130	14	1	1	0	443
November	219	42	3	1	0	0	265
December	192	43	2	1	1	0	239
Whole year	1,481	662	179	44	12	2	2,380

TABLE 1 (b)

Monthly mean frequency distribution of echoes for different periods of the day (Time IST)

	0530-0830	0830-1230	1230-1730	1730-2030	2030-0530	Total
January	8	11	15	7	10	51
February	4	3	5	1	2	15
March	3	6	20	9	13	51
April	12	16	47	14	16	105
May	10	13	61	35	35	154
June	5	4	98	69	63	239
July	6	3	83	59	64	215
August	11	16	113	82	127	349
September	16	16	75	56	91	254
October	51	75	129	64	124	443
November	35	41	69	38	82	265
December	25	41	58	32	83	239
Total	186	245	773	466	710	2,380

TABLE 2 (a)

Mean seasonal distribution of radar echoes for different height ranges

Season	⩽5 km	5.1-7 km	7.1-9 km	9.1-11 km	11.1-13 km	>13 km	Total
Winter (Jan-Feb)	59	5	2	0	0	0	66
Hot Weather (Pre-monsoon) (March, April, May)	98	98	74	30	8	2	310
Monsoon (June-Sept)	616	344	84	11	2	0	1,057
Post monsoon (Oct-Dec)	708	215	19	3	2	0	947
Total	1,481	662	179	44	12	2	2,380

TABLE 2 (b)

Mean seasonal distribution of radar echoes for different periods of the day

Season	0530-0830 IST	0830-1230 IST	1230-1730 IST	1730-2030 IST	2030-0530 IST	Total
Winter	12	14	20	8	12	66
Pre-monsoon	25	35	128	58	64	310
Monsoon	38	39	369	266	345	1,057
Post monsoon	111	157	256	134	289	947
Total	186	245	773	466	710	2,380

TABLE 3

Percentage frequency distribution of number of occasions of rainfall

Radar echo ht range in 1000 ft	Pre-monsoon Apr-May (a)	Monsoon Jun-Sep (b)	Post monsoon Oct-Dec (c)	a+b+c (Apr-Dec)
<10	0	0	4	1
10-15	20	18	22	20
15-20	32	36	47	40
20-25	20	35	25	30
25-30	11	8	2	6
>30	17	3	0	3

Also from the same table it is seen that only 20 per cent of the occasions of rainfall is due to clouds below 15,000 feet (*i.e.*, below freezing level) and the rest 80 per cent is due to clouds reaching above freezing level. So we can say that over Madras the rain due to warm cloud is only 20 per cent.

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