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Heights of cumulonimbus cloud tops over the Deccan Plateau and adjoining plains of Andhra Pradesh and east Maharashtra—A Radar study

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ABSTRACT . A radar study of heights of tops of Cumulonimbus clouds over the Deccan Plateau and adjoining plains of Andhra Pradesh and east Maharashtra is presented in this paper. The study is based on all routine and non-routine weather radar observations taken and recorded by the meteorological office, Hyderabad Airport (Andhra Pradesh) during a five-year period from June 1969 to May 1974. Frequency distribution at different height intervals and also for different periods of the day have been computed. A season wise analysis has also been made.

1. Introduction

In an earlier communication Thomas (1973), has presented a preliminary study on the percentage distribution of cumulonimbus clouds of various heights based on all routine and non-routine radar observations taken and recorded at Hyderabad (Andhra Pradesh) during a two-year period from June 1969 to May 1971. In the present paper the period of study is for five years. Therefore, this paper based on more extensive data, not only confirms the findings of the earlier preliminary study but also presents some additional information, *viz.*, the diurnal variation of the percentage distribution, monthwise as well as season-wise This aspect was not studied in the earlier communication.

The entire data for the five-year period from June 1969 to May 1974 have been processed by the IBM 1620 computer at Pune. The maximum and effective range of the radar is 400 km.

2. Procedure

The procedure followed in finding the frequency, distribution and percentage frequency distribution of different height groups monthwise and season-wise, was the same as outlined under sub-heading 2 of the earlier communication. Besides that, in order to find out the diurnal variations, dividing the day into six equal time intervals, the percentage frequency distribution in respect of the various time intervals for the different height groups was worked out.

3. Height distribution

The total number of echoes in each of the four height groups was found for every month taking into account all the observations taken and recorded during the month for all the five years.

The precentage frequencies of different height groups were also determined monthwise. The results are in Table 1.

Further, in order to determine the distribution during different seasons, the data were divided into four groups:

(*i*) Pre-monsoon season, March to May,

(*ii*) Monsoon season, June to September.

(*iii*) Post-monsoon season, October to November.

(*iv*) winter season, December to February. The percentage frequency distribution among different height intervals on the above four seasons is shown in Table 2.

On a scrutiny of Tables 1 and 2 one can see that the inferences enumerated in the earlier communication are generally confirmed by this study. In addition, the following features may also be noted. During the period September to October, percentage frequencies of cumulonimbus clouds having tops at 12 km and above show a secondary maximum. This is due to the withdrawing monsoon and post monsoon systems which give rise to plenty of thunderstorm activity. Cumulonimbus clouds of group D, *i.e.*, those having tops at 15 km and above show a predominance in May. Further more, in order to have an idea as to upto what maximum height cumulonimbus clouds can grow in different months, the maximum height attained in any of the five years for each month has been noted. These values are shown in Table 3.

TABLE 1

Frequency distribution of *Cb* cloud tops among different height intervals — Monthwise

	Group A		Group B		Group C		Group D	
	No. of cases	Frequency (%)	No. of cases	Frequency (%)	No. of cases	Frequency (%)	No. of cases	Frequency (%)
Jan	7	63·6	4	36·3	0	0	0	0
Feb	33	76·7	6	13·9	2	4·6	2	4·6
Mar	109	74·6	24	16·4	12	8·2	1	0·6
Apr	685	66·6	241	23·4	74	7·2	27	2·6
May	772	65·5	233	19·7	130	11·0	42	3·5
June	811	67·5	274	22·8	92	7·6	24	1·9
Jul	746	82·3	124	13·6	31	3·4	5	0·5
Aug	610	74·3	173	21·0	32	3·9	5	0·6
Sep	679	73·4	191	20·6	50	5·4	4	0·4
Oct	794	76·1	192	18·4	45	4·3	12	1·1
Nov	157	73·3	37	17·2	18	8·4	2	0·9
Dec	56	93·3	4	6·6	0	0	0	0

TABLE 2

Frequency distribution of *Cb* cloud tops among different height intervals–Seasonwise

Season	Group A		Group B		Group C		Group D	
	No. of cases	Frequency %	No. of cases	Frequency %	No. of cases	Frequency %	No. of cases	Frequency %
Pre-Monsoon (Mar-May)	1566	66·6	498	21·1	216	9·1	70	2·9
Monsoon (Jun-Sep)	2846	73·9	762	19·7	205	5·3	38	0·9
Post Monsoon (Oct-Nov)	951	75·6	229	18·2	63	5·0	14	1·1
Winter (Dec-Feb)	96	84·2	14	12·3	2	1·8	2	1·8

TABLE 3

Maximum *Cb* tops

Month	Maximum height (km)	Month	Maximum height (km)
Jan	9	Jul	16
Feb	15	Aug	15
Mar	15	Sep	15
Apr	18	Oct	16
May	19	Nov	15
Jun	17	Dec	9

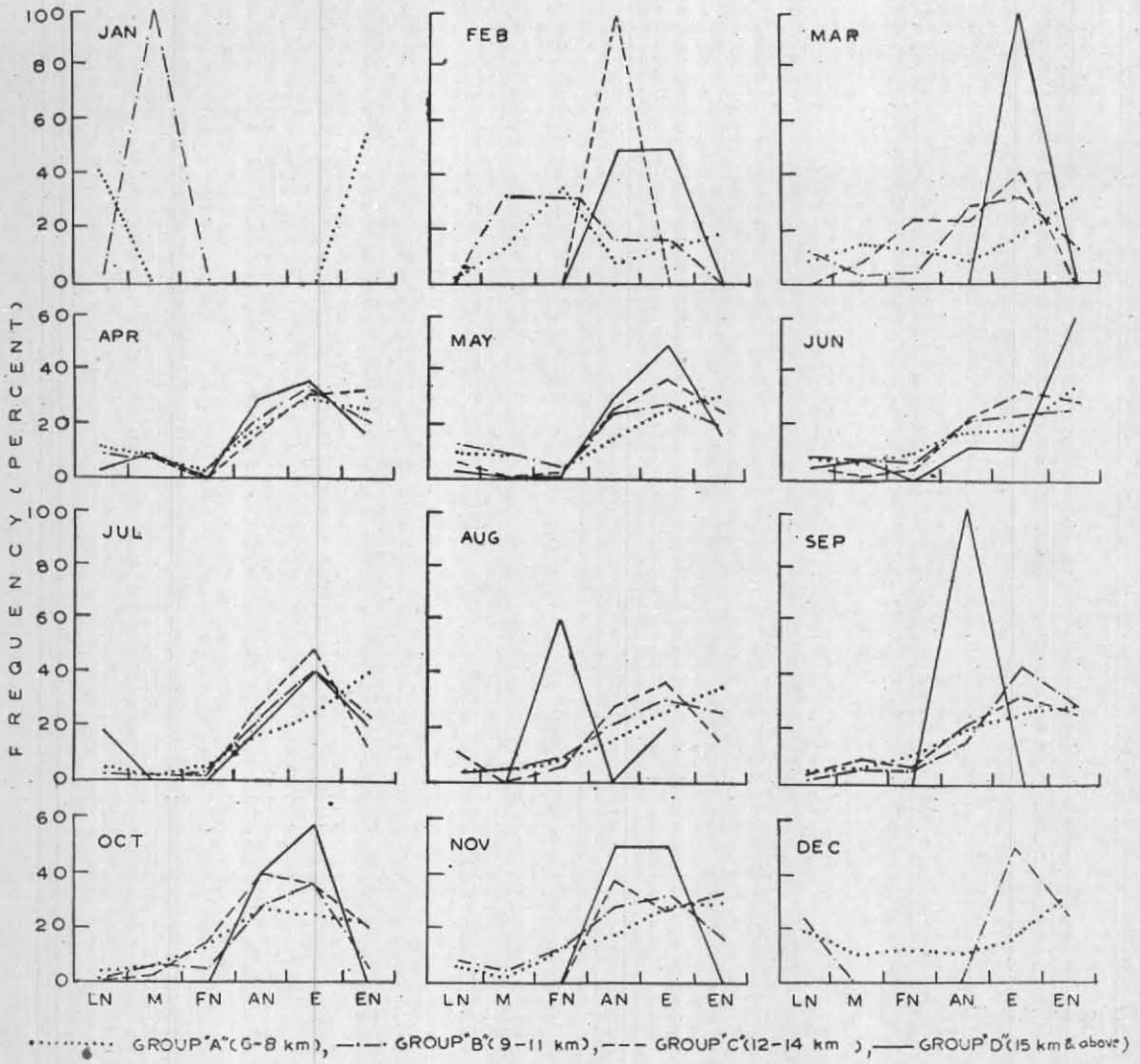

Fig. 1. Percentage frequency distribution of *Cb* cloud tops in different time interval for the various height groups, monthwise

4. Diurnal variations

It is well known that even in a particular month or season, the height attained by cumulonimbus cloud tops are different during different periods of the day. In order to study the diurnal variation of the heights of cumulonimbus cloud tops, the day was divided into six equal time intervals as follows:

1	LN	Late night	0001—0400	IST
2	M	Morning	0401—0800	IST
3	FN	Forenoon	0801—1200	IST
4	AN	Afternoon	1201—1600	IST
5	E	Evening	1601—2000	IST
6	EN	Early night	2001—2400	IST

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The entire data were further grouped in the above six time intervals. That is the number of occasions when cumulonimbus clouds of different height groups were observed in the diffferent time intervals, were determined. Then for each height group, the percentage frequency in respect of the time intervals was computed so as to study the diurnal variation in the occurrence of cumulonimbus clouds for each height groups. The results are represented in Fig. 1 for all the twelve months.

On a scrutiny, the following inferences can be made :

(*i*) Cumulonimbus clouds of all groups have generally a higher percentage frequency in the afternoon and evening from March to November.

(*ii*) During the winter season, *viz.*, December to February, occurrence of cumulonimbus cloud

is more an exception than the rule. When they do occur they have generally a higher percentage in the evening, early night, late night and morning and they do not go beyond 9 km in height except on February when height can go even beyond 14 km in the afternoon or evening.

(*iii*) If cumulonimbus clouds of group A (ht 6 to 8 km) only are considered they show highest percentage frequency in the early night practically throughout the year. They show lowest percentage frequency in forenoon or afternoon in winter months, in forenoon in the pre-monsoon period, late night to forenoon in monsoon season and late night to morning in post monsoon period.

(*iv*) If we consider cumulonimbus clouds of group B (ht 9 to 11 km) only, they show highest percentage frequency in the evening practically throughout the year except in January and February. They show lowest percentage frequency in morning or forenoon in practically all the months, except in February when it is lowest in early night and late night.

(*v*) If we consider cumulonimbus clouds of group C (ht 12 to 14 km) only, they show highest percentage frequency in the evening in all the months from March to September, whereas in February, October and November, the highest percentage frequency is in the afternoon. Low percentage frequency is seen generally in late night to forenoon in almost all the months.

(*vi*) If we consider cumulonimbus clouds of group D (ht 15 km and above) only, they show highest percentage frequency in the evening from March to July, and also in October, except that in June, there is remarkably the highest percentage frequency in the early night. Highest percentage frequency is seen in the forenoon or afternoon in August and September, and in the afternoon and evening in February and November. Low percentage frequency is seen from late night to forenoon in all the months except in August when in the forenoon there is remarkably the highest percentage frequency.

5. Concluding remarks

The most significant fact that emerges out of the analysis is, in short, that the occurrence of large cumulonimbus clouds, that is, those having tops at 12 km or more, is most abundant in the month of May in the area four hundred kilometres around Hyderabad and that the most favourable part of the day for these tall cumulonimbus clouds to occur in May is the evening, *i.e.*, from 1601 to 2000 IST.

REFERENCE

Thomas, S. I. T. 1973 *Indian J. Met. Geophys.*, 24, pp. 163-164.