MAUSAM, 52, 2(April 2001), 357 - 364

551.58 : 551.515.4

Some climatological features of thunderstorms at Thiruvananthapuram, Kochi and Kozhikode airports

K. SANTHOSH, R. SARASAKUMARI, V.K. GANGADHARAN

and

N.V. SASIDHARAN

Meteorological Centre, Thiruvananthapuram

(Received 4 May 2000, Modified 13 September 2000)

सार - इस शोध-पत्र में तीन हवाई अड्डों नामतः तिरूवनंतपुरम, कोची एवं कोजीकोड पर आए गर्जते तूफानों की मासिक औसत आवृत्ति, उनकी वार्षिक और मासिक ठहराव की आवृत्ति, तूफान की अवधि एवं आरम्भ के समय के संबंध में गर्जते तूफानों के आरम्भ का समय एवं आवृत्ति का अध्ययन किया गया है। इस अध्ययन से, तिरूवनंतपुरम और कोची में मानसून वर्षा ऋतु से पूर्व तथा कोजीकोड में मानसून वर्षा ऋतु के बाद गर्जते तूफानों की अधिकतम सक्रियता का पता चला है। अधिकाँश तूफानों के ठहराव की अवधि तीन घटों से कम समय की होती है तथा सभी स्थानों पर ये 9 और 18 यू.टी.सी. के बीच आते हैं जबकि अधिक समय वाले तूफान प्रायः 9 और 15 यू.टी.सी. के बीच आते हैं।

ABSTRACT. Thc average monthly frequency of thunderstorms, its annual and monthly frequency of duration, time of commencement and frequency of thunderstorms in relation to duration and time of commencement at three aerodrome stations of Thiruvananthapuram, Kochi and Kozhikode have been presented in this paper. It is found that thunderstorm activity is maximum in pre-monsoon months at Thiruvananthapuram and Kochi and in post monsoon months at Kozhikode. Majority of the thunderstorms are of duration less than three hours and have a preference to commence between 9 and 18 UTC in all stations whereas long duration thunderstorms generally commence between 9 and 15 UTC.

Key words – Thunderstorm, Climatological feature, Air field warning.

1. Introduction

Forecasting of thunderstorms over an airfield has been a challenging task to a meteorological forecaster from time to time. Since thunderstorm is one of the major aviation hazards, a knowledge of its various climatological aspects will be handy for a forecaster while issuing TREND forecast and Airfield warning. Viswanathan and Faria (1962) and Krishnamurthy (1965) studied climatology of thunderstorms over Bombay and Pune respectively. The diurnal frequency of incidence and duration of thunderstorms at four international aerodromes of Bombay, Calcutta, Madras and Delhi were studied by Rao, *et al.* (1971). A similar work on thunderstorms at the aerodrome stations of Ahmedabad, Bangalore, Agarthala and Hyderabad was done by Philip *et al.* (1974). Various statistical aspects of occurrence of thunderstorms at Lucknow airport were studied by Awadhesh Kumar (1992). A similar study of thunderstorms at Mohanbari Airport was conducted by Moid (1996). The present study was taken up with a view to work out statistics of thunderstorm occurrence at different times and months of the year over three major airports in Kerala *viz.* Thiruvananthapuram, Kochi, and Kozhikode.

2. Data

Current Weather Observational data of Thiruvananthapuram Airport for the period 1979-98, Kochi Airport for the period 1975-98 and Kozhikode Airport for the period 1993 - 98 were used for the study. A thunderstorm accounted for in this study includes all those occasions when 'thunder heard' was reported.

3. Analysis and discussion

3.1. *Average monthly frequency of thunderstorms*

The average monthly frequency of thunderstorms at each of the three stations have been worked out and are given in Table 1. The averages have been worked out by dividing the total number of occurrences by the number of years of study. It is noticed that Thiruvananthapuram has maximum average thunderstorm frequency of 14.3 in

TABLE 1

Average monthly frequency of thunderstorms

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Thiruvananthapuram AP	1.4	2.3	5.1	14.3	13.4	3.5	0.7	0.4	3.9	12.7	11.2	3	72
Kochi AP	1	1.5	4.8	12.8	15.6	11.6	4.4	2.7	5.3	14.1	9.5	2.5	86
Kozhikode AP	0.2	0.2	2.3	9.7	11	11.3	5.3	3	3.3	18.2	10.2	3.2	78

April followed by May (13.4) and October (12.7). In Kochi, May has the highest average frequency of 15.6 thunderstorms with a slightly lower maximum of 14.1 in October. Kozhikode has a maximum average thunderstorm frequency in October (18.2). A second maximum of the order of 11 was seen in May and June. This shows that thunderstorm activity is maximum in pre-monsoon months at Thiruvananthapuram and Kochi whereas at Kozhikode, the maximum activity is observed in the post monsoon season. Incidence of thunderstorms is minimum in August (0.4), July (0.7) and January (1.4) at Thiruvananthapuram, and in January and February at Kochi (1, 1.5) and Kozhikode (0.2, 0.2).

3.2. *Average annual and monthly frequency of duration of thunderstorms*

The average annual frequency of duration of thunderstorm activity at the three stations, given in Table 2, reveals that at Thiruvananthapuram 75% of thunderstorms were of duration less than three hours, whereas at Kochi and Kozhikode it was only 62% and 65 % respectively. In 27% of cases the thunderstorms at Kochi were of duration 3-6 hours; the figures at Thiruvananthapuram and Kozhikode being 19% and 22% respectively. The occurrence of thunderstorms of duration more than 12 hours was found to be very less, *i.e.*, less than 1% at all the three stations.

The average monthly frequency of duration of thunderstorms (Table2) shows that at Thiruvananthapuram the highest frequency of thunderstorms of duration less than 3 hours was found to be in April (10.3) followed by October (9.8), May (8.5) and November (8.3). The minimum activity was seen in August.(0.4) and July (0.6) . Thunderstorms of duration 3-6 hours were found to be maximum in May (3.5) and then in April (3.1). No thunderstorm was observed in the month of August in this category. In the 6-9 hours duration category, May recorded average frequency of 1 whereas April and October recorded 0.5 each. During other months, the frequencies were very low. Frequency of thunderstorms of duration more than 9 hours also was found to be very low.

At Kochi, the average maximum frequency of thunderstorms of duration less than 3 hours was 9.0 in May followed by April (8.1) and June (7.9). January recorded the lowest average frequency of 0.7 in the above category. October was the month of maximum thunderstorm activity of 3-6 hours duration (4.9) followed by May (4.3). January (0.7) and February (1.0) were the months of minimum thunderstorm activity. Frequency of thunderstorms of duration more than 6 hours but less than 9 hours was maximum in May (1.6). October and April registered average frequency of 1.3 and 1.2 respectively. In all other months, frequencies of thunderstorms of the above duration were found very less. Frequencies of thunderstorms lasting more than 9 hours duration was found negligible.

The average frequency of occurrence of thunderstorms of duration less than 3 hours at Kozhikode was maximum in the month of October (9.8) followed by June (9.1) and May (7.5). The occurrence was minimum in the months of January and February (0.2) each. In the 3-6 hours duration category, October (5.2) registered maximum average frequency followed by November (2.7) whereas no thunderstorm of duration 3-6 hours was recorded during January and February. The maximum average frequency of 2.7 was observed in the month of October for thunderstorms of duration 6 to 9 hours. The average frequencies in all other months were negligible except during April (0.8), May (1.0) and June (0.7). Similarly, thunderstorms of duration more than 9 hours had very low frequencies.

3.3. *Average monthly distribution of time of commencement of thunderstorms*

The average monthly distribution of time of commencement of thunderstorms at 3 hourly intervals is shown in Table 3. The annual average and the percentage of occurrence in each of the three hourly intervals is also given in this table. It is seen that the average monthly occurrence is maximum during 0900-1200 UTC interval at Thiruvananthapuram (40%) followed by 1200-1500 UTC interval (20%) and 0600-0900 UTC interval (16%). The occurrence is least during 0300-0600 UTC interval (1.7%) and in 1800-2100 UTC interval (3.0%).

TABLE 2

Average annual and monthly frequency of duration of thunderstorms

Months	Stations	Duration (hrs IST)				
		≤3	3-6	6-9	9-12	>12
January	Trv AP	1.3	0.1	0.0	0.0	0.0
	Kochi AP	0.7	0.3	0.0	0.0	0.0
	Kozhikode AP	0.2	0.0	0.0	0.0	0.0
February	Trv AP	2.0	0.1	0.1	0.1	0.0
	Kochi AP	1.0	0.4	0.1	0.0	0.0
	Kozhikode AP	0.2	0.0	0.0	0.0	0.0
March	Trv AP	4.0	1.0	0.1	0.0	0.0
	Kochi AP	3.4	1.1	0.3	0.0	0.0
	Kozhikode AP	1.2	0.7	0.3	0.2	0.0
April	Trv AP	10.3	3.1	0.5	0.2	0.2
	Kochi AP	8.1	3.3	1.2	0.3	0.0
	Kozhikode AP	4.8	2.3	1.8	0.5	0.2
May	Trv AP	8.5	3.5	1.0	0.3	0.1
	Kochi AP	9.0	4.3	1.6	0.6	0.1
	Kozhikode AP	7.5	2.3	1.0	0.2	0.0
June	Trv AP	3.2	0.3	0.1	0.0	0.0
	Kochi AP	7.9	2.2	0.9	0.3	0.3
	Kozhikode AP	9.1	1.3	0.7	0.2	0.0
July	Trv AP	0.6	0.1	0.0	0.0	0.0
	Kochi AP	3.4	0.7	0.0	0.0	0.3
	Kozhikode AP	4.0	0.7	0.3	0.3	0.0
August	Trv AP	0.4	0.0	0.0	0.0	0.0
	Kochi AP	2.1	0.4	0.1	0.0	0.1
	Kozhikode AP	2.3	0.5	0.2	0.0	0.0
September	Trv AP	3.1	0.7	0.1	0.1	0.0
	Kochi AP	3.2	1.5	0.4	0.1	0.1
	Kozhikode AP	2.8	0.3	0.2	0.0	0.0
October	Trv AP	9.8	2.3	0.5	0.1	0.1
	Kochi AP	7.5	4.9	1.3	0.3	0.1
	Kozhikode AP	9.8	5.2	2.7	0.3	0.2
November	Trv AP	8.3	2.5	0.3	0.1	0.0
	Kochi AP	4.9	3.3	0.9	0.2	0.1
	Kozhikode AP	6.7	2.7	0.3	0.5	0.0
December	Trv AP	2.7	0.2	0.1	0.1	0.0
	Kochi AP	1.8	0.5	0.2	0.0	0.0
	Kozhikode AP	2.2	1.0	0.0	0.0	0.0
Annual	Trv AP	54.1	13.9	2.8	0.8	0.4
	Kochi AP	53.0	22.9	7.0	1.8	1.2
	Kozhikode AP	50.8	17.0	7.5	2.2	0.3

TABLE 3

Average monthly distribution of time of commencement of thunderstorms

Months	Stations	Time (UTC) of commencement							
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24
January	Trv AP	0.2	0	0.1	0.5	0.4	0.1	0.2	0.1
	Kochi AP	0	0	0	0	0.1	0.3	0.3	0.2
	Kozhikode AP	0	0	0	0.2	0	0	0	0
February	Trv AP	0.1	0	0.3	1.1	0.7	0.1	0.1	0
	Kochi AP	0	0	0	0	0.4	0.3	0.4	0.3
	Kozhikode AP	0	0	0	0.2	0	0	0	0
March	Trv AP	0.4	0.1	0.5	2.3	1.2	0.4	0.1	0.2
	Kochi AP	0.1	0	0	0.6	1.1	1.8	0.8	0.4
	Kozhikode AP	0	0	0	1.2	0.5	0.5	0	0.2
April	Trv AP	0.4	0.1	1.9	7.1	3	0.9	0.3	0.7
	Kochi AP	0.4	0	0.2	2.8	4	2.8	1.3	1.3
	Kozhikode AP	0	0	0.7	3	4.2	0.3	1	0.5
May	Trv AP	1.7	0.4	1.3	4.8	3.1	0.6	0.5	1.3
	Kochi AP	0.9	0.7	0.6	2.5	2.9	3.6	2.2	2.3
	Kozhikode AP	0	0	1	4	3.2	1.3	0.8	0.7
June	Trv AP	0.4	0.3	0.8	0.7	0.4	0.2	0.2	0.7
	Kochi AP	1.5	1.1	0.7	1.4	1.5	1.7	1.7	2
	Kozhikode AP	0.8	0.5	1.2	1.2	2.8	2	1.3	1.5
July	Trv AP	0.1	0	0.1	0.3	0.1	0.1	0	0.2
	Kochi AP	0.5	0.2	0.3	0.3	0.8	1	0.6	0.7
	Kozhikode AP	0.5	0.2	0.5	0.7	2	0.7	0.2	0.7
August	Trv AP	0.1	0	0.1	0.2	0.1	0	0	0.1
	Kochi AP	0.2	0.1	0.1	0.1	0.3	0.8	0.5	0.5
	Kozhikode AP	0.2	0.3	0.5	0.5	0.3	0.2	0.3	0.7
September	Trv AP	0.3	0.1	1.2	1.5	0.4	0.3	0.1	0.4
	Kochi AP	0.5	0.1	0.3	0.8	0.6	1.1	1.0	0.9
	Kozhikode AP	0.2	0.2	0.3	1.7	0.0	0.5	0.2	0.3
October	Trv AP	0.2	0.3	3.6	5.0	2.0	1.0	0.4	0.4
	Kochi AP	0.5	0.3	0.6	3.3	4.0	2.9	1.6	1.0
	Kozhikode AP	0.5	0.5	2.2	8.2	2.7	2.0	1.2	1.0
November	Trv AP	0.5	0.1	1.8	4.5	2.5	1.2	0.3	0.3
	Kochi AP	0.2	0.0	0.4	2.9	2.9	1.7	0.7	0.7
	Kozhikode AP	0.3	0.0	1.2	6.2	1.0	0.7	0.3	0.5
December	Trv AP	0.1	0.1	0.3	1.1	0.9	0.4	0.2	0.2
	Kochi AP	0.0	0.0	0.1	0.5	0.5	0.7	0.4	0.2
	Kozhikode AP	0.0	0.0	0.3	1.3	0.8	0.2	0.2	0.3
Annual	Trv AP	4.4	1.2	11.7	28.8	14.4	5.1	2.1	4.3
	Kochi AP	4.9	2.5	3.4	15.2	19.2	18.6	11.4	10.6
	Kozhikode AP	2.5	1.7	7.8	28.2	17.5	8.3	5.5	6.3
Percent	Trv AP	6.1	1.7	16.3	40.0	20.0	7.0	3.0	5.9
	Kochi AP	5.7	2.9	3.9	17.7	22.3	21.7	13.3	12.4
	Kozhikode AP	3.2	2.2	10.0	36.2	22.5	10.7	7.1	8.1

TABLE 4

Frequency of thunderstorms in relation to duration and time of commencement – Thiruvananthapuram AP

Months	Duration (hrs IST)	Time (UTC) of commencement								
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	Total
January	<3	3	0	1	9	8	1	2	1	25
	3-6	0	0	0	1	0	0	0	0	1
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	1	0	1
February	<3	2	0	5	17	13	2	1	0	40
	3-6	0	0	0	3	0	0	0	0	3
	6-9	0	0	0	1	0	0	0	0	1
	9-12	0	0	0	1	0	0	0	0	1
	>12	0	0	1	0	0	0	0	0	1
March	<3	7	0	7	36	19	8	1	3	81
	3-6	1	1	3	10	4	0	0	0	19
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
April	<3	7	1	21	97	50	16	4	9	205
	3-6	0	0	12	37	6	1	1	5	62
	6-9	0	0	3	5	3	0	0	0	11
	9-12	1	0	1	1	1	0	0	0	4
	>12	0	0	1	2	0	0	0	0	3
May	<3	27	7	14	53	35	9	3	23	171
	3-6	7	0	10	28	17	1	6	1	70
	6-9	0	0	2	10	6	1	0	1	20
	9-12	0	0	0	3	3	0	0	0	6
	>12	0	0	0	1	0	0	0	0	1
June	<3	7	4	15	12	5	4	3	14	64
	3-6	1	1	0	1	2	0	0	0	5
	6-9	0	0	1	0	0	0	0	0	1
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
July	<3	1	0	1	5	1	2	0	2	12
	3-6	1	0	0	0	0	0	0	1	2
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
August	<3	2	0	1	3	1	0	0	1	8
	3-6	0	0	0	0	0	0	0	0	0
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
September	<3	5	2	15	23	4	5	1	7	62
	3-6	0	0	7	4	2	0	0	0	13
	6-9	0	0	1	1	1	0	0	0	3
	9-12	0	0	0	1	0	0	0	0	1
	>12	0	0	0	0	0	0	0	0	0
October	<3	4	3	52	76	34	15	6	6	196
	3-6	0	1	14	20	4	4	2	2	47
	6-9	0	0	4	4	1	0	0	0	9
	9-12	0	1	0	0	0	0	0	0	1
	>12	0	0	1	0	0	0	0	0	1
November	<3	10	2	27	64	36	19	3	4	165
	3-6	0	0	7	23	12	5	3	1	51
	6-9	0	0	0	1	4	2	0	0	7
	9-12	0	0	0	1	0	0	0	0	1
	>12	0	0	0	0	0	0	0	0	0
December	<3	2	1	3	19	16	5	3	4	53
	3-6	0	0	2	1	0	1	0	0	4
	6-9	0	0	0	1	1	0	0	0	2
	9-12	0	0	0	0	0	1	0	0	1
	>12	0	0	0	0	0	0	0	0	0

TABLE 5

Frequency of thunderstorms in relation to duration and time of commencement – Kochi AP

Months	Duration (hrs IST)	Time (UTC) of commencement								
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	Total
January	<3	1	0	0	0	2	5	4	3	15
	3-6	0	0	0	0	1	3	2	1	7
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	1	1
February	<3	1	0	1	1	6	5	5	5	24
	3-6	0	0	0	0	4	2	2	1	9
	6-9	0	0	0	0	0	1	1	1	3
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	1	0	1
March	<3	2	0	1	8	19	30	14	9	83
	3-6	0	0	0	4	5	11	6	0	26
	6-9	0	0	0	2	3	1	0	0	6
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	1	0	0	1
April	<3	10	1	1	37	64	33	19	30	195
	3-6	0	0	2	20	22	23	8	3	78
	6-9	0	0	2	8	7	8	3	0	28
	9-12	0	0	0	3	1	2	0	0	6
	>12	0	0	0	0	1	0	0	0	1
May	<3	14	9	12	31	39	39	30	43	217
	3-6	5	5	0	20	20	27	18	9	104
	6-9	0	0	0	7	9	15	5	2	38
	9-12	1	2	3	2	2	4	0	0	14
	>12	1	0	0	0	0	1	0	0	2
June	<3	31	19	14	25	24	18	21	39	191
	3-6	4	5	2	3	5	12	16	6	53
	6-9	1	1	0	2	4	8	3	2	21
	9-12	1	0	0	0	2	2	0	1	6
	>12	0	1	1	3	2	0	0	0	7
July	<3	12	4	6	7	14	15	11	12	81
	3-6	0	0	1	1	2	6	3	4	17
	6-9	0	0	0	0	0	1	0	0	1
	9-12	0	1	0	0	0	0	0	0	1
	>12	1	0	1	0	3	1	0	0	6
August	<3	5	3	2	3	5	12	9	11	50
	3-6	0	0	0	0	1	5	2	1	9
	6-9	0	0	0	0	0	0	2	0	2
	9-12	0	0	0	0	0	1	0	0	1
	>12	0	0	0	0	1	0	0	1	2
September	<3	11	3	4	10	6	12	13	17	76
	3-6	2	0	2	6	6	9	8	4	37
	6-9	0	0	0	2	2	5	1	0	10
	9-12	0	0	0	2	0	0	0	0	2
	>12	0	0	0	0	1	0	1	0	2
October	<3	10	6	10	32	46	30	28	19	181
	3-6	1	0	2	29	39	30	10	6	117
	6-9	0	0	2	13	8	8	0	0	31
	9-12	0	0	0	4	2	1	0	0	7
	>12	1	0	0	1	1	0	0	0	3
November	<3	3	0	5	33	33	21	11	12	118
	3-6	1	0	1	27	26	15	6	4	80
	6-9	0	0	3	9	6	4	0	0	22
	9-12	0	0	0	1	4	0	0	0	5
	>12	0	0	0	0	1	0	0	1	2
December	<3	0	0	2	7	10	12	7	4	42
	3-6	0	0	0	3	2	3	3	1	12
	6-9	0	0	1	2	1	1	0	0	5
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0

TABLE 6

Frequency of thunderstorms in relation to duration and time of commencement – Kozhikode AP

Months	Duration (hrs IST)	Time (UTC) of commencement								
		0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	Total
January	<3	0	0	0	1	0	0	0	0	1
	3-6	0	0	0	0	0	0	0	0	0
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
February	<3	0	0	0	1	0	0	0	0	1
	3-6	0	0	0	0	0	0	0	0	0
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
March	<3	0	0	0	5	1	0	1	0	7
	3-6	0	0	0	2	0	2	0	0	4
	6-9	0	0	0	0	1	1	0	0	2
	9-12	0	0	0	0	1	0	0	0	1
	>12	0	0	0	0	0	0	0	0	0
April	<3	0	0	2	9	12	2	2	2	29
	3-6	0	0	1	4	5	0	3	1	14
	6-9	0	0	0	4	6	0	1	0	11
	9-12	0	0	0	1	2	0	0	0	3
	>12	0	0	1	0	0	0	0	0	1
May	<3	0	0	4	18	12	5	3	3	45
	3-6	0	0	2	2	5	2	2	1	14
	6-9	0	0	0	3	2	1	0	0	6
	9-12	0	0	0	1	0	0	0	0	1
	>12	0	0	0	0	0	0	0	0	0
June	<3	5	3	6	7	13	11	4	6	55
	3-6	0	0	1	0	0	1	4	2	8
	6-9	0	0	0	0	3	0	0	1	4
	9-12	0	0	0	0	1	0	0	0	1
	>12	0	0	0	0	0	0	0	0	0
July	<3	3	1	2	2	9	3	1	3	24
	3-6	0	0	0	2	1	0	0	1	4
	6-9	0	0	1	0	0	1	0	0	2
	9-12	0	0	0	0	0	2	0	0	2
	>12	0	0	0	0	0	0	0	0	0
August	<3	1	1	3	3	1	1	1	3	14
	3-6	0	1	0	0	0	0	1	1	3
	6-9	0	0	0	0	1	0	0	0	1
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
September	<3	1	1	2	7	0	3	1	2	17
	3-6	0	0	0	2	0	0	0	0	2
	6-9	0	0	0	1	0	0	0	0	1
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0
October	<3	3	2	7	26	6	5	4	6	59
	3-6	0	1	2	12	8	5	3	0	31
	6-9	0	0	3	9	2	2	0	0	16
	9-12	0	0	1	1	0	0	0	0	2
	>12	0	0	0	1	0	0	0	0	1
November	<3	2	0	5	24	3	3	1	2	40
	3-6	0	0	2	8	3	1	1	1	16
	6-9	0	0	0	2	0	0	0	0	2
	9-12	0	0	0	3	0	0	0	0	3
	>12	0	0	0	0	0	0	0	0	0
December	<3	0	0	0	6	4	0	1	2	13
	3-6	0	0	2	2	1	1	0	0	6
	6-9	0	0	0	0	0	0	0	0	0
	9-12	0	0	0	0	0	0	0	0	0
	>12	0	0	0	0	0	0	0	0	0

At Kochi, it is seen that majority of the thunderstorms occur during 1200-1500 UTC (22.3%) and 1500-1800 UTC (21.7%) Intervals. The minimum occurrence of 2.2% was observed during 0300-0600 UTC interval.

The monthly distribution of thunderstorm activity at Kozhikode reveals that maximum thunderstorms occurred during 0900 - 1200 UTC interval which is 36.2% of the total. A second maximum was observed during 1200 - 1500 UTC interval with a percentage occurrence of 22.5. The minimum occurrence (2.2%) was during the period 0300-0600 UTC.

3.4. *Frequency of thunderstorms in relation to time of commencement*

Frequency distribution of thunderstorms in relation to duration and time of commencement in respect of Thiruvananthapuram, Kochi and Kozhikode are shown in Tables 4, 5 and 6 respectively. Thunderstorms of duration more than 6 hours are arbitrarily taken as long duration thunderstorms, which are only considered here.

It may be seen from Table 4 that at Thiruvananthapuram most of the long duration thunderstorms have a tendency to commence around 0900 UTC in most of the months except in June and October, when it commences before 0600 UTC.

At Kochi (Table 5), majority of the long duration thunderstorms begin between 0900-1200 UTC in all the months except in March, July and November, when it has a preference to begin between 1200-1500 UTC . However there are isolated incidents of formation of long duration thunderstorms between 1500-1800 UTC in May, June and September between 1800-2100 UTC during February and August and between 2100-2400 UTC interval in January.

At Kozhikode (Table 6), majority of the thunderstorms of duration more than 6 hours commence between 0900-1200 UTC in May, September, October and November, between 1200 and 1500 UTC in March, April,- June and August and between 1500 and 1800 UTC in July. Thunderstorms of duration of more than 6 hours are not observed in January, February and December.

4. Conclusion

The study reveals that the thunderstorm activity is maximum in pre-monsoon months in Thiruvananthapuram and Kochi and in post-monsoon months at Kozhikode. Incidence of thunderstorms is minimum during monsoon season in Thiruvananthapuram whereas at the other two stations it is during winter, though a general decrease is noticed during monsoon months. The average annual frequency of duration of thunderstorm activity reveals that majority of the thunderstorms are of duration less than 3 hours at all the three stations. The distribution of time of commencement of thunderstorm shows that a maximum of 40 % thunderstorms commence between 0900 and 1200 UTC at Thiruvananthapuram, 44% in 1200-1800 UTC interval at Kochi and 59% between 0900-1500 UTC at Kozhikode. Majority of long duration thunderstorms (*i.e.*, duration more than 6 hours) at Thiruvananthapuram commence between 0900 and 1200 UTC whereas at Kochi and Kozhikode most of the thunderstorms of duration more than 6 hours show a tendency to begin between 0900 and 1500 UTC.

References

Awadhesh, Kumar, 1992, "A Climatological study of thunderstorms at Lucknow Airport", *Mausam*, **43**, 4, 441-444.

Krishnamurthy, V., 1965, "A Statistical study of thunderstorms over Poona", *Indian J.Met.Geophys.*, **16**, 3, 484-487.

Moid., S.A.,1996, "A Climatological study of thunderstorms at Mohanbari airport", *Mausam*, **47**, 2, 200-204

Philip, N.M., Daniel, C.E.J. and Punjabi, K.G., 1974, "A study on the diurnal frequency and duration of thunderstorms at four aerodrome stations", PPSR No.203 of I.M.D.

Rao, K. N., Daniel, C.E.J and Punjabi, K.G., 1971, "A study on the diurnal frequency and duration of thunderstorms at four aerodrome stations", PPSR No.154 of I.M.D.

Viswanathan, T.R and Faria, S.F., 1962, "A Climatological study of thunderstorms at Bombay airport", *Indian J.Met.Geophys.*, **13**, 3, 377-383.