551·515·4 : 519·28

A statistical study of thunderstorm activity over Agartala airfield

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ABSTRACT. The results of a study of thunderstorm activity over Agartala airfield based on data for the years 1957 to 1959 have been presented in this paper. There are, on the average, 105 days of thundery conditions per year when about 126 thunderstorms occur. These thunderstorms are often associated with severe squalls and, on a few occasions, with hail. The thundery activity over Agartala airfield begins perceptibly in February, gradually attains a maximum in May and June, subsides only slightly during the monsoon months and suddenly shoots up to a much higher maximum in September to dwindle gradually by the end of October. Occurrence and persistence over long duration of thunderstorms on a large number of days during monsoon months constitute an interesting feature of the weather at Agartala. Monthly frequencies of thunderstorms, their duration, their prevalence during various hours of the day, and percentage of rainfall associated with thunderstorms are also discussed.

1. Introduction

Most places in northeast India, and particularly those in Assam, Tripura and Manipur States, are characterised by an unusual "richness" of weather. Agartala in Tripura State is one such place where almost all weather phenomena present themselves with exceptional virulence and with considerably large frequencies of occurrence. Fog in winter on many days, thunderstorms and nor'westers with frequent squalls in the premonsoon period, incessant rain or thundershowers, sometimes very heavy, with persistent low clouds in the monsoon season, passing of secondary western disturbances and westerly waves over the station late in winter, and a few hailstorms occurring with the passage of cold fronts over Agartala, constitute major weather sequences at Agartala. The access to this place by land route through Indian Union is not quick and easy. Aviation, therefore, plays an important role inspite of adverse weather conditions throughout the year in these parts.

Actually, the large number of aircraft movements that take place here have to combat persistently with various hazards of weather. Fog and thunderstorms constitute major aviation hazards and a detailed study of these weather elements becomes imperative. This paper briefly describes the statistical study of thunderstorm activity over Agartala airfield based on the data for the years 1957 to 1959.

2. Presentation of meteorological data

A day of thunder is defined as one on which thunder is heard. Table 1 gives, monthwise, the number of days on which thunderstorms have occurred. The number of days when thunderstorms occurred in the morning has been given under M, days when thunderstorms occurred in the evening have been listed under E, while the number of days when thundery conditions started in the morning and continued till the evening, *i.e.*, prevailed almost throughout the day has been counted under ME. The total number of days of thunder (N) in the month (given by N=M+E—ME) is given in bold types.

On some days two or three thunderstorms have occurred at Agartala. These thunderstorms have been separately counted, and the results are presented in Table 2.

In Table 3, thunderstorms have been grouped according to the periods for which they lasted.

Prevalence of thunderstorms during the various hours of the day has also been studied. A day has been divided into

TABLE 1

Number of days of thunder at Agartala airfield

Year	Jan			Feb			Mar			Apr			May		
	M	E	ME	M	E	ME	M	E	ME	M	E	ME	M	E	ME
1957	..	2 **2**	..	1	.. **1**	..	..	1 **1**	..	..	11 **11**	..	3	13 **14**	2
1958	..	1 **1**	..	2	6 **7**	1	1	3 **3**	1	3	10 **12**	1	6	11 **13**	4
1959	2	2 **3**	1	5	4 **8**	1	8	6 **8**	6	3	7 **9**	1	11	12 **20**	3
Mean	0·7	1·7 **2·0**	0·3	2·7	3·3 **5·3**	0·7	3·0	3·3 **4·0**	2·3	2·0	9·3 **10·7**	0·7	6·7	12·0 **15·7**	3·0

Year	Jun			Jul			Aug			Sep			Oct			Total
	M	E	ME	M	E	ME	M	E	ME	M	E	ME	M	E	ME	
1957	8	17 **17**	8	..	3 **3**	..	4	16 **18**	2	6	16 **17**	5	1	4 **5**	..	**89**
1958	4	12 **12**	4	..	10 **10**	..	3	5 **6**	2	12	16 **22**	6	4	11 **12**	3	**98**
1959	4	13 **14**	3	11	13 **19**	5	8	13 **15**	6	6	15 **18**	3	5	11 **13**	3	**127**
Mean	5·3	14·0 **14·3**	5·0	3·7	8·7 **10·7**	1·7	5·0	11·3 **13·0**	3·3	8·0	15·7 **19·0**	4·7	3·3	8·7 **10·0**	2·0	

TABLE 2

Frequency of thunderstorms during the years 1957—59

	1957	1958	1959	Total		1957	1958	1959	Total
Jan	2	1	4	7	Jun	23	15	16	54
Feb	1	8	7	16	Jul	4	11	24	39
Mar	1	4	19	24	Aug	18	5	18	41
Apr	11	12	10	33	Sep	22	27	22	71
May	21	16	22	59	Oct	5	12	16	33
					Total	108	111	158	377

TABLE 3

Frequency of thunderstorms according to their duration

		Duration (hr) of thunderstorms between				Total No. of thunderstorms
		½—2	2—4	4—6	>6	
Jan	1957	..	2	..	..	2
	1958	1	..	..	..	1
	1959	..	2	2	..	4
Feb	1957	1	..	..	..	1
	1958	3	2	2	1	8
	1959	2	2	2	1	7
Mar	1957	..	1	..	..	1
	1958	..	2	1	1	4
	1959	8	5	3	3	19
Apr	1957	7	3	1	..	11
	1958	2	7	..	3	12
	1959	4	3	1	2	10
May	1957	7	4	9	1	21
	1958	3	7	3	3	16
	1959	8	9	4	1	22
Jun	1957	8	9	4	2	23
	1958	5	8	1	1	15
	1959	5	6	3	2	16
Jul	1957	3	1	..	..	4
	1958	7	2	2	..	11
	1959	6	10	6	2	24
Aug	1957	5	4	8	1	18
	1958	1	3	..	1	5
	1959	5	6	5	2	18
Sep	1957	6	7	5	4	22
	1958	5	13	5	4	27
	1959	10	8	3	1	22
Oct	1957	..	5	..	..	5
	1958	2	3	2	5	12
	1959	3	8	4	1	16
	Total	117	142	76	42	377

twelve intervals, each of two hours duration. The number of thunderstorms during these intervals are given in Table 4.

3. Discussion

(*i*) The average annual frequency of days of thunder is 105. If each occasion of thunder heard is counted separately, the average per year is 126.

(*ii*) Hailstorms are comparatively few in number, about 1 or 2 in a year, generally in March or April.

(*iii*) Violent squalls, on the average one per week, with speeds exceeding 50 knots on many occasions occur in association with the thunderstorms, particularly during March, April and May. The directions of these squalls, although predominantly northnorthwesterly, varies from westnorthwest to northeast. Sometimes, squalls coming from southerly or southeasterly directions attaining a maximum speed of 50 knots have been observed. Severe squalls with thunderstorms also occur in June and July even when the monsoon is fully established. The number of squalls observed, monthwise, is given in Table 5.

(*iv*) Thunderstorms occur at Agartala during the period from January to October. No thunderstorms have been recorded in November and December during these three years. Thunderstorm activity begins perceptibly in February, gradually attains a maximum in May and June, subsides only slightly during the monsoon months and suddenly shoots up to a much higher maximum in September to dwindle gradually by the end of October.

(*v*) Occurrence of thunderstorms on a large number of days during the monsoon months is an interesting feature of the weather at Agartala. Breaks in the monsoon and passage of an upper air trough also stimulate considerable thunderstorm activity at Agartala for many days.

TABLE 4

Number of thunderstorms during different intervals

	Interval in hours (IST)											
	0–2	2–4	4–6	6–8	8–10	10–12	12–14	14–16	16–18	18–20	20–22	22–24
Jan 1957	..	..	..	..	..	..	..	1	2	1	1	..
1958	..	..	..	..	..	..	1	..	..	..	..	..
1959	..	1	1	1	1	1	1	1	2	2	1	..
Feb 1957	..	..	..	..	..	1	..	..	..	..	..	..
1958	1	2	1	1	1	1	3	4	2	2	2	..
1959	2	3	2	..	..	1	1	1	3	3	3	2
Mar 1957	..	..	..	..	..	..	..	..	1	1	1	..
1958	..	..	..	1	1	..	1	2	3	3	..	..
1959	4	4	4	5	5	4	4	4	6	6	4	5
Apr 1957	..	..	..	..	..	..	..	2	10	6	3	..
1958	2	1	..	..	1	1	1	3	6	8	6	2
1959	2	2	..	1	1	..	2	5	5	5	3	..
May 1957	3	2	1	2	2	1	3	7	11	12	9	4
1958	4	3	..	1	1	3	3	5	5	8	9	7
1959	5	3	4	4	1	1	3	6	7	5	6	5
Jun 1957	1	2	3	4	2	4	5	5	9	8	7	3
1958	..	1	1	1	..	3	4	11	9	4	2	1
1959	1	2	1	1	1	2	4	9	9	7	5	1
Jul 1957	..	..	..	..	..	..	1	3	2	..	..	..
1958	..	..	..	..	..	..	1	4	5	6	3	1
1959	7	7	7	3	3	2	4	6	8	6	6	4
Aug 1957	1	2	1	1	1	1	4	10	10	9	6	3
1958	2	1	..	..	..	1	1	1	1	1	4	4
1959	5	5	2	2	2	1	3	5	7	7	6	5
Sep 1957	1	3	5	5	5	4	5	9	11	8	5	1
1958	7	8	6	4	3	..	3	8	10	9	10	8
1959	1	2	3	3	3	2	6	6	9	7	5	2
Oct 1957	..	..	1	1	..	..	1	3	3	2	1	..
1958	1	..	1	2	1	3	7	9	10	5	..	1
1959	1	2	2	3	3	2	5	8	8	5	2	..

TABLE 5

Frequency of occurrence of squalls

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
1957	1	..	..	2	5	4	..	2	..	1	15
1958	..	2	1	3	4	2	..	..	2	1	15
1959	..	..	9	6	8	..	1	..	..	..	24

(*vi*) A study of Tables 3 and 4 shows that thundery activity is mainly restricted to the period from 1300 IST to 0300 IST of the next day during the months of March, April and May and to the period from 1300 IST to 0600 IST during the months of June, July and August. There is also considerable thunderstorm activity during the morning hours on some days in March over Agartala.

September happens to be the month of maximum thunderstorm activity which persists on many days practically during all hours of the day, the period from 1300 to 2300 IST being the most probable for the occurrence and persistence of thunderstorms. In October, thundery activity is mainly restricted to the period from 1300 to 2000 IST.

Although the average duration of a thunderstorm over Agartala varies from 2 to 4 hours, as many as 31 per cent of thunderstorms have been seen to persist for a period of more than 4 hours.

Some interesting extreme departures from the normal duration of thunderstorm activity over Agartala have been noted. For instance, on 26 March 1959, the thunderstorm commenced at 1155 IST and lasted for 19 hours 25 minutes, giving in all 29·4 mm of rain. Three distinct squalls from northwesterly direction with wind speeds of 35, 50 and 35 knots were recorded at 1725 and 2100 IST of 26th and 0440 IST of 27th respectively. On 27 March 1959, a series of fresh thunderstorms broke out, one of them giving hail at 1429 IST with a northnorthwesterly squall, speed exceeding 35 knots. An active secondary western disturbance was seen to be moving eastwards from northeast Madhya Pradesh to south Bihar, West Bengal and thence towards lower Assam. Agartala experienced this unusually long spell of thunderstorm activity when the secondary western disturbance, in course of its movement, remained stationary over Gangetic West Bengal.

Agartala experienced another long spell of thunderstorm activity for 11 hours 10 minutes commencing from 0220 IST of 5 September 1957. A monsoon depression originating in the northwest angle of the Bay of Bengal and moving in a northwesterly direction was centred near Lat. 28°N, Long. 79°E at 1730 IST of 4 September 1957: while it was moving further in a northwesterly direction, conditions were simultaneously becoming markedly unsettled in the West Central Bay of Bengal. These developments resulted in a weak pressure field over Assam. Upper winds over Agartala became very weak right up to 15000 ft. The resulting thunderstorm gave about 71 mm of rain at Agartala airfield.

Persistence of thundery activity for 10½ hours on 29 August 1958 was seen to have occurred in association with the

TABLE 6

Rainfall (mm) associated with thunderstorms

	1957		1958		1959	
	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
Jan	66·0	23·9	1·3	0·8	38·4	35·8
Feb	49·8	24·1	76·8	85·9	23·1	18·8
Mar	1·6	Trace	26·4	14·2	158·2	153·8
Apr	35·1	35·1	133·2	132·7	162·8	158·2
May	271·6	267·8	362·7	318·3	223·4	185·6
Jun	377·4	288·3	163·4	117·7	190·4	96·6
Jul	264·9	54·1	203·4	111·7	475·0	342·1
Aug	297·7	266·4	314·3	46·3	369·5	143·6
Sep	192·8	136·9	323·2	204·1	219·3	120·1
Oct	48·0	29·7	220·8	131·4	414·7	255·2
Nov	..	..	7·9	..	..	..
Dec	0·5	..	..	..	..	..

(*a*) Total rain during the month (*b*) Rain associated with thunderstorms

easterlies of a depression that developed over west central Bay of Bengal. Some of the premonsoon thunderstorms in May at Agartala also were found to have long durations. A thunderstorm which commenced at 1410 IST of 6 May 1958 persisted upto 0215 IST of 7 May.

(*vii*) An attempt has been made to find out the amount of rain associated with thunderstorms at Agartala. It is seen that during the years 1957, 1958 and 1959, out of total rainfall of 1605·4, 1832·2 and 2274·8 mm at this station, as much as 1126·3, 1163·1 and 1509·8 mm of rain occurred in association with thundery conditions, giving a percentage of 70, 63 and 66 respectively. Thus, nearly 66 per cent of the total rainfall at Agartala is associated with thunderstorms. Almost all the rainfall in March, April and May occurs as a result of thunderstorms. In the monsoon months from June to September, about 56 per cent of the total rainfall was seen to have occurred in association with thunderstorms.

Table 6 brings out this result clearly.