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Fog over Agartala Airfield

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(*Received 24 June 1958*)

ABSTRACT. An analysis of fog formation at Agartala regarding commencement, dispersal and duration has been made and its contributory factors discussed.

1. Introduction

That fog is one of the major aviation hazards is a well-known fact. Its effect on aviation is particularly significant in a State like Tripura where economic life depends to a very large extent on the efficient operation and maintenance of a freighter service.

The watch hours at Agartala, which is the principal airport in the state, are from 0400 to 1830 IST. In order to make maximum use of daylight hours and also with a view to make intensive utilization of available aircraft, it is imperative that aircraft should start operating very early in the morning and for this purpose a correct idea of the landing conditions at Agartala early in the morning should be available in advance.

It is in this context that a study of fog over Agartala airfield has been considered worthwhile and has been undertaken. Though the present study covers only one season, it is felt that the results may be taken to be fairly representative considering the large number of occasions when fog occurred.

The fog at Agartala often commences as a thin stratus layer through which sky is visible and this slowly settles down.

2. Location of Agartala airport

Agartala (Lat. 23°53′ N, Long. 91°15′E) is about 100 miles from the sea and the airfield is in a flat country with distant trees. There is no marshy land in the vicinity nor are there any sources of industrial smoke near by. The nearest large river is Meghna about 20 miles away to the W/SW. Fig.1 indicates the topography of Agartala.

Agartala is the only 1st class observatory in Tripura. The nearest observatory at Kailasahar, 51 nautical miles away, is a non-instrumental one. The nearest observatories from which night observations are available, are all more than 150 miles away.

3. Fog Season

Fog generally occurs at Agartala during the period October to March. Occasionally a few instances of fog may occur in September and April also. It occurs only in the early morning hours.

4. Sources of data

The data used in this study have been collected mostly from current weather registers, pocket registers, monthly meteorological registers and monthly summaries of Agartala. Data regarding Dacca have been extracted from the current weather reports of that station received as a routine at Agartala. Data regarding fog at Dum Dum have been obtained from the meteorological office there.

The thermograph at the station was not in proper working condition during the period considered in this study, and hence hourly dry bulb and dew point temperatures were recorded daily from 2100 GMT and 0300 GMT during the fog season and these have been utilised where necessary.

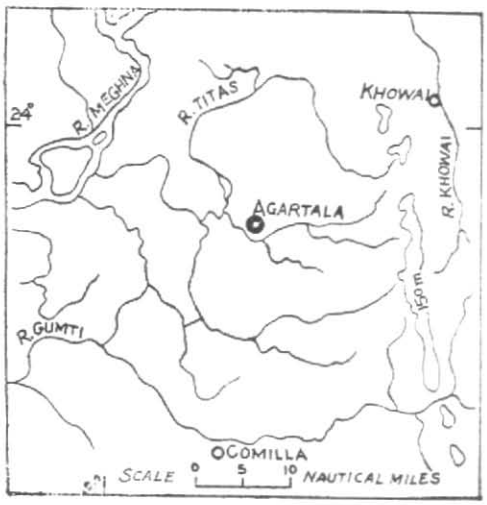

Fig. 1. Topography of Agartala

There is no radiosonde station at Agartala and hence inversion data were not available. Thus, except for the broad synoptic features and local factors, no other useful observations were available.

5. Frequency of occurrence

The distribution of fog days monthwise during the fog season of 1957–58 is indicated in Table 1.

It may be seen from the table that the frequency distribution is almost uniform except for the months of September and October.

6. Times of onset and dissipation of fog

The hourly distribution of the times of onset and dissipation of fog at Agartala shown in Tables 2 and 3 also indicates some interesting features.

Out of a total of 23 occasions, on no less than 12 occasions fog has set in between 0501 and 0600 IST and on 5 other occasions between 0601 and 0700 IST. It would, therefore, be clear that the interval 0501 to 0700 IST is the most favourable one for the onset of fog.

A comparison of the times of onset of fog with sunrise time indicates that in the majority of cases (19 out of 23) fog set in either before sunrise or within half an hour after sunrise. Even out of these 19 occasions, 11 cases of fog commenced in the one hour interval from half an hour before to half an hour after sunrise. Only in 4 cases fog commenced more than half an hour after sunrise. On one particular occasion fog set in at 0750 IST nearly one hour and 45 minutes after sunrise.

It will be seen from Table 3 that the most favourable time for the dispersal of fog appears to be 0700-0800 IST. As is to be expected, fog dissipates generally after sunrise. Out of the 23 cases studied only on one occasion fog lifted before sunrise.

TABLE 1

No. of occasions of fog over Agartala

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Year
No. of occasions	1	1	4	5	4	5	3	23

TABLE 2

Time interval (IST)	No. of occasions when fog set in
0201 — 0300	1
0301 — 0400	2
0401 — 0500	2
0501 — 0600	12
0601 — 0700	5
0701 — 0800	1

TABLE 3

Time interval (IST)	No. of occasions when fog dissipated
0500 — 0559	1
0600 — 0659	5
0700 — 0759	11
0800 — 0859	6

TABLE 4

Name of airfield	No. of occasions of fog							
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Year
Dacca	0	0	0	2	2	2	0	6
Dum Dum	0	0	0	0	1	3	1	5
Agartala	1	1	4	5	4	5	3	23

TABLE 5

Duration	Visibility (metres)										
(hrs)	100 or less	101 to 200	201 to 300	301 to 400	401 to 500	501 to 600	601 to 700	701 to 800	801 to 900	901 or more	Total
>4	2	..	..	..	..	..	..	..	..	..	2
3 — 4	3	..	..	..	..	..	..	..	..	..	3
2 — 3	1	..	..	..	..	..	..	..	..	..	1
1 — 2	..	4	..	1	..	..	1	1	1	..	8
1 or<	2	1	..	..	1	..	..	2	2	1	9
Total	8	5	..	1	1	..	1	3	3	1	23

7. Occurrence of fog at Agartala and other neighbouring airfields

Data for Dacca and Dum Dum airfields which are the alternate aerodromes for Agartala, have been examined in order to assess their suitability for the purpose. The number of occasions when Dacca and Dum Dum were covered by fog within 2 hours of fog at Agartala were found out and the results are indicated monthwise in Table 4.

It is seen that out of 23 occasions of fog over Agartala, the number of occasions of simultaneous occurrence of fog over Dacca and Dum Dum are only 6 and 5 respectively. Thus it would appear that both are suitable as alternate aerodromes for Agartala, Dacca being better, in view of its shorter distance from Agartala.

8. Duration and intensity of fog at Agartala

The frequencies of fog classified according to the lowest visibility reached and duration have been worked out and are given in Table 5. These are also represented graphically in Figs. 2 and 3.

As is to be expected, duration of fog and the lowest visibility recorded are closely related. With higher visibility figures, duration is found to be less. Duration exceeds 2 hours only in the case of the thickest fogs. Also, frequency is actually higher in the lowest ranges of visibility which is contrary to expectations. Out of 23 occasions, visibility came to less than 200 metres on 13 occasions. The reason is perhaps that at Agartala, instances of advection-radiation fog, when thick stratus clouds settle down to ground level as fog, are fairly numerous. This type of fog at times lifts giving rise to very low stratus which may settle down to ground level for a second time as fog. This may explain why when once fog settles down, visibility suddenly comes down to very low figures. On one particular occasion, passing

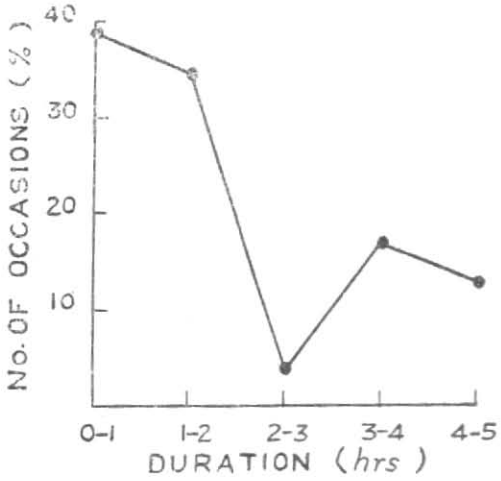

Fig. 2. Duration of fog

stratus clouds settled down as fog at 0750 IST, nearly 1 hour and 45 minutes after sunrise, suddenly reducing visibility to 500 metres.

9. Factors responsible for fog

A number of factors which may have a bearing on the formation of fog have been examined in order to determine those which may be useful in forecasting this phenomenon. As is well known, formation of fog is affected to a very large extent by purely local factors. Keeping this in view, an attempt was made to devise an objective method for forecasting fog. These results are described below. In the absence of a radiosonde station at Agartala, inversion data could not be considered.

(*i*) *Surface wind and fog*—At places like Delhi, it has been found (Kundu 1957) that the surface wind tendency shows a significant change when data are compared for a few days before and after a fog-day. This factor has, however, not proved useful in the case of Agartala. On most of the days during the season, surface wind was either calm or very light during night and early morning, and no significant change either in speed or direction could be detected on comparing wind data for a few days before and after fog occurred at Agartala.

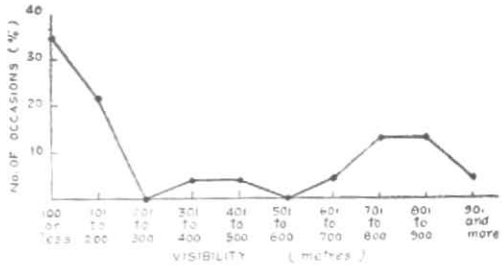

Fig. 3. Frequency distribution of lowest visibility

This is also strikingly brought out by Table 6. Table 6(*a*) gives the percentage frequencies of surface wind velocity at different hours on foggy nights alone and Table 6(*b*), the frequencies considering all days from October to March. While it is true that the percentage in the lowest range of wind velocity is high in the case of foggy nights, this is equally true in the case of other days also. Actually, hour for hour, the percentages in the range of 0-2 knots are uniformly lower in the case of foggy nights, which is contrary to expectations.

(*ii*) *Fog in relation to relative humidity, dew point temperature and dew point depression*—Even in these cases, no useful relationship could be found. A comparison of dew point temperatures and relative humidities at 1800 GMT and at the approximate times of commencement of fog for a few days before and after fog, was made. Relative humidity was generally more than 85 per cent and very often more than 90 per cent both on fog days and other days. Also, there does not seem to be any optimum range or limits of dew point temperature which favour the formation of fog as in the case of Delhi (Kundu 1957). Fog has formed with $TdTd$ values as low as 49°F and as high as 67°F.

The trend of dew point depression in the early morning hours has also not proved useful. This trend shows no significant day to day variation. Even on days of fog which could be ascribed purely to radiation, this

TABLE 6

Percentage frequencies of wind velocity at different hours

Wind velocity (knots)	Hours (GMT)						
	1030	1230	1430	1630	1830	2030	2230
	(*a*) Foggy nights						
0 — 2	26	61	65	61	69	69	74
3 — 5	35	30	26	26	22	17	17
6 — 10	39	9	9	13	9	13	9
	(*b*) All nights (October—March)						
0 — 2	34	70	72	78	82	75	75
3 — 5	35	24	23	18	15	20	20
6 — 10	27	6	4	4	3	5	4
11 — 15	4	..	..	..	..	..	..
16 or more	..	..	..	..	..	..	1

factor did not show any hourly trend which could be used in forecasting the occurrence of fog.

An attempt was also made to construct a fog prediction diagram on the lines done by Basu (1952). Dry bulb temperatures at 1800 and 2100 GMT were plotted against the corresponding dew point depressions both for fog days and non-fog days. In both cases the points were found to be rather mixed up, no distinct line of separation being observed between fog cases and others.

(*iii*) *Fog in relation to upper winds*— Upper winds at 1800 GMT which is the latest upper wind observation on which prediction of fog has to be made at Agartala every morning, were tabulated in the form of vertical cross-section diagram in order to analyse the day to day variation. These generally gave an indication of the changes in the synoptic situation such as passage of low pressure areas, consequent advection of moisture in the lower levels etc. To this extent these were found useful. One interesting feature in this connection is that there were some occasions of fog even when wind speeds in the lower levels were of the order of 20 knots. These are further discussed in the subsequent paragraphs.

(*iv*) *Fog in relation to 1800 GMT pressure difference between Dum Dum and Agartala*— It has been shown (Basu 1952) that a high in the head Bay or extending to the head Bay influences the formation of fog at Dum Dum. Agartala which is about 200 miles northeast of Dum Dum is affected by more or less the same pressure systems. By an extension of the fact indicated above, a higher pressure value at Dum Dum compared to Agartala may be expected to influence fog formation at Agartala. On this basis, an attempt was made to develop an objective method of forecasting fog at Agartala. The difference of pressure between Agartala and Dum Dum at 1800 GMT (Pressure of Calcutta minus pressure of Agartala) during the fog season were found out. It was seen that in 22 out of 23 fog days at Agartala, the pressure difference was 0 or positive (0 on two occasions and positive on 20 occasions). There was one day of fog when the pressure difference was negative but even on this occasion visibility came down to just 1 km and this remained for only half an hour.

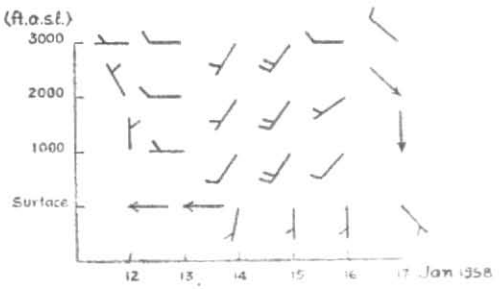

Fig. 4. 1800 GMT winds over Agartala

	Associated weather—	
15 Jan	Morning	Fog
16 Jan	Morning	Low stratus
17 Jan	Morning	Fog
18 Jan	Morning	Mist

Though this gives only a negative indication, yet it seems to be important enough to be of help in forecasting fog at Agartala when other conditions are favourable.

10. Synoptic situation associated with fog

An examination of the synoptic situation associated with the formation of fog at Agartala indicates that occasions of fog at Agartala fall into two broad categories *viz.*, (*i*) those associated with western disturbances, which form roughly about 75 per cent of the cases and (*ii*) those which are not associated with western disturbances. Those falling under category (*i*) may be further subdivided into two classes, one, advection-radiation fog associated with the approach of western disturbances and secondaries and the other, radiation fog after the passage of western disturbances. These are considered in detail below.

(*i*) *Fog associated with approaching low pressure waves*—When a western disturbance or secondary develops to the west of Calcutta and gradually moves in some easterly direction, the upper winds over Agartala which are usually W NW, begin to back and become strong S SW especially in the lower layers. A simultaneous intensification of the high over the Bay helps this process. The consequent advection of moist air, favours the formation of stratus clouds in the early morning hours. This stratus cloud often settles down to ground as fog if surface wind also remains weak. As already indicated, fog sets in very suddenly in such cases. Also, it is this type which persists for a long time and even when fog lifts, very low clouds persist for some more time.

Sometimes when surface wind is also strong, the stratus remains as such with base as low as 180 ft at times. This type of weather persists until the low moves off. Sometimes the low causes some rain and sometimes only clouding.

One typical example of such a sequence of weather may be cited here. A low pressure area approached Assam area on 14 January 1958. Upper winds at Agartala which were westerly, backed to SW upto 3000 ft at 1800 GMT of 14th. 6-7 oktas high and medium clouds covered the sky during day time but the sky cleared at night. Next morning 6 oktas of *St* formed at 0530 IST and settled down as fog at 0600 IST. Fog lifted at 0810 IST but low clouds persisted till 1030 IST.

Upper winds further strengthened on 15th. There was *Cb* formation at night and next morning stratus again formed. But presumably because surface wind was strong the stratus clouds persisted as such.

Heavy clouding persisted during 16th with *Cb* formation and rain. Again the sky cleared during the course of the night and on 17th morning stratus clouds formed and settled down as fog reducing visibility to less than 100 metres. The low moved off on this day. Sky cleared, and upper winds weakened and began to veer. On the 18th morning the residual moisture gave mist. The change in the 1800 GMT upper winds on these days is shown in Fig. 4.

When a disturbance moves away and the sky clears during night, the residual moisture with nocturnal cooling is sometimes sufficient to cause thick fog. Visibility in some

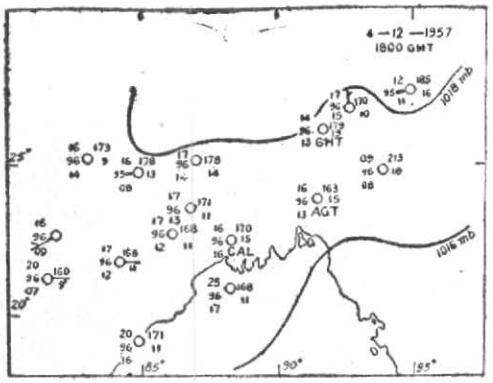

Fig. 5

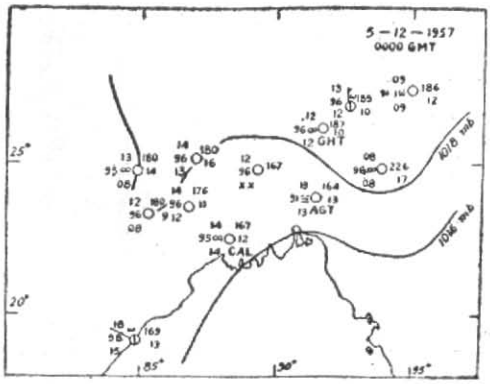

Fig. 6

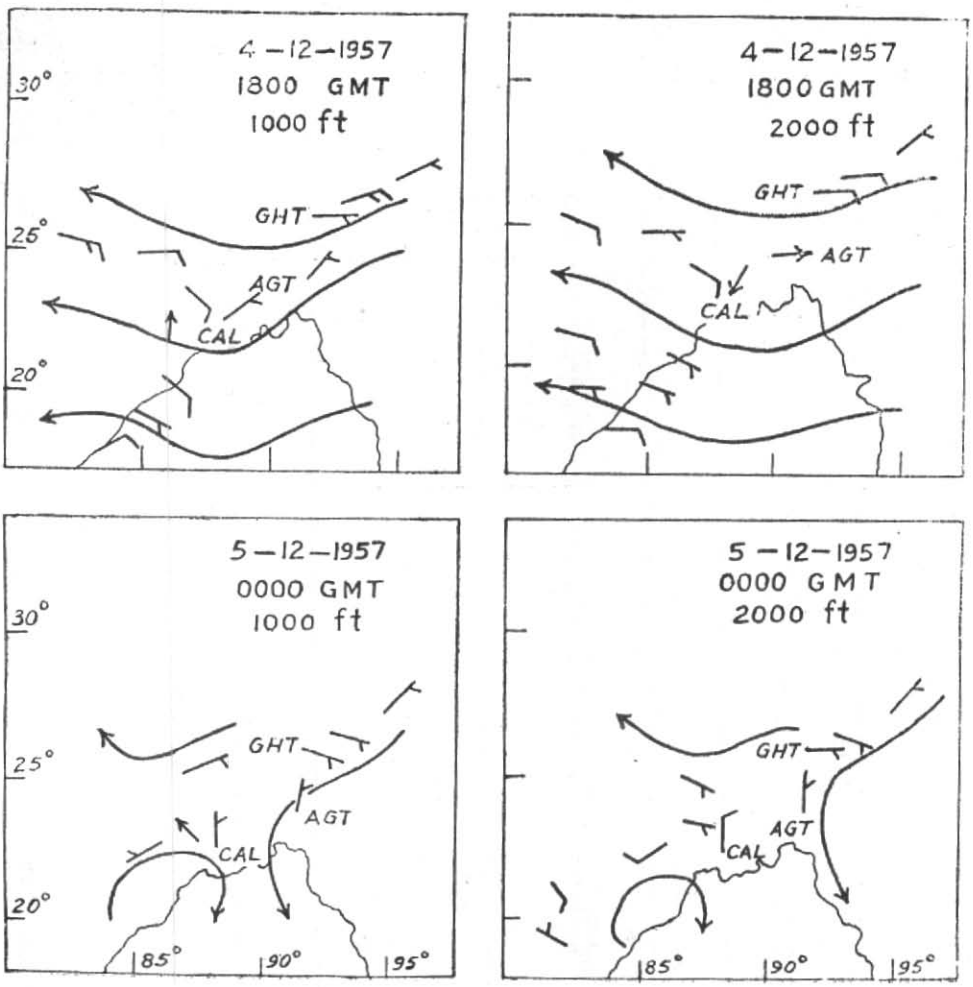

Fig. 7

such cases, comes down to as low as 100 metres. A typical instance is the fog on 11 December 1957. In such cases, upper winds clearly indicate the passing away of the disturbance.

A western disturbance moved over Assam area on 9-10 December 1957 giving some rain at Agartala on 10th. The sky cleared during that night. Upper winds upto 3000 ft which were light easterlies at 1800 GMT on 9th changed to westerly 5 knots at 1800 GMT of 10th indicating that the disturbance had moved away. Thick fog formed on 11th morning reducing visibility to 200 metres.

(*ii*) *Fog not associated with western disturbances*—In roughly about 25 per cent of the cases, synoptic situations and observations at Agartala did not indicate the possibility of fog. There were 4 instances when very thick fog settled over the station with no prior indication on the synoptic charts.

On one occasion (5 December 1957), fog commenced as early as 0300 IST and persisted till 0748 IST (*i.e.*, for nearly 5 hours). Most of this period, visibility remained as low as 100 metres.

The surface charts at 1800 GMT on 4th and 0000 GMT on 5th are given in Figs. 5 and 6 respectively. Fig 7 shows the upper winds at 1000 and 2000 ft at 1800 GMT of 4th and 0000 GMT of 5th. It will be seen that the synoptic features do not indicate the possibility of fog on this occasion. Perhaps some topographical feature not known to us is responsible for causing these fogs.

REFERENCES

Basu, S. C.	1952	*Indian, J. Met. Geophys.*, 3, 4, pp. 281-287.
Kundu, T. K.	1957	*Ibid.*, 8, 3, pp. 298-301.