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ON LIFTING OF FOG AT CALCUTTA AIRPORT

Early morning fog is most common at Calcutta airport in January and less frequent in February and December. The frequency of occurrence is still less in October, November and March (Table 1). Incidentally early morning hours are also the busiest hours of the day at this airport. Quite often the incidence of fog poses a serious problem to operators and inconvenience to passengers waiting for the take off. As such all concerned are interested in information on lifting of fog at the earliest. Thus, an accurate forecast of lifting of fog is of great importance so far as aviation forecasting is concerned.

A number of workers (Roy 1951, Basu 1952, Basu 1954, Majumdar 1957) have studied the occurrence of fog at Calcutta airport with special reference to its causes and frequency. Chakrabortty (1955) has studied the time of onset of fog based upon 1500 UTC (Co-ordinated Universal Time) radiosonde observations being taken at that time. But no attempt has so far been made for prediction of lifting of fog which is so important operationally.

In the present article we have suggested a simple working rule on lifting of fog which can be followed for improving trend forecast that is appended to each half hourly METAR (Met. Report) or SPECI (Special Met. Report). These are also termed as "Take off and landing forecast".

2. Fog is generally classified into four categories as follows :

(*i*) *Light fog* — Visibility less than 1000 m but more than 500 m.

(*ii*) *Moderate fog* — Visibility less than 500 m but more than 200 m.

(*iii*) *Thick fog* — Visibility less than 200 m but more than 50 m.

(*iv*) *Very thick fog* — Visibility less than 50 m.

A histogram showing distribution of fog of different types in each month is indicated in Fig. 1. It is observed that frequencies of light and moderate fog are almost equal in December but in January moderate fog is more frequent than light fog. Frequencies of thick and very thick fog are also more in January. Overall frequencies of light, moderate, thick and very thick fog are found to be 46, 39, 12 and 3 respectively. Persistence of fog is found to be more during 00-02 UTC compared to other hours (Table 3).

As visibility status during the next 2 hours is indicated in the trend forecast, distribution of the duration of fog for 2 hours or more have been studied (Table 2). It is observed that duration, more than 2 hours but less than 4 hours, is more frequent (36%). Number of occasions of longer duration fog are maximum in January. On 44% occasions of fog days in January persisted for 8-10 hours. Persistence of fog for more than 8 hours is also significantly higher in December. Thus, fog is likely to last longer in January and December compared to other months.

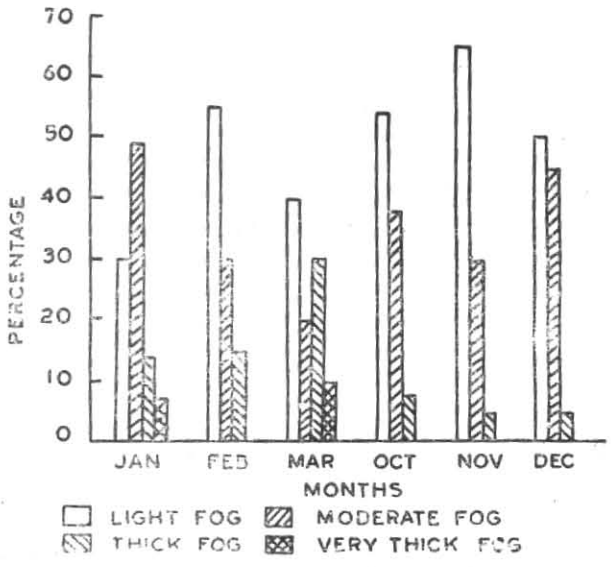

Fig. 1. Histogram of fog intensity

TABLE 1
Frequency of fog

Month	Year			Average
	1984	1985	1986	
January	22	23	15	20
February	12	14	7	11
March	3	4	3	3
October	6	6	1	4
November	5	10	5	7
December	15	14	9	13

TABLE 2
Distribution of fog duration

Duration (hr)	Jan	Feb	Mar	Oct	Nov	Dec	Total	%
2-4	15	9	8	4	14	12	62	36
4-6	7	8	1	2	3	5	26	15
6-8	7	8	1	5	3	7	31	18
8-10	26	7	0	2	0	13	48	27
>10	5	1	0	0	0	1	7	4
Total	60	33	10	13	20	38	174	100

TABLE 3
Persistence of fog at different hours of the night
(Monthly average)

Month	Time (UTC)				
	18-20	20-22	22-24	00-02	02-04
January	12	12	13	17	3
February	4	6	8	9	1
March	0	0	1	3	0
October	1	3	3	3	0
November	2	2	2	4	1
December	8	9	9	10	1
Total	27	32	36	46	6

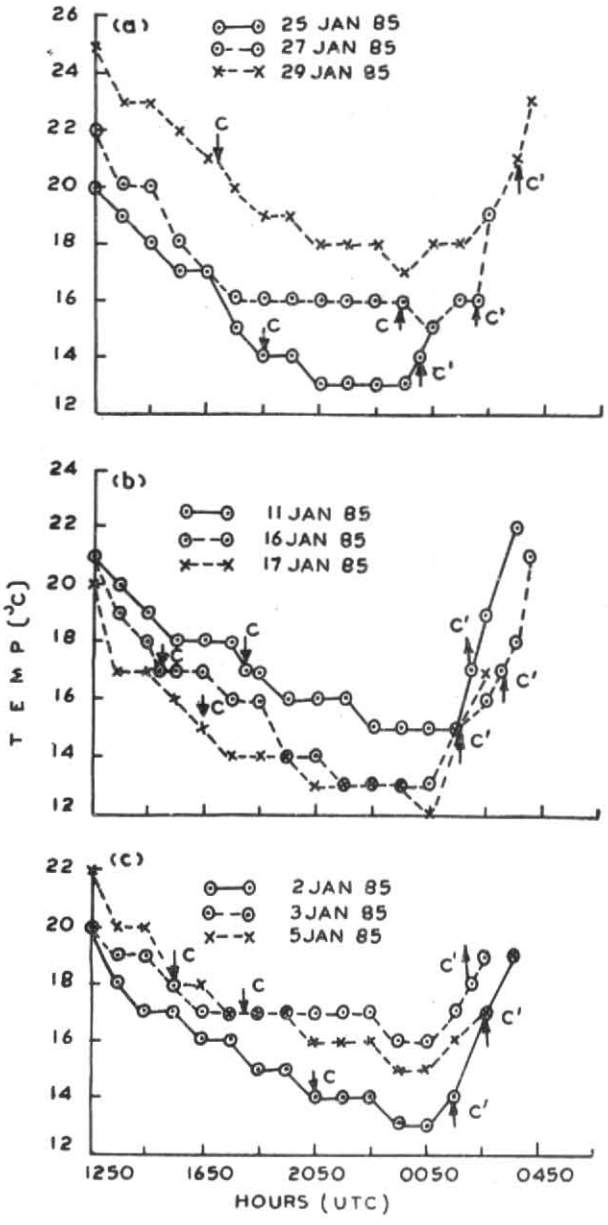

Fig. 2. Maps of temperature

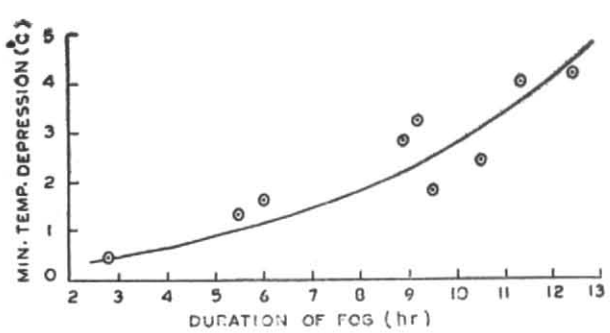

Fig. 3. Min. Temp. depression *vs.* duration of fog

TABLE 4

Date (Jan '85)	Temp. (°C)/ time (UTC) at C	Temp. (°C)/ time (UTC) at C'	Fog lifted at (UTC)	Duration h m	Dif. of C & Min Temp. (°C)	Duration from curve h m
2	15 (2050)	15 (0150)	0320	06 30	1.6	07 30
3	18 (1550)	18 (0220)	0220	10 30	2.4	09 20
5	17 (1820)	17 (0250)	0350	09 30	1.8	08 00
11	17 (1820)	17 (0230)	0315	08 55	2.8	10 00
16	17 (1525)	17 (0320)	0350	12 25	4.2	12 00
17	15 (1710)	15 (0150)	0220	09 10	3.2	10 40
25	14 (1850)	14 (0020)	0020	05 30	1.3	06 30
27	16 (2350)	16 (0220)	0240	02 50	0.4	02 50
29	21 (1710)	21 (0350)	0430	11 20	4.0	10 45

3. As is evident from Tables 1 and 2 and Fig. 1 frequency of occurrence of fog, its intensity and duration are all maximum in the month of January. Hence, some typical cases of longer duration fog during January 1985 were examined critically. It was found that very thick fog occurred on two days (16th & 29th), thick fog on three days (2nd, 5th and 27th) and moderate and light fog on 9 days each. There had been no fog on rest 8 days.

Scrutiny of tephigrams showed that 1200 UTC Environmental Lapse Rate (ELR) at the lowest levels was almost dry-adiabatic on all days except on 1st having ELR 4° C/km when light fog of very short duration occurred. At 0000 UTC isothermal or inversion layer prevailed upto about lowest 500 m except on three occasions when temperature fell by 2-3°C within this layer. Light fog of short duration occurred on all those days. Strong inversion of 3-6°C upto the lowest 500 m followed by almost similar fall upto the next 500 m above it, was found on 8 occasions, out of which moderate fog occurred on 5 days and light fog on 3 days. On days of even thick or very thick fog almost isothermal layer prevailed upto about 1 km a.s.l. On 30th isothermal layer upto about 1 km a.s.l. and 1°C inversion thereafter upto 1.5 km a.s.l. produced light fog of 8 hours duration compared to very thick fog on 29th where there was an inversion of 2°C upto 500 m a.s.l. and a fall of 3°C thereafter upto about 1 km a.s.l.

On very thick fog days on 16th and 29th synoptic situations played important roles. Calcutta airport experienced thunderstorm on 16th morning. In addition to that under the influence of an anticyclonic circulation at 0.9 km a.s.l. over north Orissa and adjoining areas northwesterly wind prevailed upto 1.5 km a.s.l. This helped rapid fall of temperature and fog occurred due to radiational cooling. Minimum temperature was 3.8 degrees lower than previous day's value. Visibility went down to zero between 0120 & 0250 UTC and the fog lasted for 12 hours 25 minutes and lifted at 0920 IST on 17th. On 29th on the other hand, very thick fog occurred due to moisture advection under the influence of a trough extending from submontane Bihar to north coastal Orissa upto 0.6 km a.s.l. Fog started late (1710 UTC) because of high 1200 UTC temperature (26° C) and

appreciable dew point depression (8°C). However, fog lasted for 11 hours and 20 minutes and lifted at 1000 IST.

On thick fog days (2nd, 5th and 27th) also synoptic situations such as low over Bihar plains and adjoining areas, anticyclonic circulations over north Bay etc were favourably advecting moisture over Calcutta. Radiational cooling also enhanced when there were clear skies.

Thus, although stable lower layers are essential for formation of fog, strong inversion or the vertical extent of the stable layer do not seem to play much significant role in deciding either the intensity or the duration of the fog. Synoptic situations, on the other hand, play decisive role on intensity and duration of fog by advection of more moisture and by causing more radiational cooling.

4. Forecasting of duration of fog is a difficult job. 1200 UTC radiosonde observations are not of much help except in, probably, prediction of commencement of fog and 0000 UTC observations are received late when on most occasions fog ceases to exist. The only observational data available with the forecaster is half-hourly/hourly surface observations indicating the march of temperature, humidity and surface wind. Forecasters use these data for qualitative indication of lifting of fog. So attempt was made to find out some criterion to forecast lifting more objectively, once fog has already formed.

Careful study of the march of temperature (Fig. 2) shows that just after formation of fog temperature goes down slowly and starts rising only before lifting and at that phase the rise of temperature is quite abrupt. We have identified two temperatures C and C', where, C is the temperature at which fog starts and C' is the temperature which is more or less equal to C but on the rising leg of the temperature curve. The data for the month of January 1985 have been enumerated in Table 4. It is observed that fog generally disperses within one hour of attaining the temperature C'. So once fog has commenced we may look for the temperature C' to attain and indicate lifting within one hour in the trend forecast. The prevailing surface wind and the trend in changes in temperature and dew point are readily available in airport instruments panel. These observations and the knowledge of local sun rise time can be suitably manipulated to predict C' and thus, forecast time can be enhanced.

5. Duration of fog was also found to depend upon the minimum temperature during the fog nights. We have studied the relation between duration of fog and the dipping of minimum temperature from the fog temperature C. This is indicated in Fig. 3 by a mean curve which may very well be considered as a prediction diagram. This can be utilised for forecasting the lifting of fog of longer duration once the minimum temperature is known. The standard deviation of the curve is one hour.

6. The authors are thankful to Shri C. M. Barma, Director, Meteorological Office, Calcutta for taking keen interest in the study.

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