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Horizontal convergence as a factor for forecasting fog or stratus

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ABSTRACT. Influence of horizontal convergence in the surface layers bounded by thermal inversion on formation of radiation fog at Palam, Santacruz and Begumpet during the winter 1960-61 is studied in this note.

Gangopadhyaya and George (1959) have suggested that horizontal convergence within the surface inversion was an additional factor which favoured formation of radiation fog or stratus at Calcutta (Dum Dum). Besides causing accumulation and sustained cooling of the converging air capped by the ground inversion, horizontal convergence of air flow had also the role of increasing moisture advection in the region studied by them. This obviously could apply only to coastal places where sea breeze contributed chiefly to the convergence. Owing to the complexity of forecasting fog—a major aviation hazard during winter—the approach made by them was applied in this note to study the incidence of fog at three other aerodrome stations—Palam, Santacruz and Begumpet and the results are summarised below.

For computing the horizontal convergence by Bellamy's (1949) method, the following triangular networks of pilot balloon stations were chosen in the absence of a closer network of pibals— Ambala, Jaipur and Lucknow for Palam; Vengurla, Chikalthana and Veraval for Santacruz; and Gadag, Gannavaram and Nagpur for Begumpet. On days when no wind data were available at any one of the grid-stations, a suitable neighbouring alternate station reporting the wind was chosen, *e.g.*, Bareilly for Lucknow. Upper winds at 0·9 km a.s.l. were chosen for the latter two grids while winds at 0·6 km a.s.l. were used for computing the convergence in the case of Palam. The horizontal divergence obtained within the triangular grids was assumed to apply to the stations which are approximately at the orthocentre of the respective triangular grids. The normal heights of the surface inversion were found to extend upto about 1 km a.s.l. at all the three stations. This justifies the choice of the winds as stated above to obtain the horizontal divergence within the surface inversion over the stations. The latter was computed for 1200 and 1800 GMT of the day previous to fog formation and for 0000 GMT of the day when fog or stratus actually developed over the stations. The computed values of horizontal divergence and the days of fog are given in Table 1. It is clear that horizontal convergence of air flow within the surface inversion existed at all the stations, on all the days prior to and/or during the time of fog formation.

In order to establish that horizontal convergence of air flow within the surface layers of inversion has a positive influence on the formation of radiation fog, it is necessary to prove that in the absence of such convergence, a combination of other favourable meteorological conditions do not produce fog. To illustrate this, the horizontal divergence as well as meteorological conditions that prevailed for instance at Begumpet for each of the days in December 1960 and January 1961 were studied. The relevant values

TABLE 1

Station	Date of occurrence of fog (during winter season)	Horizontal divergence* hr^{-1}			Remarks
		Previous day		Of date 00 GMT	
		1200 GMT	1800 GMT		
Palam (New Delhi)	16 Dec 1960	—3·0	—1·0	—3·0	
	30	5·0	..	..	
	1 Jan 1961	0·0	—9·0	—9·0	Bareilly data
	18	9·0	—4·0	—11·0	
	30	—4·0	—1·0	—8·0	
	31	—6·0	6·0	—1·0	
Bombay (Santacruz)	18 Jan 1961	1·0	—5·0	—6·0	
	29	—5·0	1·0	—1·0	
Hyderabad (Begumpet)	4 Dec 1960	—4·0	—4·0	—4·0	Extrapolated from graph
	8	1·0	6·0	—1·0	
	23	0·0	—1·0	0·0	
	7 Jan 1961	—4·0	—1·0	—1·0	
	8	—3·0	—1·0	—1·0	
	14	—4·0	—5·0	—4·0	

TABLE 2

Fog and stratus at Begumpet

Date	Horizontal divergence* hr^{-1}		Meteorological conditions							Whether fog occurred or not	Weather remarks
			Temperature	Dew Point	Dew Point depression	Relative humidity	Surface wind		Cloud cover		
							Direction	Speed			
	1800 GMT	0000 GMT	(°C)	(°C)	(°C)	(%)		(kt)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dec 1960											
3	—4·0	..	20·0	19·4	0·6	96	E	3	St_3, Sc_4, Ac_1	No fog	
4	..	—4·0	20·0	19·7	0·3	98	ESE	1	St_8	Fog	Fog and stratus from 0540 to 0715 IST
7	6·0	..	21·8	15·0	6·8	65	E	5	Clear sky	No fog	..
8	..	—1·0	16·6	15·0	1·6	90	Calm	0	Clear sky	Fog	Stratus completely covered the sky from 0610 IST

*Actual values multiplied by 10^2

NOTE—Positive values are divergence and negative values convergence

TABLE 2 (*contd*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dec 1960											
15	5·0	..	16·0	14·0	2·0	88	NE	2	Ci_3	No fog	..
16	..	5·0	13·6	12·5	1·1	93	Calm	0	Ci_2	No fog	..
20	4·0	..	16·6	11·3	5·3	71	N	3	Clear sky	No fog	..
21	..	—2·0	14·6	11·0	3·6	79	Calm	0	Clear sky	No fog	..
22	—1·0	..	16·2	11·6	4·6	74	Calm	0	Clear sky	No fog	..
23	..	0	13·5	11·0	2·5	81	N	2	Clear sky	Fog at 0930 IST	Lowest min. temp. recorded; *Fog* from 0930 to 0950 IST
26	1·0	..	17·4	11·8	5·6	70	ESE	2	Clear sky	No fog	
27	..	3·0	14·6	11·0	3·6	79	Calm	0	Clear sky	No fog	
Jan 1961											
6	—1·0	..	18·8	13·4	5·4	71	Calm	0	Clear sky	No fog	
7	..	—1·0	14·6	11·8	2·8	83	Calm	0	Clear sky	Fog	Sky covered with 7/8 *St* with fog 0700-0830 IST
7	—1·0	..	19·6	12·1	7·5	62	ESE	2	Clear sky	No fog	..
8	..	—3·0	16·4	14·1	2·3	86	ESE	5	Ci_1	Fog	Fog between 0730-0826 IST and covered airport
8	—3·0	..	18·0	13·3	4·7	74	E	2	Ci_2	No fog	..
9		1·0	15·4	12·3	3·1	82	Calm	0	Ci_3	No fog	..
13	—5·0	..	18·2	13·1	5·1	72	Calm	0	Ci_2	No fog	..
14	..	—4·0	15·2	13·5	1·7	90	Calm	0	Ci_2	Fog	Fog between 0625-0730 IST
17	4·0	..	19·4	14·8	4·6	75	E	1	Ac_1, Ci_1	No fog	
18	..	1·0	15·0	13·5	1·5	91	Calm	0	Ci_6	No fog	
22	4·0	..	21·8	9·8	12·0	46	ESE	6	Ci_1	No fog	
23	..	4·0	15·0	10·7	4·3	75	Calm	0	Ac_1, Ci_1	No fog	

NOTE —Positive values denote divergence and negative values convergence

for 1800 GMT of the previous day and for 0000 GMT of date are given in Table 2. For the sake of brevity only the dates when fog actually occurred as well as dates of highest horizontal divergence (positive values) observed on days of no fog are included in this table.

It may be seen that although almost identical meteorological conditions prevailed over Begumpet on many days during the above period, fog occurred only on days when there was horizontal convergence of low level winds at 1800 GMT and/or 0000 GMT, while no fog occurred on days when there was horizontal divergence during this period.

This leads to the conclusion that, given other well-known favourable conditions, horizontal convergence of air flow within the surface layers of inversion has a positive influence on formation of radiation fog at the above stations also, just as at Calcutta (Dum Dum). It is also observed that thick mist occurred at these places particularly at Santacruz on many days, almost invariably associated with horizontal convergence of air flow in the surface layers; while no mist or fog formed on days when the air flow was divergent. A more detailed study of the bearing of horizontal convergence on incidence of fog or stratus at other important stations in India is in progress and the results will be published elsewhere.

REFERENCES

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