

Some cases of clear air turbulence

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1. In accordance with the ICAO recommendation for collection of data on turbulence, India Meteorological Department is supplying along with the flight forecast folder, blank turbulence report forms to the commanders of all aircraft flying above 3·0-km level. Recently a few cases of turbulence in clear air were reported to the Meteorological Office at Dum Dum (Calcutta). Although these reports refer to flights at not too high a level, it was considered worthwhile to present them here, because of certain interesting synoptic associations noticed and also because such turbulence reports are received only occasionally.

2. The details of the turbulence report are given in Table 1.

Except the third one, all the other cases of turbulence occurred during level flight. From the speed of the aircraft and the reported duration of the turbulence, the horizontal dimensions of the eddies in which clear air turbulence occurred, were of the order of 25 to 35 nautical miles in the first three cases.

3. The upper air charts for the nearest synoptic hour corresponding to the level at which the turbulence cases were reported are given in Figs. 1(a) to 1(d) and 2(a) to 2(d)—Figs. 1(a) to 1(d) showing the streamlines and Figs. 2(a) to 2(d), the isotherms. It is seen from these charts that on all the occasions the locality of the turbulence was close to a trough line with a sharp cyclonic wind shift.

4.1. It is now well-known that the jet-stream zones are the major areas of clear air turbulence. However, there are also other

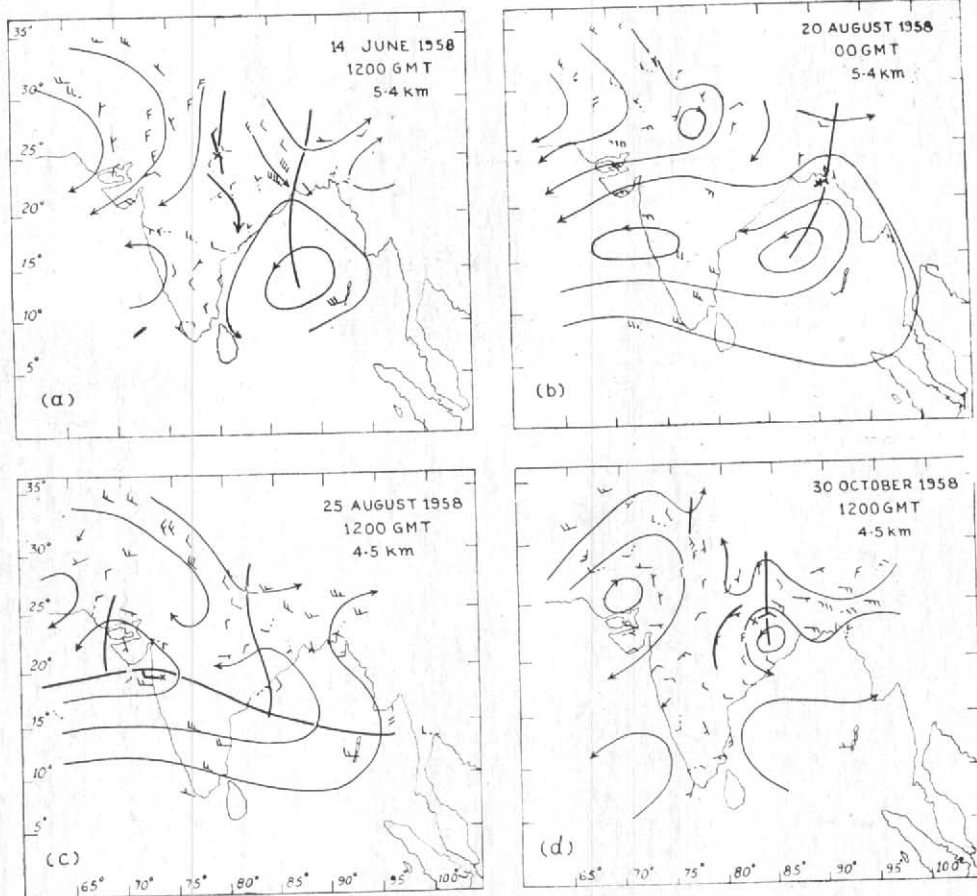
upper patterns which are associated with clear air turbulence—although the intensity and frequency in the latter cases may be comparatively less. Over Western Europe clear air turbulence has been associated with upper air depressions and troughs. The cases referred to in para 2 above also occurred very near trough lines or over areas of cyclonic circulation. From Figs. 2(a) to 2(d) it may also be seen that the locality of turbulence has been in all cases an area of significant thermal gradient, although not associated with any air mass discontinuity. The temperature gradients on these occasions were appreciable compared to the normal gradients for the locality.

4.2. From a study of Dine's meteorograph records over Agra, Sinha (1954) has shown that between 500-mb and 200-mb levels, two maxima in the incidence of clear air turbulence occur—one in August-September and the other in December. At these levels in the neighbourhood of Agra, there is a semi-permanent trough line during August-September (Riehl 1954) and also troughs in easterlies move westwards across the area (Srinivasan 1960); in December, troughs in westerlies and jet maxima move eastwards across the area. Hence one can perhaps also associate the two maxima noticed by Sinha, with the higher frequency of upper air perturbations that move across northern India at these levels during the southwest monsoon and the winter seasons.

5. The neighbourhood of upper troughs (or cyclonic circulations) with marked thermal

TABLE 1
Details of the turbulence reports

	14-6-1958	20-8-1958	25-8-1958	30-10-1958
Time (GMT) when turbulence started	1250	0712	1215	1430
Type of aircraft	DC 6B	Viscount	Viscount	L1049
Route	Karachi to Calcutta via North (ADR 433)	Calcutta to Rangoon	Bombay to Calcutta	Karachi to Calcutta (direct)
Position of aircraft	Abeam Kanpur	21°15' N 90°15' E	19°15' N 73°30' E	23° N 83° E to 23° N 87° E
Flight level	175	175	120 to 140 (Climbing rapidly)	155 (descending at end of turbulence to 100)
Indicated air speed (kts)	172	185	155	194
Intensity and characteristic of turbulence	Slight	Slight	Slight intermittent	Slight, choppy and continuous
Aircraft reaction	—	Momentary upset	Momentary upset	Wallowing
Clouds in the vicinity reported by the aircraft	3/8 large Cu, 20 n. miles from aircraft: base 10,000 ft, tops 17,000 ft	Broken stratified at 20,000 ft: scattered cumuliiform 5000 ft	Aircraft between layers of stratus	Scattered stratus approx. 7000 ft
Approx. duration of turbulence	10-15 mts	7 mts	10 mts	60 mts



Figs. 1(a) to 1(d)

Thin lines—Streamlines, Thick lines—Trough lines; x—Position where turbulence was experienced; Broken barb shows off time winds or winds at the next lower standard level; Thick barb shows wind reported by the aircraft in the neighbourhood of the turbulence zone

gradients (or cold areas), therefore, appears to be not only regions of thunderstorm activity, but also of clear air turbulence; the occurrence of clear air turbulence in these areas reported in para 2 above, is in line with similar

findings in respect of Western Europe and America. In view of the difficulties of forecasting clear air turbulence (India met. Dep. 1957), even such empirical associations, may be of some help in routine forecasting work.

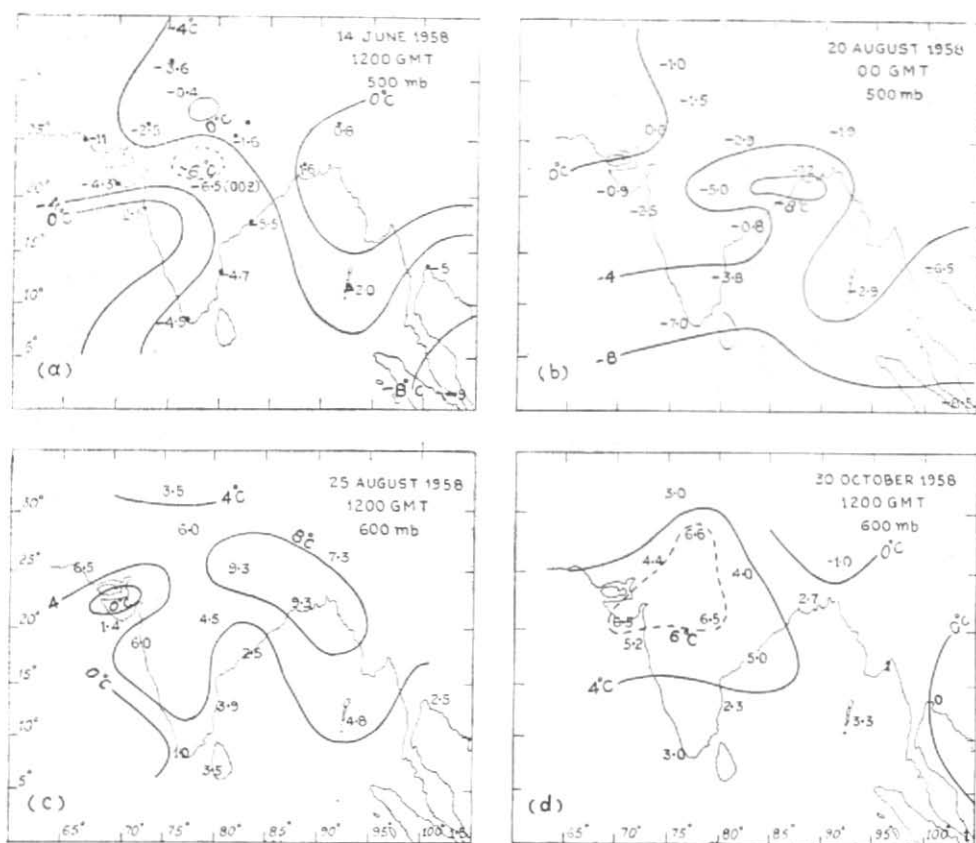


Fig. 2(a) to 2(d). Isotherms

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