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A northeasterly squall at Dum Dum airport during the pre-monsoon season of 1957–A radar study

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ABSTRACT. A northeasterly squall which struck Dum Dum airport during the pre-monsoon season of 1957 was studied with the help of the meteorological radar installed at the Meteorological Office, Dum Dum airport, Calcutta. It has been shown that the movement of the isolated *Cb* cells may be controlled by the prevailing upper winds at 10,000 ft and above. The wind currents upto 5000 ft have been found to be responsible for the movement of the northeasterly squall lines in the Gangetic West Bengal.

1. Introduction

During the pre-monsoon season (March-May), West Bengal and neighbouring places experience thundersqualls from NW which are commonly referred to as 'Nor'wester'. Thundersqualls from other directions also occur, but only on rare occasions. One such unusual thundersquall from the northeast occurred at Dum Dum airport on 3 May 1957 at 1620 IST. Earlier workers (India met. Dep. 1944) had classified this type of thundersquall as 'Type C'. During the special investigations carried out by the India Meteorological Department during April-May 1941, this type of thundersquall was only found on two days. It was suggested that these unusual thundersqualls originated from the eastern hills. However, in the case of the thundersquall that struck Dum Dum airport on 3 May 1957, radar observations indicated that it did not originate from the eastern hills. On the contrary, its first formation could be traced on the PPI scope of the Storm Detecting Radar (*Indian J. Met. Geophys.* 1954) only 40-50 miles to the northeast of Calcutta.

2. Radar observations

The equipment employed was Decca Type 41 meteorological radar. The effective range of the radar may be taken as 150 miles only although the maximum range is 250 miles.

On this particular day, no echoes were observed upto 1330 IST. At 1430 IST an isolated large *Cb* cell was observed to the west about 50 miles away; another line type echo was seen in the northeastern sector about 30-45 miles away from Dum Dum. The synoptic situation indicated that the large *Cb* cell to the west was more important as far as Dum Dum airport and its neighbourhood was concerned. It was inferred that (*a*) the individual cell to the west might develop into a squall line and move towards the station and (*b*) the squall line to the northeast would move further northeast or eastwards and would not affect the observing station. An airfield warning for a moderate northwesterly squall was issued.

The radar picture at 1445 IST (Fig. 1 a) shows an isolated cell at 270°/48 miles covering about 10 square miles and line type of echoes towards the northeast, the lie of the line being from 010°/30 miles to 080°/45 miles and extending upto 100°/60 miles. By 1520 IST, (Fig. 1 b), the large cell in the west broke up into two small cells—one moving towards the station at the rate of about 20 mph and the other remaining almost stationary. The main squall line in the northeast appeared much nearer the station—the lie of the line being from 010°/20 miles through 040°/18 miles to 090°/32 miles. By this time a modified airfield warning for a northeasterly squall of moderate intensity was issued.

The squall finally struck Dum Dum airport at 1620 IST from the northeast. Fig. 1 (d) shows the position of the squall line at

that time. The records of autographic instruments at Dum Dum airport (Fig. 2) show a typical pre-monsoon squall of moderate intensity. Alipore Observatory located 10 miles to the southwest of Dum Dum reported a thundersquall of 25 mph from east/southeast.

3. Synoptic situation

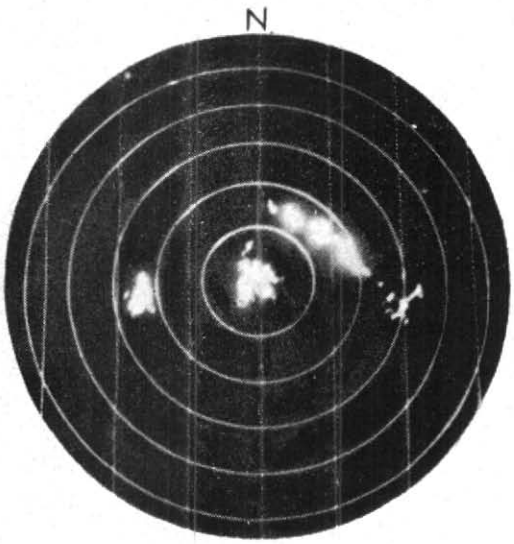
The synoptic situation on 3 May 1957 did not show any special feature favourable for the formation of a squall line to the northeast of Calcutta. A trough of low pressure passing through Calcutta from northwest to southeast was noticed on the surface chart at 0530 IST. A wind discontinuity lay to the west of Calcutta upto 3000 ft a.s. l. and to the east of Calcutta from 5000 to 7000 ft (Fig. 3). At 10,000 ft and above the wind current over northeast India was north/northwesterly. At 0830 IST (Fig. 4), 1130 and 1730 IST surface charts, the trough of low pressure was seen to be almost at the same place as at 0530 IST. But the wind field at 1130 IST showed the line of discontinuity upto 10,000 ft lying more to the east of Calcutta. The winds reported by stations in Assam at 2000 and 3000 ft were northeast/easterly, speed 15-20 knots, which decreased in speed considerably at 5000 and 7000 ft. At 10,000 ft and above, the wind field over the northeast India was predominantly westerly. It may be mentioned that the winds over Calcutta were westerly at almost all levels.

4. Discussion

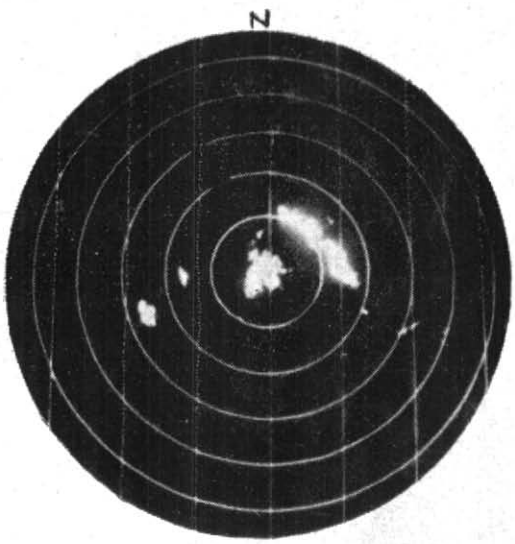
(A) *On the movement of the isolated cell in the west*—The cell noticed on the scope at 1445 IST towards west (Fig. 1a) had almost reached maturity stage with a few smaller cells close to the main ones. At 1455 IST the cell broke up into two large cells—one remained almost stationary and the other moved eastwards (towards the station) at the rate of about 15/20 mph and gradually dissipated away. The coverage of the parent cell, *i.e.*, as seen at 1445 IST 50 miles to the west (Fig. 1a), did not remain constant and at 1538 IST (Fig. 1c) its activity was very much reduced. After 1538 IST the cell was also seen to be moving eastwards at almost the same speed as that of the wind at 10,000 ft and above (*i.e.*. 15/20 mph). This is in support of the work of earlier workers (Das *et al.* 1957, Byers and Braham 1949a), who found that the movement of isolated cells may be controlled by the prevailing upper winds at 10,000 ft and above.

(B) *On the movement of the squall line*—The most interesting phenomenon in the present case is the movement of the squall line from northeast to southwest. The exact mechanism leading to the formation of the squall line about 50 miles to the northeast of Calcutta is not clearly understood. The radar photographs suggest that the squall line did not originate in the eastern hills because at 1330 IST no precipitation echo was noticed on the scope, although within an hour thereafter a solid line type echo was noticed only 30-45 miles to the northeast of Calcutta. It is worthwhile to note that winds over Calcutta did not show any marked easterly component throughout the day as can be seen from the time-section of upper winds over Dum Dum (Fig. 5). The wind field observed over Dum Dum may be assumed to hold good for the neighbouring area also. Thus, the squall line, formed within 30-40 miles and located to the northeast of Calcutta, would normally be expected to move more towards the northeast. Consequently when the first formation of the squall line was seen on the PPI scope at 1430 IST, it was thought that it would be moving towards east and the stations located to the northeast or east of Calcutta, say Agartala, might be affected by the squall line.

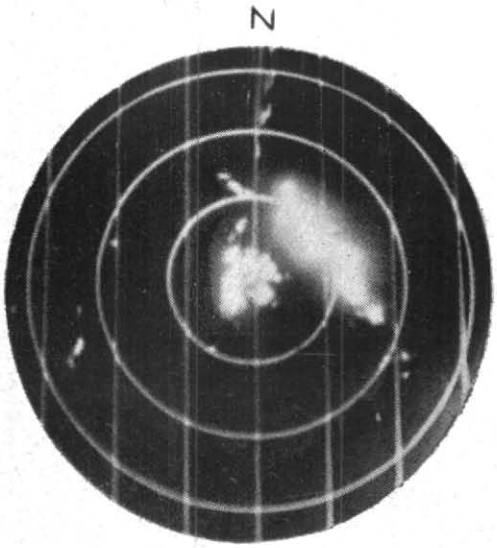
The heights of the base and the top of *Cb* cells were estimated, by tilting the aerial of the radar, to be about 2500 ft and 35,000 ft respectively. From the 1130 IST pilot balloon chart, easterly winds over stations situated to the northeast or east of Calcutta were seen only at 2000 and 3000 ft. The layer within which the clouds



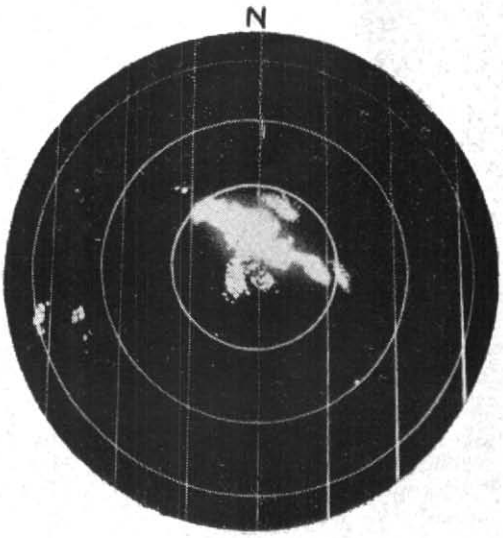
1445 Fig. 1(a) 20



1520 Fig. 1(b) 20



1538 Fig. 1(c) 20



1620 Fig. 1(d) 20

Fig. 1. PPI presentations of storm detecting radar at Dum Dum Forecasting Office on 3 May 1957

(Figures in the left and right bottom corners indicate time in IST and range rings in miles respectively)

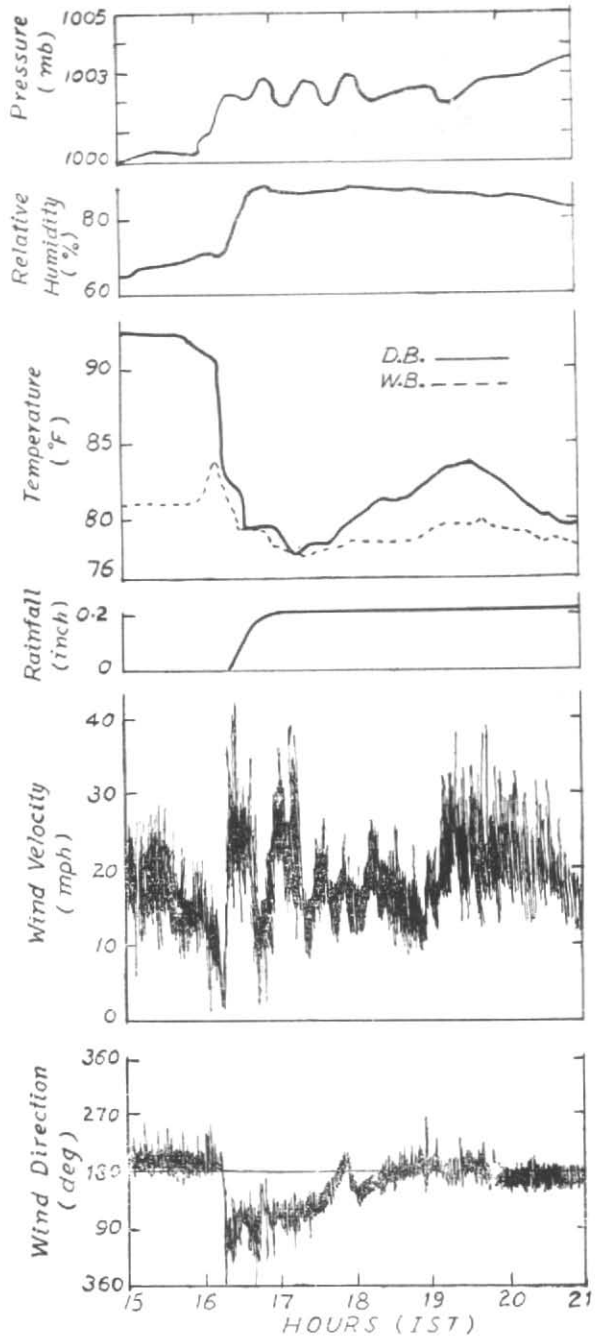


Fig. 2. Records of autographic instruments at Dum Dum Forecasting Office on 3 May 1957

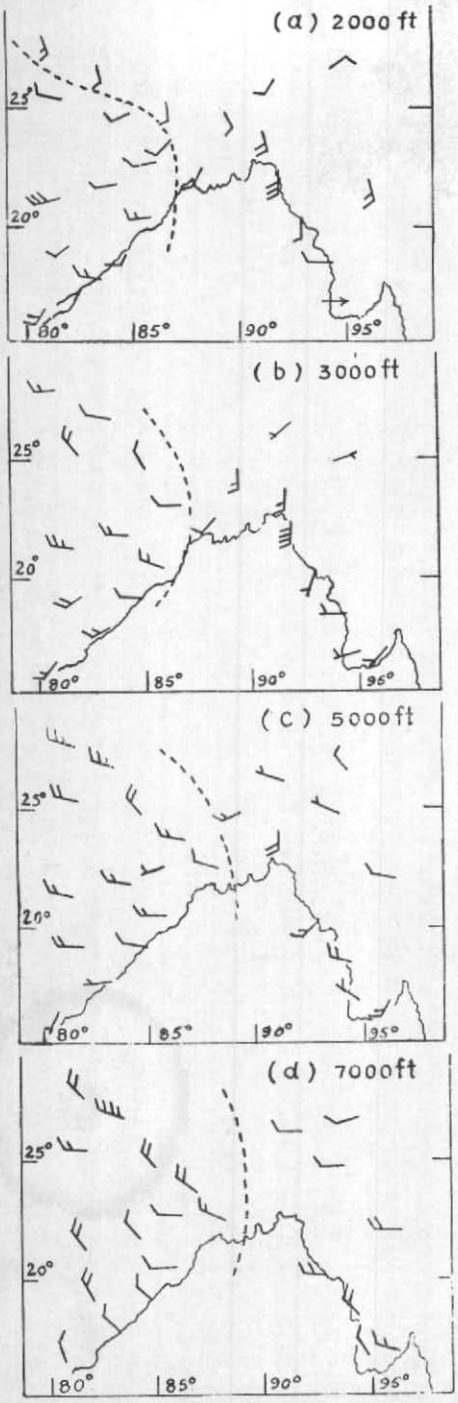


Fig. 3. The upper wind charts at 0530 IST of 3 May 1957 at 2000, 3000, 5000 and 7000 ft
(The wind discontinuity is shown by broken lines)

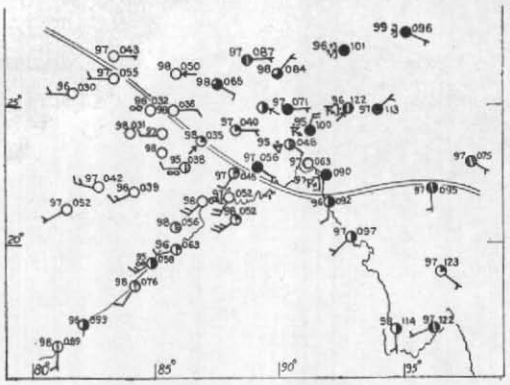


Fig. 4. Weather chart at 0830 IST of 3 May 1957
(The wind discontinuity is shown by a double line)

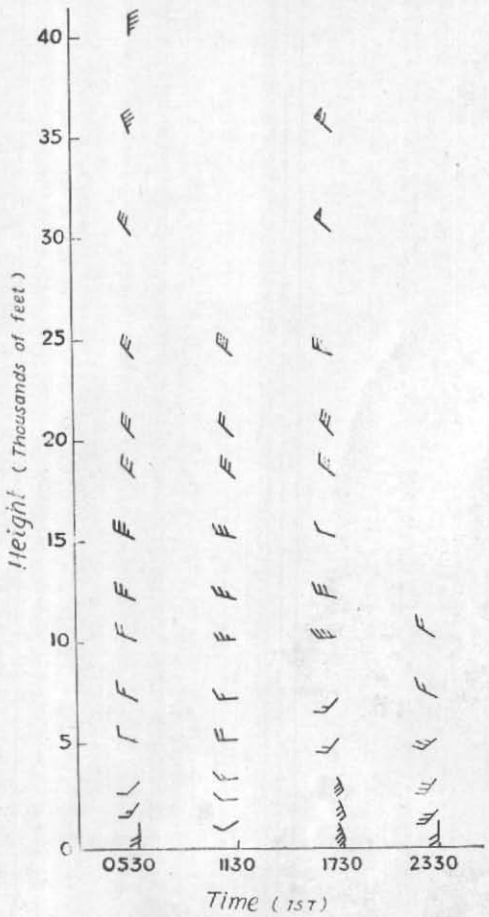


Fig. 5. Time-section of the upper winds over Dum Dum airport on 3 May 1957

were imbedded had been under the influence of two opposite wind currents, *i.e.*, (*i*) easterlies upto 3000 ft and (*ii*) westerlies above 3000 ft. If the wind aloft at 10,000 ft and above is considered the controlling factor for the movement of the squall line, the latter should have moved eastwards.

It is known (Byers and Braham 1949b) that during the building up stage of a thunderstorm cell when updrafts are predominant, the transfer of horizontal momentum to the upper layers may cause the movement of the cell to be influenced by the winds of the lower layers. But when the cells have developed, *i.e.*, during the mature stage, downdraft is more predominant and the downward transfer of horizontal momentum may cause the movement of the cell to be influenced by the winds of the upper layers. Therefore, the movement of the squall line under study should have been from west to east.

Humphreys (1940) has suggested that the vector mean wind of the layer in which cloud is imbedded corresponds to the speed and direction of the cloud movement. Though this may generally be true for isolated cells, workers in the Thunderstorm Project (Byers and Braham 1949b) observed greatest deviations from the above suggestions of Humphreys in these cases when clouds extended from a few thousand feet above ground to over 30,000 ft, and the air flow in the upper 15,000 ft was opposite to that in the lower 15,000 ft. In the present case under study, though the wind current from ground upto only 3000 ft was opposite to that above 3000 ft a similar deviation was noticed.

It is well known that the outflow of air in the downdraft of a thunderstorm forms a dome-shaped mass of cold air extending from the surface to several thousand feet. It has been observed that the mass of cold air (cold dome) spreads out considerably farther on the downwind side of the cell than on the upwind side. However, in the case under study, lower level easterly winds over the Assam area suggest that the lower layers on the downwind side were not sufficiently moist for fresh formation of cells. It is possible that availability of moist air in the lower layers to the west of the squall line might have contributed towards fresh development on that side resulting in movement of the squall line from northeast/east to southwest/west, which was opposite to the movement of the air at 10,000 ft and above.

It may be mentioned that on a number of occasions of easterly squalls at Dum Dum airport during the pre-monsoon season, a similar synoptic situation has been noticed, *viz.*, easterly wind currents upto 3000-5000 ft over the stations situated to the northeast/east of Calcutta. It would, therefore, appear that the lower level wind might have played an important role in causing northeasterly movement of the squall line.

5. Conclusion

In conclusion it may be stated that although the movement of the isolated *Cb* cells may be controlled by the prevailing upper winds at 10,000 ft and above, it does not always hold good for the movement of the squall lines, specially for northeasterly or easterly squall lines. In the latter case it has been found that wind currents upto 5000 ft are generally responsible for the movement of the squall lines in Gangetic West Bengal.

6. Acknowledgement

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REFERENCES

Byers, H. R. and Braham, R. R. 1949(a) *The Thunderstorm*, p.110.
1949(b) *Ibid.*, p. 113.
Das, P. M., De, A. C. and Gangopadhyaya, M. 1957 *Indian J. Met. Geophys.*, **8**, 4, pp. 399-406.
Humphreys, W. J. 1940 *Physics of the Air*, pp. 357-359.
India met. Dep. 1944 *Tech. Note*, 10.
1954 *Indian J. Met. Geophys.*, **5**, 3, p. 279.