Letters to the Editor

551·515·4 : 551·508·19 (541·1)

RADAR STUDY OF A PRE-MONSOON THUNDERSTORM AT AGARTALA AIRPORT

1. Radar study of a pre-monsoon thunderstorm (6 June 1964) as observed with the help of a low power storm detecting radar* installed at Agartala Airport has been made. At 1330 IST on this day, a few scattered precipitation echoes from convective clouds of tops 3·6 km were observed in the northern sector about 60 n. miles away from Agartala. By the time of the next hourly radar observation, it was noticed at 1430 IST that the echoes had increased in number and attained a height of 7·0 km. At 1530 IST the radar echoes had not only increased in number but also shown a tendency to form a broken line to the N, extending from 325°/068 to 025°/040 n. miles. The maximum height of top of the echoes was 14 km. The locations of the squall line at different times of observation are represented in a polar diagram (Fig. 1). The radarscope picture at 1630 IST shows fresh developments to the W as well as to the E, extending the line further in length. The main thunderstorm cell at 330°/062 n. miles started dissipating as inferred from its decrease in height to 11 km at 1630 IST. On the other hand, the height of the thunderstorm cell at 020°/035 n. miles increased further and reached 15 km. At 1720 IST the main cell to the N joined with the adjacent cells and showed a southerly movement of 15 knots. Their heights were declining whereas the height of the isolated cell at 280°/040 n. miles increased to 14 km. By 1745 IST two distinct lines appeared more or less at right angles to each other, one to the N and other to the W. After 17 minutes (*i.e.*, at 1802 IST) it was observed that the line to the N was moving at a speed of 15 knots (southerly) and the line to the W at 18 knots (easterly). A light rain of 3·0 mm occurred over the station from 1810 to 1820 IST from the isolated secondary cells in front of the line. The PPI picture at 1825 IST shows that the line to the N came quite close to the station while the line to the W also continued its movement to the E. It was also observed that a third line appeared at the further end of the second line.

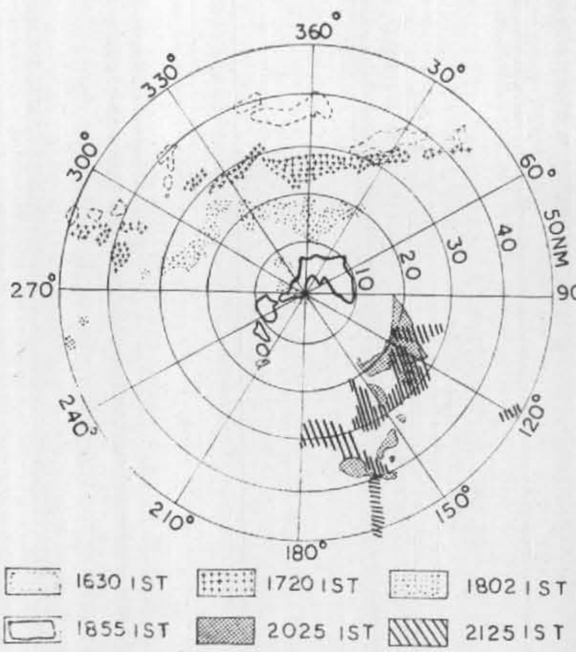

Fig. 1. PPI presentations of the Storm Detecting Radar at Agartala airport on 6 June 1964

(Range rings are 10 n. miles apart)

Heavy thundery activity around the station started by about this time. These radar pictures obtained by tilting the antenna clearly revealed the structure of the thunderstorm cells in the NW sector, just before approaching the station. The cells which came over the station took a peculiar U shape. The characteristic sharp edged and well defined echoes began to burst into fleecy rain patch type of echoes from 1856 IST onwards. The squall struck Agartala at 1900 IST from W with a maximum speed of 45 knots. As a result of the squall, the surface temperature decreased from 26°C to 22°C , the surface humidity increased from 91 per cent to 93 per cent and the surface pressure increased by 1·5 mb as seen from the records of autographic instruments at Agartala (Fig. 2). Thunderstorms with rain started over the station after the cessation of the squall.

The rainfall recorded at the observatory under the influence of the above cells was 38·4 mm. The rain patch drifted towards SE at a speed of about 20 knots and lay over SE sector at 2025 IST. The tops of echoes were still quite high

*Type Bendix WTR-1, maximum range 150 n. miles, beam width 2·9°, peak power 20 KW, p.r.f. 400 pps, wave length 3·2 cm

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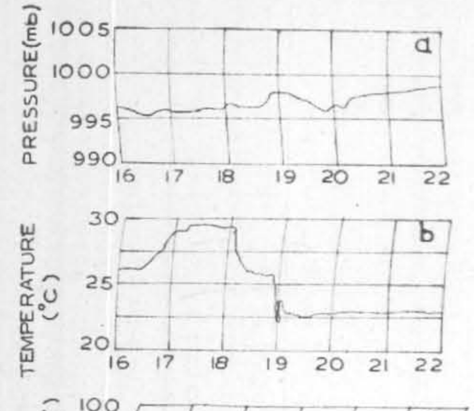

Fig. 2. Records of autographic instruments at Agartala aerodrome on 6 June 1964

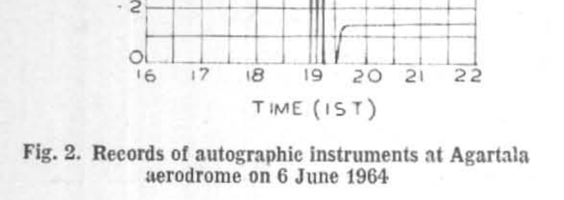

Fig. 3. Weather chart at 0830 IST of 6 June 1964

(Trough line shown by double dotted line)

(5-6 km). The radar observation at 2130 IST revealed that the echoes continued to persist in the SE sector. They, however, disappeared at 2230 IST.

2. *Synoptic situation* — The synoptic situation on the day revealed that a surface trough passed W to E along 26° N at 0830 IST (Fig. 3). 0530 IST upper air charts (Fig. 4) showed a line of wind discontinuity running along 26° N from W to E at 0·6 km. A feeble upper air trough along 88° E at 1·5 km was also noticed. The upper winds at 1130 IST showed convergence in the eastern part of India (Fig. 5). 1730 IST surface chart revealed that there were two troughs of low pressure—one passing through Dinajpur, Dhubri, Gauhati and Tezpur and the other through Malda, Dacca and Chittagong. Southwest monsoon continued to be weak and its northern limit did not advance upto NE India. There was a western disturbance which was moving away eastwards across the western Himalayas as an upper air trough. This western disturbance was responsible for the occurrence of fairly widespread rainfall over the hilly regions.

Rain and thundershower have been widespread in Bay Islands and Assam. The chief amounts of rainfall were : Cherrapunji 27·4 cm, Silchar 12·6 cm, Imphal 2·6 cm and Goalpara 1·2 cm. A hot spell of weather with maximum temperature 6°—8°C above the normal affected Bihar and adjoining parts of Gangetic West Bengal. Day temperatures were markedly below normal in lower Assam and Tripura.

3. *Discussion* — The isolated thunderstorm cell at 285°/050 n. miles observed at 1630 IST (Fig. 1) was found moving ESE at an average speed of 15 knots. The small line echo located to the W was also found to be moving E or ESE at the same speed. The wind at 3·0-km level was 280°–290°/15–20 knots. It is thus observed that isolated echoes and line type echoes of small length were drifted by the winds at 3·0-km level. This is in support of the findings of the earlier workers (Byers and Braham 1949, Das *et al.* 1957, De 1958).

The main squall line detected on the radarscope at 1630 IST (Fig. 1) towards N was found moving S or SSE at an average speed of 15 knots. This movement does not correspond to the upper winds over Agartala and neighbourhood. This shows that the movements of the squall lines might not always agree with the prevailing upper winds. It is suggested that the movements of squall lines are effected by the well known

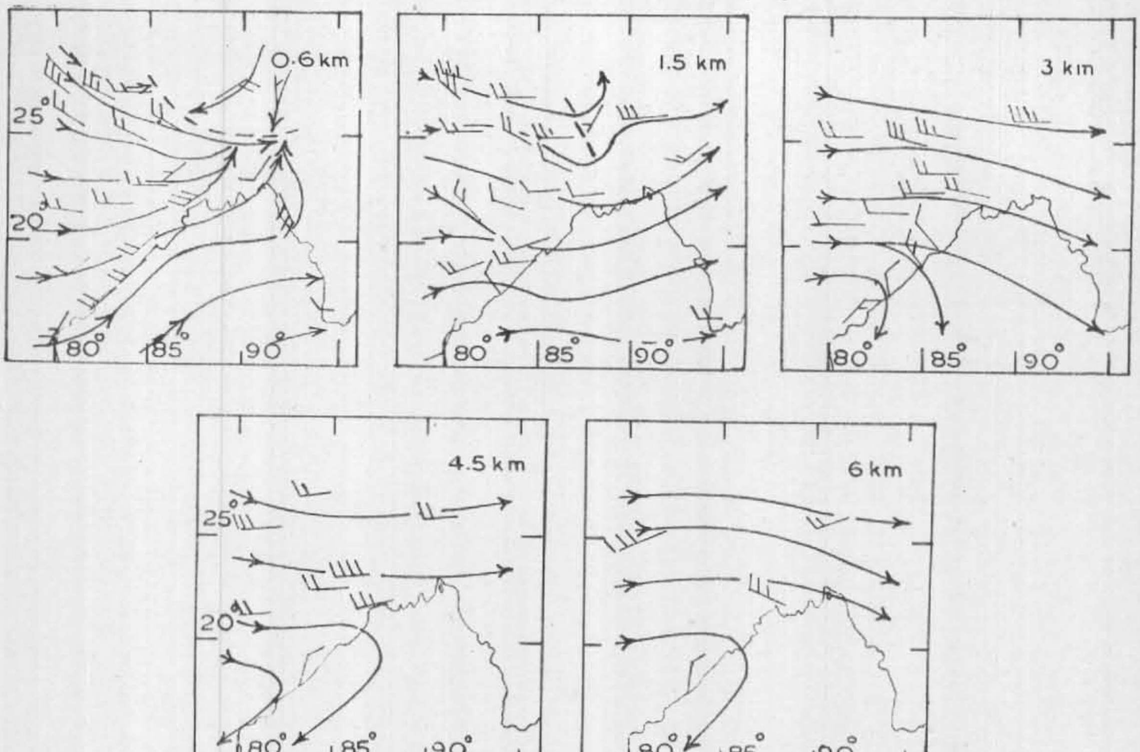

Fig. 4. Upper wind charts at 0530 IST of 6 June 1964 at 0·6, 1·5, 3, 4·5 and 6 km (wind discontinuity is shown by broken line)

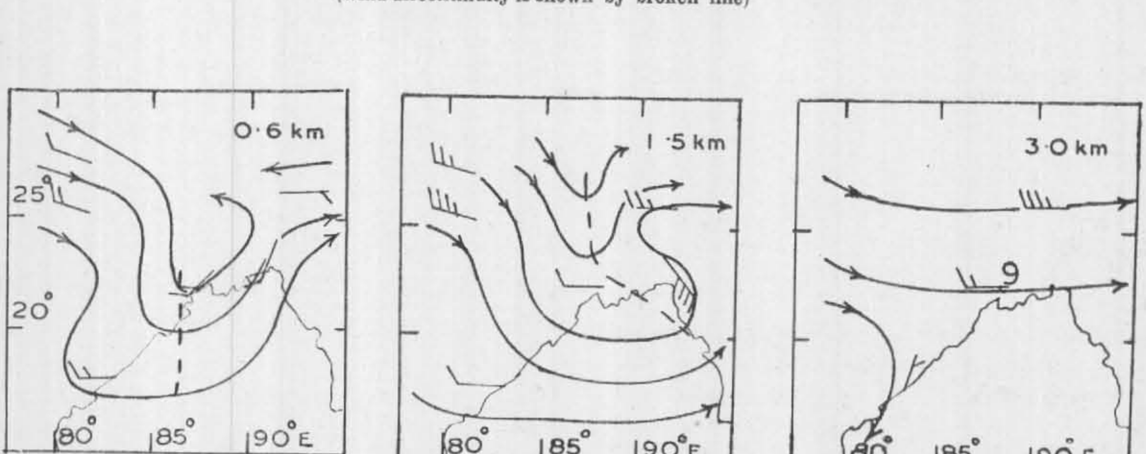

Fig. 5. Upper wind charts at 1130 IST of 6 June 1964 at 0·6, 1·5 and 3 km (wind discontinuity is shown by dotted line)

'Regeneration process' suggested by the Thunderstorm Project (1949) which envisaged the formation of fresh cells in the forward sectors caused by the outflow of cold downdraft from the parent thunderstorm cells—matured and closely located *Cb* cells formed into a line. In this particular case, as the cold downdraft moved through the warm, moist air in the Meghna valley it caused convection and new thunderstorm cells were formed. It is by generating new thunderstorm cells on the down wind side that the squall line appears to move. The formations of these new cells are not readily detectable on the radarscope probably due to the limited resolution of the radar.

It may be mentioned that such cross movements—one to the S and the other to the E—within the field of view of the radar is of particular interest to the meteorologists. Another interesting feature in regard to the movements of the echoes is that the combined line echoes as they were observed at 1925 IST moved SE. The western part of the northern line showed counter clockwise motion while the northern part of the western line showed clockwise motion. It is presumed that these were under the influence of different forces. Hence the over-all movement of the resultant line was found to be the mean of their earlier movements, *i.e.*, SE in this case. The northern portion of the western line was probably under the influence of 'translation' as well as 'propagation' due to the regeneration (Battan 1959). As a result, this portion of the line showed faster movement than any other portion of the combined line.

Though the squall line retained its identity even after a lot of thunderstorm activities and rain over the station as seen in Fig. 1 at 2025 IST, it weakened considerably as revealed by the lowering down of the echo tops. The movement of the line in the SE sector was found to be very slow. It might be due to the fact that propagation by regeneration had already ceased and it was being drifted by the translation process only related to the wind at 3·0 km. Hence, the precipitation echoes were found to be more or less stationary since 2025 IST.

4. *Conclusion* — From the above discussion the following salient features are brought out—

(*i*) 'Northers' of Agartala originate near the Garo, Khasia and Jantia hill ranges.

(*ii*) The movement of the isolated *Cb* cells and squall lines of small length might be controlled by the prevailing upper winds at 3·0 km and above.

(*iii*) The movement of the squall lines of appreciable dimension is controlled by the well known process of regeneration.

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