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# On the formation of line type angel echo

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ABSTRACT. An observation of a line type angel echo ahead of a line type of echo from strong convective clouds has been made by means of an X-band radar set at Agartala Airport. It was detected and kept under observation for about 40 minutes. The angel echo moved with an apparent horizontal speed of 56 km/hr. The angel echo appeared prior to the arrival of the downdrafts of the thunderstorm. The possible echo sources have been discussed.

## 1. Introduction

Instances of occurrence of line type angel echoes in India have been reported by Rai (1959), Kulshrestha (1961 , 1962) and Bhattacharjee *et al.* (1965). An instance of line type angel echo as observed on the low power Bendix Radar WTR-1 at Agartala Airport, Tripura has been presented in this note.

## 2. Radar Observation

On 8 June 1964 at 1730 IST the radarscope showed some isolated echoes at 320°/32 n.m. The echo was moderately strong in intensity. The top of the echo extended upto 7·8 km. By 2015 IST a squall line developed. The position of the line type echo was 220°/45 n.m. through 270°/18 n.m. to 330°/35 n.m. The echoes became very strong in intensity (Fig. la). The maximum height of the top of the echo was 9·0 km. The squall line was moving towards east while approaching the station. At 2040 IST another line type echo was observed at the back of the main squall line (Fig. 1b). At that time a short diffused and thin line type of angel echo with N-S orientation located at about 7 n.m. in front of the main squall line appeared on the radarscope. This type of angel echo was seen moving towards east along with the main squall line. After seven minutes the broken angel echo bacome a continuous one and could be seen together with the ground clutters in Fig. 1 (c). The angel echo moved further in the easterly directon and crossed the station and lay on the eastern side of the station. The radarscope picture taken at 2055 IST is shown in Fig. 1(d). The surface wind became gusty immediately after the passage of the line type angel echo over the station. After a few minutes the angel echo again became diffused and broken while maintaining its easterly movement (Fig. 1e). Out of three faint isolated remainings of the angel echo; the one in front of a sharp pointed protuberance of the main squall line was the most prominent. Faint angel echo could be traced till 2121 IST (Fig. 1f) when the main squall line started dissipating after giving rain over the station and neighbourhood.

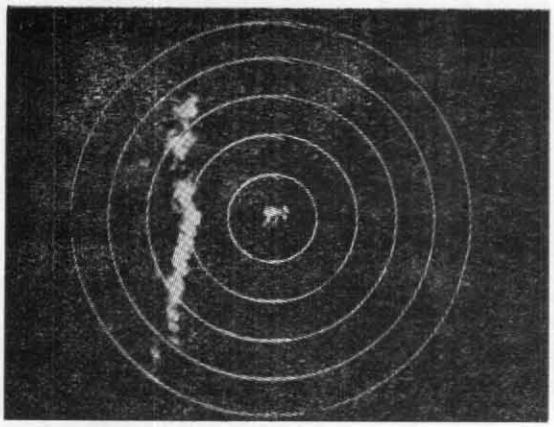
## 3. Weather condition

From about 1850 IST onwards, lightning from distant *Cb* cells at the western side, was observed from the station and at 2025 IST thunder was heard. From 1930 IST surface wind began to back from 160°/05 kt and by 2055 IST it became 260°/15 kt when the cool downdraft from the *Cb* cells arrived at the station. The surface wind was gusting to 20 kt. Temperature fell by 4°C and the humidity by 2 per cent (from 90 per cent to 88 per cent) and the pressure rose slowly by 4·4 mb (Fig. 2). A prominent hump was produced by the gradual rise and fall in the pressure values in the barograph under the influence of this spell of thunderstorm. The observatory at Agartala Airport recorded rainfall of 6 mm only during the thunderstorm.

## 4. Chief features of the angel echo

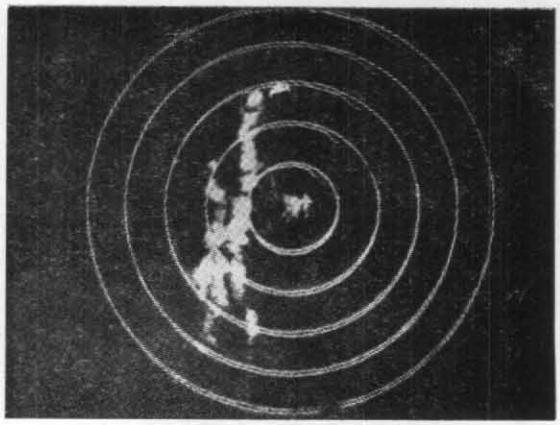
On scrutiny of the PPI photographs of radarscope in Fig. 1 the following characteristics of the observed angel echo could be brought out —

1. The angel echo was a thin line type of echo with its axis in the N-S direction almost parallel to the main squall line echo.
2. The angel echo appeared in front of the squall line echo. It maintained almost a constant distance of separation of about 7 nautical miles from the precipitation line echo.
3. When over the station, the angel echo could be observed as a continuous line of about 16 nautical miles.



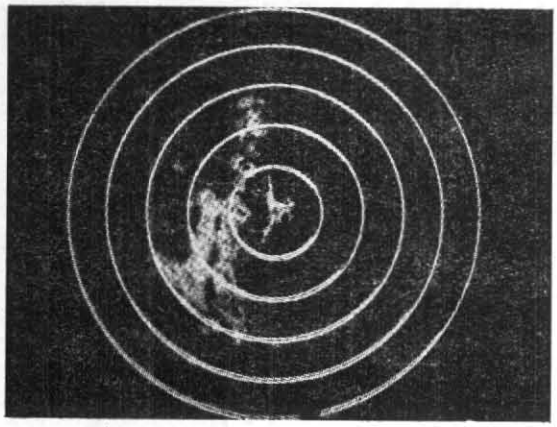
2015 10

Fig. 1 (a)



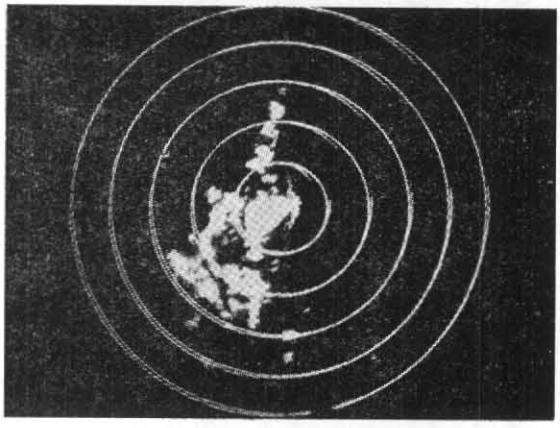
2040 10

Fig. 1 (b)



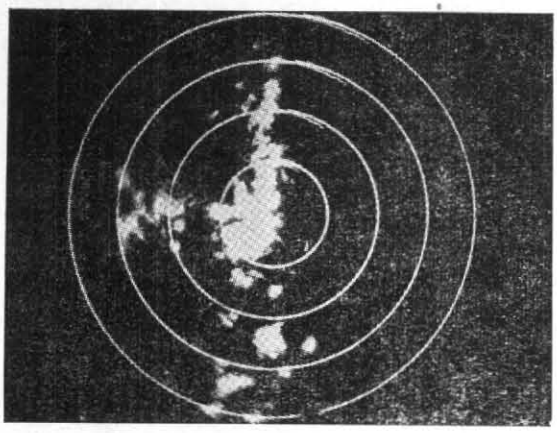
2047 10

Fig. 1 (c)



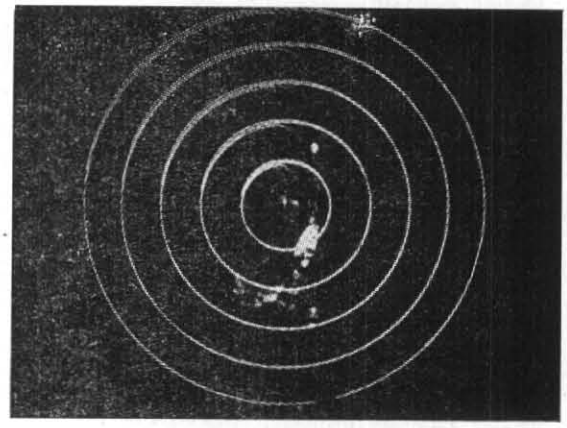
2055 10

Fig. 1 (d)



2058 5

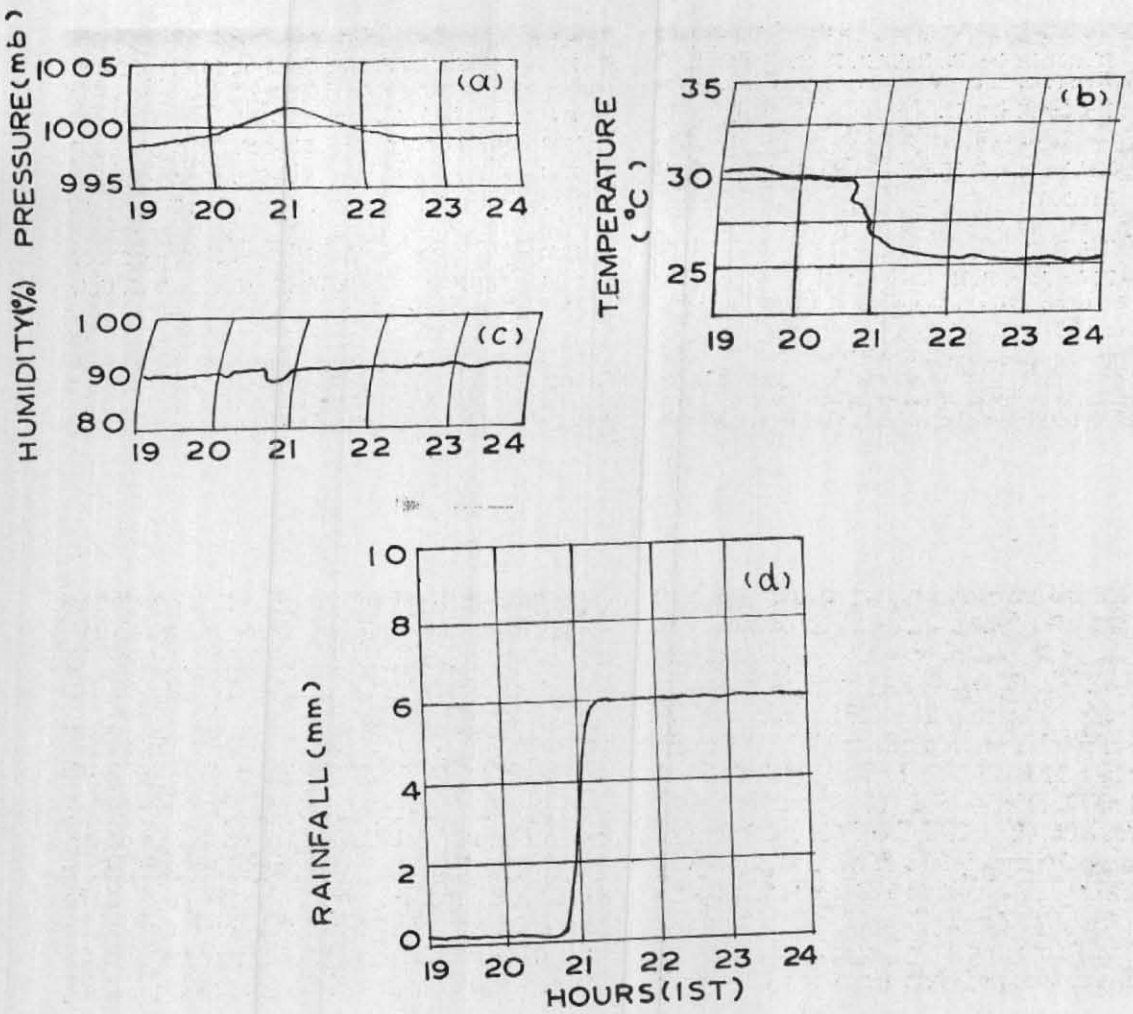
Fig. 1 (e)



2121 10

Fig. 1 (f)

**Figs. 1 (a-f). PPI radarscope photographs taken on 8 June 1964 of Bendix weather radar at Agartala airport, Tripura**
Figures given below the photographs indicate (from left to right) time IST and range rings in n. miles respectively




**Figs. 2 (a-d). Portions of the autographic records during the thunderstorm on 8 June 1964 at Agartala Airport**

4. The angel echo showed an eastward movement in consonance with the movement of the squall line. The apparent speed of movement of the angel echo was of the order of 56 km/hr while that of the squall line was of the order of 40 km/hr.
5. The life cycle of the angel echo was about 40 minutes.

**5. Discussion**

The bird hypothesis postulated by Richardson *et al.* (1958) which envisaged that these angel echoes are from birds or insects flying in the upper air in front of the convective clouds, does not appear tenable in this case. The formation and movement of the angel echo do not suggest that it is caused by birds. The angel echo was gradually increasing in length and then showed decreasing tendency. Further the angel echo maintained a constant separation from the main precipitation cells between 2040 and 2058 IST (Figs. 1 b and 1 c). It is unlikely for the birds to maintain such constant separation from the convective cells through out the period. The line type of angel echo passed over the station but no birds were noticed flying at that time.

There may be another explanation of the formation of the angel echoes, *viz.*, back scattering of the radar beam due to the inhomogeneities in the atmosphere. The inhomogeneities may be either due to gravity waves or due to the "nose" portion of an undercutting weather front (Leach 1957).

It is also interesting to note that the line type angel echo has been associated with the pressure hump (Fig. 2a). This means that there has been a line of atmospheric discontinuity, ahead of the main precipitation echo, associated with a pressure hump on the surface. This atmospheric discontinuity might be responsible for the formation of the line type angel echo.

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