

TWO EXAMPLES OF UNUSUAL ANGEL ACTIVITY OVER NEW DELHI

In India, few instances of angel activity have been reported in the past (Rai 1959). However, no instances of observations of some other less frequent but probably more interesting types like ring angels and thin line angels appear to have been recorded.

Presented below are two examples when the high power CPS-9 radar at New Delhi (wave-length 3·2 cm, peak power 250kW, beam 1 degree conical) recorded two such occurrences of angel activity.

1. Ring angels of 28 September 1959

Fig. 1 shows the PPI presentation at 1455 IST of 28 September 1959. A number of rings can be seen. Some of these have been outlined separately in Fig. 2 for the sake of clarity. The activity lasted for about 10 minutes only. Since this was the first occasion (and the only one till date) to observe ring angels and also because at the time the radar was being run for operational use, it was not possible to follow the formation of these rings from the 'point' stage.

Ring angels have been described and discussed at some length by Elder (1957) but he recorded these on a 23 cm L band radar. These have also been discussed by Plank (1959). According to Elder, the preferred time of occurrence of this type of angels is in the afternoon as in the present case. Elder could not observe any correlation of angel occurrence with observed surface weather and his observations pertained to surface weather

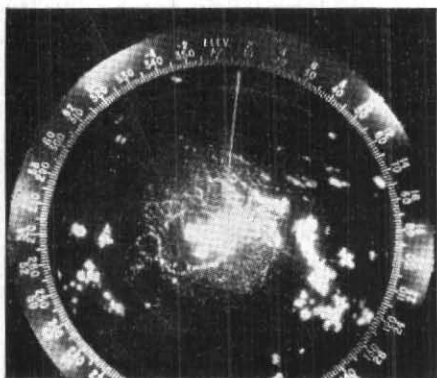


Fig. 1. RING ANGELS
PPI 28-9-59 1455 IST
Range 75 miles, Elev. 1°

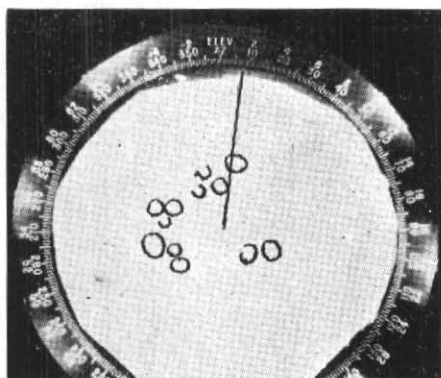


Fig. 2. OUTLINES OF
RING ANGELS OF FIG. 1

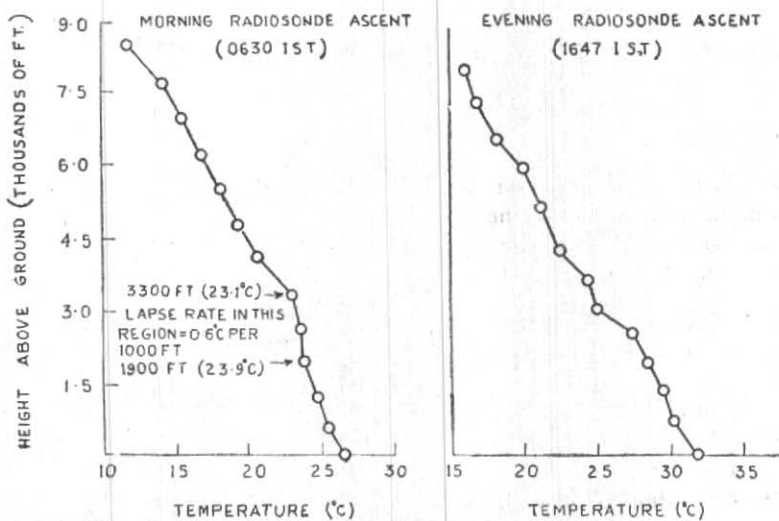


Fig. 3. TEMPERATURE PROFILES AT NEW DELHI ON 28-9-1959

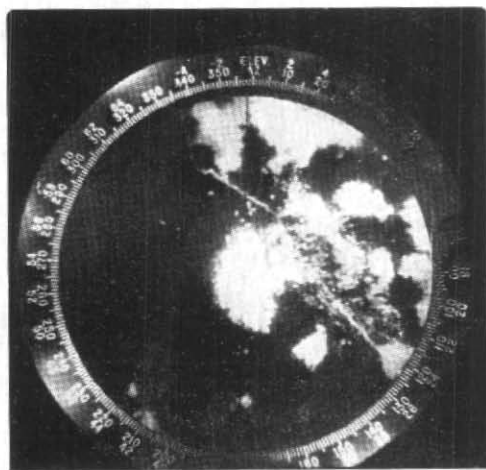


FIG. 4. THIN LINE ECHO
PPI 1-10-59 1133 IST
Range 25 miles, Elev. 1°

conditions ranging from clear skies to moderate continuous snow. Thus the presence of thundercells in the neighbourhood in Fig. 1 is perhaps of no important consequence.

Elder suggested that this type of angels occur due to the reflection of energy from shear gravity waves existing on a surface of density discontinuity. From an examination of the radiosonde observations in the neighbourhood, he showed that on the days when ring angel activity occurred, there usually were temperature inversions of the order of 2°C per 1000 ft at 2000–5000 ft.

Fig. 3 shows the temperature profiles at New Delhi on 28 September 1959. The morning ascent had a near isothermal layer between 2000–3000 ft where the temperature lapse rate was about 0.6°C per 1000 ft. However, the evening radiosonde ascent does not show any inversion or even an isothermal layer. Since the ring angels were observed at about 1500 IST, it is reasonable to regard the evening radiosonde ascent as more representative of the atmospheric conditions prevalent at the time the ring angels were recorded. May be that a low level inversion could have developed in the afternoon on a

scale not detected by the conventional radiosonde equipment. However due to the meagreness of data in the present case, it is not considered desirable to hazard a guess of the possible angel source—in any case at this stage at least.

2. Thin line angel echoes of 1 October 1959

Various investigators have reported thin lines of echoes in the vicinity of strong convective echoes such as presented in Fig. 4 which shows the PPI presentation at 1133 IST on 1 October 1959. Bigler (1959) has described a few case histories for such line echoes.

The thin line in the present case was moving ahead of the convective cells and may be described as what has been called a precursor or a first gust line or a wind shift line. At the time of the radar photograph, it was still about 10 miles to the northeast of the station and was approaching the station.

The station did experience a squall at 1201 IST, *i.e.*, about 27 minutes after the time of taking the radar picture shown in Fig. 4. The wind speed, which had been of the order of 10 km hr⁻¹ upto 1130 IST developed a lull and at 1200 IST, the wind speed suddenly rose to 66 km hr⁻¹. The squall lasted for only 4 minutes. Thereafter the wind speed again fell to about 15 km hr⁻¹. During the squall, the wind direction shifted from SW to NE. However, no rain was recorded.

For this type of angel activity, as for the other types of angels also, there is controversy about the possible echo sources. These precursor lines, giving sharp and distinct echoes, are known to be devoid of any scattering particles. Leach (1957) has made an extensive study of such lines and has concluded that they are either gravity waves or the 'nose' portion of an 'undercutting' weather front. With this one example recorded by the CPS-9 radar, it is perhaps not desirable to attempt a discussion on the possible echo source in the present case.

This type of angels, however, show great promise of practical use in short range forecasting of squalls. More data has to be collected and analysed before a reliable technique can be perfected. Such squall precursor lines are recorded more frequently on longer wavelengths; the best detection being on 23 cm wavelength when the precursor line may be detected as much as 50 to 60 miles in advance of the squall to enable forewarning of squall to be issued sufficiently in advance.

The above two angel occurrences were recorded during the course of normal routine operational use of the radar. These types of echoes are found to be of a less frequent nature. It is proposed to discuss them in detail and attempt an explanation for the possible echo sources when a number of complete histories of such echoes are available.

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