

## Letters To The Editor

### FURTHER EVIDENCE OF 'ABNORMAL' SUPER-REFRACTION

Mathur and Kulshrestha (1961) have discussed the phenomenon of super-refraction observed just after the passage of a frontal thunderstorm. They chose to term it 'abnormal' super-refraction because it occurred under unusual and abnormal conditions as against the stable atmospheric condition with which the usual super-refraction is generally associated.

The authors also put forth a tentative explanation on the basis of the abnormal moisture lapse rate and temperature inversion created by the cooling of layers near the earth's surface by as much as  $10^{\circ}\text{C}$  due to the evaporating rainfall. In their opinion, the stratification could maintain itself for some time because of very light winds which, combined with the overcast sky, helped to delay the ground heating and consequent mixing. They considered the existence of light winds, after the thunderstorm, a prerequisite for the 'abnormal' super-refraction. They observed that such phenomena were very rare because of the limitations imposed by the necessity of simultaneous occurrence of all the conditions mentioned above and the Safdarjung radar recorded only one instance during the period between September 1957 and February 1960. They felt that such phenomena should be mostly associated with frontal thunderstorms which generally follow a certain sequence and the weather is more systematized.

Since the publication of their paper, another similar case of abnormal super-refraction has been recorded by the 3 cm

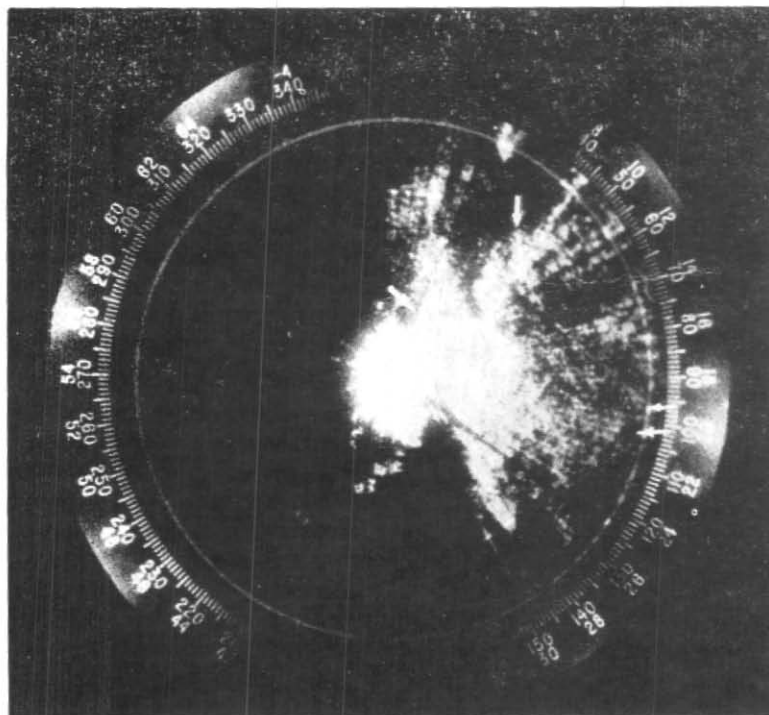
CPS-9 radar at Safdarjung Airport (New Delhi) and is discussed below with a view to provide further evidence of the correctness of the ideas put forth by Mathur and Kulshrestha.

At 0830 IST on 14 April 1961, a western disturbance existed over the Punjab (India) as an upper air low between 1.5 and 3.0 km above sea level. It subsequently moved away eastwards across the Punjab-Kumaon hills as an upper air trough. In its wake, rain and/or thundershowers were fairly widespread in Himachal Pradesh and the Punjab-Kumaon hills and were scattered in the plains of the Punjab and of northwest Uttar Pradesh.

At 1425 IST, the radar detected the presence of a very large number of closely packed strong convective cells at a range of about 50-100 miles in the southwest sector. These cells aligned themselves in the form of a 'front' and were approaching the station. The heights of the echo tops were about 20,000 ft above ground and were increasing. The 'front' came over the station at about 1800 IST. By about 2000 IST, the 'front' had passed over the station and the sky was partly cloudy. The weather recorded at Safdarjung Observatory is given in Table 1.

Super-refraction of the type observed in 1957 was recorded on this occasion also as will be evident from the PPI photograph reproduced in Fig. 1.

It will be seen that the weather observations in the present case fully support the earlier ideas in as much as the occurrence of rainfall, the cooling at earth's surface of the order of  $10^{\circ}\text{C}$ , light wind after the thunderstorm had passed, the cloudy sky thereafter, and the frontal characteristic of the



2043 IST

Range 34 statute miles

Elev. 1°

Fig. 1

TABLE 1

$$\swarrow \frac{1755}{1800} \quad \searrow \frac{1800}{1803} \quad \nearrow \frac{1800}{1840} \quad \nwarrow \frac{1930}{2045}$$

Maximum wind speed	:	92 kmph; Direction W
Average wind speed before the squall:	:	32 kmph; Direction NW
Average wind speed after the squall:	:	12 kmph; Direction WSW
Rainfall	:	3.4 mm
Fall in temperature	:	8.4°C (from 30.5° to 22.1°C)
Change in humidity	:	From 32 per cent at 1745 IST to 74 per cent at 1850 IST and thereafter to 49 per cent at 2022 IST

## REFERENCE

Mathur, L. S. and  
Kulshrestha, S.M. 1961 *Indian J. Met. Geophys.*,  
12, 1, pp. 71-78.

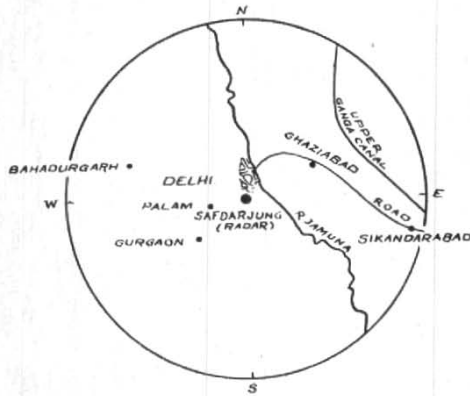


Fig. 2

storm, are concerned. As the wind after the thunderstorm was not very light, the quasi-stable conditions were vitiated relatively early due to mixing and the abnormal super-refraction did not persist for as long a period as in the 1957 case.

It may be quite interesting to identify the various targets which comprise the extended ground coverage due to the abnormal super-refraction in Fig. 1. Fig. 2 gives a corresponding map of the area covered by the PPI photograph in Fig. 1. It is easy to identify the following prominent features in the radar photograph with the help of the arrows marked thereon—

(1) The upper Ganga Canal, (2) The Delhi-Ghaziabad-Sikandarabad Road (a first class metalled road). These are not normally visible since ordinarily the ground clutter extend to only about 17 miles from the station in this direction.

River Jamuna is not seen. This may be due to the nature of the bank terrain, and the comparatively lower level of water in River Jamuna in this season.

S. M. KULSHRESTHA

*Meteorological Office,  
New Delhi  
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