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Cyclonic storm of 13-14 September 1958 in the Bay of Bengal—A radar study

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ABSTRACT. Photographs of radar observations taken at Calcutta of a cyclonic storm of 13-14 September 1958 in the head Bay of Bengal are presented in the paper. It is interesting that with a cyclone of moderate intensity, the eye of the storm was clearly seen on the radarscope in the form of a 'hook', which enabled accurate location of the storm. Such detection of the eye on the radarscope is the first of its kind in the Indian latitudes. The observed dimension and movement of the 'eye' and the associated observed precipitation echoes around the storm centre are discussed.

1. Introduction

A tropical storm being primarily a maritime phenomenon, even with a fairly close network of surface and upper air observations from coastal and inland stations, it is difficult to collect detailed information within the storm area itself. The 'eye' of a tropical cyclone characterised by light winds and fair weather at the centre of matured cyclone has been the subject of study since many years, but detailed observational records particularly at higher levels above the eye are still inadequate. Radar has played an important role in recent years in such studies. The eye of the typhoon near Philippine Islands in December 1944 was very clearly seen with a 10-cm radar (Westwater 1946). In India, several attempts were made to locate the eye of cyclonic storms with a medium power (30 KW peak) 3-cm radar, Decca Type-41, installed at Dum Dum Airport in 1954. These attempts were not successful due to low power of the radar, none of the 'storm tracks' being sufficiently near the radar site and thirdly due to attenuation of radar beam caused by precipitation in the forward sectors of the storms. The present note is intended to present the radar observations of the cyclonic storm of 13-14 September 1958 by a high power 3-cm radar recently installed at Dum Dum Airport (Calcutta). The storm came within 100 km of Calcutta and the eye of the storm was clearly seen on the radarscope and its movement could be watched with remarkable accuracy.

2. The cyclonic storm of 13-14 September 1958

The cyclone originated as a depression in the head Bay of Bengal on the morning of 13 September 1958. Later, it intensified into a cyclonic storm and moving northwest it crossed the West Bengal coast near Contai in the early morning of 14th. At 1200 GMT of the 13th, Saugar Island reported 40 kt NW'ly wind. The anemograph record at Saugar Island shows that wind steadily increased after 1200 GMT on 13th and reached a maximum speed of about 75 kt near about midnight when the cyclone was close to Saugar Island.

The cyclone caused widespread damage in the Midnapore district. It damaged many huts and buildings and destroyed a large area of plantations and gardens. The cyclone continued to move northwest after crossing the coast and by the afternoon of the 14th it weakened into a depression. The track of the cyclone is reproduced in Fig. 1.

3. The Radar observations

The observing radar was a Japanese type MMD-451A radar. The radar works on 3-cm wave band and has a peak power of 250 KW. The beam width of the radar is 1·2° between the half power points. The height of the

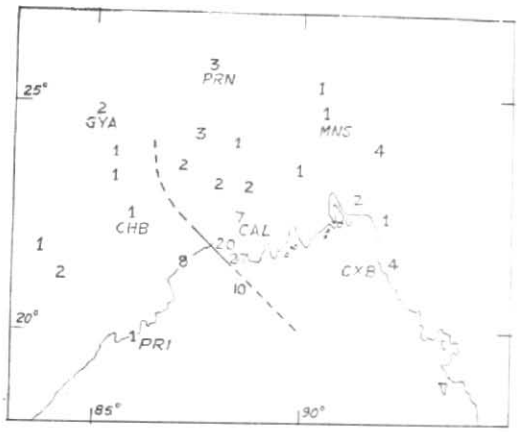


Fig. 1. Track of the cyclonic storm of 13-14 September 1958

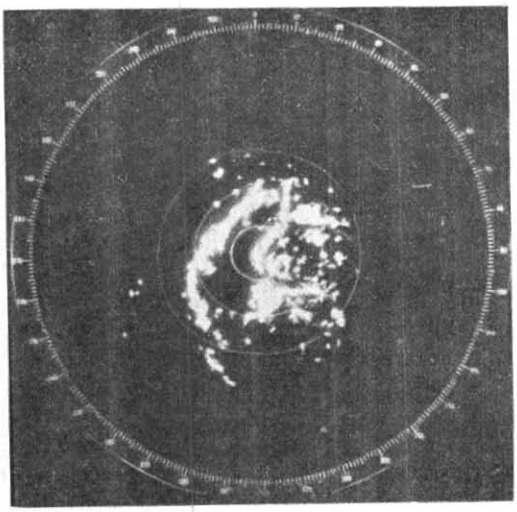
Rainfall (in cm) during 24 hrs ending 0830 IST on 14 September 1958 are also shown
Cyclone —— Depression – – – –

antenna is 64 ft a.s.l. and the maximum range is 300 km. Apart from Plan Position Indication (PPI) there are provisions for Range Height Indication (RHI) and A-scope presentations in the radar.

As stated earlier, the cyclonic storm of 13-14 September 1958 had its origin in head Bay of Bengal, about 320 km to the south-east of Calcutta. The radarscope picture on 12 September showed isolated patches of echoes in the SE sector at distances ranging from 50 to 200 km from the observing station. At 1400 IST, the echoes appeared in the form of 'spirals' or 'bands' in the same sector. These bands were quite interesting and were later seen to move in the northwest direction in succession. The situation remained almost the same throughout the day on the 12th and also on the following morning.

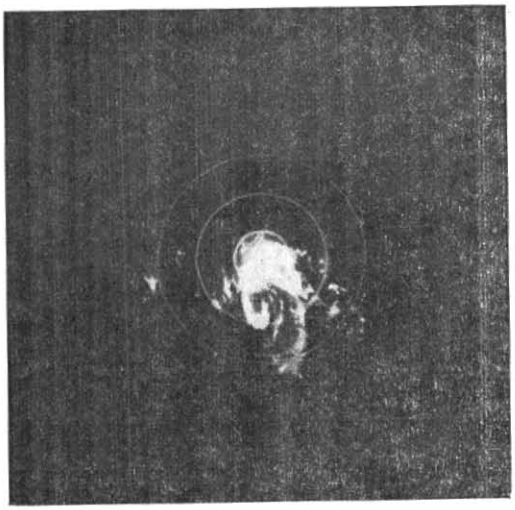
At 1220 IST on 13 September (Fig. 2a), two bands appeared on the scope, one from 190°/240 km through 270°/90 km to 020°/110 km and the other from 180°/50 km through the observing station to 060°/120 km. At 1807 IST, as many as five bands appeared on the radarscope. The bands were later seen to move northwest and fresh bands appeared on the radarscope. The centre of the cyclone was not well defined but could be roughly located at about 170°/120 km. About two hours later, at 1950 IST, the centre of the storm now took a regular shape on the echo pattern and was located at 180°/105 km. The spirals could be seen to be part of a large circulation system around the centre. The distant echoes did not presumably appear on the radarscope due to heavy attenuation of the radar beam. At 2030 IST (Fig. 2b), the centre of the storm appeared as a 'hook' with centre located at 185°/100 km. The quasi-circular heavy precipitation bands to the north and east of the storm centre are clearly outlined. The absence of such bands in the SW sector is noteworthy. At 2113 IST (Fig. 2c) the eye of the cyclone was clearly visible on the radarscope with a ring of echoes surrounding it. The centre of the eye was located at 190°/95 km. The spirals could still be seen to the north of the storm centre extending upto the observing station and to the northeast of the storm centre. At 2225 IST (Fig. 2d), the eye was seen to have moved further NW, the centre being located at 200°/92 km. Apart from the echoes close to the observing station, one spiral could be seen extending from NW to NE sector of the storm, which moved north or northwestwards across the observing station. The eye was thereafter seen to move in the northwest direction and, becoming gradually diffuse, soon lost its identity on the radarscope. The storm crossed the coast near Contai at about 0300 IST on the 14th. At 0735 IST (Fig.3a), the storm moved sufficiently inland and weakened—distant spiral echoes could still be seen extending up to 200 km in the NW, E and SE sectors. As the depression penetrated further inland, the pattern of echoes became unsymmetrical. The echoes appeared in the form of one or two spirals with some scattered echoes in the neighbourhood of the depression.

Fig. 3(b) shows the RHI picture at 1135 IST on 14 September 1958. The aerial was pointed to 268°N, *i.e.*, approximately towards the centre of the deep depression. The



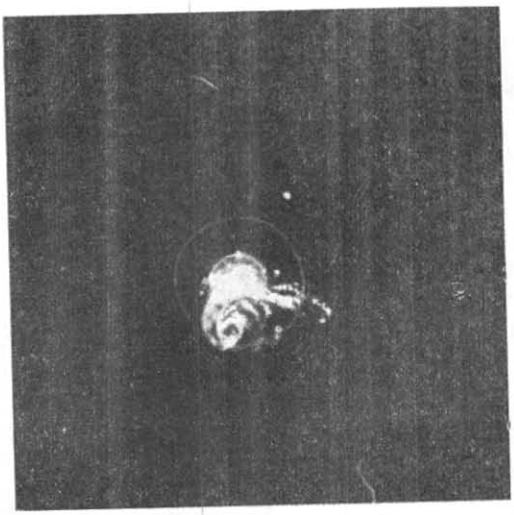
1220 60 km

Fig. 2(a)



2030 60 km

Fig. 2(b)



2113 60 km

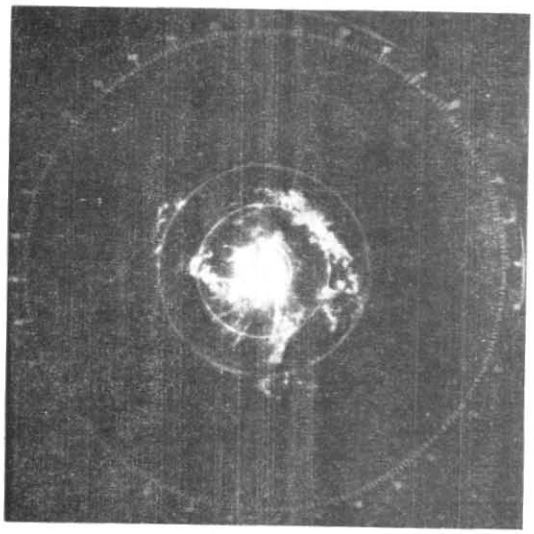
Fig. 2(c)

2225 60 km

Fig. 2(d)

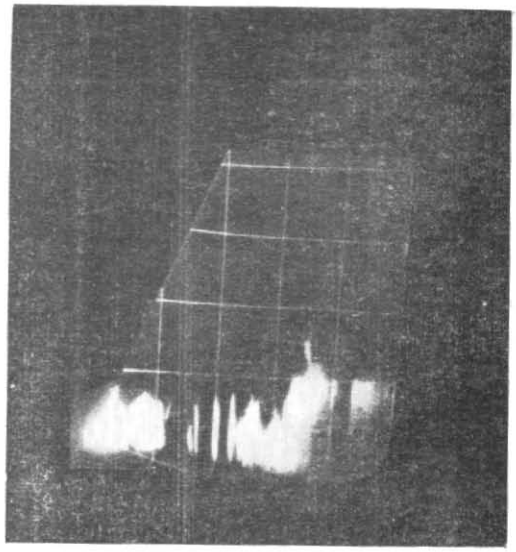
Fig. 2. PPI presentations of the storm detecting radar at Dum Dum airport on 13 September 1958

Figures in the left and right hand bottom corners indicate time in IST and range rings in km respectively



0735 60 km

Fig. 3(a)



1135 20 km

Fig. 3 (b)

Fig. 3. PPI (Fig. 3a) and RHI (Fig. 3b) presentations of the storm detecting radar at Dum Dum airport on 14 September 1958

2030 60 km

Fig. 4 (a)

2113 60 km

Fig. 4 (b)

Fig. 4. PPI presentations of the storm detecting radar at Dum Dum airport on 13 September 1958

Figures in the left and right hand bottom corners indicate time in IST and range rings in km respectively (For Fig. 3b only—Azimuth 268°N, and Height markers 5 km)

gaps between the successive spirals were observed to be fairly well marked. The echoes extended upto a height of 5 km only. RHI photograph could not be taken earlier, when the storm centre was out at sea.

In Fig. 4 are shown two enlarged photographs of the radar PPI pattern depicting clearly the eye of the cyclone. The existence of the eye at the storm centre is clearly demonstrated by these typical radarscope photographs.

4. Characteristics of the eye and its movements

Deppermann (1939) studied 23 instances of typhoons with the minimum pressure at the centre less than 973·6 mb. In the case of the Bay cyclone reported in this paper, pressure recorded by Saugar Island was 995 mb at 1200 GMT on 13th when the storm centre was about 50 miles away from Saugar Island and corresponding pressure departure from the normal was only of the order of 8 mb. It is inferred that minimum pressure at the storm centre did not lower below 988 mb with a pressure departure of the order of 15 mb only. Thus, this cyclonic storm did not attain severe or hurricane intensity and it is noteworthy that even with a storm of such slight or moderate intensity, the eye was well defined and appeared on the radarscope with remarkably clear definition in the form of a 'hook' at one stage and a circular echo around the eye at another.

The diameter of the eye of this cyclone as observed on the radarscope has been measured at intervals and is found to be varying within a range of 18-25 miles. Dunn (1951) reported that the average diameter of the eye is generally of the order of 12-15 miles and on some occasions the diameter is as large as 20-25 miles. It may be of interest to mention that diameter of the eye of another Bay of Bengal cyclone (Krishna Rao and Sen 1953) as derived from visual observations was found to be of the order of 20 miles.

The movement of the eye of the cyclone as observed on the radarscope is reproduced

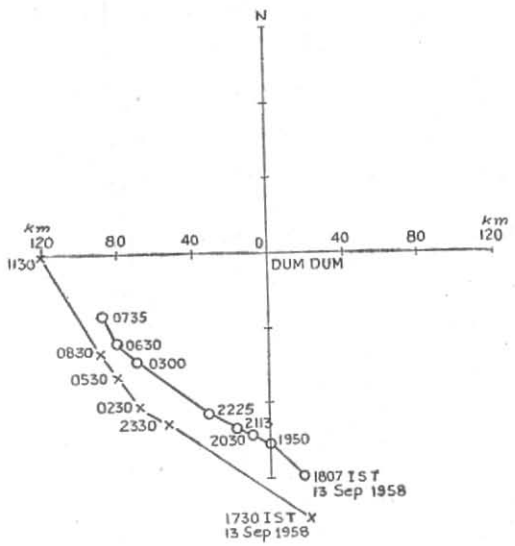


Fig. 5. Locations of the storm centre obtained from radar observations (o–o–o) and those based on synoptic observations (x–x–x)

in Fig. 5. The track of the cyclone as obtained from the official bulletins based on synoptic observations is also reproduced in the same diagram. The track obtained from the radar observations obviously represents the exact course of the cyclone. From the observed position of the storm centre on the radarscope, it is calculated that it moved at the rate of about 14 km hr^{-1} between 1807 and 2225 IST on the 13th and thereafter it moved slower at the rate of about 10 km hr^{-1}.

As Dum Dum airfield was not traversed by the centre of the storm, the radar observations at Dum Dum airfield alone cannot be expected to reveal vertical structure above the storm centre. Radiosonde and rawin observations taken over and near the eye of the storm could have thrown light on its vertical structure. Kessler (1958) studied the Hurricane Edna of 1954 by radar and dropsonde observations. He reported that over the eye there was a thick layer cloud derived from the wall cloud surrounding the eye.

5. Rainfall associated with the cyclone

The surface chart at 0300 GMT on 12 September 1958 showed unsettled condition over head Bay. A depression formed by 0000 GMT on 13th when the centre of the depression was located at Lat. 21° N and Long. 90°E. By 1200 GMT the depression had deepened and was centred at Lat. 21°·5 N and Long. 88°·5 E. Sandheads recorded 6 cm of rain. Light to moderate rain also occurred to the northwest and northeast sectors of the deep depression. Thereafter the depression further intensified into a cyclonic storm and crossed coast near Contai in the early morning of the 14th. Rainfall recorded by 0300 GMT of 14th are reproduced in Fig. 1. Significant amounts of rainfall are Saugar Island 27 cm, Contai 20 cm and Sandheads 10 cm.

The appearance of radar bands deserves special mention. These bands revealed the presence of large scale convection zones spiralling towards the centre of the storm. By vertical scanning, it was found that the convection extended upto a height of about 5 km. The absence of precipitation echoes in the SW sector, during the mature stage, is noteworthy, as it is contrary to distribution of rainfall generally observed in monsoon depressions. The rainfall associated with this storm occurring towards the end of the monsoon season were found to extend more to the NW and NE sectors instead of SW sector. Although rainfall did not extend much to the southwest sector, stations just to the southwest of the storm track, such as Sandheads, Saugar Island and Contai, recorded heavy rain. The absence of precipitation echoes in the southwest sector might be due to attenuation caused by heavy rain occurring just to the southwest of the cyclone centre.

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