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## Cyclonic storm of 14-15 August 1974 in the Bay of Bengal—A radar study

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**ABSTRACT.** Tracking of the cyclonic storm of 14-15 August 1974 with the help of S-Band radar at Calcutta has been reported in this communication. The rather slow moving storm remained within a radius of 200 km from the radar site for about 36 hours thus enabling the radar to track it. The eye of the storm could be seen on the radarscope for more than 24 hr, even 12 hr after crossing of the coast. Saugar Island and Contai, two of the coastal observatories were traversed by the eye of the storm. The radar data were compared with the surface observations recorded at these two stations. The characteristics of the eye of the cyclonic storm, the vertical structure and sector-wise distribution of the associated cloud system and rainfall distribution are discussed.

### 1. Introduction

Instances of detection of an 'eye' of a tropical cyclone with the help of X-Band (3-cm) and S-Band (10-cm) radars in India have been rare. It was only during September 1958 that the eye of a cyclonic storm was detected with the help of a X-Band radar at the Calcutta Airport when the storm track was within 100 km from the radar station (De and Sen 1959).

The present communication reports an occasion, when the cyclonic storm was within a radius of 200 km from the radar site for about 36 hr and was tracked with the help of a S-Band radar at Calcutta. The eye of the storm was clearly seen with spiral bands around the storm centre (Fig. 2). The movement and characteristics of the storm could be tracked with accuracy.

### 2. Details of the storm

The cyclonic storm had its origin as a depression in the head Bay of Bengal in the early morning of 13 August 1974 which intensified into a deep depression the same evening, the centre being about 170 km southeast of Calcutta. It further intensified into a cyclonic storm on the morning of 14 August, remained practically stationary for about a day and started showing a movement from 1300 GMT of 14 August. The storm ultimately became a severe cyclonic storm at 1600 GMT of 14 August. The 'eye' of the storm was first detected at 1700 GMT of the 14th and continued to be seen for more than 24 hr, even 12 hr after it crossed coast at about 0700 GMT of 15 August near Contai in the district of Midnapore, West Bengal, Saugar Island, which

was traversed by the eye of the storm, recorded maximum wind speed of 104 kmph at 0055 GMT on the 15th. Alipore Observatory (Calcutta) recorded maximum wind speed of 94 kmph at 0451 GMT on the same day. According to newspaper reports wind speed of gale force (100 to 120 kmph) lashed the coastal areas of 24 Parganas and Midnapore districts of West Bengal on the 15th. High winds and heavy to very heavy rains caused considerable damage to standing crops, uprooted large number of trees and completely disrupted telecommunication links of the above districts.

The cyclone after crossing the coast continued its northwesterly movement and later changed its course gradually from northwest to west and thence to southwest. Finally it started moving again towards northwest before dissipating on the radar screen. The radar track of the storm is shown in Fig. 1.

### 3. Radar Observation

3.1. *General*—The radar observations were taken with a 10 cm Mitsubishi type RC-32 E meteorological radar. It has got a nominal peak power output of 500 kw, the beam width being 1.8° both in horizontal and vertical planes between half power points. The antenna is located at a height of 66 m above ground level (about 70 m above mean sea level). The maximum range of the radar is 500 km in long pulse (4  $\mu$  sec) and 200 km in short pulse (1  $\mu$  sec) radiations. A few selected photographs are presented in Fig. 2.

3.2. *Estimated centre*—Radar observations were taken during the entire life cycle of the cyclonic

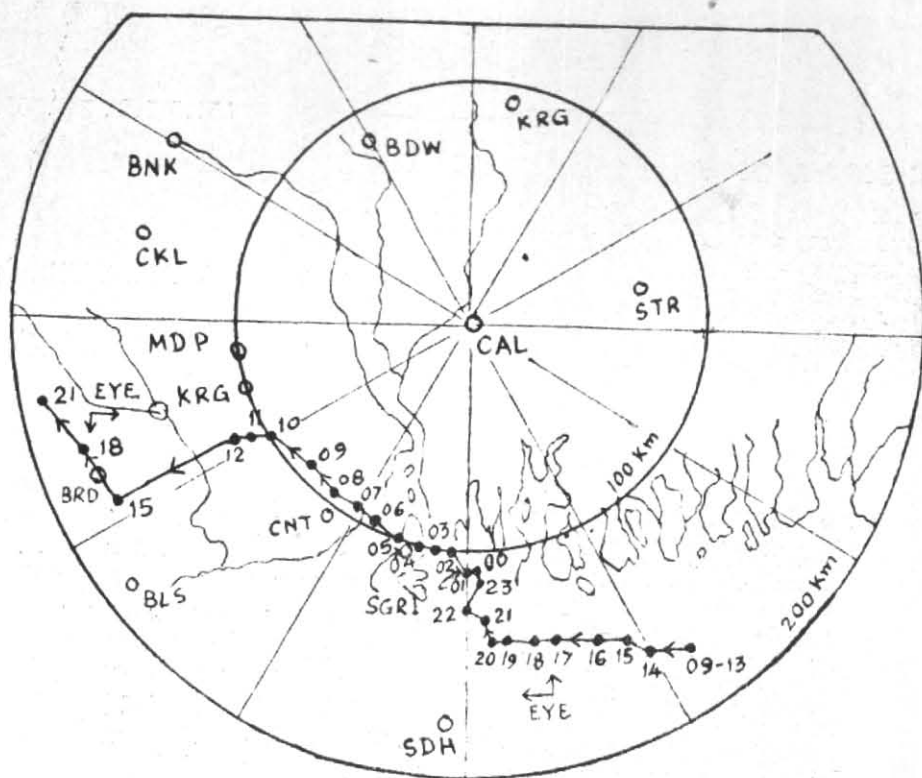


Fig. 1. Radar "fixes" by Cyclone Warning Radar at Calcutta during 14-15 August 1974.  
Eye visible from 17 GMT of 14 August to 18 GMT of 15 August

storm developed in the head Bay of Bengal to the southeast of Calcutta. From the early morning of 13th till 0600 GMT of 14th, the echoes on the radarscope were all scattered and did not show any organisation or pattern so as to enable extrapolate the centre of the system. From 0700 GMT of 14th the echoes started arranging themselves in the form of curved broken lines and at 0900 GMT the centre of the system could be estimated at 145 deg/170 km from Calcutta with the help of a suitable equi-angular spiral overlay (Fig. 2 a).

3.3. *Movement*—From 0900 to 1300 GMT the estimated centre was found to be practically stationary. From 1300 GMT onwards the storm was found moving W-NW-W wards upto 1900 GMT, thereafter it showed NW-W-NW ward movement till it crossed coast at about 0700 GMT of the 15th. The NW-ly movement continued for another three hours, *i.e.*, upto 1000 GMT. Thereafter it showed SW-ly movement upto 1500 GMT and NW-ly upto 2100 GMT.

3.4. *Intensity*—The 'eye' of the storm could be clearly seen on the radarscope first at 1700 GMT of the 14th (Fig. 2 b). The eye of the

storm remained clearly visible on the radarscope for about 26 hours, 12 hours after crossing of the coast. Though the storm crossed coast at about 0700 GMT, it maintained its intensity for more than 12 hours over land which is quite interesting and rare. The intensity of the storm started decreasing from about 2100 GMT of 15th when the system was about 200 km to west of the radar station.

#### 4. Discussion

4.1. *Characteristics of the eye*—Deppermann (1939) made a study of 23 instances of typhoons with the minimum central pressure of less than 973 mb. In the present case the minimum pressure of 973.1 mb was recorded by Contai at 0800 GMT of 15th when the central region of the storm was about 10 km away from Contai, while Saugar Island recorded minimum pressure of 973.4 mb at 0700 GMT when the central region of the storm was about 30 km away from the station. Considering the pressure departure from normal in the vicinity of the storm it was synoptically inferred that the lowest pressure at the storm centre was about 972 mb.

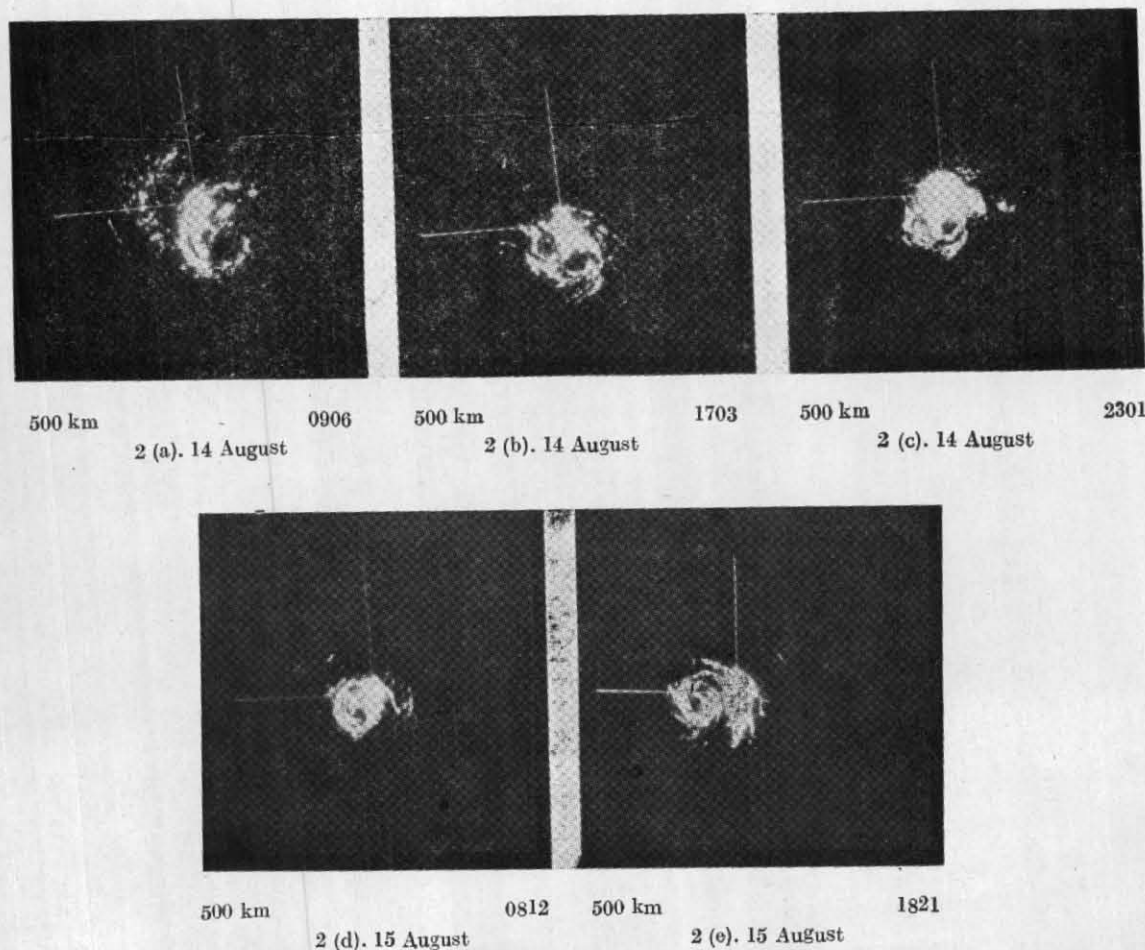


Fig. 2. PPI presentation of the cyclone on the radarscope at Calcutta during 14-15 August 1974

Details of radar settings and time (GMT) are indicated on the left and right of the photographs respectively. The vertical and horizontal lines indicate true north and elevation angle respectively

It is mentioned earlier that the 'eye' of the storm grazed two of the coastal stations. It was near Saugar Island and Contai between 0300-0400 GMT and 0600-0700 GMT respectively. Fig. 3 (a and b) shows the pressure profile, indicating the wind pattern in respect of Saugar Island and Contai. Rainfall recorded at these two stations are also indicated in the figures. The locations of the 'eye' as seen by the radar at different hours have also been schematically represented in the same figure to give a clear idea whether the 'eye' was over the station at a particular time or not.

It is interesting to note that when the 'eye' was over the stations (Saugar Island and Contai), there was practically no rainfall. An observer from Contai reported that there was a period of lull and the sky was clear for about 3 hr before the gale started again from the opposite direction. The changes in the wind field with the passage of the 'eye' are interesting and may be seen from

Fig. 3 (a) that the maximum wind was experienced at 0900 GMT at Saugar Island when the 'eye' had already crossed the stations, i.e., the maximum wind was at the rear of the storm.

A pressure hump was noticed during the passage of the 'eye' over Saugar Island (Fig. 3 a). The situation in respect of Contai (Fig. 3 b) was almost the same as in the case of Saugar Island, but the pressure hump was less pronounced. The reason may be that while the 'eye' passed over Saugar Island, it just grazed over Contai.

The diameter of the 'eye' has been measured at hourly intervals. It was found that the 'eye' was not symmetrical or circular. It has been seen that the diameter of the 'eye' varied from 45 to 80 km giving an average of 48 km (about 25. n. miles). Dunn (1951) reported the average diameter of the 'eye' to be generally of the order



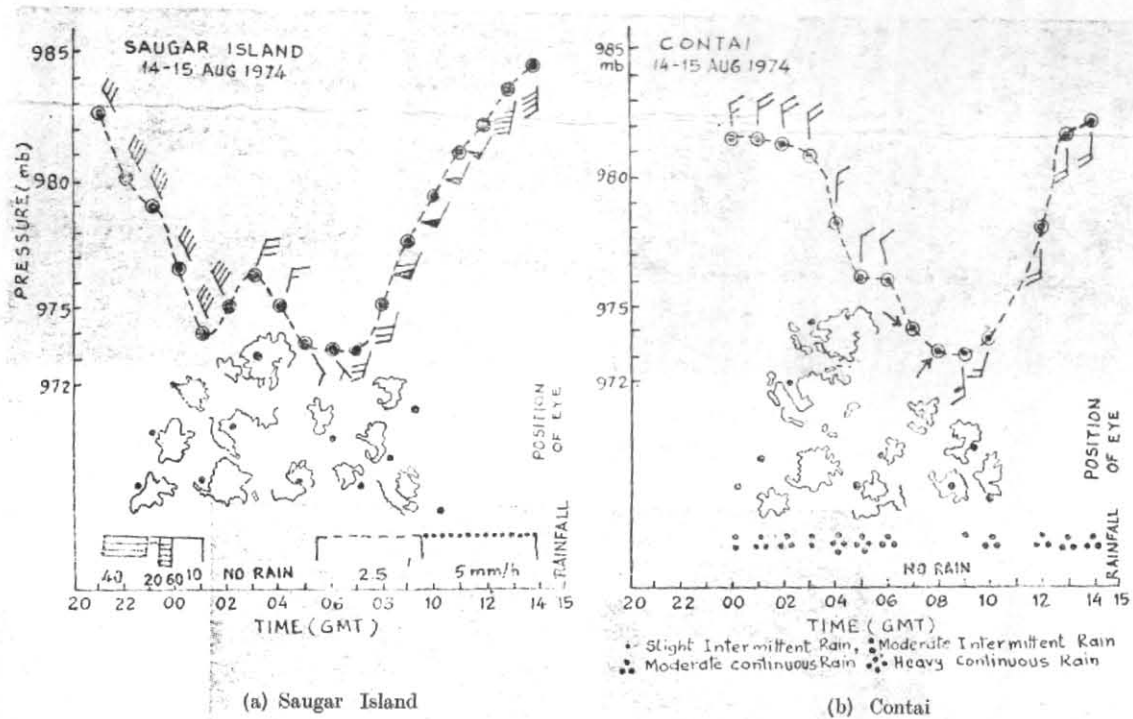


Fig. 3. Time cross-section chart indicating pressure profile, wind velocity, position of the eye with respect to the station (indicated by a dot) and rainfall

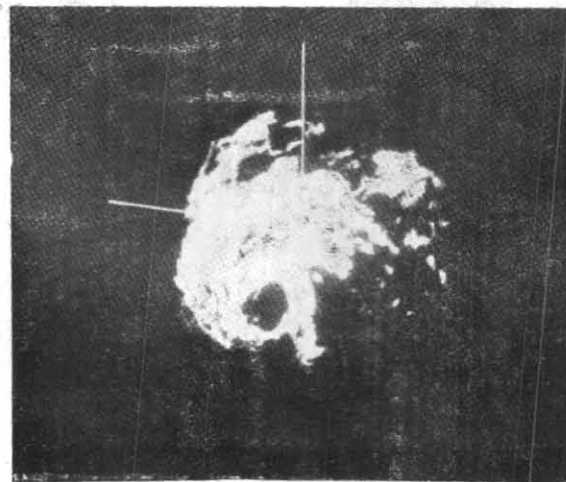


Fig. 4. PPI presentation of the cyclone on the radarscope at Calcutta on 15 August 1974 at 0401 GMT (Range 200 km with an angle of elevation of  $+2$  deg.)

of 12 to 15 miles and on some occasions was as large as 20 to 25 miles. The diameter of the cyclonic storm of 13-14 September 1958 as observed by the 3 cm radar at Calcutta Airport (1959) was of the order of 18 to 25 miles. Imai (1963) observed a wide variation in the diameter of the 'eye' ranging from 25 to 60 km. WMO technical experts (WMO 1966) also studied the diameter of the 'eye' and observed it to be of the order of 80 km. The diameter of the 'eye' reported in this communication is therefore, in general, in

conformity with the findings of earlier workers. The radar photographs in Fig. 2 (c to e) shows the 'eye' of the storm at different hours. The above photographs were taken at  $0^\circ$  elevation angle. It may be seen that the 'eye' was not completely closed when seen at  $0^\circ$  elevation scan but the spiral bands associated with the system were converging towards the centre. Fig. 4 shows a radar photograph taken at 0401 GMT of 15th at an elevation angle of  $+2^\circ$  where the 'eye' is seen completely closed.

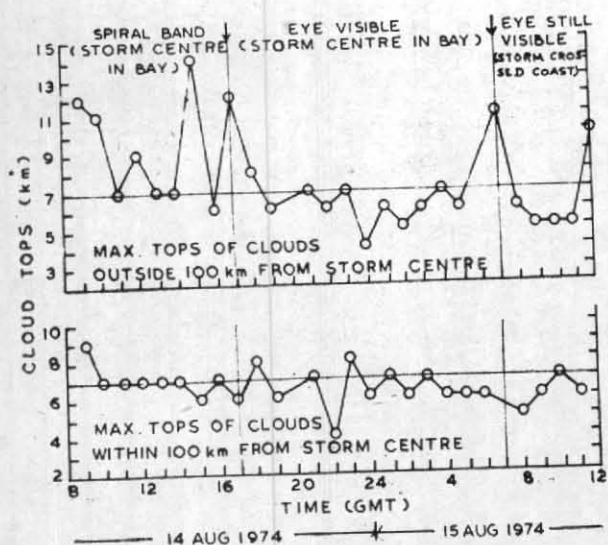


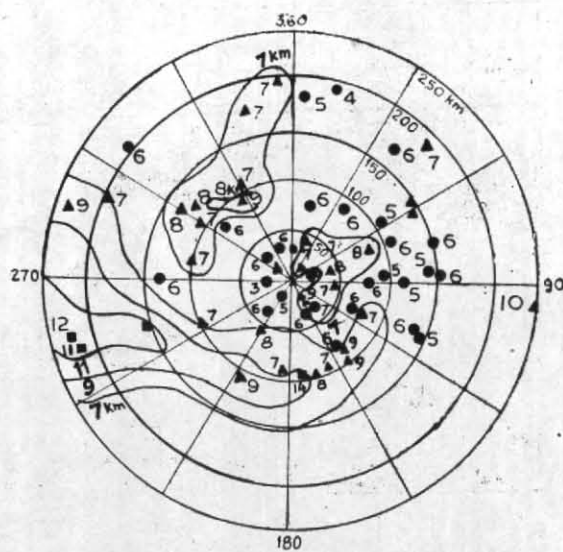
Fig. 5. Maximum tops of radar clouds during 14-15 August 1974  
 Lower : cloud heights within a radius of 100 km from storm centre  
 Upper : cloud heights beyond a radius of 100 km from storm centre

It may be stated that no special attempt was made to measure the width of the 'eye wall' over sea or over land. From the available records, the average width of the 'eye wall' has been worked out to be of the order of 20-30 km.

The most interesting and significant feature of this cyclonic storm was the persistence of the 'eye' for more than 12 hr even after landfall. This is contrary to expectations, because the 'eye' of a cyclone is expected to be filled up rapidly soon after its landfall, mainly due to frictional effects. That the 'eye' persisted for such a long period after landfall indicates that the frictional effects over land is not the only criterion for the filling up process.

The 'double eye' as suggested by Imai (1963) could not be observed during the period of journey of the 'eye' over land. The other causes of filling of the 'eye' as suggested by Imai were also not observed. In this particular case it has been observed that the system became gradually weak as a whole due to non-availability of sufficient moisture feed deep inside land and ultimately became less pronounced.

4.2. Vertical structure — It has been found that the cloud tops reached generally 7 km or less within a radius of 100 km from the storm centre. Fig. 5 shows cloud tops at different hours during 14-15 August. It may be seen from the figure that the heights of tops of radar clouds extended above 9 km beyond a distance of 100 km from the



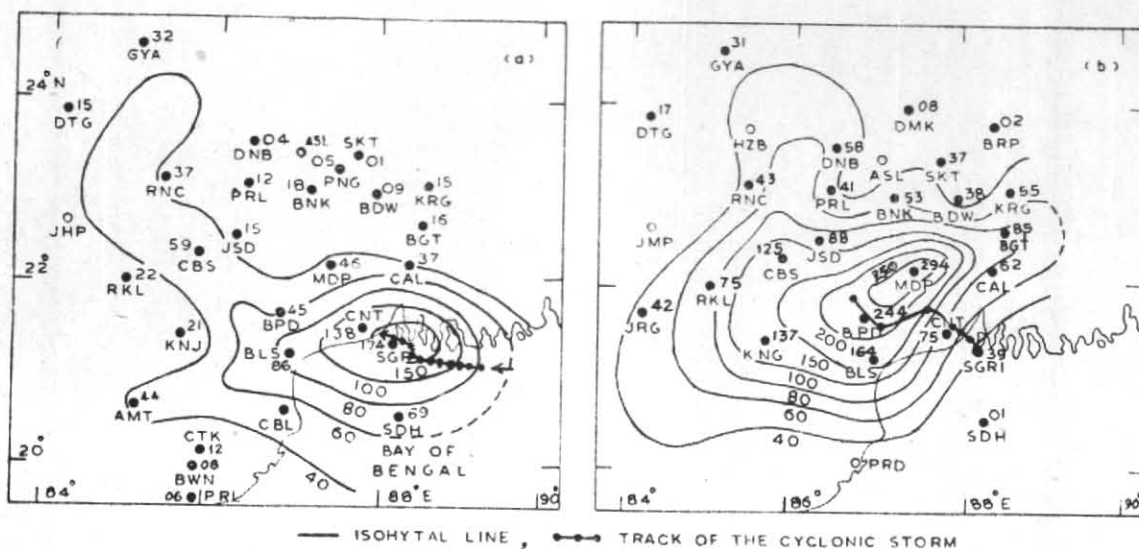
● - UPTO 6 km, ▲ - ABOVE 6 km - UPTO 10 km, ■ - ABOVE 10 km  
 Fig. 6. Sector-wise distribution of radar cloud tops of the cyclonic storm of 14-15 August 1974  
 (Location of the clouds have been reduced with respect to the centre of the storm)

storm centre. Fig. 5 also reveals the following interesting features :

- (a) Cloud tops reached generally higher values before the 'eye' was visible and the system was over sea ;
- (b) When the 'eye' was visible and the system was over sea, cloud heights were generally much less and
- (c) When the 'eye' was still visible but the system was over land, cloud heights again reached higher values.

An attempt was made to study sector-wise distribution of radar cloud heights. For this purpose the maximum tops of radar clouds recorded during routine observations of the cyclonic storm of 14-15 August have been analysed. In order to study the sector-wise distribution of cloud heights with respect to the centre of the system, all observations of the locations of clouds, (azimuth and distance with respect to the radar site) have been reduced with respect to the centre of the storm. The result is shown diagrammatically (Fig.6) by broadly dividing cloud tops into three categories according to their heights, viz., (i) cloud tops upto 6.0 km, (ii) cloud tops from 6.1 km to 10.0 km and (iii) cloud tops 10.1 km and above.

Iso-heightal lines are also drawn at an interval of 2 km.



(a) 15 August 1974  
(b) 16 August 1974

Fig. 7. Maps showing rainfall (mm) during 24-hr ending 03 GMT of 15 and 16 August 1974

The following salient features are revealed from the above figure :

- A belt of maximum heights of cloud tops was generally located to the southwest of the storm centre;
- Another belt of high clouds was located to the northwest sector and
- Cloud tops around the centre of the storm did not generally extend beyond 6 km except to the northeast sector where a less prominent belt of 7-8 km cloud tops was located.

#### 5. Rainfall associated with the cyclone

As stated earlier the cyclone had its origin in the lead Bay of Bengal initially as a depression in early morning of 13 August, intensified into a deep depression in the afternoon of the same day and into a cyclonic storm on the morning of 14th. It became a severe cyclonic storm in the afternoon of 14th. The principal amount of rainfall recorded at 0300 GMT of 15th and 16th during the past 24 hr were : Saugar Island 173.6 and 39.0 mm, Contai 138.2 and 74.9 mm, Alipore

(Calcutta) 26.5 and 62.4 mm, Balasore 85.6 and 164.4 mm, Balopal 80.1 and 168.0 mm; Remuna 36.0 and 126.0 mm, Bhograi 113.8 and 179.7 mm, Bhanga 40.0 and 114.0 mm, respectively. The rainfall recorded in these two days and the track of the cyclonic storm during the period of recording of rainfall is shown in Fig. 7 (a and b). It may be seen that the belt of heavy rainfall showed a bifurcation—one to the southwest and the other along the track of the cyclonic storm. The extension of the heavy rainfall belt to the southwest is according to the expectations in respect of a disturbance during the monsoon season. The above finding is also corroborated from the radar pictures which showed prominent and intense bands to the southwest sector of the system.

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