

Letters to the Editor

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SOME CHARACTERISTIC FEATURES OF THE CHANDBALI AND SRIHARIKOTA CYCLONES OF 1984

1. During the post monsoon period the frequency of development of cyclonic storms over the Bay of Bengal is very high. Three to four such disturbances develop over this area every year. They normally form north of 13°N in first half of October, south of 15°N in second half of October and south of 15°N and west of 90°E in November and move in a northwesterly direction. Some of them recurve northeastward and hit Bangla Desh or Burma coasts. The average diameters of these storms are of the order of 600-1000 km. Storms having diameter of 350 km are, of course, not uncommon.

During the post monsoon season of 1984 three cyclonic storms developed in the Bay of Bengal, of which two were having very small diameters. These two storms developed during 12-15 October and 9-14 November. Both these storms were rather unconventional in nature. These special characteristics are :

- (i) they intensified in a relatively high latitudinal belt,
- (ii) one of these storms took a southerly course,
- (iii) the dimensions were small and
- (iv) these storms intensified rather rapidly.

Here an attempt has been made to explain the anomalous behaviour of these two storms from dynamical considerations.

2. *Chandbali cyclone, 12-15 October 1984* — A depression developed over north and adjoining central Bay at noon-time of 12th and lay at 1200 GMT of that day over northwest Bay centred near 19.0°N , 89.5°E . Moving westnorthwestwards it rapidly intensified into a severe cyclonic storm with core of hurricane winds by 13th morning and lay centred at 0300 GMT near 19.5°N , 87.5°E . It crossed north Orissa coast near Chandbali in the morning of 14 October.

During the last century, there were several instances when tropical disturbances had intensified into tropical cyclones north of the latitude 18°N in the Bay of Bengal in the month of October, but they were all

northerly or northeasterly moving systems. A few of them had even intensified into severe cyclonic storms before crossing the coast. But all these systems attained depression intensity to the south of latitude 18°N , which is normally the area of cyclogenesis during October.

The formation of Chandbali severe cyclonic storm with core of hurricane winds in October 1984 may be considered statistically a unique case for the following considerations :

(i) Though it appeared as a tropical disturbance in the region of Inter-Tropical Convergence Zone (ITCZ) over Andaman Sea and adjoining southeast Bay it did not develop into a depression there.

(ii) It moved northwards for a considerable length of time and space without intensification and then intensified into a depression at Lat. 19.0°N .

(iii) Very rapid (just over half a day) intensification took place from depression stage to severe cyclonic storm.

(iv) The storm was of small dimension.

(v) The wind maxima had been observed in the left hand rear quadrant w.r.t. the storm motion.

The rapid intensification of the system might be attributed to the influence of a middle tropospheric trough in the westerlies and an anticyclone in the upper tropospheric levels over the north Bay. The trough at 500 hPa level which was to the northwest of the system on 11th, moved near and over the system (Fig. 1) on 12th. Also the upper tropospheric anticyclone, which was over southeast Asia, was observed over north Bay (250-200 hPa levels) on 12th morning. These two synoptic features provided necessary upper divergence for the rapid growth and intensification of the system on the later part of the day.

On 12th, the ship VWWF from about 125 km north-northwest of the storm centre reported wind $020^{\circ}/19$ kt at 0400 GMT while the ship ATKH, which lay at 0300 GMT about 300 km SSW of the storm centre, reported the wind $270^{\circ}/35$ kt. From these observations it could be inferred that the 30 kt isotach covered 300 km or slightly more to the south of the storm centre, while to the north, it covered only about 100 km from the centre around 0300 GMT of 13th. The wind maxima

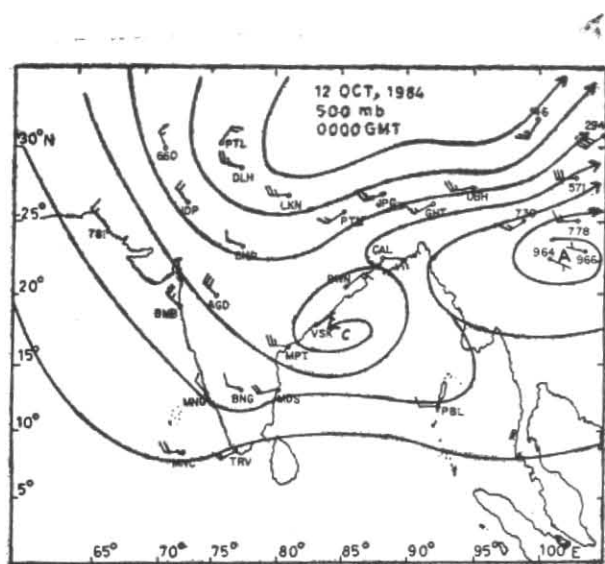


Fig. 1. 500 mb chart at 0000 GMT of 12 October 1984

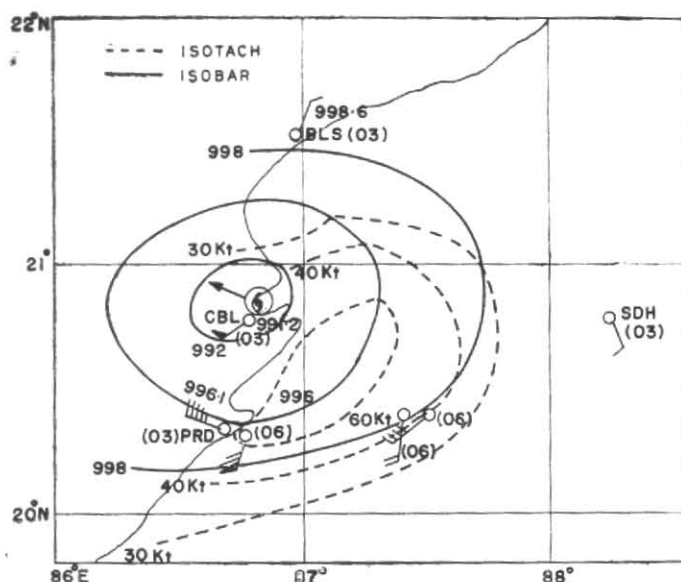


Fig. 2. Composite wind observations on 14 October 1984 of Chandbali storm (figures in the parenthesis indicate the time of observation)

were to the left quadrant. Paradip cyclone detection radar reported 'open eye' at 0300 GMT of 13th, when the wall clouds were seen in the left quadrant but not in the right quadrant. The radar PPI suggested that one convective band extended about 200 km northwards from the wall cloud region but the right hand rear quadrant w.r.t. storm motion was free from any convective cloud band. On the other hand 4 to 5 convective bandings were observed to the left quadrants extending to about 175 km from the storm centre. The wind maxima appeared to be associated with the wall cloud. At 1200 GMT of 13th the asymmetry in the wind field around the storm was maintained as it was in the morning, i.e., the strongest wind in the left hand rear quadrant of the storm w.r.t. its motion. At this time the wind reported by the ship ATKH (18.5°N, 88.1°E) was 260°/50 kt and that by Sandheads (21°39'N, 88°03'E) was NNE/20 kt. These observations also confirm that the wind maxima were in the left hand quadrants, probably in the rear one.

Fig. 2 shows the available wind and pressure observations in the storm field on 14th morning. In the inner core of the storm the pressure gradient appeared to be symmetric around the storm. The observed wind field was asymmetric as on 13th. In the morning of 14th the convective bands were in the left quadrants while the right quadrants were free from any convective bands as shown in the radar PPI. Normally, the wind intensity increases on the right side and diminishes on the left side (looking down-streams) of the storm (Frank and Gray 1980). In the case of Chandbali storm the wind maxima have been found to the left hand rear quadrant with respect to the storm motion on 13th and 14th morning.

Report also indicated that the highest wind speeds observed over land was of the order of about 120 kmph in Chandbali of Balasore district and adjoining Cuttack

district between 0700 and 1000 IST of 14th. These observations and damage reports corroborated the fact that maximum winds associated with the Chandbali cyclone were to its left hand rear quadrant. Such characteristic wind features were reported by Simpson and Palissier (1971) in case of Atlantic hurricane 'celia' in 1970.

3. Sriharikota cyclone, 9-14 November 1984 — A well marked low pressure area developed over southeast Bay in the ITCZ on 9th and it concentrated into a deep depression and moved in westerly direction initially and subsequently took a northwesterly course and rapidly intensified into a hurricane and lay centred near Lat. 12.0°N, Long. 80.8°E on 12th at 0300 GMT. At this time the intensity of the storm was T 5.0. The peak intensity attained by the storm was T 6.0 at 1000 GMT of 13th. It crossed south Andhra coast, north of Sriharikota around 0430 GMT of 14th as a hurricane. After crossing the coast the storm took a southerly course.

Highest Closed Isobar (HCI) is sometimes taken as a measure of the extent of a storm. In case of this storm the mean radius of the HCI was about 230 km at 1200 GMT of 11th which became about 170 km at 0300 GMT of 12th. By 1200 GMT of that day the mean radius of the HCI increased to 270 km. But the mean radius of HCI again decreased. On 13th it measured about 140 km and on 14th morning about 160 km. These suggest that the storm was of small size on 13th when it had peak intensity, and also on 14th when it was weakening.

The highest vertical extension of the storm was at 1200 GMT of 12th, when it extended up to 200 hPa level. On the other days the vertical extension was generally up to 300 to 250 hPa level.

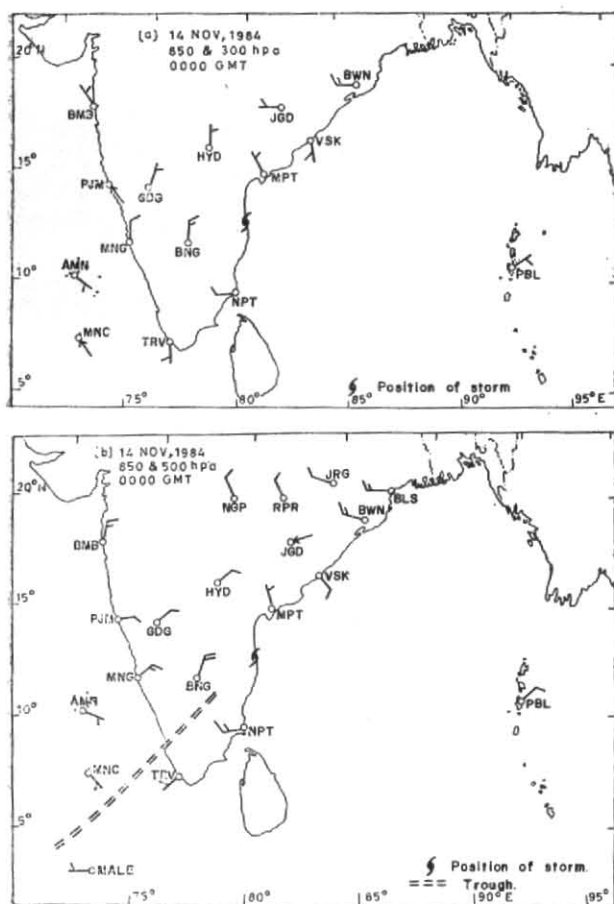


Fig. 3(a & b). Pressure weighted mean wind between 850 mb and (a) 300 hPa & (b) 500 hPa

The characteristic features associated with the storm were :

(i) Very rapid growth/intensification of the storm from 11th morning to 12th morning.

(ii) The storm moved in a southerly direction after crossing the coast even though it was on the poleward side of the upper tropospheric ridge line in the morning of 14th.

The rapid intensification of the system may be attributed to the favourable positioning of the anticyclone at 200 hPa level on 11th to the north/northeast of the system providing necessary upper divergence for the rapid growth.

Since the storm was of small core, coriolis parameter had very little effect on its meridional displacement. The movement was mainly governed by the steering current. The steering current concept at a level is an over simplification for prediction of the movement of a storm. 'Steering layer' concept is a better proposition.

In the present study the pressure weighted mean wind of the layer between 850 and 300 hPa (Fig. 3a) and between 850 and 500 hPa (Fig. 3b) were computed. It is

evident from the figures that the pressure weighted mean winds in both the aforesaid layers were having northerly components to the north of the storm indicating a southward drift of the system. Also, it could be noticed that in the layer between 850 and 500 hPa (Fig. 3b) there was a trough extending from the periphery of the system southwestwards to Lakshadweep-Maldives areas. The storm apparently moved along the same trough lines of the said layer.

Gray found, that 24 hours before the turn time the average wind parallel to the storm motion (V_p) within 7° and 11° radius from the storm centre in octant 1 (front of the storm w.r.t. its motion) for left turning and straight moving storms, wind shear (V_p) between 900 and 200 hPa levels ($V_{p200} - V_{p900}$) have positive values. Behind the storm (octant 5) the vertical wind shear between these two levels is also positive for left or right turning storms.

In case of Sriharikota cyclonic storm $V_{p200} - V_{p900}$ in the front of the storm, 27 hrs in advance, i.e., at 0000 GMT of 13th, had positive value of the order of 5.1 m/s. This value was obtained with the upper wind observations of Hyderabad, Nagpur and Bombay. The shear value is not quite high. It may be due to the fact that the number of observations was limited.

The development of the ridge/anticyclone to the south of the storm in the upper tropospheric levels was due to the strong outflow that took place from the southern sector of the storm.

4. Conclusion — (i) In a cyclonic storm, the wind maxima may sometime occur in the left hand quadrant w.r.t. the storm motion contrary to the normal feature.

(ii) Under the influence of a mid-tropospheric trough in the westerlies a system in the Bay of Bengal in the early post monsoon season may rapidly intensify into a storm.

(iii) Steering layer concept is a better tool than the conventional steering current concept for prediction of storm movement.

(iv) A cyclone tends to move along the lower and middle tropospheric trough line.

(v) The wind shear between 900 and 200 hPa levels parallel to the motion of the storm in octant 1 may be taken as an indicator of turning motion in the subsequent 24 hours.

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