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Synoptic study of the October 1982 Bay cyclone

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सार — इस शोधपत्र में 18 अक्टूबर 1982 के बंगाल की खाड़ी के चक्रवात का विश्लेषणात्मक दृष्टिकोण से अध्ययन किया गया है। यह अध्ययन इसकी गति और सघनता का पता लगाने के लिए और सिनॉप्टिक विश्लेषण की महत्ता को बताने के लिए किया गया है।

ABSTRACT. In this study the Bay cyclone of 18 October 1982 is studied from analytical angle to find out its movement and intensity and hence, to highlight the importance of synoptic analysis.

1. Introduction

The forecasting of the movement and landfall of the cyclone has been a difficult problem and its recurvature a distant aim. A careful study of the synoptic charts can help substantially in arriving at the proper and definite conclusions. This case study of the Bay cyclone of 18 October 1982 has been taken up with this objective in view.

2. History of the cyclone

A low pressure area formed in southwest Bay off the coasts of Sri Lanka and south Tamilnadu on 15 October 1982 and persisted as a low till 17th with a little northeastward movement, probably under the influence of the cyclonic storm off north Andhra coast. When the latter weakened, the low pressure area in southwest Bay off the coasts of Sri Lanka and south Tamilnadu concentrated into a depression with its centre near 11.5°N, 82.2°E (about 275 km eastsoutheast of Madras), and into a severe cyclonic storm by 0300 GMT of 18th centred near 12.7°N, 81.3°E (about 120 km eastsoutheast of Madras). The rapid intensification from low pressure area into a severe cyclonic storm, thus, took less than 24 hours. Then, moving in a northwesterly direction came close to the coast to the north of Madras near Sriharikota. After a few hours, it crossed the coast between 1600 and 1700 GMT at about 20 km north of Sriharikota, maintained its intensity for a few hours and then weakened rapidly in its onward journey. The track of the storm is shown in Fig. 1.

3. Discussion

3.1. *Formation.*

A low pressure area formed *in situ* as early as 15 October off Sri Lanka and south Tamilnadu coasts and it moved a little northeastwards by 17th. The conditions stipulated by Palmen (1956) and Gentry (1973) for the formation of a cyclone have been fully met since the sea surface temperature reported by three ships adjoining the area of formation were 29° and 30°C, the latitudinal position was around 10°N and the vertical wind shear in the basic current, as seen from the coastal stations Madras, Karaikal and Colombo, was weak.

Riehl (1948) suggested two criteria for the formation of a cyclonic storm, *i.e.*, a pre-existing low level disturbance and a region of upper level divergence or outflow above the surface disturbance. These are also satisfied as the low pressure area on 17th can be considered as a pre-existing low level disturbance which has come under the influence of an upper divergent outflow.

3.2. *Intensification and movement*

Having got the minimum requirements for the formation, the low started intensifying from 0600 GMT on 17th in an area of uneven wind distribution, maximum of 30 kt being on the south and southeast sectors where the air temperature as reported by ships was 28°C. By 1200 GMT on 17th the system intensified into a deep depression.

When the system was still a depression on 17th evening near 11°N, 82.5°E the subtropical ridge line at 250 mb lies in a NE-SW orientation extending from 21°N in the Bay of Bengal to as far south as 10°N in the Arabian Sea across the Peninsula (Fig. 2). The northern portion of the depression has come below the southern periphery of upper tropospheric ridge. A significant feature at 250 mb is the appearance of a trough in the westerlies along 65°E extending up to 10°N. This persisted at 200 mb also. Under the influence of this trough the small anticyclonic circulation at 250 mb over Kerala-Lakshadweep area shifted

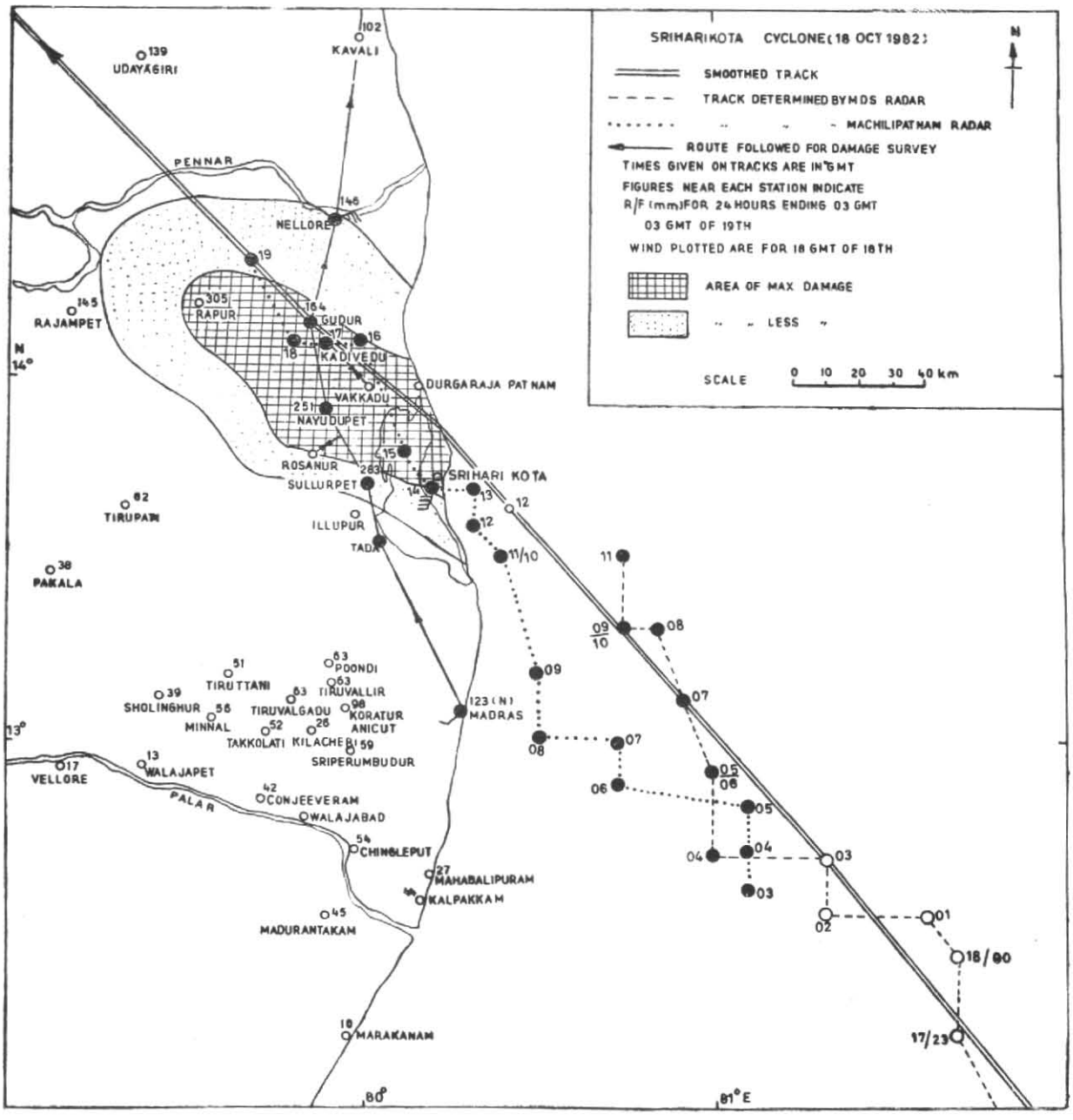

Fig. 1. Track of the Sriharikota cyclone

eastsoutheastwards to over southwest Bay and adjoining Tamilnadu. Under the influence of this trough the depression intensified into a severe cyclonic storm (SCS) at 0300 GMT of 18 October 1982. Movement of this severe cyclonic storm has been along the periphery of the Bay of Bengal anticyclone at 250 mb.

Gupta *et al.* (1977) could infer that the Porbandar cyclone intensified rapidly into a severe cyclonic storm because of a warm pool above the surface circulation and marked upper tropospheric divergence in addition to the warm sea surface. In the present case the contributing factors are the warm sea surface and diffluent area.

The trough in the westerlies, even though weakened by 1200 GMT on 18th (Fig. 3), the westerlies to the south of SCS at 250 mb strengthened, thus slowing down its movement and helping in intensification.

3.3. *Surface pressure and wind distribution*

Sriharikota and Nellore are the only two stations where the surface wind and pressure data are available on hourly basis. Surface wind at Nellore, though persistently maintained its northnorthwest direction, had suddenly veered to northeast direction at 1300 GMT on 18th and continued till the storm completely crossed

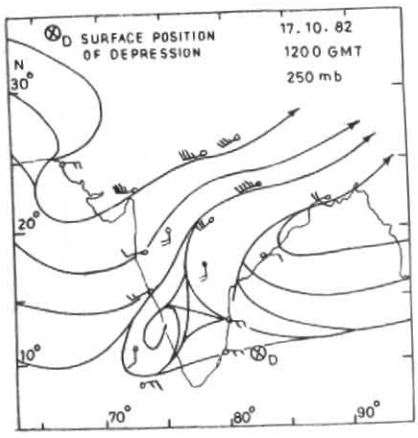

Fig. 2. Upper air chart of 17 Oct 1982

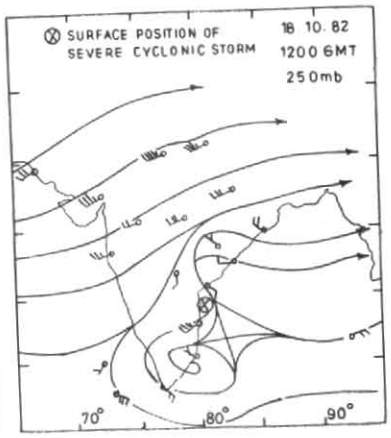

Fig. 3. Upper air chart of 18 Oct 1982

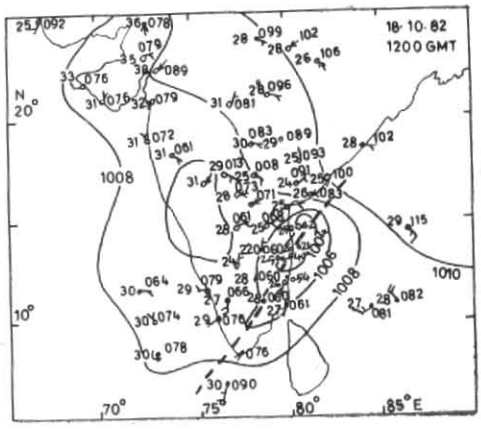

Fig. 4. Surface chart of 18 Oct 1982

the coast. On the other hand Sriharikota reported backing of wind from northeast to northnorthwest almost at the same time and further backed to south-southwest (estimated) by 1530 GMT and thereafter maintained throughout the night. This gives the first indication that the storm will cross the coast definitely in the latitudinal zone between Nellore and Sriharikota. The almost constant wind speed at Nellore from 1200 GMT onwards as against the rapid increase of wind speed at Sriharikota indicates the landfall of the storm nearer to Sriharikota.

The study of the surface observations in conjunction with the upper air features also gives clue to know the characteristics of the storm. The storm having circular isobars at 0600 GMT on 18th was under the influence of the subtropical ridge to its north and was moving in a northwesterly direction. By 0900 GMT the anticyclonic vortex, as stated earlier, could have moved eastward with a col between the two anticyclonic systems. This is the time when both the northern portion and the southern portion of the surface system were under the influence of two different upper air systems. There was a trough in the westerlies around 65° E during this period. These could have resulted in the change from circular isobaric pattern to the elliptic isobaric pattern as seen at 1200 GMT on 18 October 1982 (Fig. 4). It appears the severe cyclonic storm developed an elliptic axis under opposing influence of two upper air anticyclonic systems at 250 mb. However, the net movement was guided by the northern Bay anticyclone which happened to be the nearer and in control of the system from the beginning. In association with the upper air westerly trough, the southern transitory anticyclone at 250 mb might have contributed to the intensification of the system between 1200 GMT of 17th and 1200 GMT of 18th.

The maximum destruction or damage to property occurred in the left (south) sector of the track, as observed by the author, and continued unabated for few hours till the anitcyclonic vortex became ineffective. This was an unusual feature of this cyclone as usually the northeast sector of the cyclone contain peak maximum sustained wind speeds causing maximum destruction to the north of the track on landfall.

3.4. *Estimation of central pressure and maximum wind speed*

The variation of mean sea level pressure and wind speed with time for Sriharikota, the only station near the centre of the storm, is given in Fig. 5. The wind directions are also marked in the diagram. The highest maximum sustained wind speed of 60 kt from southsouthwest direction was initially recorded at 1630 GMT (earlier data not available) when the storm was in its landing phase. The frictional forces or local factors have made the winds in the storm-field appear weakening temporarily between 1630 and 1730 GMT. The wind speed and pressure curves show the minima of pressure and surface wind around the same time at 1430 GMT. However, the pressure curve with time is more smooth while the plot of maximum sustained winds with time shows frequent fluctuations mainly due to surface friction and other local features. It may be significant to note that even though the pressure fall associated with the centre of the cyclone has diminished and by 1830 GMT the mean sea level pressure was around 1001 mb the maximum sustained surface winds of about 40 kt could be still recorded. It establishes the fact that when the cyclone is still in the intensification phase or under favourable atmospheric conditions at the time of landfall the gale force winds could be experienced for 4 to 6 hours after the filling up of the cyclone. One of the probable reasons for this could be that the southern sector of the centre of the storm in its elliptical shape has been over Sriharikota for sometime. Nellore reporting a maximum wind speed of 30 kt at 2000 GMT when the storm was at its nearest point at Gudur; also confirms existence of strong winds associated with this storm for 4 to 6 hours after its landfall.

At about 1800 GMT the storm was centred to the east of Kadivedu (about 15 km from the coast). At this time Ongole came under the influence of the storm in its extreme periphery, recording a pressure of 1005 mb (P_n). Sriharikota reported a maximum wind speed of 60 kt (V_{max}) at this time. Using the equation of Mishra and Gupta (1976) :

$$V_{max} = 14.2\sqrt{P_n - P_0}$$

the central pressure (P_0) of the storm works out to 987.2 mb. This shows a gradient of 14 mb from Sriharikota to the centre of the storm near Kadivedu which appears reasonable.

Using the lowest pressure of 982.8 mb as reported by Sriharikota at 1430 GMT and the peripheral pressure of 1005 mb the maximum wind speed works out from the above equation to be 67 kt which is slightly more than the reported maximum of 60 kt at 1630, 1800 and 1830 GMT. The elliptical configuration of the cyclone could be responsible for this variation of the maximum sustained wind and reduced it slightly to a lower value of 60 kt as compared to the expected 67 kt.

3.5. *Rainfall distribution*

This is a case where the rainfall and damages due to wind force are concentrated to the left of the storm track. The bulk of the rainfall was on 18th since the life of the storm was about 24 hours. The highest rainfall of 305 mm was recorded on 19th at 0300 GMT at Rapur in Nellore district and other significant rainfalls of more than 250 mm per day were : Sullurpet 283 mm and Naidupet 251 mm, all to the left of the storm track. Koteswaram and Gasper (1956) in their study of a number of Bay of Bengal storms also found that the rainfall was heaviest immediately to the left of the storm centre.

The post-cyclone survey of the storm indicates that the rainfall has been heavy and concentrated during the period 1630 to 2330 GMT on 18th. The possible explanation for this also lies in the movement of the upper level anticyclonic vortex to overlie the close vicinity of the storm around this time, thus providing the upper level divergence. Raghavan *et al.* (1984) in their radar study of the same cyclone could also conclude that the occurrence of maximum radar reflectivity, heaviest rainfall rate and maximum wind in the southwest sector of the centre could be common to Bay storm, striking this region of the country, just close to the withdrawal of the southwest monsoon. Mishra and Gupta (1984) observed first maxima in northeast sector and a second maxima of winds in the southwest sector of storms in Indian seas in the composite analysis of 50 storms. The wind maxima in southwest sector could belong to this category of storms.

4. Conclusions

(*a*) The cyclonic storm of 18 October 1982 developed when the southern edge of the subtropical anticyclone lay over the surface low pressure area.

(*b*) It intensified into a severe cyclonic storm when a trough in the upper tropospheric westerlies approached and pushed an anticyclonic vortex over the southern Peninsula eastwards in the close vicinity of the cyclone.

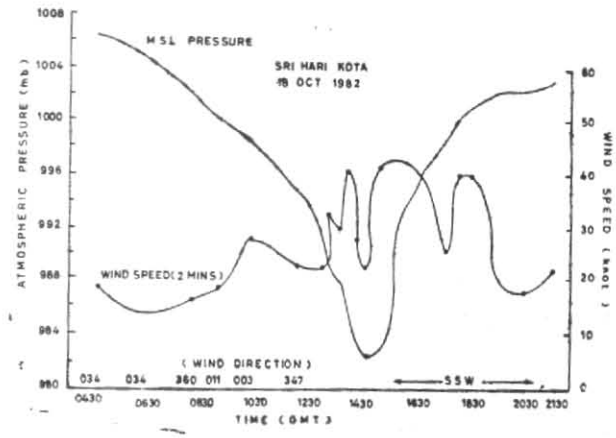

Fig. 5. Variation of pressure and wind with time

(*c*) Both the upper level anticyclonic systems could have a bearing on the surface structure of the storm which modified it from the initial circular to elliptic isobaric pattern.

(*d*) Under favourable atmospheric conditions and during the intensification phase of tropical storms, it is probable that the associated maximum sustained winds could maintain cyclonic intensity till even after 4 to 6 hours of the filling up of the system.

(*e*) Probably this is an unusual case of quick intensification close to the coast, reporting peak sustained maximum winds in the southwest sector and causing high rainfall amounts and maximum damage south of its track. This could be a common feature of Bay storms striking south Peninsula just close to the withdrawal of southwest monsoon.

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