

Some salient features of the Bay of Bengal cyclone of November 1989

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सारा— नवम्बर 1989 के दौरान बंगाल की खाड़ी में आए चक्रवात से अपेक्षाकृत कम वर्षा हुई। इस चक्रवात से हालांकि गहन क्षति हुई, किन्तु यह अपेक्षाकृत छोटे क्षेत्र तक सीमित थी। थल-प्रवेश के बाद प्रणाली शीघ्रता से क्षीण हो गई। प्रमुख विशिष्टताओं पर विचार किया गया है और नवम्बर 1984 के चक्रवात से तुलनात्मक अध्ययन भी किया गया है तथा परिणाम प्रस्तुत किए गए हैं।

ABSTRACT. The cyclone which occurred in the Bay of Bengal during November 1989 produced relatively less rainfall and the damage though intensive was confined to a relatively small area. After landfall the system weakened rapidly. Salient features of the cyclone are discussed and a comparative study has also been made with the cyclone of November 1984 and the results presented.

Key words— Cyclone, T-number, Radius of maximum reflectivity.

1. Introduction

The cyclone which occurred in the Bay of Bengal during November 1989 was tracked by INSAT-1B & 1C and the coastal radars installed at Visakhapatnam, Machilipatnam and Madras. The cyclone after crossing the south Thailand-south Burma Peninsula emerged into the Indian Sea on 4 November as a severe cyclonic storm with a core of hurricane winds. Moving in a westnorthwesterly direction the hurricane crossed Andaman Island, south of Mayabandar on 6 November and then moving in a westnorthwesterly/westerly direction crossed south Andhra coast near Kavali as a hurricane on 8 November around 1900 UTC. The system crossed south Andhra coast at the time of low tide.

This is one of the most severe cyclones of the century over the Bay of Bengal and it maintained hurricane intensity throughout its course in the Bay for a period of over 4 days. The storm with the intensity of hurricane travelled about 2000 km over the Bay of Bengal which is one of the longest tracks of hurricane over the Bay. Available records show that this is very close to the earlier longest sea travel by a severe cyclone over the Bay of Bengal in November 1891 when the storm travelled about 2100 km over the sea before crossing the West Bengal coast.

According to Meteorological Data Utilisation Centre (MDUC), New Delhi the storm retained its highest intensity T 6.0/6.5 between 0500 UTC of 7 Nov and 1500 UTC of 8 Nov 1989.

2. Results and discussion

2.1. Satellite and radar observations

The track of the storm during the period 2 to 9 Nov as observed by satellite and radar observations (Madras) from 0300 UTC of 8 November are presented in Fig. 1. Table 1 shows the T number as reported by the MDUC, New Delhi at various timings and the corresponding maximum sustained windspeed according to Mishra (1984). It can be inferred from the table that the storm maintained the hurricane intensity throughout its course in the Bay. However, from the satellite imagery and the synoptic evidence it was observed that the areal extent was small and hence the storm can be classified as a narrow core system.

The entire extent of the storm in its mature and intense stage on the 8th as seen by Madras radar is shown in Fig. 2. Fig. 3 gives the hourly variation of radius of maximum reflectivity (RMR), thickness of the eyewall and the diameter of the eye of the storm as reported by Madras radar. The radius of maximum reflectivity in the eyewall (within about 5 km) will approximately represent the radius of maximum winds (RMW) of the cyclone. The practical importance of the RMW measurement is for predicting the height of storm surge to a sufficient degree of accuracy.

The eyewall thickness remained almost constant throughout the period of observation with standard deviation (S.D.) of 3.4 km and mean 17.7 km. The RMR of the storm also remained practically constant

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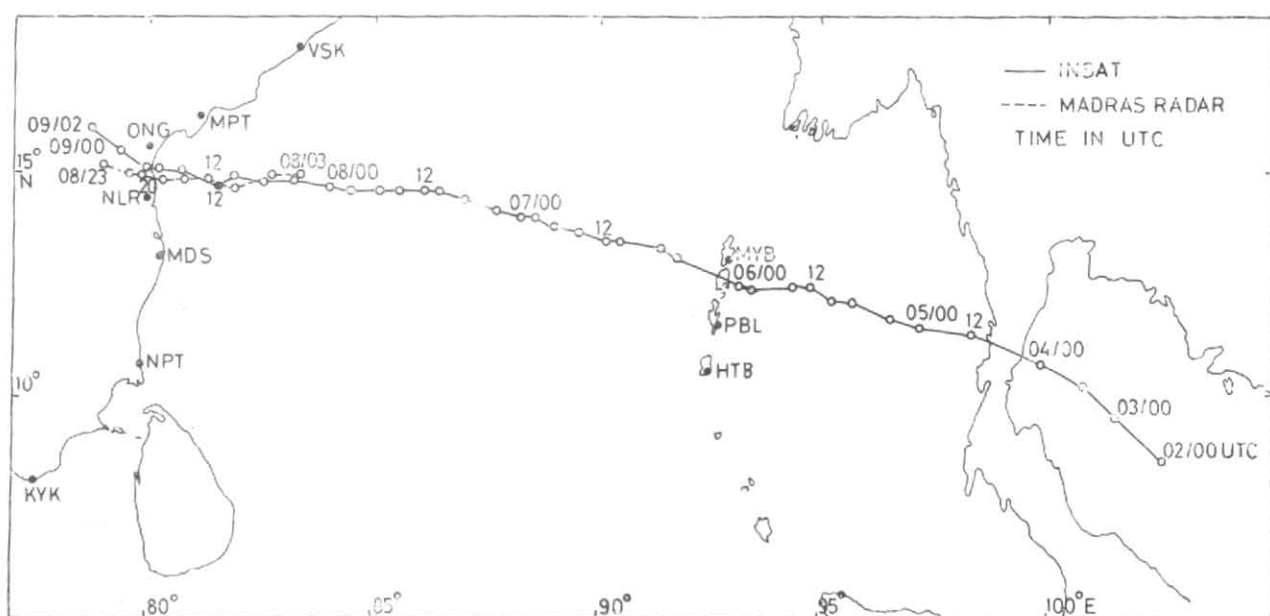


Fig. 1. Satellite and radar track of Nov 1989 Bay cyclone

throughout the period of observation with a little fluctuation. This is in agreement with the study made by Raghavan *et al.* (1989) on Sriharikota cyclone of November 1984 wherein they have concluded that changes in RMR and eyewall thickness seem to be negatively correlated with changes in cyclone intensity. The standard deviation (SD) of RMR is about 2.6 km with a mean of 20.9 km. The eye diameter of the storm can be seen to be decreasing from the first radar observation until 3 hours before it crossed the coast from 35 km to 10 km and then started increasing and was 35 km at the time of storm crossing the coast.

2.2. Moisture field and movement

The moisture content both at the surface and in the upper levels over the coastal stations in the vicinity of storm did not change significantly even on the 8th evening when the storm centre was only about 120 km away from the coast.

An analysis of the movement of the storm revealed that the storm moved rather fast. It travelled initially with a speed of about 19 km/hr till 1200 UTC of 6 Nov and the speed increased slightly thereafter. So the passage of the storm over a place was very quick which in turn might have reduced the damage and rainfall. The storm travelled about 750 km in the Bay in westerly direction before crossing the coast. This resulted in the storm striking the coastal strip almost at right angle. The relatively fast movement and the striking angle also contributed to relatively less rainfall associated with this hurricane.

2.3. Rainfall, surface wind and pressure

Spatial distribution of 24 hr rainfall up to 0300 UTC on 9 and 10 Nov are shown in Fig. 4. The rainfall distribution is not very significant considering the fact that the system maintained hurricane intensity throughout its course in the Bay. The survey team that visited the coastal

TABLE 1

T numbers at various UTC and the corresponding maximum sustained wind (MSW) of the severe cyclonic storm with a core of hurricane winds

Date (Nov 1989)	Time (UTC)	T. No.	MSW (kmph)
4	1200	4.5	143
5	0300	5.5	189
	1200	4.5	143
6	0300	4.0	121
	1200	5.0	167
7	0300	5.5	189
	0600	6.0	213
	1200	6.0	213
8	0300	6.0	213
	0600	6.0	213
	1200	6.5	235
	1800	5.5	189
	1900	5.5	189

area soon after the storm crossed coast reported that the intense precipitation was mainly confined to 4 hr period between 1700 and 2100 UTC of 8 Nov.

Based on the damage the survey team estimated the maximum wind speed in the core region to be between 200 and 220 kmph. However, the nearest departmental coastal observatories at Nellore about 50 km south of Kavali and Ongole about 60 km north of Kavali reported respectively maximum wind speeds of 56 kmph at 1900 UTC and 46 kmph at 1800 and 1900 UTC on 8 Nov.

The lowest pressure recorded at Nellore was 1002.3 hPa at 1820 UTC while Ongole reported the lowest pressure of 1004.2 hPa at 1940 UTC on 8 Nov. At

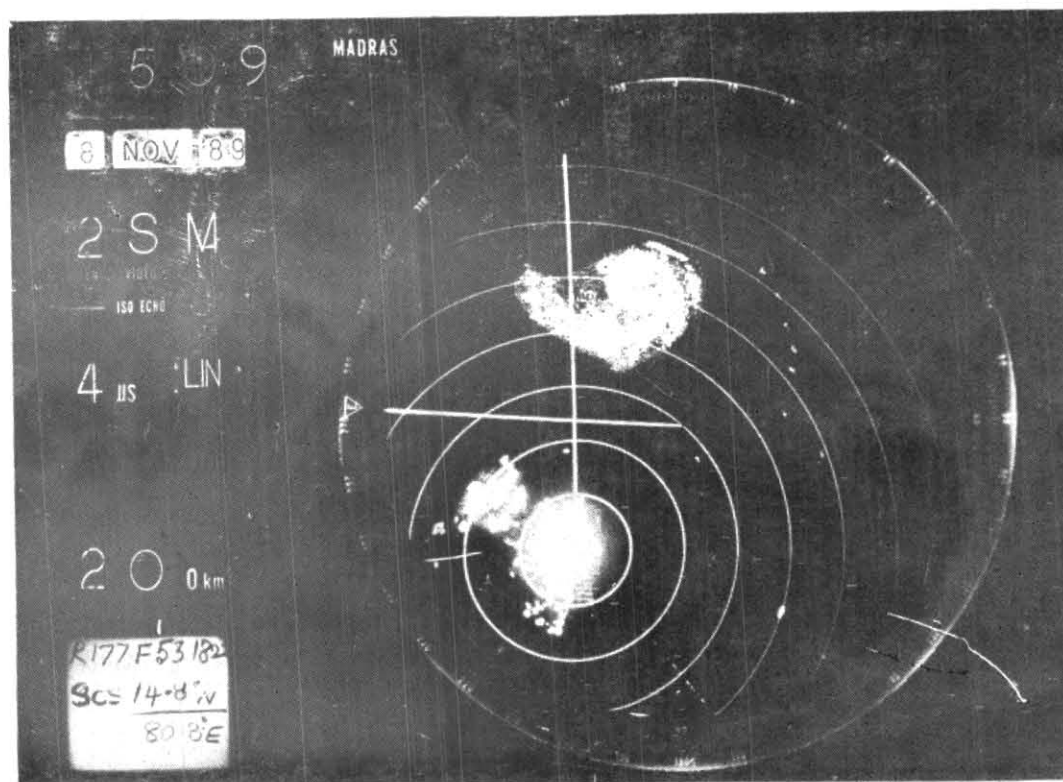
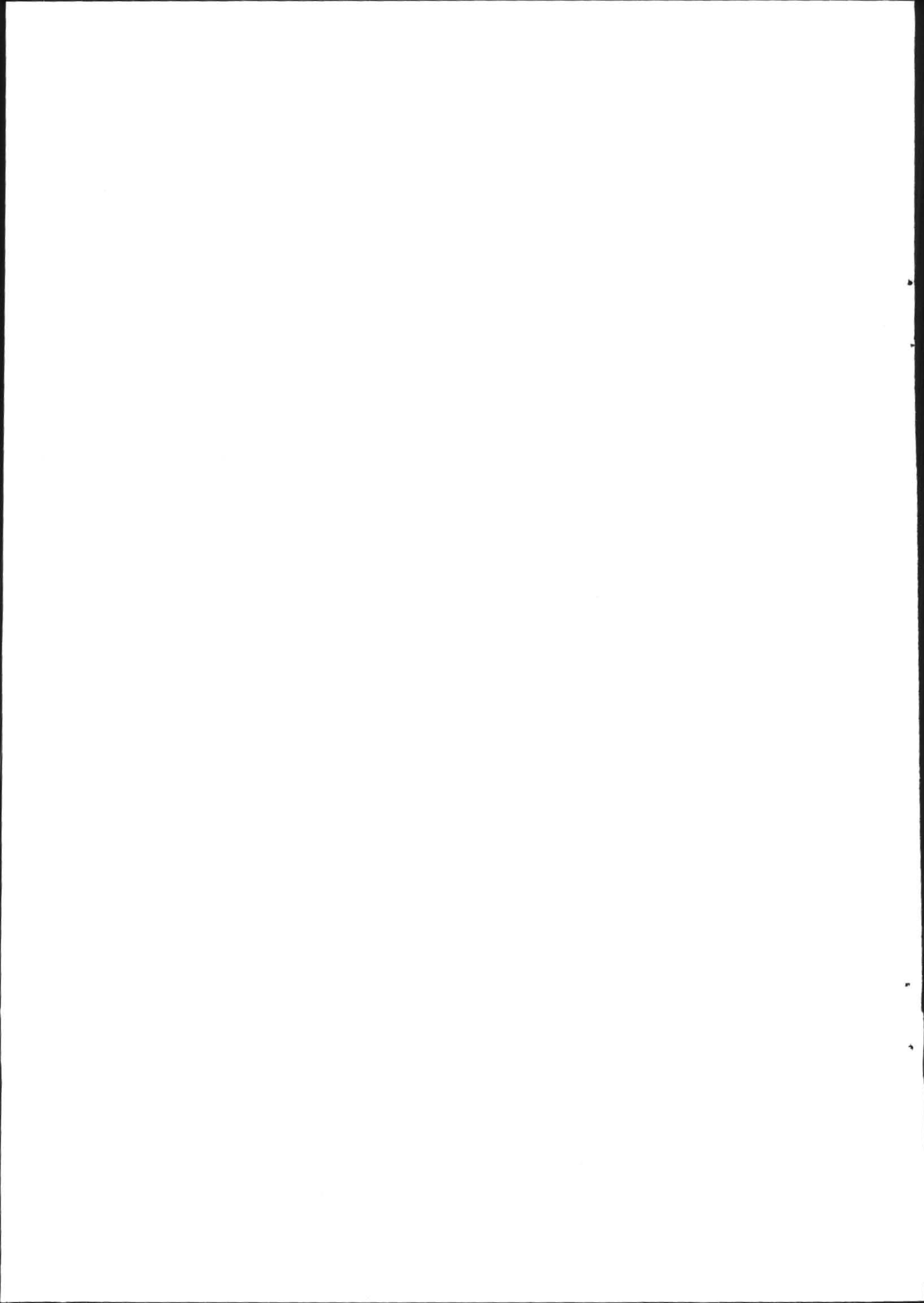


Fig. 2. Radar picture at 1509 UTC, 8 Nov 1989 (Range markers are at 40 km interval)



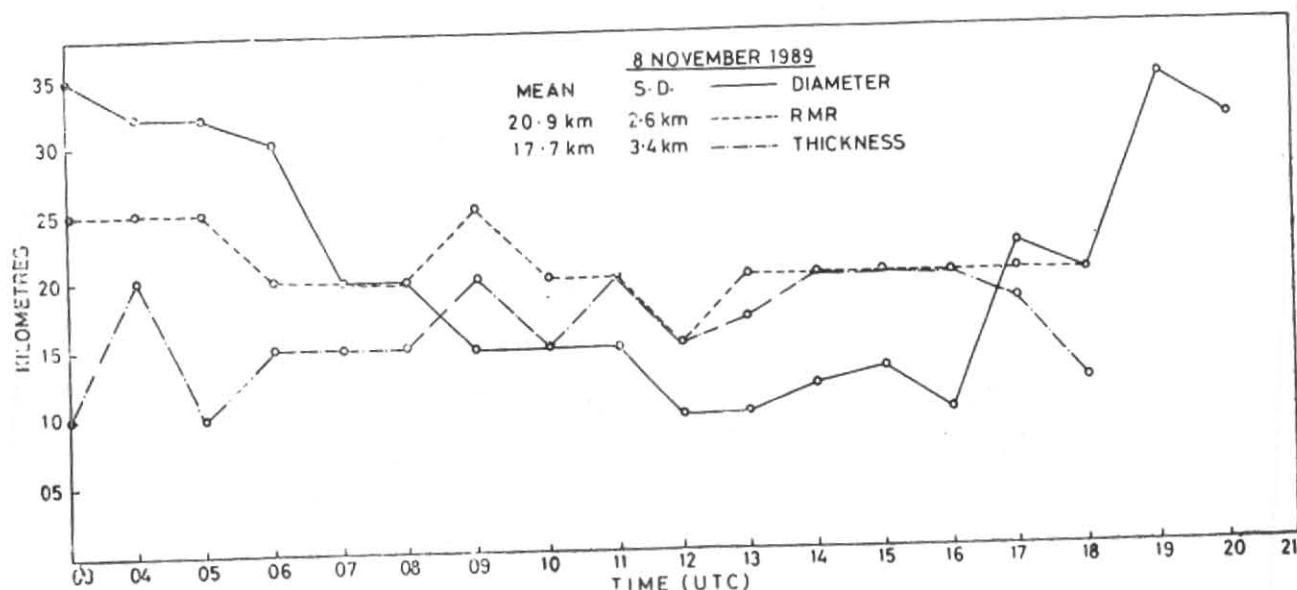


Fig. 3. Hourly variation of RMR, thickness of the eye wall and diameter of the eye

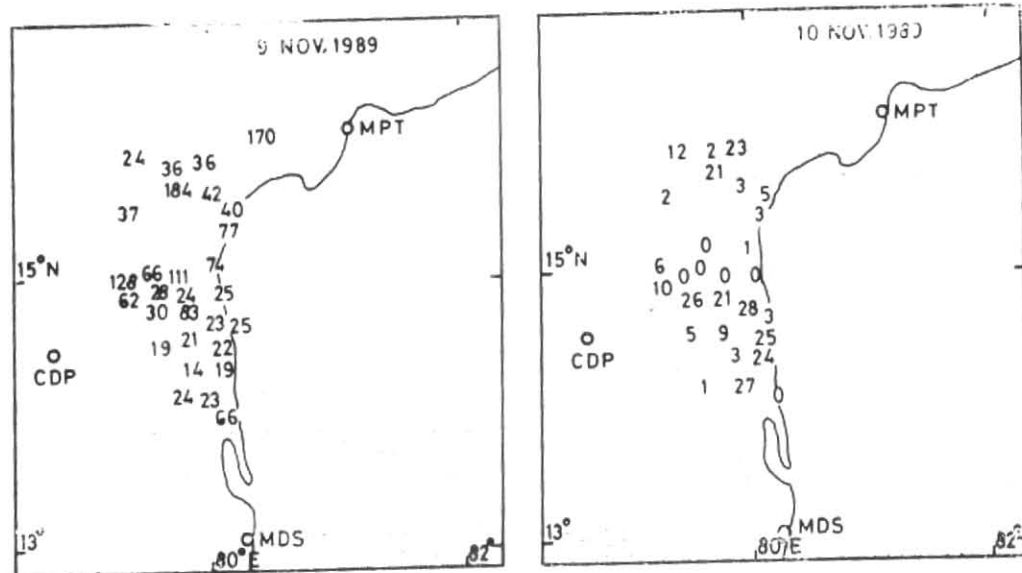


Fig. 4. Spatial distribution of rainfall (mm) for the 24-hr ending at 0300 UTC on 9 and 10 Nov 1989

1800 UTC on the 8th, the current intensity number of the system based on satellite cloud imagery was 6.0. Assuming maximum wind to be 213 kmph the central pressure is estimated to be 942 hPa using the formula of Mishra and Gupta (1976). Further, based on Nellore observation the pressure gradient is estimated to be 1.2 hPa/km from Nellore to the centre.

2.4. In relation to Nov 1984 Bay of Bengal cyclone

After the studies on different aspects of cyclones, Raghavan *et al.* (1980 a), Raghavan and Rajagopalan (1980 b), Raghavan & Varadarajan (1981), Raghavan *et al.* (1985) and Raghavan *et al.* (1989) made a detailed study of Sriharikota cyclone of Nov 1984. The Kavali

cyclone of Nov 1989 and Sriharikota cyclone of Nov 1984 both had small core region and crossed south Andhra coast with almost same intensity. Hence a comparative study was made to bring out some of the features of Kavali cyclone.

The RMR of Nov 1984 storm was found to be decreasing from 40 to 12 km till 1200 UTC of 13 Nov showing that the storm was intensifying, whereas the RMR of the Nov 1989 storm remained almost constant. The T No. classification of the MDUC also supports this statement. In Fig. 5 the satellite classification of 1984 and 1989 storms are shown together. The eye diameter of 1984 cyclone was about 24 km and it did not indicate any fluctuation despite change in intensity. In the case of Nov

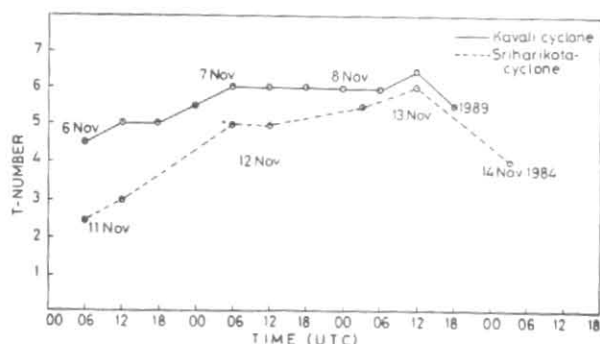


Fig. 5. Satellite intensity classification of Kavali (Nov 1989) and Sriharikota (Nov 1984) cyclones.

1989 cyclone as mentioned earlier the eye diameter showed a decreasing trend till about 3 hours before crossing coast. The thickness of the eyewall also invites attention. In the case of Nov 1984 cyclone there existed a negative correlation between eyewall thickness and intensity. It is evident from Fig. 3 that the eyewall thickness was almost constant with a little fluctuation in the case of 1989 cyclone. This may presumably due to the fact that the cyclone reached its peak intensity by 0500 UTC of 7 Nov and maintained it thereafter, whereas Nov 1984 cyclone exhibited some rapid intensification a day before crossing the coast.

The study of the moisture content of the two storms indicated a marked difference in the moisture pattern between these two storms. The land area in the storm field was comparatively dry till 1200 UTC of 8 Nov 1989 when the storm was about 120 km from the coast, whereas for Nov 1984 storm it was quite moist when the storm was at a similar distance from the coast. This may perhaps be due also to the vector storm motion. The storm of Nov 1984 travelled very slowly parallel to the coast for nearly two days before landfall. In the case of 1989 storm, it approached the coast with comparatively high speed almost double that of the earlier one and hit the coast at right angles to the strip and, therefore, the moisture incursion though sudden was not significant. The rainfall distribution and the areal damage were also comparatively less in the case of 1989 cyclone compared to the cyclone of 1984 even though both were almost of the same intensity.

The Sriharikota cyclone of Nov 1984 survived for several hours after landfall while in the case of 1989

storm, the system weakened rapidly within a few hours. This is possible since in Nov 1989 cyclone, a balance was already reached between inflow and outflow as the system was a mature one long before it crossed the coast and as the storm crossed the coast, due to land friction, the inflow might have increased resulting in an imbalance between inflow and outflow and therefore by law of conservation of mass the system might have decayed. Entrainment of relatively dry continental air into the storm field might have further accelerated the weakening.

3. Conclusion

The Bay of Bengal cyclone of Nov 1989 had a small core region and maintained the hurricane intensity throughout its course in the Bay for a period of over 4 days. The relatively less rainfall and less areal damage were partly due to the fast movement, direction of approach (vector storm motion) and narrow core feature of the storm. The rapid weakening of the system after crossing the coast may be due to an imbalance between inflow and outflow and the entrainment of relatively dry continental air into the system.

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