

Cyclones and depressions over the Indian seas in 1977

P. S. PANT, A. R. RAMAKRISHNAN AND R. JAMBUNATHAN

Meteorological Office, Pune

(Received 24 April 1979)

1. Chief Features

During 1977, an exceptionally severe cyclone hit the east coast of India near Masulipatnam in Andhra Pradesh causing considerable loss of life and property. In the last 100 years that part of the coast had not experienced the effects of such a severe storm.

In the first half of the year no cyclone or depression directly affected the Indian coast. One storm in the Bay of Bengal in May 1977 moved towards Bangla Desh coast while another in June in the Arabian Sea hit the Arabian coast. But in the second half of the year there were nine depressions in the monsoon season. Seven of these formed in the Bay and entered land while one formed and dissipated over land and another formed over land and dissipated over the Arabian Sea.

Four depressions and four severe cyclones formed in the post-monsoon season. Three depressions formed in the Arabian Sea and moved away westwards. The fourth formed in the Bay and broke over Sri Lanka. All the four severe cyclones, three in the Bay of Bengal and one in the Arabian Sea occurred within a short period of less than a month starting from the end of October. For a few days two of these cyclones had simultaneous existence, one in the Bay and the other in Arabian Sea and seem to have interacted with each other and influenced their courses. Both of them which were moving steadily westwards for some days, abruptly changed their course simultaneously; the Bay storm moving northwestwards and the Arabian Sea storm southeastwards and performing a big loop. The Arabian Sea storm which had its origin also in the Bay had an unusually long track of about 5000 km and a long period of life of about 15 days.

The tracks of the various systems are shown in Fig. 1. The maximum wind and lowest mean sea level pressure associated with the cyclones are given in Table 1.

The salient features of the various disturbances are discussed below:

Bay of Bengal

1. Severe cyclone of 9-13 May

A depression formed over southwest Bay on 9th morning. A trough in the mid-tropospheric westerlies remained practically stationary over northeast India along 85°E from 10th to 12th. Under its influence the system moved north-northeastwards and intensified into a cyclonic storm on 11th morning near 16°N and 87.5°E. It became a severe cyclonic storm on 12th morning near 19.0°N, 89°E. Moving steadily north-northeastwards it crossed Bangla Desh coast on 13th morning and weakened into a low over Bangla Desh and adjoining Assam by the morning of 14th.

This storm did not cause any damage to life or property over Indian area. A few persons were reported killed and several missing in the coastal districts of Bangla Desh. Scattered to fairly widespread rain occurred in Gangetic West Bengal on 12th and 13th and in Assam and adjacent states on 13th and 14th. Cherrapunji recorded 35 cm of rain and Shillong 12 cm on 14th morning.

The intensity of the system could be assessed as a cyclone and severe cyclone on 11th and 12th respectively mainly with the help of satellite pictures. NOAA, Washington classified this system as T3.5/3.5 on 12th in Dvorak's scale corresponding to a maximum wind of 55kt. Joint Typhoon Warning Centre at Guam estimated the

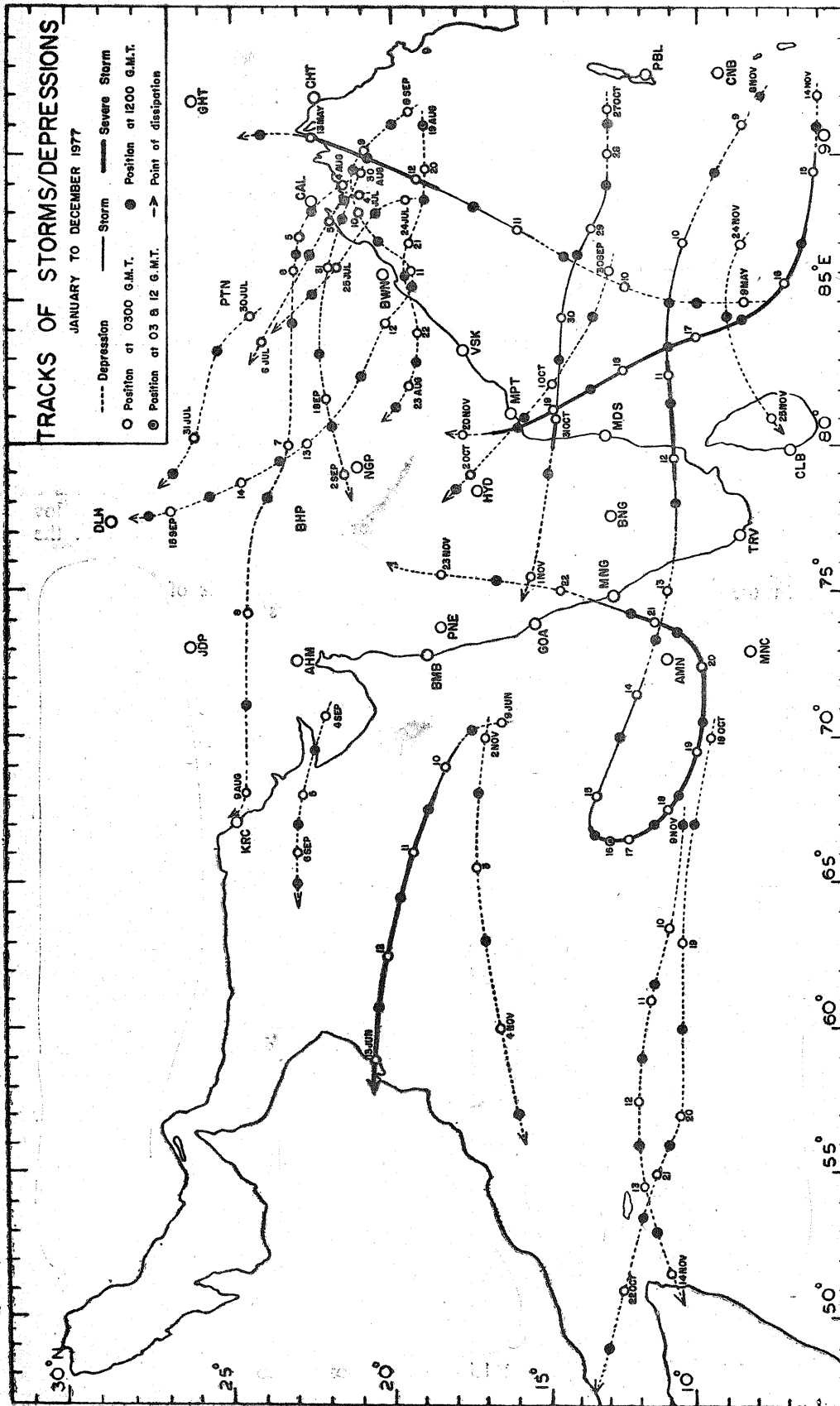


Fig. 1. Tracks of storms and depressions

TABLE 1
Maximum wind and minimum pressure in cyclones

Cyclonic disturbance	Wind (kt)		Pressure (mb)	
	Max. estimated from satellite pictures	Max. reported from nearest observation	Estimated lowest msl pressure at the centre	Lowest msl pressure reported from nearest observation
Severe cyclonic storm (9-13 May)	60	40 (Ship PGAF about 75 km from centre; also at Sandheads about 150 km from centre)	984.0	989.4 (Ship PGAF)
Severe cyclonic storm (9-13 June)	90	52 (Ship GOXX about 100 km from centre)	964.0	959.0 (At Masirah very close to storm centre)
Severe cyclonic storm (27 Oct-1 Nov)	55	40 (Ship WJGH about 150 km from centre)	996.0	1004.0 (Ship WJGH)
Severe cyclonic storm (8-12 Nov)	75	45 (At Karaikal and Tiruchchirapalli)	984.0	984.7 (979 inferred from barogram) (At Nagapattinam)
Severe cyclonic storm (13-23 Nov)	90	52 (Ship GRPA within 70 km from centre)	974.0	991.0 (At Androth)
Severe cyclonic storm (14-20 Nov)	125	104 (Ship <i>Jagatswamini</i> within 50 km from centre)	943.0	941.0 (uncorrected) (Ship <i>Jagatswamini</i>)



Fig. 2. Satellite view of Bay of Bengal cyclone at about 0300 GMT on 12 May.

maximum wind as 65 kt on the evening of 12th based on satellite pictures. The APT picture received at Bombay on 12th showed the system in stage X, category 3 with 'eye' visible. The satellite picture of this storm on 12th morning is reproduced in Fig. 2. Assuming the maximum wind associated with this system as 60 kt, the pressure at the centre of the storm on the basis of Fletcher's formula works out to be 984 mb.

This cyclone was tracked by Paradip radar from 0400 to 0900 GMT and by Calcutta radar from 1000 to 1800 GMT on 12th. The centre was estimated only from spiral bands. Important observations from ships and land stations in the field of this storm are given in Table 2.

2. Deep depression of 4-6 July

A well marked low which lay over north Bay on 3 July, concentrated into a depression on the morning of 4th, with its centre near 21.0°N, 88.5°E. It became deep that evening and moving northwards, crossed coast near Contai on 5th forenoon and weakened into a low over southeast Uttar Pradesh and adjoining Bihar by 6th evening.

This system caused generally widespread rain in Gangetic West Bengal, Orissa, Madhya Pradesh and Vidarbha from 4th to 6th and in Bihar

plateau on 6th and 7th. The monsoon was active to vigorous in Orissa, Bihar plateau, Madhya Pradesh and Vidarbha during this period. Kondagaon in Bastar district (Madhya Pradesh) recorded 17 cm of rain on 5th while Baihar and Balaghat in Balaghat district (Madhya Pradesh) recorded 25 cm and 14 cm respectively on 6th. The pressure departure from normal near the depression centre was about minus 12 mb.

3. Depression of 24-25 July

Under the influence of a low pressure wave moving westwards across north Burma, a depression formed over north Bay on the morning of 24 July with its centre near 19.5°N, 88.5°E. Moving northwestwards, it weakened into a low over Bihar Plateau and adjoining northeast Madhya Pradesh on 26th.

This system caused generally widespread rain in Orissa, Gangetic West Bengal, Bihar State, Madhya Pradesh, Vidarbha and Telangana on 25th and 26th and in coastal Andhra Pradesh on 25th with isolated heavy falls over most of these areas. Dantewda in Bastar district (Madhya Pradesh) reported 25 cm on 25th and Antagarh in the same district reported 26 cm on 26th. The pressure departure from normal near the centre of the depression was about minus 7 mb.

4. Deep depression of 4-9 August

A low pressure area which lay over northwest Bay on 3 August, concentrated into a depression on 4th under the influence of a trough in the upper tropospheric easterlies extending from Assam to east central Bay and a low pressure wave apparently moving westwards across Burma. The depression was centred at 0300 GMT on 4th near 21.5°N, 89.0°. It moved into Gangetic West Bengal that evening and was centred near Jamshedpur on 6th morning. Moving westwards rather fast the depression became deep on the morning of 7th near Jabalpur. While continuing to move westwards, it merged with the seasonal low over south Pakistan by 9th evening. This system caused a spell of active monsoon over the central parts of the country. Heavy to very heavy rain occurred in Gangetic West Bengal, Orissa and Bihar plateau between 4th and 6th, in east Madhya Pradesh from 4th to 7th, in west Madhya Pradesh on 7th and 8th, in east Rajasthan and Gujarat region on 8th and in Saurashtra and Kutch on 9th. Many stations in Madhya Pradesh reported 24-hour rainfall of 15 to 18 cm between 4th and 8th. Panna (Madhya Pradesh) recorded a rainfall of 31 cm on 5th. Tarana in Ujjain district reported 36 cm on 8th. The same day Petlawada (Jhabua district in Madhya Pradesh) reported 22 cm and Dewas, Ujjain and Kannod (all in Madhya Pradesh) 20 cm each. On 4th Baripada (West Bengal) reported 20 cm of rain.

Sandheads reported pressure departure from normal as minus 7 mb and Calcutta low level

winds were ENE 15-20 kt on 4th morning. These indicated that the system in the Bay had concentrated into a depression on 4th. On 7th morning, the pressure departure near the depression centre was about minus 10 mb and the winds, particularly the easterlies at 0.9 km asl in the depression field were 25 to 35 kt indicating that the depression had become deep on 7th. This strong wind field was maintained upto 9th morning.

5. Deep depression of 19-23 August

A low pressure area moved westwards across Burma into east central Bay on 18th August and concentrated into a depression on the morning of 19th with its centre near 19°N, 91°E. Moving practically westwards, the depression became deep on the morning of 20th, crossed coast near Gopalpur on the early morning of 22nd and weakened into a low over southeast Madhya Pradesh by 24th morning.

This system caused active or vigorous monsoon in Orissa from 20th to 22nd, in coastal Andhra Pradesh on 21st and 22nd, in Telangana between 22nd and 24th, in Vidarbha on 23rd and 24th and in Marathwada on 23rd. Rainfall was also generally widespread in Madhya Pradesh from 22nd to 24th. A few heavy to very heavy falls occurred in Orissa, east Madhya Pradesh, Vidarbha and Telangana on one or two days. According to press reports, river *Indravathi* (a tributary of Godavari) in southeast Madhya Pradesh rose in spate. Athgarh block in Cuttack district was affected by floods.

The four Russian ships UMay, UNAC, EREH and EREI which participated in Monsoon-Experiment 1977 moved from central Bay to Calcutta during the period of the formation of the depression and gave useful surface and upper air observations from 18th to 20th. They were right in the depression field on 19th and 20th. Indian Naval ship BEAS also gave some useful observations from the depression field. The pressure departure from normal at the depression centre was about minus 12 mb. Important observations from ships and land stations in the depression field are given in Table 3.

6. Depression of 30 August-2 September

A cyclonic circulation which lay over Bangla Desh on 28 August, moved southwards to north Bay on 29th and gradually intensified into a depression on the morning of 30 August with its centre near 21.0°N, 89.5°E. Moving practically westwards across north Orissa, it weakened into a low over west Madhya Pradesh by the evening of 2 September.

This system caused generally widespread rain in Gangetic West Bengal, Orissa, Madhya Pradesh and interior Maharashtra during the above period and in Konkan and Gujarat on 2 and 3 September with some heavy falls on 1 or 2

TABLE 2

Severe cyclonic storm of 9-13 May

Date	Time (GMT)	Ship/Station	Location		Approximate distance from storm centre (km)	Wind		Pressure (mb)
			Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
9	0000	LMUO	6.0	87.5	about 350 km to SE	SW	30	1005.5
	0600	9MTT	6.0	84.0	about 350 km to SSE	W	25	1006.5
	0600	ATIU	12.2	85.4	about 400 km to N	SE	20	1008.1
10	0600	GKKE	14.1	87.1	about 200 km to NE	E	24	1005.9
12	0000	Bhubaneswar	—	—	—	NNE (at 0.6 and 0.9 km asl)	35	—
	1200	Calcutta	—	—	—	NE (at 0.6 and 0.9 km asl)	30-40	—
	1200	Sandheads	—	—	—	NNE	40	995.2
	1200	PGAF	21.4	89.5	75 km to NW	NE	40	989.4
13	0000	Calcutta	—	—	—	N (at 0.3 and 0.6 km asl)	35	—
	0000	Agartala	—	—	—	ESE (upto 0.9 km asl)	30-35	—
	1200	Agartala	—	—	—	S (at 0.6 and 0.9 km asl)	35	—

TABLE 3

Deep depression of 19-23 August

Date	Time (GMT)	Ship/Station	Location		Approximate distance from storm centre (km)	Wind		Pressure (mb)
			Lat. (°N)	Long. (°E)		Direction	Speed (kt)	
19	0000	EREH	19.1	88.9	200 km to W	NW	22	998.2
	0000	UMAY	17.2	90.9	200 km to S	WSW	26	999.8
20	0000	UNAC	19.0	88.0	150 km to W	NNW	30	997.0
	0000	EREI	17.5	89.0	about 200 km to SSW	W	40	998.2
	0000	UMAY	19.5	90.0	about 100 km to NE	ENE	20	997.3
	1200	EREI	19.6	88.8	close to centre	NE	22	991.4
21	0000	Bhubaneswar	—	—	—	N/NE (upto 0.9 km asl)	25-40	—
	0000	Gopalpur	—	—	—	N (upto 0.9 km asl)	20-30	—

days. Panna (Madhya Pradesh) recorded 24 cm on 30th, Raigarh (Madhya Pradesh) 17 cm on 31st, Jalna (Marathwada) 22 cm, Dahanu 20 cm and Dharampur (Gujarat) 16 cm on 2 September and Alibag 20 cm, Bombay 18 cm on 3rd.

On 30th morning Calcutta reported upper winds ENE 20/25 kt upto 0.9 km asl suggesting that the low over North Bay had concentrated into a depression. By that evening the winds over Calcutta changed to E/ESE 20/25 kt. On 31st the easterlies in the lower troposphere over Uttar Pradesh and Bihar were 30 to 35 kt. The low level westerlies over the Peninsula were also of that order. These strong easterlies and westerlies were maintained upto 2 September. The maximum pressure departure from normal near the depression centre was minus 7 mb.

7. Deep depression of 8-15 September

A well marked low with associated cyclonic circulation extending to the middle troposphere moved slowly westwards across Arakan coast into east central and adjoining northeast Bay on 7 September and concentrated into a depression on the morning of 8th with its centre near 19.5°N 91.5°E. Moving northwestwards till 9th night and later skirting Orissa coast, the depression became deep on the morning of 11th with its centre south of Puri. It crossed coast that night between Puri and Gopalpur and started moving northwest subsequently. The deep depression weakened into a depression by 14th evening over northwest Madhya Pradesh and adjoining southwest Uttar Pradesh and into a low over north Rajasthan and adjoining Haryana by 16th.

Generally widespread rain occurred in Gangetic West Bengal on 9th and 10th, in Orissa and Bihar Plateau from 9th to 13th, in east Madhya Pradesh from 11th to 13th, in east Uttar Pradesh on 13th, in west Madhya Pradesh from 13th to 15th, in Vidarbha on 13th and 14th, in the plains of west Uttar Pradesh and Haryana from 14th to 16th and in east Rajasthan on 15th and 16th. Very heavy falls were reported from a few places in Orissa on 11th and 12th, in Madhya Pradesh between 13th and 15th and in east Rajasthan on 15th and 16th. Ambabhona (Orissa) recorded 20 cm of rain on 11th, Titlagarh 20 cm and Bhawanipatna 16 cm on 12th. Several stations in Madhya Pradesh reported 24 hours rainfall ranging from 15 to 23 cm between 13th and 15th. Sawai Madhopur in east Rajasthan recorded 22 cm of rain on 15th and 17 cm on 16th. According to reports, the *Narmada* and *Indravathi* rose in spate and disrupted road communications in Madhya Pradesh on the Khalghat road bridge on the Agra-Bombay National Highway and between Jagdalpur and Raipur. On 11th evening Puri reported a pressure departure of minus 10 mb from normal close to the depression centre. On the 12th morning, when the de-

pression was over land (in Orissa), four closed isobars at 2 mb interval covered the depression field.

8. Deep depression of 30 September-2 October

A low which lay over Andaman Sea on 28 September moved westnorthwestwards and concentrated into a depression on the morning of 30th with its centre near 13°N, 86°E. Moving in a northwesterly direction the depression became deep on the morning of 1 October with its centre near 15°N, 82°E. The depression crossed coast near Masulipatnam early that night and weakened into a low over north Telangana and adjoining Maharashtra by the morning of 3rd.

In associated with this depression, generally widespread rainfall occurred in Orissa on 1st and 2nd, in Andhra Pradesh and north Interior Karnataka on 2nd and 3rd and in Marathwada and Vidarbha on 3rd with isolated heavy to very heavy falls in Andhra Pradesh on 2nd. Achampet (Mahbubnagar district) recorded 18 cm of rain and Mahbubnagar and Nagarkurnool 14 cm each on 2nd. Jagdalpur in southeast Madhya Pradesh also recorded 12 cm of rain on 2nd.

9. Kavali cyclone of 27 October-1 November

Under the influence of a low pressure wave moving westwards across north Andaman Sea and adjoining east central Bay, a depression formed on the morning of 27 October with its centre near 13°N, 91.5°E. Port Blair reported southwesterly wind of 25 kt between 0.3 and 0.9 km asl that morning and evening. Moving slowly westwards, the depression intensified into a cyclonic storm on the evening of 28th when it was centred near 13°N, 89°E. The satellite picture that evening indicated (Fig. 3) that the system could be classified as T2.5/2.5 in Dvorak's scale which gives the estimated maximum wind as 35 kt. Continuing to move in a westerly direction, the storm became severe by the morning of 31st near 15°N, 81°E as was indicated by the satellite picture on that morning, which showed the system in class T3.5/3.5 with estimated maximum wind of 55 kt. On the previous evening ship WJGH reported N/NE winds of 30-40 kt within 100 to 150 km from the storm centre. At 0000 GMT on 31st, Ganavaram reported winds ENE/E 30-35 kt at 0.6 and 0.9 km asl while at 0600 GMT Hyderabad reported ENE 35-40 kt at these levels. The cyclone crossed south Andhra coast near Kavali (between Nellore and Ongole) around noon of 31 October and weakened into a depression over the interior parts of Karnataka by morning of 1 November and emerged into the Arabian Sea off south Maharashtra coast as a low that evening.

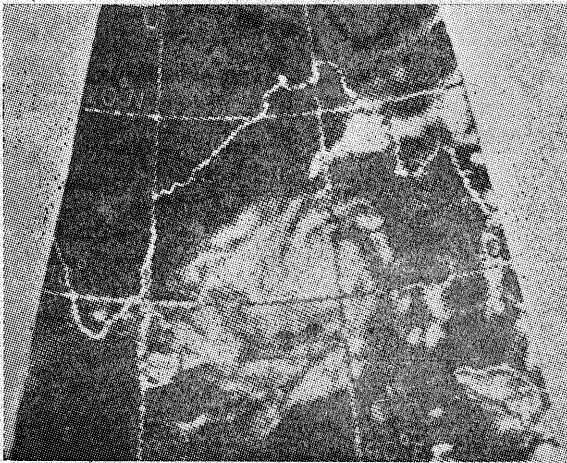


Fig. 3. Kavali cyclone as viewed by satellite at about 1500 GMT on 28 October

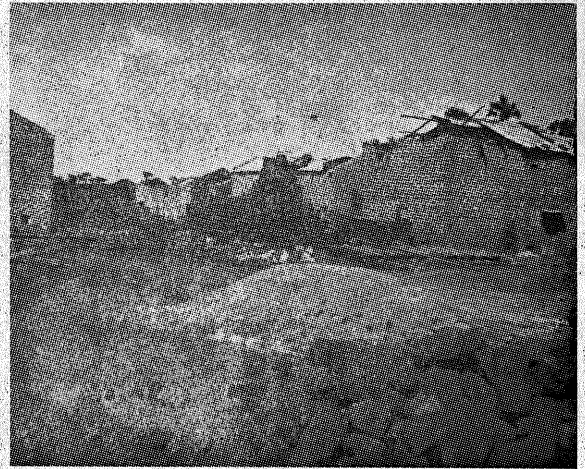


Fig. 4. Tobacco barns in Gauravaram village with walls damaged and roofs blown off

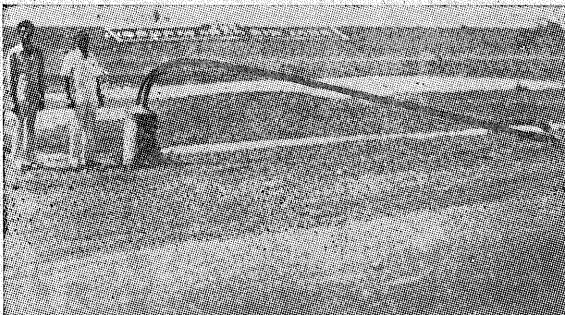


Fig. 5. Mangled electric pole near Gauravaram village

Generally widespread rainfall occurred in Andaman and Nicobar Islands from 27th to 30th, in coastal Andhra Pradesh on 31 October and 1 November and in Rayalaseema and north Interior Karnataka on 1 November. Heavy rain was reported from some places in Nellore and Prakasam districts of coastal Andhra Pradesh. Udayagiri recorded 19 cm of rain and Kavali 12 cm on 1 November. According to the report of the officer who toured the storm affected areas, this cyclone had a narrow core as it approached the coast and gale force winds were confined to within 40 km from the storm centre. Nellore and Ongole observatories which are within about

50 km from the storm centre reported maximum winds of only 20 to 25 kt. Heavy rain extended to 130 km north of the track but was confined to 20 to 30 km south of the track. No tidal waves were reported in association with this storm. Tender tobacco crops in about 35000 acres required replantation. One passenger bus plying on the Kavali-Udayagiri road was overturned by gales. Telegraph posts over 80 km stretch from Kovur to Singarayakonda about 40 km on either side of the storm track, stood slanting. Some photographs of damage caused by this storm may be seen in Figs. 4 and 5.

This storm was tracked by the radar at Madras from 29 2100 GMT to 31 0700 GMT. The spiral bands of this system were seen in the Madras radar even when it was as far away as 600 km from that station. The centre was estimated mainly from the spiral bands. The complete 'eye' was not seen. The radar track of the storm is reproduced in Fig. 6.

10. Nagapattinam cyclone of 8-12 November

A low pressure area moved westwards across south Andaman Sea into southeast Bay on the morning of 8 November and concentrated into a depression on that evening with its centre near 8° N, 92° E. Moving northwestwards initially and later in a westerly direction, the depression intensified into a cyclonic storm on the morning of 10th and into a severe cyclonic storm on the

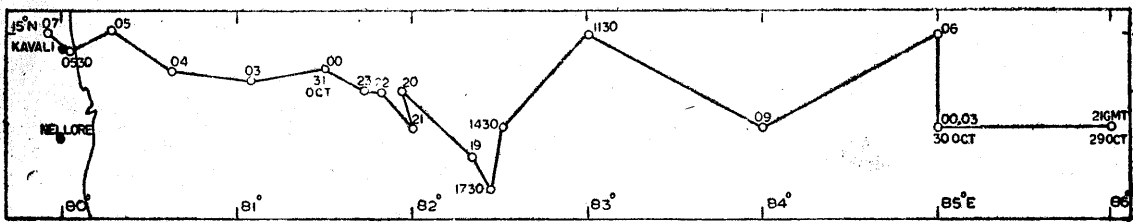


Fig. 6. Radar track of Kavali cyclone of 29-31 October

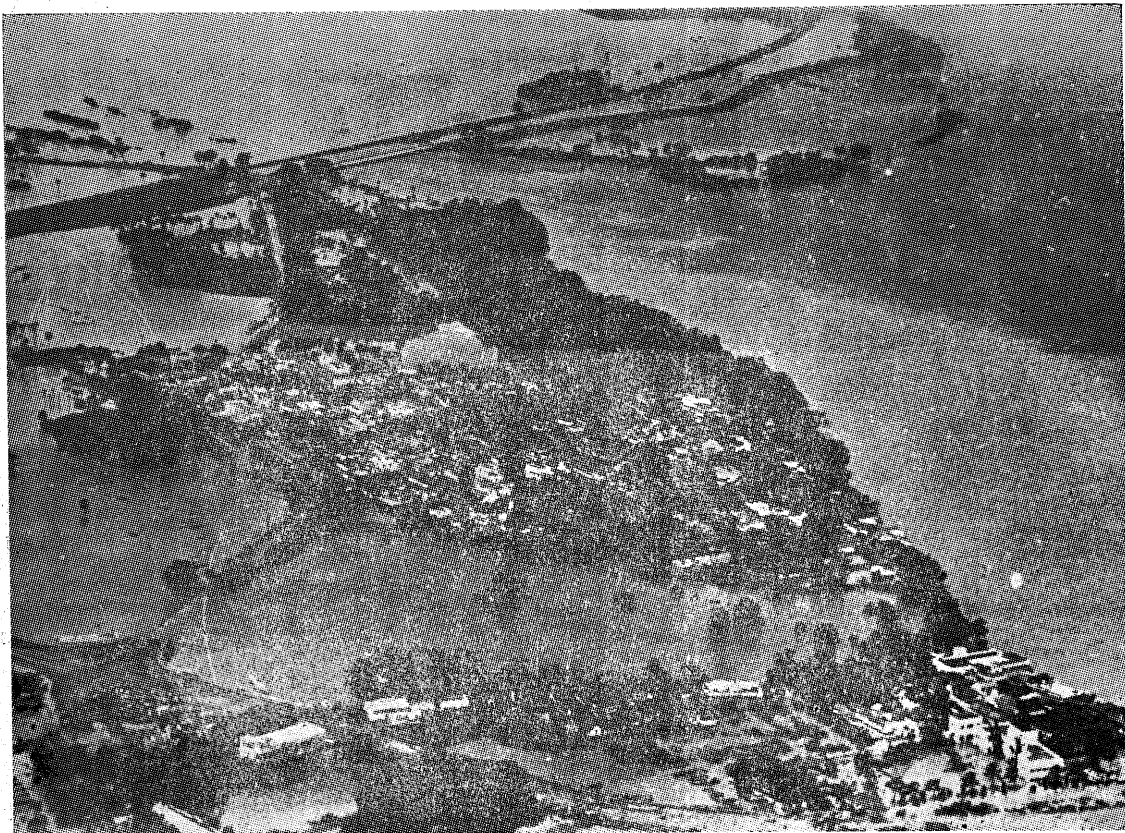


Fig. 7. Aerial view of flood-hit Srirangam town in Tiruchirappalli district (Photo by courtesy The Hindu, Madras)

morning of 11th when it was centred near 11.0°N , 82.5°E . The storm crossed Tamil Nadu coast within 10 km to the south of Nagapattinam in the early morning of 12th (around 2230 GMT of 11th). It weakened into a cyclonic storm by that evening over interior parts of Tamil Nadu and emerged into Lakshadweep off north Kerala coast on the morning of 13th as a deep depression.

This system caused generally widespread rain in Andaman and Nicobar Islands from 8th to 10th and in Tamil Nadu and Rayalaseema on 12th and 13th and in Kerala on 13th with heavy

to very heavy falls in Tamil Nadu on 12th and 13th and in Kerala on 13th. Considerable loss to life and property was reported from Thanjavur, Tiruchchirappalli, Pudukottai, Madurai, Salem, south Arcot and Chingleput districts of Tamil Nadu and in Pondicherry. Gales reaching about 120 kmph lashed Thanjavur, Tiruchchirappalli and Pudukottai districts uprooting many trees. Electric and telegraph posts were bent and twisted in Thanjavur district, the worst affected taluks being Nagapattinam, Mannargudi and Tiruthuraiipundi. Roofs of pucca buildings were blown off in these areas. Madurai, Pudukottai and Tiruchi districts were worst affected by floods.

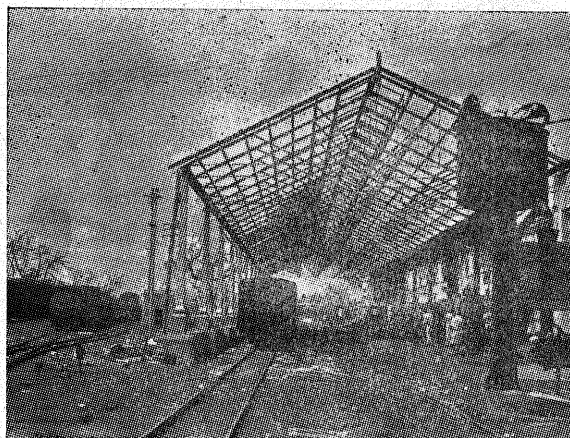


Fig. 8. Nagapattinam railway station with entire roof blown off



Fig. 9. Aerial mast of wireless repeater station at Man-nargudi damaged by Nagapattinam cyclone

560 persons were reported to have lost their lives mainly due to flash floods and house collapses and 23,000 heads of cattle including sheep and 5,000 poultry perished. Crops over an area of 4 lakhs acres were affected and the damage was estimated to be about Rs. 42 crores. Total value of damage to private and public property was estimated at about Rs. 155 crores. About 10 lakhs people mostly fishermen, weavers, farm labourers, beedi and cigar workers were rendered homeless. Train services in the southern railway were dislocated due to breaches in the railway tracks. The railway bridge on the *Amaravathi* river near Karur was washed away. No tidal waves were associated with this storm. Some photographs of damage due to this storm are reproduced in Figs. 7 to 9. Nagapattinam recorded an exceptionally heavy rainfall of 32 cm on 12th. Some places in Thanjavur, south Arcot, Salem, Tiruchchirappalli, Pudukottai and Madurai districts reported 24-hour rainfall ranging from 12 to 19 cm on 12th and 13th.

This system was assessed to have concentrated into a depression on 8th evening from the satellite picture which showed the system in class T1.5/1.5 and from the surface wind of SSW/19 kt reported by ship *Musashimaru* about 350 km from the centre of the system. On 9th and 10th no ships, reports were available near the depression field. This system was upgraded into a cyclonic storm on the morning of 10th with its centre near 10.5° N, 87.0° E, only on the basis of satellite picture. It could be classified as T3/3 on Dvorak's scale, which gives the maximum wind as 45 kt. On the 11th morning the satellite picture showed that this system had further intensified into a severe storm. It could be classified as T4/4 which gives the maximum wind as 65 kt. Ship *GHRK* about 300 km away from the storm centre reported surface wind ESE/30 kt at 0600 GMT that morning. The same morning Madras and Karaikal reported upper winds as NNE 35-40 kt at 0.9 km asl and Madras reported that evening ENE/50 kt wind at 0.9 km a.s.l. On 12th morning ship *ATGT* about 150 km to the east of the storm centre reported southerly surface winds of only 25 to 30 kt. The highest classification given to this storm based on satellite picture was T4.5/4.5 on 11th evening and 12th morning which gives the maximum wind as 77 kt. Hence the storm appears to have developed a core of hurricane winds from 11th evening to 12th morning over a very short distance from the storm centre.

According to the report of the officer who toured the storm affected areas, the eye of the storm had a diameter of only about 10 km. The core of hurricane winds was confined to about 20 km from the storm centre. Karaikal which is about 25 km to the north of Nagapattinam recorded strongest surface winds of about 45 kt between 2200 and 2400 GMT of 11th and the

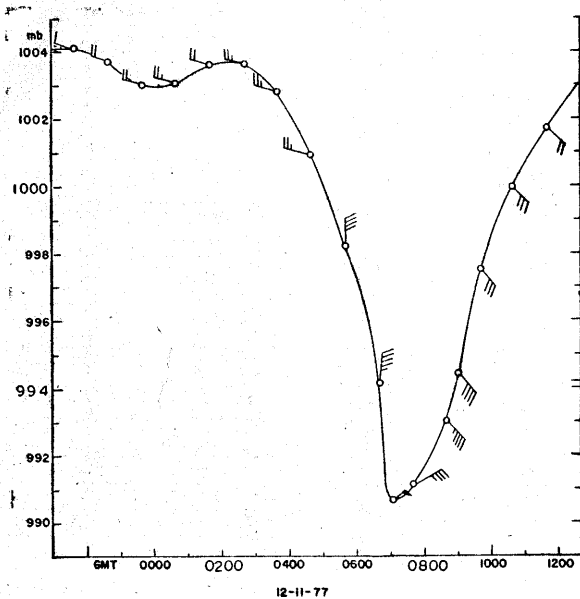


Fig. 10. Observations of wind (kt) and pressure (mb) at Tiruchirappalli on 12 November

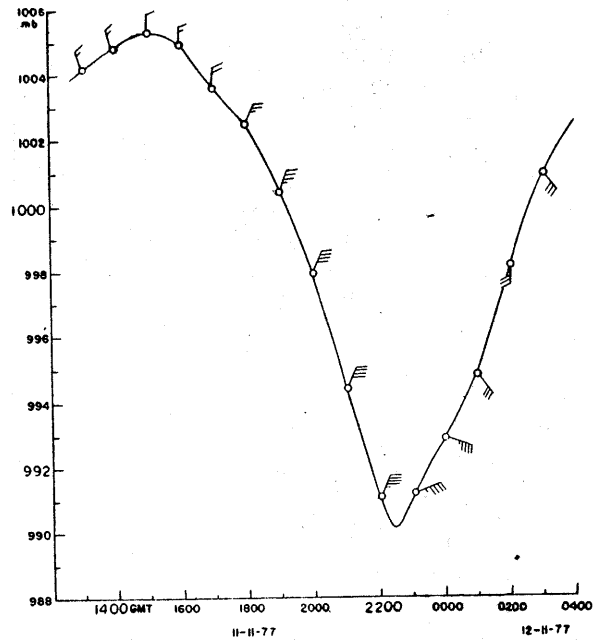


Fig. 11. Observations of wind (kt) and pressure (mb) at Karaikal on 11-12 November

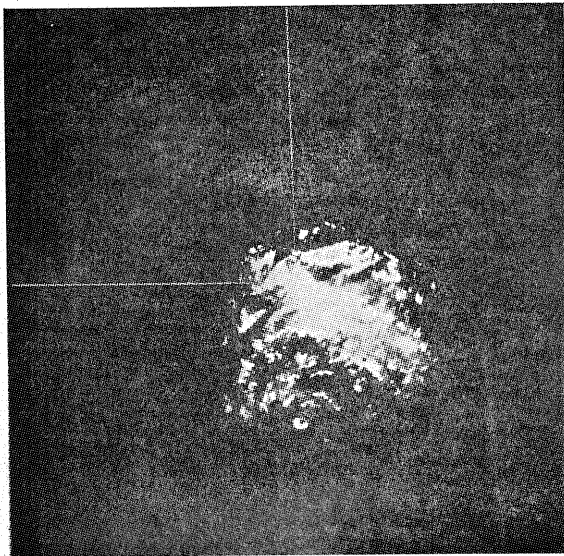


Fig. 12. Nagapattinam cyclone as seen by the Madras radar at 2048 GMT on 11 November, showing the small 'eye' at about 250 km south of Madras

lowest msl pressure of 991 mb at about 2230 GMT of 11th. Nagapattinam observatory did not record observations after 2200 GMT of 11th as the signal mast of the port office had fallen making the wind instruments and barometer room unapproachable. The barograph at Nagapattinam had recorded the lowest pressure of 965 mb at 2215 GMT. As the barometer reading could not be taken at this time, the lowest sea level pressure is estimated to be 979 mb from the barogram.

This storm though of narrow core retained its severe intensity over land upto Tiruchchirappalli. The observatory at Tiruchchirappalli recorded 40 to 45 kt winds from 0530 to 0900 GMT on 12th with a peak wind force of about 70 kt in gusts from NE at 0645 GMT. The lowest sea level pressure at Tiruchchirappalli was 990.7 mb at 0700 GMT on 12th. The hourly values of wind and pressure recorded at Tiruchchirappalli and Karaikal are shown in Figs. 10 and 11 respectively.

This storm was tracked by the cyclone warning radar at Madras from 0230 GMT of 11th to 0400 GMT of 12th. The radar picture of this storm on 11th showing the small 'eye' (about 10 km in diameter) is reproduced in Fig. 12.

11. Andhra cyclone of 14-20 November

The genesis of this cyclone was a low pressure area which moved westwards across Malaysia and south Andaman sea into extreme southeast Bay of Bengal and concentrated into a deep depression with its centre near 6°N , 92°E on 14th morning. Car Nicobar reported easterly winds of 25 to 35 kt at 0.6 and 0.9 km asl that morning and satellite picture showed organised cloud bands associated with this system. Moving westwards, the system rapidly intensified into a cyclonic storm by 15th morning. Ship ELTP (ALRAZIQ) close to the storm centre reported a pressure of 995 mb at 0120 GMT of 15th and located the centre of storm in their radar near 6°N , 90°E at that time. Ship ATJZ and ATMM about 400 km away to the northwest and northeast of the storm centre, reported surface winds

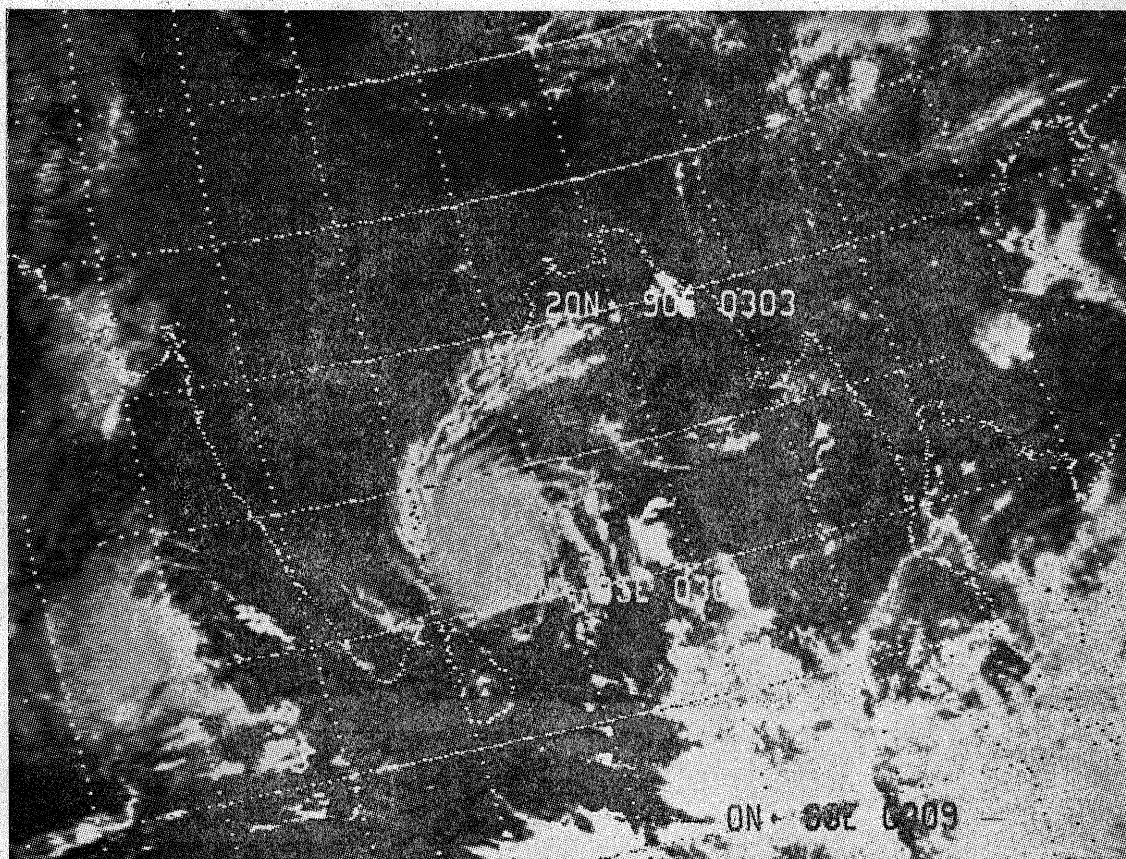


Fig. 13. Satellite view of Andhra cyclone at about 0300 GMT on 18 November showing the 'eye' of the cyclone

of 35 kt that morning which suggested that this storm was covering a large areal extent. The satellite picture showed that the storm had become severe by that evening. It could be classified as T4/4 in Dvorak's scale which gives the maximum wind associated with this storm as 65 kt.

Continuing to move westwards and intensifying, the storm lay near 7°N , 85.5°E on the morning of 16th and had developed a core of hurricane winds. The satellite picture on this morning showed the system in class T5/5 which gives the maximum wind as 90 kt. Ship ATJZ reported northerly winds of 40 kt about 150 km to the west of the storm centre at 0000 GMT on 16th.

The first clear indication that the storm which was moving practically westwards from 14th to 16th, was changing its course towards a more northerly direction was furnished by the satellite picture on the evening of 16th. The centre was now seen to be near 8.5°N , 84.5°E , whereas on the morning it was near 7.0°N , 85.5°E . The 'eye' was seen dimly in the satellite picture. This

change in the track of the cyclone from 16th, appears to be the result of its interaction with another severe cyclone in the Arabian Sea which also started changing its course abruptly from a practically westerly direction to a southerly one from about the same time. The two storms turned cyclonically around each other, the Bay storm moving northwestwards and the Arabian Sea storm moving southeastwards upto 19th.

Ship *Jagatswamini* (ATFY) recorded many crucial and very valuable observations close to the storm centre on 17th and transmitted them to the storm warning centre, Madras. The ship also requested all ships in the neighbourhood to record and report observations of pressure, wind and state of sea. A few ships like ATOA and S2LU did report observations to *Jagatswamini*. The ship *Jagatswamini* went right into the 'eye' of the storm on the evening of 17th. The minimum pressure recorded at the centre was 941 mb (uncorrected). The maximum wind speed experienced by this ship in the storm field was 16 B.F. i.e. about 104 kt at 1030 GMT. This report served to confirm the order of winds as estimated by the satellite earlier and to alert the forecasters

on the nature of the potential threat associated with this storm. Some important observations

giving significant data recorded by his ship on 17th are given below:

Observations recorded by ship *Jagatswamini* (ATFY) on 17 November 1977

Time (GMT)	Position	Wind	Pressure (mb)	Remarks
0500	10.8° N, 83.8° E	NNE/BF 11(60 kt)	997.5	Tendency last one hour 5 mb decreasing; Very rough sea and confused mountainous swell.
0600	10.8° N, 83.9° E	NE/BF 11(60 kt)	995.5	Tendency last one hour 4 mb decreasing; Very rough sea and mountainous swell.
0845	10.8° N, 84.0° E	NE/E, BF 14-15 (90 kt)	979.0	Tendency falling last one hour seven mb; wave height 15-20 metres.
1100	10.8° N, 84.1° E	— BF 14-15 (90 kt)	—	Circular formation of clouds 18 miles in diameter., probably eye of cyclone, discernable on radar.
1200	10.7° N, 84.1° E	SSW/BF 14-15 (90 kt)	947.9	Previously passed through calmer and brighter area. Presume have passed eye of cyclone; minimum pressure 941 mb (uncorrected). All well by the grace of god.

TABLE 4
Andhra cyclone of 14-20 November

Date	Time (GMT)	Ship	Location		Approximate distance from storm centre (km)	Wind		Pressure (mb)	Remarks
			Lat. (°N)	Long. (°E)		Direction	Speed (kt)		
17	0530	ATOA (Mahapriya)	12.5	85.0	300	E	BF 6-7 (24-30)	1004.4	
17	0530	S2LU (Banglarasha)	10.4	85.6	200	ESE	70	998.0	Sea very rough; Swell 10 metres.
17	0630	VWXD (Vishva Prem)	10.5	85.0	150	ESE	BF 8-9 (37-44)	997.0	Southeasterly swell 9 metres.
17	1200	ATRD (Sri Kailash)	12.7	84.0	200	E	BF 9-10 (44-53)	1003.0	Heavy swell.
17	1200	VWLS (Vishva Jyoti)	10.0	88.2	500	ESE	36	—	
17	1200	UBVU	14.1	87.3	500	E	36	1007.3	
17	1800	A8LX (Alexander Venture)	13.5	82.3	200	ENE	44	1004.0	
18	0000	A8LX	13.9	83.3	200	ENE	44	1003.0	
18	0000	UFEH	12.2	81.2	200	N	28	998.8	Northeasterly swell 7 metres high.
18	0200	VWQQ (Vishva Mangal)	11.8	81.8	150	NNW	33	996.5	
18	0600	UFEH	11.0	81.0	250	WNW	30	999.0	
18	0600	A8LX	13.9	84.5	250	E	43	1004.0	

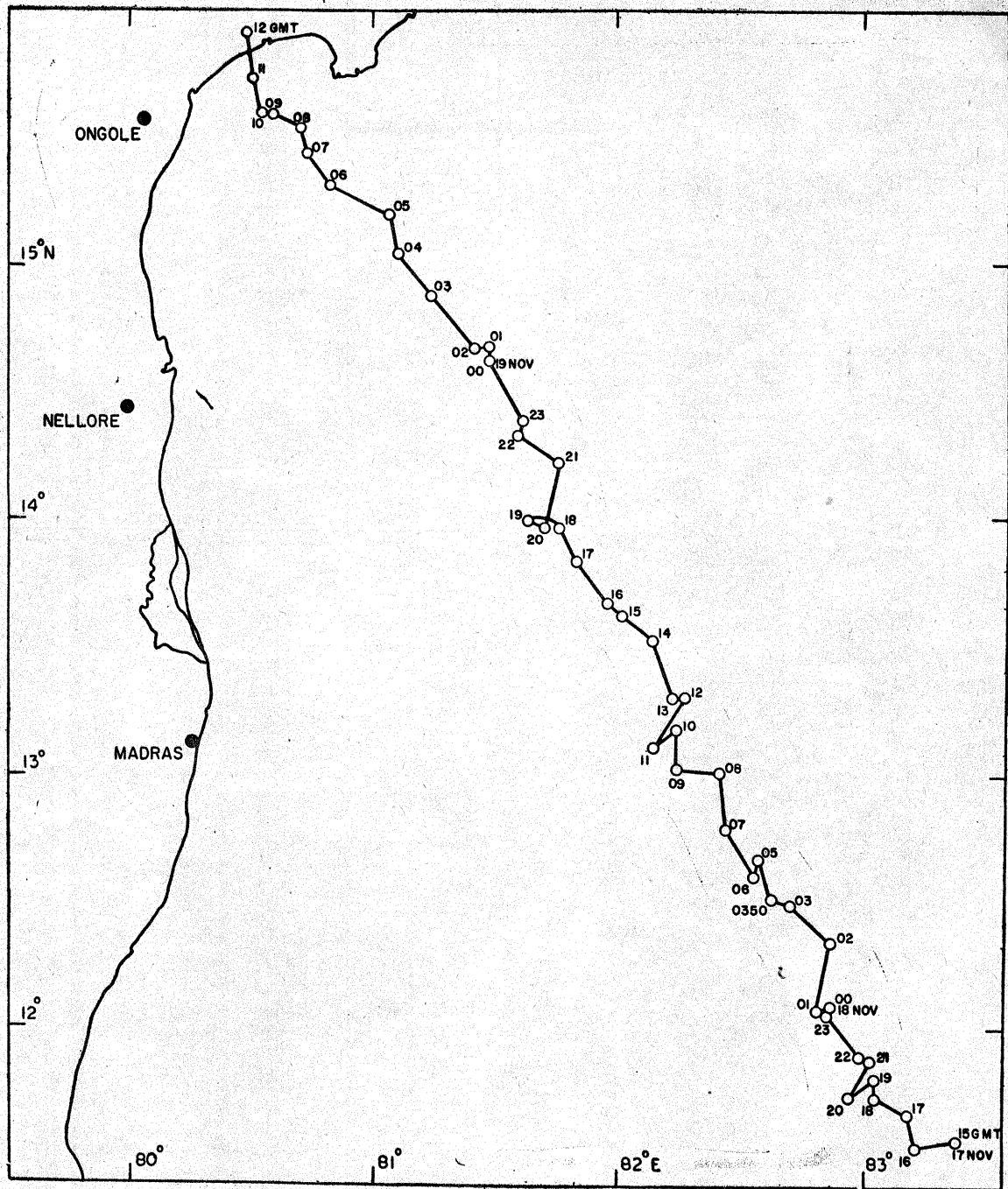


Fig 14. Radar track of Andhra cyclone

Some important observations from other ships in the storm field on 17th and 18th are given in Table 4.

The satellite reports indicated that the storm attained its peak intensity on 18th and maintained it on 19th. On those two days the National Environmental Satellite Centre at Washington classified the system as T 7/7 on the basis of satellite pictures, which gives the maximum wind associated with the storm as 140 kt. The Joint

Typhoon Warning Centre at Guam estimated the maximum wind associated with this storm as 115 kt on 18th on the basis of satellite pictures. On these days the 'eye' was clear and distinct. The satellite picture of the storm on 18th is reproduced in Fig. 13.

The storm was first seen by the radar at Madras at 0430 GMT on 17th. It was tracked hour by hour for nearly 2 days from 1500 GMT of 17th to 1200 GMT of 19th. The track of the

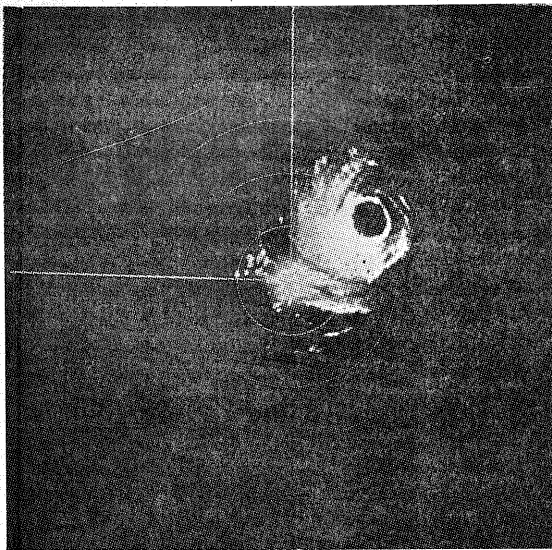


Fig. 15. Andhra Cyclone as viewed by Madras radar at 2116 GMT on 18 November, centred about 200 km northeast of Madras

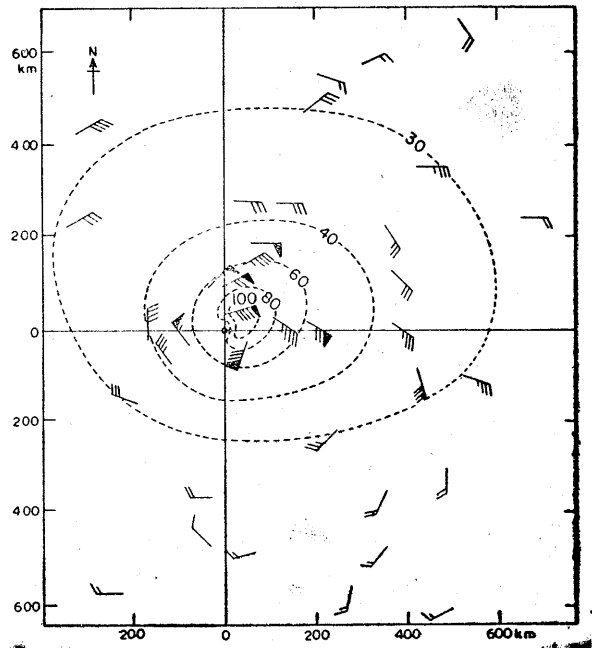


Fig. 17. Surface Wind Field in Andhra cyclone

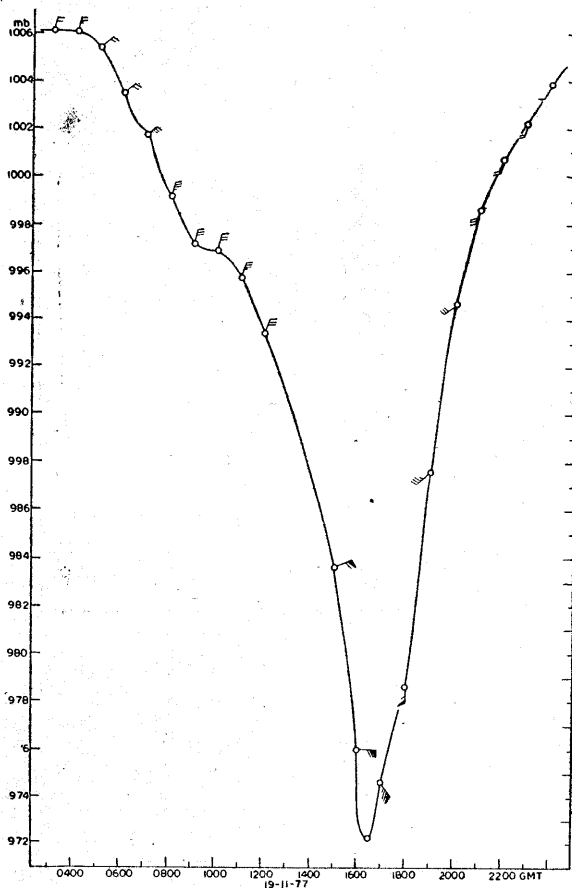


Fig. 16. Observations of wind (kt) and pressure (mb) at Gannavaram on 19 November

storm as derived from the radar fixes is given in Fig. 14. A radar picture of the storm on 19th early morning is reproduced in Fig. 15. The diameter of the 'eye' of the storm as seen in the radar was about 60 km.

The storm had moved close to Andhra coast by the morning of 19th. It crossed coast near Nizampatnam (according to the report of the officers who toured the storm affected areas) on that evening at about 1200 GMT and weakened into a low pressure area by 20th evening over the eastern parts of Telangana. The storm centre passed about 60 km east of Ongole and 50 km west of Masulipatnam between 0900 and 1400 GMT and was very close to Gannavaram at about 1700 GMT on 19th. Ongole reported maximum wind of 55 kt, Masulipatnam 65 kt and Gannavaram 75 kt. Thus it is seen that the storm retained its severe intensity with a core of hurricane winds over land upto Gannavaram. The anemometer at Gannavaram was blown off on 19th night. The lowest pressure recorded by these stations were 992, 987 and 972 mb respectively. The hourly values of wind and pressure recorded at Gannavaram on 19th are shown in Fig. 16.

As stated earlier, the storm was in its peak intensity on 18th and 19th as judged from the satellite pictures. On the basis of these pictures the maximum wind speed estimated by Washington was 140 kt, while Guam estimated the maximum wind as 115 kt. Taking the maximum wind in association with this storm to be 125 kt, the lowest pressure at the centre of the storm works out to be 943 mb which agrees well with the lowest pressure of 941 mb reported by ship *Jagatswamini* at the centre of the storm on 17th

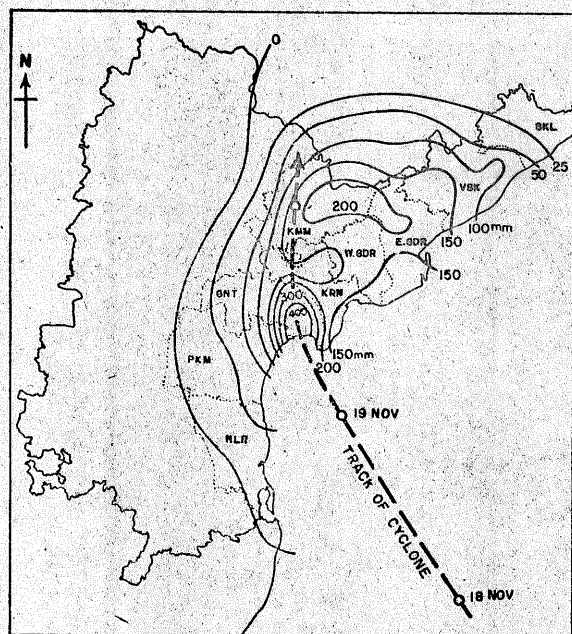


Fig. 18. Rainfall (mm) for 24 hours ending at 0830 IST on 20 November 1977

The pressure departure from normal at the storm centre works out to be minus 65 mb.

The diameter of the 'eye' of the storm as estimated by *Jagatswamini* with the help of radar was 30 km. From the satellite pictures also the diameter of the 'eye' could be estimated to be about 30 km. According to the report of the officers who toured the storm affected areas, the diameter of the 'eye' decreased as the storm moved over land and it was 15 km when it was near Vijayawada area.

Surface wind structure in the cyclone

With a view to ascertain the distribution of surface winds in the different sectors of the cyclone, all available ships' reports in the field of the cyclone from 16th to 19th have been composited and are presented in Fig. 17. The wind reports at different distances from the centre at different times as available during these days have been plotted in this single diagram and analysed. From this figure it will be seen that the strongest winds exceeding 100 kt occurred in northeast sector upto about 80 km from the centre. Gale force winds have extended 400 to 450 km from the centre in this sector while they have extended only to 200 to 250 km in the southwest sector. The areal extent of the storm was nearly 700 km.

Rainfall associated with the cyclone

This cyclone caused generally widespread rain with very heavy falls in coastal Andhra Pradesh and adjoining Telangana on 20th. Very heavy rain occurred in Guntur, Krishna, east and west Godavari districts and in the adjoining parts of Visakhapatnam and Khammam districts on 20th. Four stations in Guntur district including Guntur

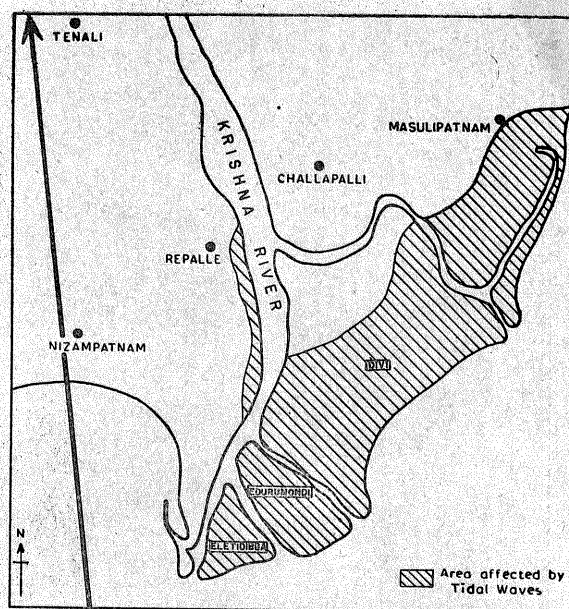


Fig. 19. Tidal inundation due to Andhra cyclone

had record rainfall of 40 cm or more on 20th. The rainfall distribution in Andhra Pradesh for the 24 hours ending at 0830 IST on 20th, is shown in Fig. 18. Rainfall was also fairly widespread in coastal Andhra Pradesh on 19th and 21st. The following stations recorded more than 30 cm of rainfall on 20th:

Repalle (Guntur district)	48
Bapatla (Guntur district)	45
Palnad (Guntur district)	45
Guntur (Guntur district)	40
Madhira (Khammam district)	33

Very heavy rain occurred mostly along the track of the storm and to its east. To the east heavy rain extended as far as 300 to 400 km, while to the west the rainfall decreased very rapidly and hardly extended 100 km.

Tidal waves associated with the cyclone

Tidal waves of height about 5 metres above mean sea level affected Divi, Edurumondi and Eletradiba Islands at the estuary of the river Krishna and the main coast south of Masulipatnam. This height was estimated from floating debris which got entangled to the trunks of the trees as well as reports ascertained from survivors who took shelter in the temples. Area affected by tidal waves is shown in Fig. 19. The tidal waves extended inland upto about 7 miles (12 km.). In Divi Island the western portion was not affected. All along the coast the tidal waters entered more or less from easterly direction and the maximum flooding occurred between 1700 and 2300 IST on 19th. Tidal bore

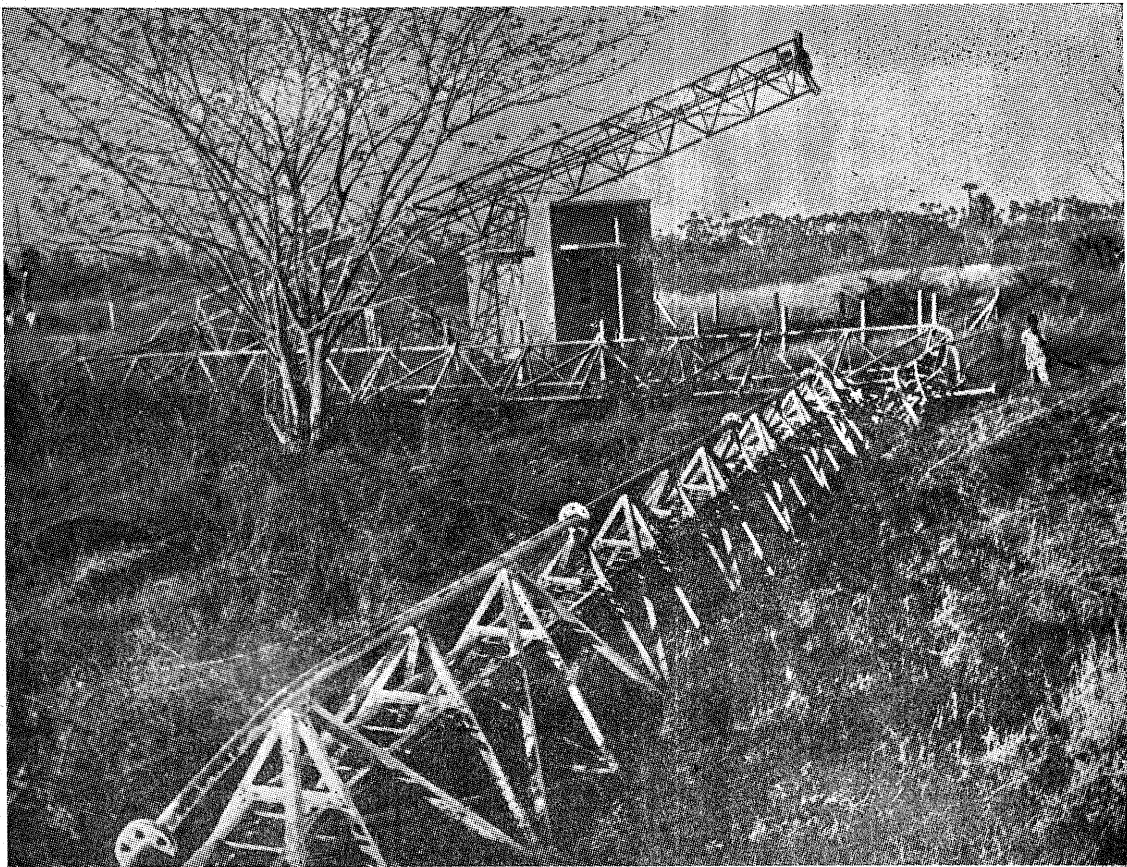


Fig. 20. AIR Transmission station at Nambur damaged

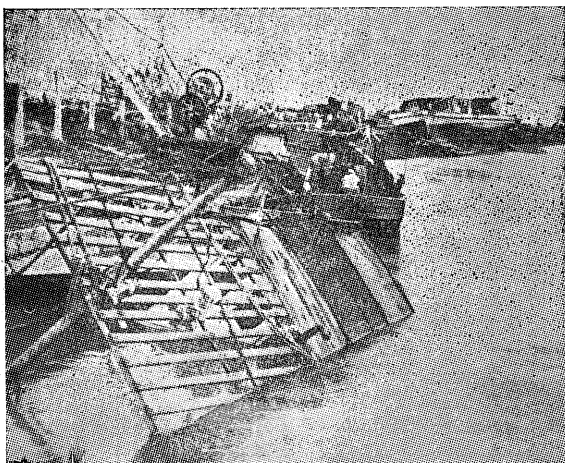


Fig. 21 Damage at Masulipatam port

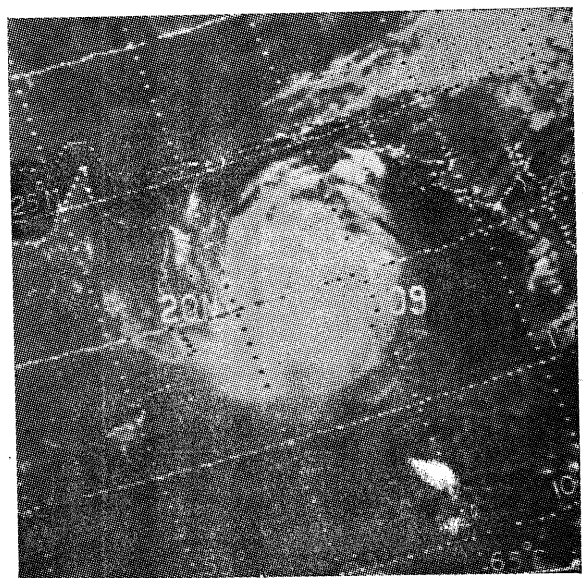


Fig. 22. Satellite view of Masirah cyclone at about 0500 GMT on 12 June, showing the eye of the storm and its large areal extent

went up the river *Krishna* and flooded the embankments as far north as Repalle taluk. The cyclone crossed coast at about 1730 IST on 19th. From the tide tables, it is seen that the high tide on that day at Kakinada was 1.44 metres above datum level (0.57 metres above mean sea level) at 1607 IST and the low tide was 0.89 metres above datum level (0.02 metres above mean sea level) at 2211 IST. Thus the contribution to the tidal waves from the astronomical tide was very small and the major contribution was from the storm surge.

Damage caused by the cyclone

Heavy to very heavy rain and gales reaching 200 kmph lashed Prakasam, Guntur, Krishna, East and West Godavari districts uprooting trees, bending telegraph and telephone posts and dislocating road and rail traffic, telecommunications and power supply in these coastal districts. Steel columns of the Vijayawada Thermal Power station under construction were sheared off. Heavy loss of life and property was reported. A few photographs of damage caused by this cyclone are reproduced in Figs. 20 and 21.

12. Depression of 24-25 November

A low pressure area which was over south Bay on 23 November concentrated into a depression on the morning of 24th with its centre near 8.5°N, 87.0°E. Moving westwards the depression lay over Sri Lanka on the morning of 25th and weakened into a low over Sri Lanka and adjoining Comorin by that evening.

This system caused widespread rain with some heavy to very heavy falls in Tamil Nadu on 25th and 26th.

Arabian Sea

1. Masirah cyclone of 9-13 June

A low pressure area which lay off Maharashtra coast on 8th concentrated into a deep depression on the morning of 9th with its centre near 16.5°N, 70.5°E. Moving northwest, it intensified into a cyclonic storm on the morning of 10th. The storm became severe that evening when it was centred near 19°N, 67.5°E. Subsequently moving westwards, it developed a core of hurricane winds on 11th. The cyclone passed through the northern tip of Masirah Island on 13th morning and entered the mainland of Oman.

This system is reported to have caused severe damage in Masirah Island and in the mainland of Oman. About 50 persons were reported killed, about 20,000 were left homeless and severe damage was caused to the main agricultural crops. Thousands of palm and lime trees were reported knocked down on both the Island and mainland. This is reported to be the worst storm

to hit this area in the last 100 years. Ship Buxom Island was reported sunk near 20°N, 63°E due to this cyclone. As a depression, this system caused the advance of the monsoon into Konkan by 9th. Fairly widespread rain occurred in Konkan and Goa from 9th to 11th and in Saurashtra and Kutch on 11th.

On 12th and 13th, ships' reports were available only from the periphery of the storm field more than 300 km away. They reported 30 to 40 kt winds. This showed that the cyclone was of large areal extent on these days. Over the northern parts of the Arabian sea, the sea surface temperature was about 30°C and it was warmer than the air by 2° to 3°C during this period.

The satellite pictures showed that this system had become a severe cyclone by 10th evening and had probably developed a core of hurricane winds by 11th. The 'eye' of the storm was seen in the satellite picture on 12th, which is reproduced in Fig. 22. Washington classified this storm in Dvorak's scale as T 5/5 on 12th evening which gives the maximum wind as 90 kt. Gaum estimated the maximum wind from satellite pictures as 85 to 90 kt on 12th. The APT pictures received at Bombay showed the system in stage X, cat-4 and diameter of the central cloud mass 3 degrees on 12th which gives the estimated maximum wind as 95 kt. Assuming the maximum wind associated with this storm as 90 kt, the lowest pressure at the centre of storm works out to be 964 mb. As the storm passed through Masirah on 13th morning the station reported lowest pressure of 959 mb. The rainfall recorded at that station was 43 cm on that day.

2. Deep depression of 18-22 October

A low pressure area which lay over Lakshadweep on 17 October moved westwards and concentrated into a depression on the morning of 18th with its centre near 9.5°N, 70.0°E. It moved away westwards to Gulf of Aden by 22nd evening. This depression was probably deep from 20th to 22nd.

This system caused scattered rainfall in Lakshadweep on 18th and 19th.

On the morning of 20th this system was classified as T 2/2 in Dvorak's scale and on the morning of 21st as T 3/3 based on satellite pictures, which corresponds to maximum wind of 30 and 40 kt respectively. Although the maximum wind estimated from the satellite picture was 40 kt, this system has been classified as a deep depression only, as two ships which moved right through the field of the disturbance and fairly close to the centre did not report more than 20 kt winds at any time.

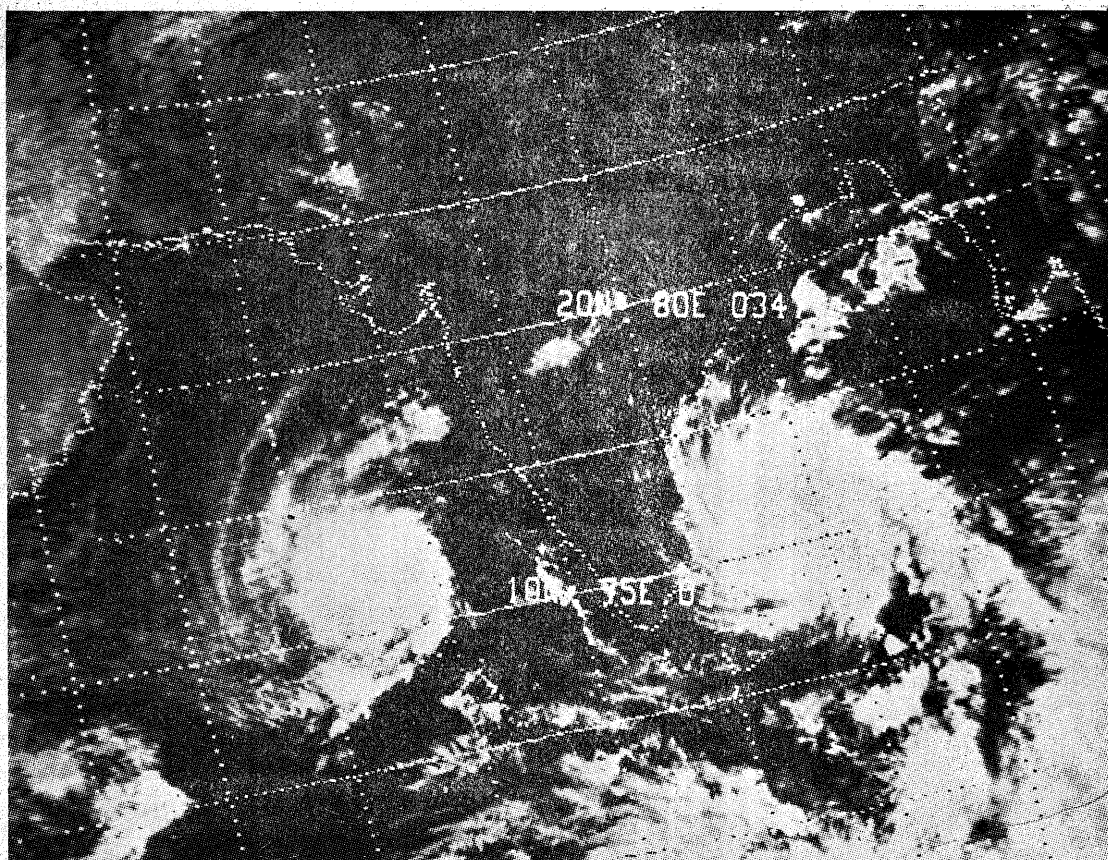


Fig. 23. Satellite picture of Arabian Sea cyclone at about 0400 GMT on 17 November 1977 co-existing with a cyclone in the Bay of Bengal

3. Depression of 2-4 November

The cyclonic storm which crossed south Andhra coast near Kavali on the noon of 31 October, emerged into east central Arabian Sea on the evening of 1 November as a low pressure area. This low concentrated into a depression on the morning of 2 November near 17°N , 70°E , moved westwards and dissipated over west central Arabian sea by the morning of 5th.

Scattered to fairly widespread thundershowers occurred in Maharashtra State and the northern parts of Karnataka on 2nd.

On the evening of 2nd, ship PJKE reported surface wind N/18 kt in the depression field (within 250 km west of depression centre). Washington had classified this system as T2/2 in Dvorak's scale from 2nd to 4th, which gives the maximum wind as 30 kt. On the evening of 4th ship FNLP near 17°N , 57.5°E reported easterly wind of 17 kt. This system was tracked over the Arabian Sea mainly with the help of satellite pictures.

4. Depression of 9-14 November

A low pressure area which was over south-east Arabian sea and adjoining Lakshadweep

on 8th moved westwards and concentrated into a depression on 9th evening with its centre near 10.5°N , 67°E . A ship about 300 km to the west of the depression centre reported surface wind as N/21 kt at 1200 GMT that day. Continuing to move practically westwards, it dissipated over the northern tip of Somalia coast by 14th evening.

This system caused fairly widespread rainfall in Kerala on 9th and Lakshadweep on 9th and 10th.

This depression was tracked mainly with the help of satellite pictures. The satellite picture on the evening of 11th showed the system in its peak intensity of T 2/2.5 corresponding to a maximum wind of 35 kt. This system was however not classified as a storm on that day, because two ships which passed close to the depression did not report more than 20 kt winds.

5. Severe cyclonic storm of 13-23 November

The severe cyclonic storm which crossed Tamil Nadu coast near Nagapattinam on the early morning of 12th, weakened gradually while moving westwards across south Peninsula and emerged into Lakshadweep on the morning of 13th as a deep depression. It was centred on

the morning of 13th near 11°N, 75°E. Ship GRLA within 50 km to the northeast of the depression centre reported surface wind SE/30 kt at 0600 GMT on that day. Androth about 100 km to the west of the depression centre reported winds of 25 kt at 0300 GMT. Moving westnorthwest the depression reintensified into a cyclonic storm on the morning of 14th near 12°N, 71.5°E as could be seen from the satellite pictures (T 3/3 on Dvorak's scale which corresponds to a maximum wind of 45 kt). Amini observatory reported S/30 kt wind on that morning from 0.3 to 0.9 km asl. On 14th evening ship JDUL about 150 km from the storm centre reported surface winds of 15 to 22 kt only which suggested that gale force winds were confined to probably within 100 km from the storm centre that day.

On 15th the storm had intensified further and Washington classified the system as T4/4 (maximum wind 65 kt) on this day. Ship EPDJ which moved to the south of the storm centre reported SSW/6-7 B F at 0900 GMT and N/7-8 B F (30-40 kt) at 1800 GMT on 15th about 100 to 150 km from the storm centre.

From 16th, this storm changed its course and moved southeastwards upto 19th. The possible interaction of this storm with the Andhra cyclone (14-20 November) was indicated earlier.

The storm was tracked mainly with the help of satellite pictures from 16th to 18th. The highest classification given to this storm by Washington was T5/5 on 17th and 18th based on satellite pictures. This would give a maximum wind of about 90 kt in association with this storm. This storm had developed a core of hurricane winds on 17th and 18th. A satellite view of this storm on the morning of 17th at its peak intensity co-existing with the Bay of Bengal storm is shown in Fig. 23.

On 19th and 20th the storm moved eastwards but retained its severe intensity over a narrow core, the core of more than 50 kt winds being confined to within about 50 km from the storm centre, as could be judged from the observations of ship GRPA and Androth observatory, close to which the storm centre moved. By 1500 GMT of 19th ship GRPA moved to 9.5°N, 71.5°E where it reported wind as S/52 kt and pressure 994.7 mb. At this time the ship was about 50 km east of the storm centre. By 1700 GMT it was close to the storm centre and reported light westerly wind and pressure of 992.1 mb. By 0000 GMT of 20th, this ship had moved to 9.5°N, 70.5°E (about 150 km to the west of the storm centre) and it reported surface wind as NW/30 kt and pressure as 1002.7 mb. On 20th Androth observatory reported 45 kt winds from 0900 GMT to 1200 GMT and the lowest pressure of 991 mb at 1000 GMT as the storm centre moved close to it. On this day observations from ships and Amini and Minicoy obser-

vatories showed that about 200 km from the storm centre, the winds were only about 20 kt. Minicoy however reported upper winds W/50 kt from 0.3 to 1.5 km asl on 20th midnight.

From 20th evening, the storm took a north-northeasterly course. It maintained its severe intensity within 50 km from its centre upto 21st afternoon. Amini observatory about 150 km to the west of storm centre and ship JLAG which was moving northwest about 100 km to the east of the storm centre reported surface winds of 30 to 40 kt on 21st morning. Androth about 100 km to the south of the storm centre reported winds of 45 kt at 0500 GMT. By that evening the storm appears to have weakened slightly as could be judged from satellite pictures and available ships' and land stations' reports. Washington and Guam estimated the maximum winds at 40 kt that evening based on satellite pictures.

The cyclonic storm crossed coast between Mangalore and Honavar in the early morning of 22nd and lay as a deep depression about 75 km to the east of Honavar at 0300 GMT on 22nd. Continuing to move northnortheastwards, the depression weakened into a low pressure area by 23rd evening over the northern parts of Maharashtra.

On the basis of satellite pictures, Washington had gradually downgraded the intensity of the system from 20th morning to 21st evening. On 21st the classifications were T2/3 and T2.5/2.5 on the morning and evening respectively which correspond to maximum winds of 45 kt and 35 kt. Assuming the maximum wind associated with this storm at its peak intensity as 90 kt on the basis of satellite pictures, the pressure at the centre of the storm works out to be 974 mb.

In association with this system, generally widespread rain with heavy to very heavy falls occurred in Kerala on 13th as it was emerging into the Arabian sea from the south Peninsula. As the system detoured and traversed Lakshadweep area, it caused widespread rain in Lakshadweep on 20th and 21st with very heavy falls on 21st, in Kerala on 21st and 22nd, in coastal Karnataka on 22nd and 23rd and in Maharashtra on 23rd with isolated heavy falls in Kerala and Maharashtra. Amini Divi recorded an exceptionally heavy rainfall of 25 cm on 21st. Due to this cyclone widespread damage was reported in the coastal belt of Kerala from Quilon to Kasargode. 72 people lost their lives. About 8400 houses were totally damaged and 19000 houses partially damaged. Crops over about 40,000 acres were damaged. Loss to standing crops of paddy, coconut, sugarcane, arecanut, houses and other property was estimated to be about Rs. 10 crores. 620 fishing vessels were damaged by tidal waves lashing against moored

fishing vessels along Kerala coast. Kalpeni Islands in Lakshadweep was the worst affected. About a lakh of coconut trees, the main cash crop of the Island, were uprooted and most of the houses in the Island were damaged.

Land Depression

1. Depression of 30-31 July

A low pressure area which lay over Bihar on 29 July concentrated into a depression on the morning of 30th with its centre near Gaya. The depression moved westnorthwest and weakened into a low over west Uttar Pradesh by 1 August.

In association with this depression, generally widespread rain with isolated heavy to very heavy falls occurred in Gangetic West Bengal, Bihar State, plains of Uttar Pradesh and Madhya Pradesh reported 14 to 19 cm of rain on 30th on 31 July and 1 August. Rainfall was fairly widespread in Orissa on 30 July and in Uttar Pradesh and west Madhya Pradesh on 1 August. A few stations in Morena district of Madhya Pradesh reported 14 to 19 cm of rain on 30th and 31st. Allahabad city and Banda reported 12 cm, Daltonganj, Lohardaga and Panna 11 cm on 30th.

Gaya reported surface wind easterly 15 kt on the morning of 30th and surface pressure 990.5 mb which is about 9 mb below normal. On 31st evening the winds at Bareilly and Bahraich at 0.9 km asl were E/30-35 kt.

2. Deep depression of 4-6 September

A depression weakened into a low over west Madhya Pradesh on the evening of 2 September. The associated upper air cyclonic circulation extending upto the middle troposphere, moved westwards to Gujarat. Under its influence, a depression formed over Gujarat State on the morning of 4th with its centre close to Rajkot. Moving westwards the depression emerged into north-east Arabian Sea on 5th morning when it was centred near 23°N, 68°E and was deep. It moved slowly further westwards and dissipated over north Arabian Sea by the morning of 7th.

This system caused widespread rain in Gujarat State on 4th and 5th with some heavy to very heavy falls on 4th. Porbandar had a record rainfall of 51 cm on 4th. The same day Dharampur recorded 13 cm, Navsari 12 cm and Veraval and Daman 11 cm each.

The pressure departure from normal was about minus 10 mb near the depression centre on the morning of 4th. On 4th evening Bhuj reported E/20 kt and Ahmedabad S/25 kt at 0.9 km asl. On 5th, the surface wind reported by many stations in Saurashtra and Kutch was S/SW 20 to 25 kt. Ship SQBD near Jamnagar Port reported southerly winds of 30 to 40 kt that day. The same evening Karachi reported ENE 25 kt and Bhuj S 25/30 kt at 0.3 and 0.6 km asl.

On the morning of 5th, Washington classified this system as T 2/2 in Dvorak's scale based on satellite picture which gives the maximum wind speed associated with this system as 30 kt.