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Cyclones and depressions over Indian seas in 1981

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1. Chief features

Six cyclonic storms of which four were severe and six depressions developed in the Indian area during 1981.

In the pre-monsoon season, there was no cyclonic storm or depression.

In the monsoon season, there were 2 cyclonic storms and 5 depressions. Both the storms developed in the Bay of Bengal and one of them which formed in September attained severe intensity for a short time. Of the five depressions, four developed in the Bay of Bengal and one over land.

In the post-monsoon season, there were four storms and one depression. Of the four storms, three formed in the Bay and one in the Arabian Sea. The Bay storm in December and the Arabian Sea storm in October/November attained hurricane intensity and caused considerable damage in the coastal districts of West Bengal and Saurashtra. The other two storms dissipated over the sea off Arakan coast. All the four storms had a northward track. The coastal areas of Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Maharashtra were not affected by any storm during this year.

The tracks of these systems are shown in Fig. 1 and their listing in Table 1. The maximum wind and the lowest mean sea level pressure associated with the cyclonic storms are given in Table 2. The salient features of the various disturbances are discussed below :

2. Bay of Bengal

2.1. *Depression of 20-24 June*

A low which lay over northeast and adjoining east central Bay on 19th morning moved northwest and concentrated into a depression over north Bay on the morning of 20th with its centre at 0300 GMT near 21° N, 89° E. Two closed isobars at 2 mb interval could be drawn on 20th morning and the pressure departure from normal near the centre of the depression was about *minus* 8 mb. Continuing to move northwest, the depression became deep on 21st morning over West Bengal coast and was centred near Midnapore. There were 4 closed isobars on 21st and the pressure departure from normal near the centre was *minus* 11 mb. Then moving practically westwards, the depression weakened into a low by 24th evening over northwest Madhya Pradesh. The low merged with the seasonal trough the next day.

This system caused generally widespread rain in Gangetic West Bengal and Orissa from 19th to 22nd, in Telangana on 22nd, in Bihar Plateau from 22nd to 24th, in Madhya Pradesh from 23rd to 25th and in Vidarbha on 24th and 25th with heavy to very heavy rain in Gangetic West Bengal, Orissa and Madhya Pradesh on some days. This system was responsible for the advance of the monsoon into northeast India, Madhya Pradesh, Uttar Pradesh and north Maharashtra State. Sandheads had a record rainfall of 47 cm on 20th and 51 cm on 21st. Contai also had a record rainfall of 27 cm on 21st. According to the "*Weekly Flood News Letter*" of Central Water Commission, about 3500 houses were damaged and 0.28 lakh hectares of paddy lands were affected in some parts of Midnapore district. According to Orissa Govt. report 362 villages in Balasore district were affected by floods covering an area of about 51000 hectares. Cultivated area of about 27000 hectares was affected resulting in an estimated crop loss of about Rs. 6.00 lakhs.

The other notable amounts of heavy rainfall (cm) were : Sandheads 18, Puri 11 on 19th; Sagar Island 20, Baripada 11 on 21st; Chakradharpur (Bihar) 21, Chaibasa 12, Pushparajgarh (Madhya Pradesh), Simdega (Bihar) 11, Sriniketan, Bulkapur (Andhra Pradesh) 10 on 22nd; Mandla 15 on 23rd; Seoni 16, Chindwara 11, Narsinghpur 10 on 24th; Dewas (Madhya Pradesh) 11, Sarangpur (Madhya Pradesh) 10 on 25th.

2.2. *Depression of 3-4 August*

A low which lay over northwest and adjoining west central Bay on 2nd, concentrated into a depression on the morning of 3rd with its centre at 0300 GMT near 19.5° N, 87.5° E. 2 to 3 closed isobars could be drawn over the depression field. Ship *ATGS* near 19° N, 90° E reported surface wind SSE/22 kt at 0000 GMT on 3rd. Moving westwards across Orissa, the depression weakened

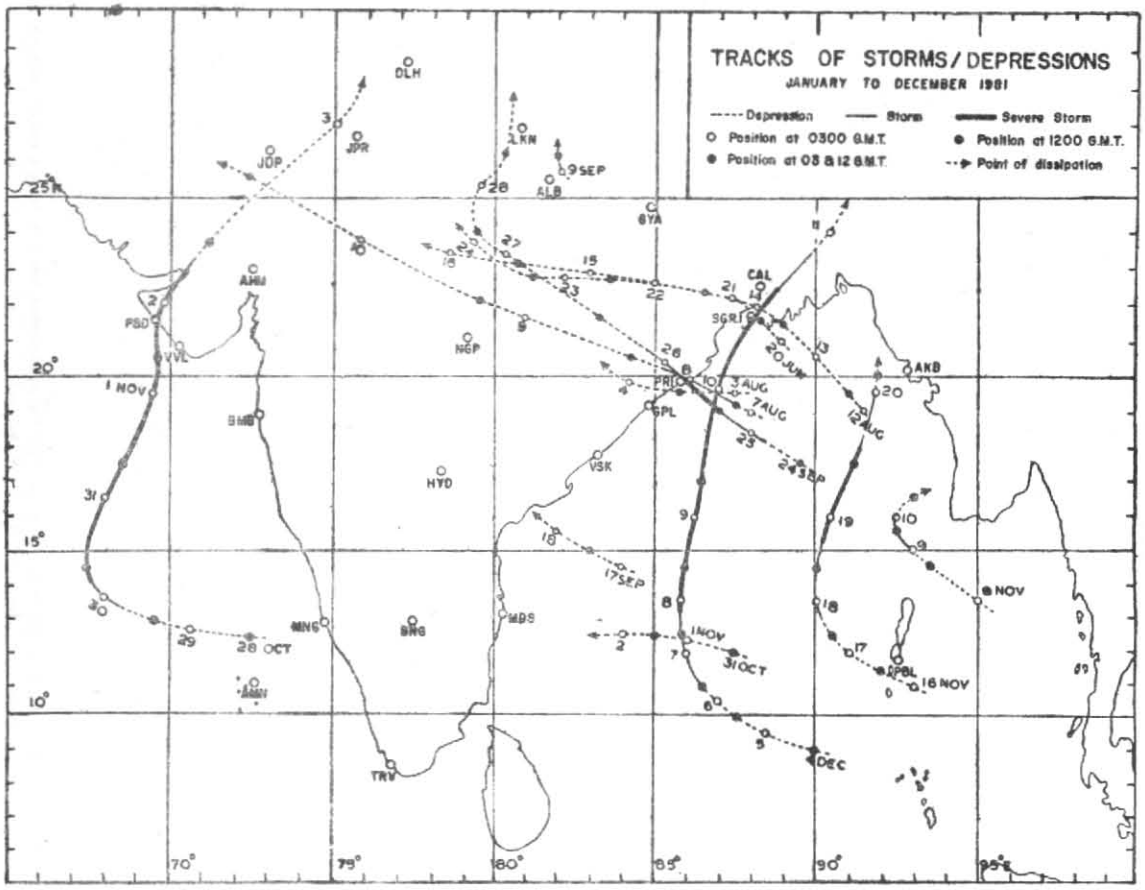

FIG. 1

into a low over west Orissa and adjoining southeast Madhya Pradesh by 4th evening. The low moved to north Madhya Pradesh by 5th evening and merged with the monsoon trough by 6th. On 4th morning, Puri reported surface wind SW/20 kt and ship *FNDY* SSW/24 kt about 200 km southeast of depression centre. The highest pressure departure from normal near the centre of the depression was *minus* 8 mb.

In association with this depression generally widespread rain occurred in Orissa, Madhya Pradesh from 3rd to 6th, in Andhra Pradesh from 3rd to 5th, in Vidarbha on 5th and 6th and in Gangetic West Bengal and Bihar Plateau on 4th and 5th. Heavy to very heavy rain occurred in Andhra Pradesh, Madhya Pradesh and Vidarbha on some days. The notable amounts of heavy rainfall (cm) were : Bhimavaram (Andhra Pradesh) 18, Keskal (Madhya Pradesh) 17, Dummagudam (Andhra Pradesh) 13, Bhadrachalam 11 on 3rd; Bhanupratappur (Madhya Pradesh) 29, Konta (Madhya Pradesh) 28, Singabhupalem (Andhra Pradesh) 27, Bhadrachalam 22, Antagarh (Madhya Pradesh) Dummagudem (Andhra Pradesh) 19, Venkatapuram (Andhra Pradesh) 17, Chinnur (Andhra Pradesh) 16, Sathupalli, Polampet (Andhra Pradesh) 13, Narayanpur (Madhya Pradesh), Sukma (Madhya Pradesh) 12, Lankasagar (Andhra Pradesh) 11 on 4th; Yeotmal 14, Rajnandgaon (Madhya Pradesh), Ichhawar (Madhya Pradesh), Murtizapur (Vidarbha), Swarna Project (Andhra Pradesh) 11 on 5th; Khajuraho 15, Bhopal, Vidisha 11, Seoni 10 on 6th.

2.3. *Cyclonic storm of 7-10 August*

Under the influence of a low pressure wave (isollobaric low) moving westwards across Burma, the low which was over northwest and adjoining west central Bay on 6th concentrated into a depression on the morning of 7th with its centre at 0300 GMT near 19 deg. N, 88 deg. E. 2 to 3 closed isobars at 2 mb interval covered the depression field on this morning. The system was upgraded into a cyclonic storm the same evening over the same area based on satellite picture which indicated that the system could be classified as T 2.5 or 3.0 in Dvorak's scale (max. wind 35 to 45 kt). The upper winds at Bhubaneswar upto 0.9 km strengthened to NE/40 kt at 1200 GMT of 7th and to 45-50 kt at 0000 GMT of 8th as the storm moved westnorthwestwards towards Orissa coast. The storm lay close to Puri at 0300 GMT of 8th. 7 to 8 closed isobars covered the storm area at this time. The 24-hr pressure fall at Puri was about 19 mb at 0300 GMT and the departure from normal was about *minus* 20 mb. The

TABLE 1

Storms and depressions of 1981

S. No.	Type of disturbance	Life period	Location
1	Deep depression	20-24 Jun	Bay of Bengal
2	Depression	3-4 Aug	Do.
3	Cyclonic storm	7-10 Aug	Do.
4	Depression	12-16 Aug	Do.
5	Do.	9 Sep	Land
6	Do.	17-18 Sep	Bay of Bengal
7	Severe cyclonic storm	24-28 Sep	Do.
8	Do.	28 Oct-3 Nov	Arabian Sea
9	Depression	31 Oct-2 Nov	Bay of Bengal
10	Cyclonic storm	8-10 Nov	Do.
11	Severe cyclonic Storm	16-20 Nov	Do.
12	Do.	4-11 Dec	Do.

TABLE 2

Maximum wind and minimum pressure in cyclones

Cyclonic storm (Date)	Maximum wind (kt)		Lowest MSL pressure (mb)	
	Estimated from sate-pictures or other sources	Reported from nearest obsn.	Esti-mated at the centre	Reported from nearest observation
7-10 Aug	45	40 (Bhubaneswar)	984	980.7 (Bhubaneswar)
24 -28 Sep	55	40 (Puri)	983	983.01 (Puri)
28 Oct-3 Nov	65	55 (Veraval and Jamnagar) 44 (Ship *ELWT* 250 km from storm centre)	983	985.3 (Porbandar)
8-10 Nov	45	40 (Ship *FNDY* 75 km from storm centre)	996	998.5 (Ship *FNDY*)
16-20 Nov	65	45 (Ship *ELEU* 100 km from storm centre)	983	—
4-11 Dec	75	55 (Sandheads at Haldia Dock) 50 (Paradip)	980	983.5 (Sagar Island)

storm crossed Orissa coast close to and north of Puri near about 0400 GMT and weakened into a deep depression the same evening over interior Orissa. The deep depression continued to move westnorthwest across Madhya Pradesh, weakened into a depression on 10th morning over west Madhya Pradesh and adjoining southeast Rajasthan and into a low over southwest Rajasthan by 11th morning. The low merged with the seasonal low over south Pakistan on 12th.

This system caused generally widespread rain over Orissa on 8th and 9th, in Madhya Pradesh from 8th to 10th, in Maharashtra on 9th and 10th, in Telangana on 9th and in Gujarat State and Rajasthan on 10th and 11th, with heavy to very heavy falls in Orissa, Madhya Pradesh, interior Maharashtra and Gujarat State. Due to floods in *Vamsadhara*, *Rusikulya* and *Indravati* rivers, extensive areas in Puri, Ganjam, Koraput and Kalhandi districts of Orissa covering an area of 36,536 hectares were affected. About 47 Blocks in the State were affected covering 1017 villages and 6 N.A.Cs. Crop area affected was reported to be 3690 hectares. Over 500 houses collapsed and 1200 houses were partially collapsed. A total area of 2173 hectares of cultivated lands were reported to have been sandcast in the districts of Puri, Ganjam and Phulbani. Altogether 15 people lost their lives. Rivers *Narmada* and *Tapti* were in spate. Ujjain and Jagdalpur were cut off by heavy rains. Some parts of eastern Vidarbha were affected by floods in the *Wainganga* and its tributory Maru. About 1500 houses were damaged in Bhandara district and crop in 2500 hectares were damaged.

The notable amounts of rainfall (cm) : Chhatrapur (Orissa)15, Seoni 13, Balod (Madhya Pradesh) 12 on 7th; Alnauki (Madhya Pradesh), Paikmal (Orisssa) 21, Balod (Madhya Pradesh), Delang (Orissa), Patnagarh (Orissa) 16, Belaguntha (Orissa) 15, Puri, Gumma (Orissa), R. Udaigiri (Orissa), Gudhiyari 13, Gunupur (Orissa) 12, Bhawanipatna, Raipur 11, Durg 10 on 8th; Antagarh (Madhya Pradesh) 34, Keskat (Madhya Pradesh) 26, Bhanupratappur (Madhya Pradesh) 23, Kanker 22, Madanpur Rampur, Bastingia, Karlamunda (Orissa) 19, Patnagarh (Orissa), Belaguntha (Orissa), Chandrapur (Vidarbha) 17, Bhanjanagar (Orissa), Balod (Madhya Pradesh) 16 Puri 13, Titlagarh 12, Pandharkawda (Vidarbha), Brahmapuri, Rajnandgaon (Madhya Pradesh), Dongargarh (Madhya Pradesh) 11 on 9th; Harsud (Madhya Praeesh) 37, Dhar (Madhya Pradesh) 22, Indore, Kalol (Gujarat), Halol (Gujarat) 21, Dohad, Sankheda (Gujarat) 18, Devgadbaria (Gujarat), Bajna (Madhya Pradesh), Depalpur (Madhya Pradesh) 17, Bagli (Madhya Pradesh), Santrampur (Gujarat) 16, Jhabua (Madhya Pradesh), Sindkhed (Maharashtra) 15, Khandwa (Madhya Pradesh), Tilakwada, Lunavada (both in Gujarat) 14, Dewas (Madhya Pradesh), Chikalda (Vidarbha) 13, Jambugam, Petlad, Godhra (all in Gujarat) 12, Jaisalmer (Rajasthan) 11 on 10th; Limkheda 26, Jamnagar 20, Sidhpur, Dasada 18, Dhrangadhra 17, Vadgam, Idar, Navsari 16, Halwad 15, Patan, Upleta 14, Himatnagar, Mundra, Junagarh, Morbi 13, Radhanpur, Jetpur, Rajkot AP 12 (all above stations in Gujarat) on 11th.

The maximum wind reported at Bhubaneswar was NE/40 kt at 0400 GMT and the lowest pressure recorded was 980.7 mb at 0500 GMT on 8th.

Assuming the maximum wind associated with this storm as 45 kt, the pressure at the centre of the storm works out to be 984 mb. However, from the lowest pressures recorded at Puri and Bhubaneswar, the lowest pressure at the storm centre could be 980 mb.

Paradip radar could estimate the storm centre from spiral bands only at 2230 GMT of 7th and 0300 GMT of 8th with poor confidence, when the storm was within 100 km of Paradip.

2.4. *Depression of 12-16 August*

The remnants of tropical depression 'ROY' moved westwards across Arakan coast on 11th and concentrated into a depression on the morning of 12th with its centre near 19° N, 91.5° E. The 24-hr pressure fall over Arakan coast was 4 mb and the pressure departure from normal at Akyab was about *minus* 8 mb. Moving northwestwards, the depression crossed West Bengal coast near Contai on the forenoon of 14th and later moved practically westwards across Madhya Pradesh and weakened into a low over west Madhya Pradesh and adjoining southeast Rajasthan by 16th evening. The low moved subsequently westnorthwest to southwest Rajasthan by 17th evening and merged with the seasonal low over south Pakistan on 18th.

Generally two closed isobars covered the depression field. Sandheads reported surface wind WSW/30 kt at 0000 GMT of 14th. The highest pressure departure from normal near the depression centre was about *minus* 8 mb.

In association with this system, generally widespread rain occurred in Gangetic West Bengal from 12th to 15th, in Orissa from 13th to 15th, in Bihar Plateau from 14th to 16th, in Madhya Pradesh between 14th and 17th, in coastal Andhra Pradesh on 13th and 14th, in Vidarbha on 15th and 16th, in Gujarat State from 16th to 18th and in east Rajasthan on 17th and 18th. Heavy to very heavy rain occurred in Gangetic West Bengal, Orissa, Madhya Pradesh and Gujarat State on some days.

The whole of Ramnagar, Egra, Potaspur, P.S. Contai sub-division was sub-merged. Floods in some parts of Gujarat and West Madhya Pradesh were reported to have caused some loss to life and property and disruption of road and rail traffic.

The notable amounts of heavy rainfall (cm) were : Sandheads 16 on 12th; Sandheads 12 on 13th; Sandheads 24 on 14th; Sandheads 10 on 15th; Khargone 23, Khandwa, Bhikamgam (Madhya Pradesh) 16, Narsinghpur, Maheswar (Madhya Pradesh) 12, Ratlam, Depalpur (Madhya Pradesh) 10 on 16th; Banswara (Rajasthan) 26, Valleb Vidhyanagar (Gujarat) 16, Ahmedabad 13, Idar 10 on 17th.

2.5. *Depression of 17-18 September*

A low which was over southeast and adjoining east central Bay on 16th moved westnorthwest and concentrated into a depression over west central Bay on 17th morning with its centre at 0300 GMT near 14.5 deg. N, 84 deg. E. Continuing to move westnorthwest, it weakened on 18th afternoon close to coast and crossed Andhra coast as a well marked low that evening. The low moved northwestwards to interior Maharashtra by 20th evening, persisted there till 22nd and then moved slowly across Gujarat to northeast Arabian Sea by 26th evening and dissipated by 27th. This system was classified as a depression mainly on the basis of satellite pictures. Two closed isobars could be drawn on 18th morning.

As a depression, it caused widespread rain in coastal Andhra Pradesh from 17th to 19th and in Orissa, interior Andhra Pradesh and north interior Karnataka on 18th and 19th and fairly widespread rain in Tamil Nadu on 17th and 18th. As a low it caused generally widespread rain in Andhra Pradesh on 20th, in Maharashtra State from 19th to 24th, in west Madhya Pradeh on 21st and 22nd and in Gujarat State and east Rajasthan on 24th and 25th. According to reports, floods in Vamsadhara inundated 800 acres of paddy fields in Srikakulam district. About 100 houses collapsed. Heavy rain in Maharashtra caused house-collapses and landslides which claimed about 65 lives. Many lakes in north Konkan were reported to be overflowing.

The notable amounts of rainfall (cm) were : Konada 22, Narasannapeth, Ichhapuram, Vizianagaram 21, Kalingapatnam, Narasapur 19, Srikakulam, Tekkali 18, Chipurupalli, Bheemunipatnam 16, Sompeta, Reddipalli, Ramachandrapuram 15, Kalyandurg 14, Koderu 13, Visakhapatnam town, Bobbili 12, Guntur 10 (all these stations in Andhra Pradesh), Kudligi 11, Gangawathi 10 (both in North Interior Karnataka) on 18th; Ichhapuram, Gangavati 11, Mummidivaram 10 on 19th.

2.6. *Severe cyclonic storm of 24-28 September*

A low which lay over north Andaman Sea from 20th to 23rd moved northwestwards to east central Bay on 24th and concentrated into a depression that evening with its centre at 1200 GMT near 17.5°N, 89.5°E. Ship *GVAM* near 19°N, 89°E reported surface wind ENE/23 kt at this time. The depression intensified into a cyclonic storm on 25th morning with its centre at 0300 GMT near 18·5°N, 88.0°E. Ships *ATKR* and *GVAM* about 300 to 400 km to the north and northeast of the storm centre reported E/ESE winds of 30-35 kt and the low level winds at Bhubaneswar strengthened to 35 40 kt at 0600 GMT on 25th. The same evening the winds at Calcutta and Bhubaneswar were 40 to 45 kt

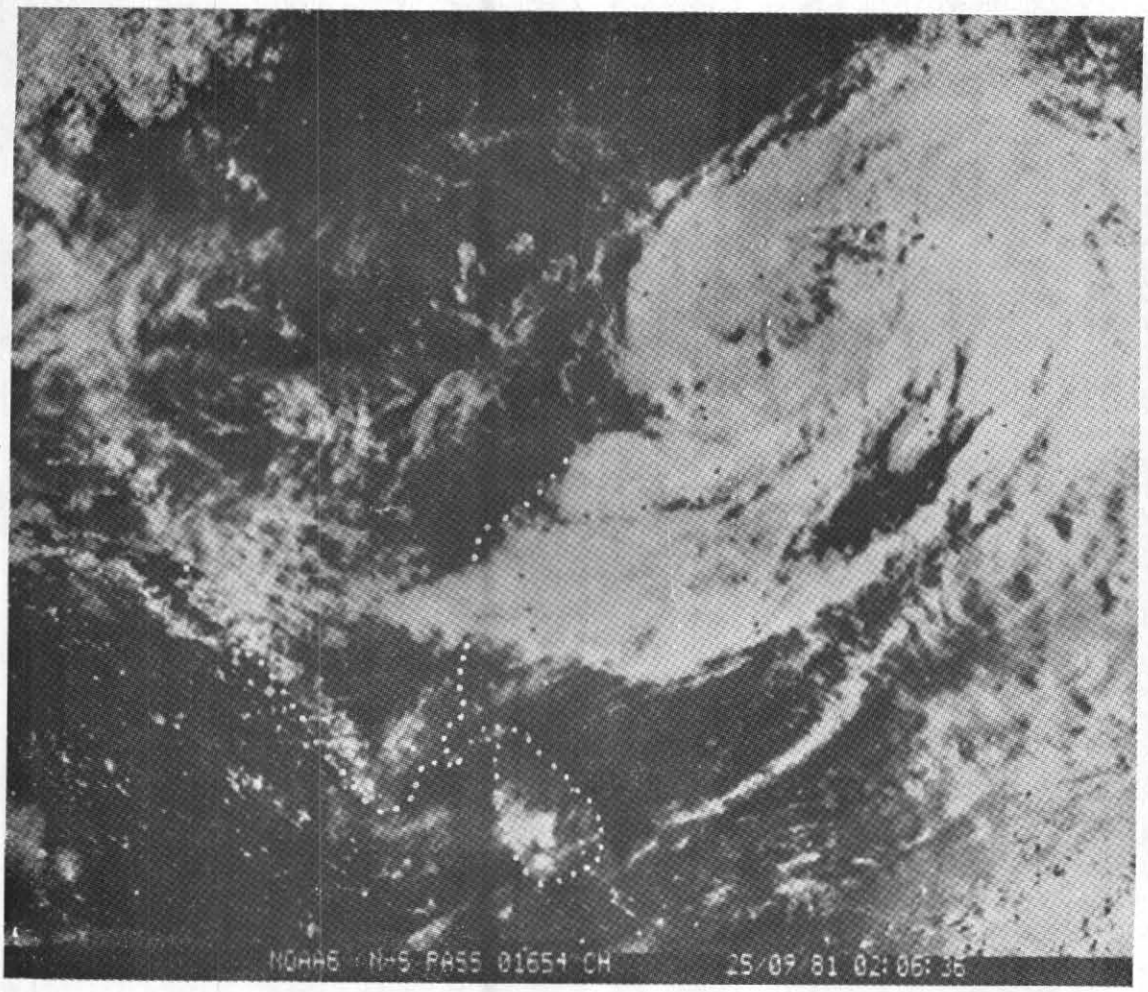

Fig. 2

at 0.9 km asl and ship *ATKR* also reported surface wind E/33 kt about 300 km northeast of the storm centre. The storm was probably severe by 1200 GMT of 25th. A satellite picture taken by NOAA -6 on 25th is shown in Fig 2. The storm crossed Orissa coast near Puri on the early morning of 26th and weakened into a depression that evening over interior Orissa and adjoining east Madhya Pradesh. Continuing to move northwestwards across east Madhya Pradesh and then northwards across central Uttar Pradesh, the depression broke up over the hills of west Uttar Pradesh and adjoining Nepal by 29th.

This system caused generally widespread rain in Orissa, Gangetic West Bengal and Bihar Plateau on 26th and 27th, in coastal Andhra Pradesh and Telangana on 27th, in east Madhya Pradesh and Vidarbha on 27th and 28th and in west Madhya Pradesh and Uttar Pradesh on 28th and 29th with heavy to very heavy falls over most of these areas on one or two days.

The notable amounts of heavy rainfall (cm) were : Sandheads 25, Belguntha (Orissa) 18, Keonjhargarh 17, Hindal (Orissa) 15, Balasore 13, Basudevpur, Bhadrak 12, Hiradharbati (Orissa) 11, Bhubaneswar, Gopalpur, Jaleswar (Orissa) 10 on 26th; Visakhapatnam 12, Brahmapuri 10 on 27th; Chhattarpur (Madhya Pradesh) 15, Sandila (Uttar Pradesh), Mau (Uttar Pradesh), Kanpur 12, Neemsar (Uttar Pradesh), Hamirpur, Balrampur 11 on 28th; Kheri 31, Balrampur 30, Sitapur 27, Kakardarighat 24, Hasanganj 23, Mankapur, Neemsar 20, Barabanki 19, Bahraich 16, Bhatpurwaghat 15, Sandila 14, Utraula 12, Lucknow 10 (all in Uttar Pradesh) on 29th.

According to press reports, 5 launches were lost in the Bay and many houses were damaged in Midnapore district of West Bengal and Cuttack district of Orissa. A number of villages in low lying areas of Balasore and Cuttack districts were flooded. About 7000 acres of paddy lands were submerged. Some areas of Dhenkanal district were also flooded. Heavy rain in Uttar Pradesh caused floods and damaged many houses.

As the storm was crossing coast near Puri, Puri reported the lowest pressure of 983.1 mb at 0000 GMT of 26th. Bhubaneswar reported easterly winds of 45-50 kt at 0.6 and 0.9 km asl at 0000 GMT of 26th and surface wind 30 kt at 0200 GMT.

The radar at Paradip could estimate the storm centre from spiral bands with low confidence on 25th night when the storm was only about 100 km from the station. The satellite classification of this system was T 2.0 to 3.0 (30 to 45 kt) by APT Delhi and T 3.5 (55 kt) by APT Bombay. Assuming the maximum sustained winds associated with the storm as 55 kt, the central pressure of the storm works out to be 983 mb which agrees with the actual pressure of 983 mb recorded at Puri at 0000 GMT of 26th very close to the storm centre. 9 closed isobars covered the storm field at 0000 GMT of 26th.

2.7. *Depression of 31 October - 2 November*

A low pressure area moved into Andaman Sea from the east on the evening of 29 October. Moving westnorthwestwards, the low concentrated into a depression on the evening of 31 October over southeast and adjoining central Bay with its centre at 1200 GMT near 12.0°N, 87.5°E. Ship *ATRC* near 12°N, 85.5°E reported surface wind NNW/25 kt at that time. Then moving westwards, the depression weakened into a low over southwest and adjoining west central Bay by the evening of 2 November. The low persisted there for the next 2 days and merged with the seasonal low over the Bay.

Three closed isobars covered the depression field. Ship *USLR* about 200 km to the eastnortheast of the depression centre reported surface wind ESE/16 kt and ship *VWPP* about 100 km to the south of the depression centre reported WSW/17 kt at 0000 GMT of 2nd. The satellite pictures showed that this system could be classified as T 2.0 in Dvorak's scale which gives the maximum wind as 30 kt.

This system caused generally widespread rain in Andaman and Nicobar Islands on 29 and 30 October and scattered rainfall in Tamil Nadu from 1 to 3 November.

2.8. *Cyclonic storm of 8-10 November*

A low pressure area which was over Gulf of Siam on 6th evening moved northwestwards into north Andaman Sea by the morning of 7th and concentrated into a depression at 0300 GMT of 8th with its centre near 13.5 deg. N, 95.0 deg. E. The low level winds at Rangoon strengthened to E/25 to 45 kt at 0000 GMT of 8th and the satellite bulletins classified the system as T 1.5 on this day. The same evening the winds at Port Blair upto 0.9 km asl strengthened to W/15 to 20 kt. The depression intensified into a cyclone on 9th morning over east central Bay and adjoining Andaman Sea with its centre at 0300 GMT near 15 deg.N, 93 deg. E. Ship *FNDY* at 14.5 deg.N, 92.5 deg. E reported surface wind WNW/35 kt and pressure 998.5 mb at 0400 GMT and 6 closed isobars could be drawn at this time within a four degree square suggesting that this storm had a narrow core of gale winds. The same ship reported N/40 kt wind at 0600 GMT of 9th near 15.2 deg. N, 92.3 deg. E and pressure 1000.0 mb. The storm moved northwards slowly, weakened into a depression by 10th evening and dissipated over the sea itself off south Arakan coast the next day.

This system caused generally widespread rain in Andaman and Nicobar Islands from 8th to 11th. Long Island reported 8 cm of rain.

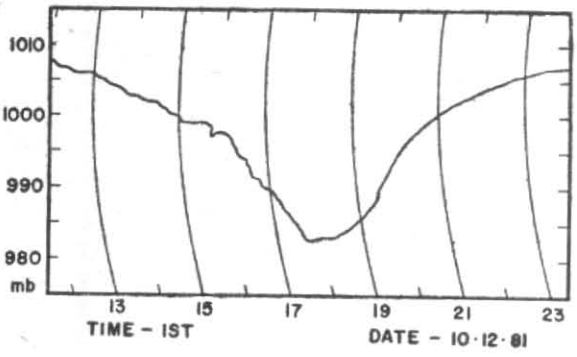

Fig. 3. Barogram of Sagar Island

This system was classified as T 3.0 in the satellite bulletins, which gives the maximum wind as 45 kt. For this maximum wind of 45 kt, the pressure at the centre of the storm works out to be 996 mb. This is in good agreement with the lowest pressure of 998.5 mb reported by ship *FNDY* about 50 km from storm centre on 9th morning.

2.9. *Severe cyclonic storm of 16-20 November*

A low which was over Andaman Sea on 15th moved slowly westwards and concentrated into a depression on the morning of 16th with its centre near 11 deg. N, 93 deg. E. Two closed isobars covered the depression field at this time. Ship *PVVT* near 12.5 deg. N, 94.5 deg. E, reported surface wind ESE/15 kt at 0000 GMT on 16th. The next day ship *ATGU* near 8.5 deg. N, 89.5 deg. E reported W/21 kt at 0000 GMT of 17th. Moving northwestwards the depression intensified into a cyclonic storm by the mid-night of 17th and lay centred on 18th morning at 0300 GMT near 13.5 deg. N, 90.0 deg. E. Ship *ATKV* near 14.0 deg. N, 87.5 deg. E reported surface wind NNW/30 kt at 1800 GMT of 17th. On 18th night at 1500 GMT ship *S2LW* near 14.5 deg. N, 87.5 deg. E reported surface wind N/33 kt. Recurving northnortheastwards, the storm became severe over east central Bay on 19th morning with its centre near 16 deg. N, 90.5 deg. E. The same evening ship *ELEU* near 18 deg. N, 91 deg. E (about 100 km from storm centre) reported surface wind NE/45 kt. Continuing to move northnortheast the system weakened rapidly into a depression off the Arakan coast near Akyab by 20th evening and dissipated *insitu* the next day.

No damage was reported in coastal Burma in association with this storm. Andaman and Nicobar Islands had generally widespread rain from 15th to 18th. Kondul recorded 10 cm of rain, Maya Bandar 9, Car Nicobar 7 on 15th and Maya Bandar 13, Long Island 7 on 17th.

This system was classified as T 2.5 to 3.0 on 18th and T 4.0 on 19th in the satellite bulletins. Gaum estimated the maximum sustained winds as 60 to 70 kt on 19th based on satellite picture. 'Eye' was seen in the satellite picture of 19th afternoon. Assuming the maximum wind associated with this system as 65 kt, the lowest pressure at the centre of the storm works out to be 983 mb.

2.10. *Severe cyclonic storm of 4-11 December*

A low moved westwards across Malaya Peninsula on 2nd and emerged into southeast Bay and adjoining south Andaman Sea by 3rd morning. It concentrated into a depression over southeast Bay on 4th evening with its centre at 1200 GMT near 9 deg. N, 90 deg. E. The satellite bulletin classified the system as T 1.5 to 2.0 at this time. The next morning the low level winds at Port Blair were ESE/20 to 30 kt and ship *ATRC* about 350 km northwest of the depression centre reported surface wind NE/20 kt. Moving slowly northwestwards, the depression intensified into a cyclonic storm by the evening of 6th with its centre at 1200 GMT near 11 deg. N, 86.5 deg E. Ship *ATRC* about 150 km to the northeast of the storm centre reported wind ESE/32 kt and pressure 999.1 mb at 1100 GMT on this day. Then moving northwards, the storm became severe by the morning of 8th with its centre at 0300 GMT near 13.5 deg. N, 86.0 deg. E. Ship *VWSV* about 400 km to the southwest of the storm centre reported wind W/30 kt at 0000 GMT and ship *ATHM* as far away as 600 km to the eastnortheast of the storm centre reported wind ESE/28 kt at this time. The satellite bulletins classified the system as T 3.5 to 4.0 (max. wind 55 to 65 kt) on the morning of 8th. The storm developed a core of hurricane winds by the morning of 9th which could be inferred mainly from the satellite bulletins which classified the system as T 4.5 to 5.0 (max. wind 75 to 90 kt). 'Eye' was reported from the satellite pictures received at Bombay on 9th and at Delhi on 10th. Moving rather fast, the storm was located on 10th morning at 0300 GMT, near 19.5 deg. N, 87.0 deg.E about 100 km southeast of Paradip. The radar at Paradip estimated the storm centre from 09,1900 GMT to 10,0300 GMT with poor confidence at intervals of one and half to two hours. The radar track showed that the storm was recurving northnortheastwards. The maximum surface wind reported from Paradip radar station was about 50 kt 0615 GMT of 10th.

The storm crossed West Bengal coast near Sagar Island around 1300 GMT of 10th and moving northeastwards rather fast, weakened into a depression on 11th morning over Bangla Desh and nto a low the same evening over Assam and Meghalaya. The low dissipated *insitu* by the morning of 12th.

As the storm crossed West Bengal coast very close to Sagar Island in the late evening of 10th, the lowest pressure recorded at that station was 983.5 mb at 1215 GMT. The pressure departure from normal at 1200 GMT at Sagar Island was *minus* 27 mb. The maximum wind recorded at Sagar Island was only about 25 kt between 0900 and 1200 GMT with peak speed in gusts reaching

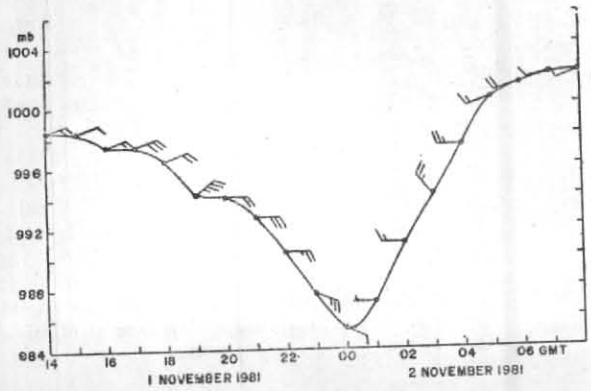

Fig. 4. Observations of wind (kt) and pressure (mb) at Porbandar

35 kt. However, ship *Sandheads* which was in Haldia Dock reported maximum wind NE/50-55 kt at 1200 and 1500 GMT. Assuming the maximum wind associated with the storm as 75 kt the pressure at the storm centre works out to be 980 mb which agrees well with the lowest pressure of 983.5 mb recorded at Sagar Island very close to the storm centre. A copy of the barogram of Sagar Island on 10 December' 81 is reproduced in Fig. 3.

In association with this system, generally widespread rain occurred in Andaman and Nicobar Islands from 3rd to 5th, in Orissa on 10th, in Gangetic West Bengal on 10th and 11th, in Bihar Plateau on 11th and in Assam and adjacent States on 11th and 12th with heavy to very heavy falls in Orissa and Gangetic West Bengal. Considerable damage was reported from coastal districts of West Bengal and north Orissa, the worst affected being the 24 Parganas district of West Bengal. About 200 people were reported to have died in the district of 24 Parganas and 3 in the district of Midnapore. At least one million people were affected in the three sub-divisions of 24 Parganas, *namely* Diamond Harbour, Basirhat and Alipore Sadar. About 1,97,000 acres of agricultural land were inundated by saline water. Damage to river embankments in the Sunderbans had been extensive. 205 km of embankments were completely washed away and 315 km of embankments were either severely or partially damaged by tidal waves apart from 1,292 breaches. In Midnapore district about 1000 huts were reported to have been destroyed in Contai sub-division. All telegraph and telephone connections snapped at Contai town. Crops worth Rs. 50 crores had been reported damaged in the cyclone hit districts of West Bengal out of which about Rs. 35 crores in the district of 24 Parganas alone.

In Orissa the districts which suffered some damage were Balasore, Cuttack and Puri, the worst affected being Cuttack. About 2800 villages and a population of about 13 lakhs were affected. Cropped area of 57,571 hectares was affected due to cyclone and saline inundation leading to a loss of about Rs. 90 lakhs. Loss to betel vines was about Rs. 162 lakhs. About 200 houses and 29,675 thatched houses were damaged. The estimated loss on this account was about Rs. 55 lakhs. Damage to 1364 public institutions, roads, river embankments etc was estimated at about Rs. 317 lakhs. Some fishing vessels berthed in Paradip port were sunk. There was no less of human life but about 400 livestocks were lost.

The principal amounts of heavy rainfall (cm) were : Magra (Bagati) 9, Paradip 7, on 10th; Sagar Island 14, Calcutta 13, Diamond Harbour 12, Contai, Nandigram (West Bengal) 11, Sand heads, Namkhana (West Bengal) 9, Magra, Canning 7 on 11th.

3 Arabian Sea

3.1. *Severe cyclonic storm of 28 Oct-3 Nov*

A low which was over southwest Bay off Sri-Lanka, south Tamil Nadu coasts on the morning of 26 October moved westwards across extreme south Peninsula into north Lakshadweep by 28th morning and concentrated into a depression the same evening with its centre at 1200 GMT near 12.5 deg. N, 72.5 deg. E. Ship *GUPX* near 13.0 deg. N, 71.5 deg. E reported surface wind NE/15 kt and Amini Divi SW/15 kt at this hour two closed isobars covered the depression field. The depression became deep on 29th morning and moving westnorthwest intensified into a cyclonic storm on the morning of 30th with its centre at 0300 GMT near 13.5 deg. N, 68.0 deg. E. The satellite bulletin from Delhi classified the system as T 2.5 and the winds at 0.9 km asl along the west coast of India had strengthened to 30 to 40 kt. The storm started recurving in a northerly direction and became severe the same evening as indicated by satellite pictures estimating the maximum wind as 55 kt (T 3·5/3·5). This was supported by the satellite bulletins from Guam. Then moving northnortheastwards, the storm probably developed a core of hurricane winds on 31st morning, the satellite classification being T 4.0 (65 kt). Ship *PDHO* within 100 km of storm centre reported S/35 kt at 0600 GMT on 31st and pressure 993 mb. Ship *ELWT* near 16 deg. N, 67 deg. E reported wind NW/ 44 kt at 0900 GMT and pressure 1000 mb and ship *GXYY* near 16.5 deg. N, 67.5 deg. E reported NW/30 kt at 1200 GMT and pressure 990.8 mb. The storm circulation covered on area of about 7 degrees square on 31st.

The storm continued to move northnortheast upto the morning of 1 November. Then it moved northwards and crossed Saurashtra coast close to and west of Mangrol shortly after mid-night of 1 November and moved close to Porbandar in the early morning of 2 November. Then moving northeastwards as a severe cyclone upto Jamnagar (*i.e.*, upto about 0600 GMT), it weakened rapidly into a deep depression that after noon and lay near Radhanpur at 1200 GMT. The depression moved

across Rajasthan and weakened into a low over north Haryana by 3rd evening and broke up over Himachal Pradesh the same night.

As the storm was crossing Saurashtra coast on the night of 1 November, Veraval reported surface wind SE/50-55 kt from 2100 GMT of 1st to 0000 GMT of 2nd and lowest pressure of 996.5 mb. As the storm lay close to Porbandar on the early morning of 2nd, the station reported the lowest pressure of 985.3 mb (at 0000 GMT of 2nd). The wind changed from E/10 kt at 0000 GMT to W/06 kt at 0100 GMT indicating that the storm centre passed almost over Porbandar. The strongest wind recorded at Porbandar was NE/ 36 kt at 1900 GMT of 1st. The hourly values of wind and pressure recorded at Porbandar are presented in Fig. 4. 10 to 11 closed isobars at 2 mb interval covered the storm field at 0000 and 0300 GMT of 2nd. The pressure depth was 22 mb at 0000 GMT and hence the estimated maximum wind was about 65 kt. At 0600 GMT of 2nd, the storm lay with its centre close to Jamnagar. 8 closed isobars covered the storm field. Ship *ATMH* in northeast Arabian Sea about 350 km to the southwest of the storm centre reported surface wind NNW/36 kt at 0600 GMT of 2nd. Jamnagar reported the lowest pressure of 989.2 mb at 0430 GMT and maximum wind NNW/55 kt at 0715 GMT on 2nd. Rajkot reported surface wind S/42 kt at 0700 GMT. These showed that the storm was severe up to Jamnagar. On 3rd morning at 0000 GMT when the system lay as a deep depression about 75 km east of Jodhpur, Jodhpur reported surface wind NNW/30 kt.

The highest classification for this system based on satellite pictures was T 4.0 (maximum wind 65 kt) on 31 October and 1November. Guam estimated the maximum sustained wind associated with this system as 60 kt gusting to 75 kt on 31 October and 1 November, based on satellite pictures. 'Eye' was not reported in the satellite bulletins. Assuming the maximum sustained wind associated with this storm as 65 kt, the lowest pressure at the storm centre works out to be 983 mb which agrees well with the lowest pressure of 985.3 mb recorded by Porbandar very close to the storm centre.

In association with this cyclone, generally widespread rain with heavy to very heavy falls occurred in Saurashtra and Kutch from 31 October to 2 November. Fairly widespread rain with isolated heavy falls also occurred in northwest India on 3 and 4 November. Rainfall was also generally widespread in Konkan and Goa and Gujarat region on 2nd and 3rd.

A large number of trees and electric and telegraph posts were damaged or uprooted in Junagadh and Jamnagar districts. About 5700 houses and about an equal number of huts were partially or fully damaged in Junagadh, Jamnagar and Rajkot districts. Only about a dozen persons were reported to have died due to wall collapses. A few cargo ships and fishing boats sank near the coastal waters. There was damage to fishing boats and nets and groundnut crop in Jamnagar and Junagadh districts. Loss to groundnut crop in these districts was estimated to be about Rs. 52 crores. Estimated loss to Veraval and Navlakhi ports was about Rs. 12.5 lakhs. No tidal wave was reported in any part of Gujarat coast.

The principal amounts of heavy rainfall (cm) associated with this system were : Banwad (Gujarat) 10, Jamjodhpur (Gujarat) 8, Veraval 7 on 31st; Dwarka 17, Veraval 14, Kalyanpur (Gujarat) 13, Khambalia (Gujarat) 11, Porbandar 10, Bhanwad 8 on 1st; Okha 18, Lalpur (Gujarat) 13, Bhuj 10, Naliya, Jamjodhpur 7 on 2nd; Mount Abu 11, Lunkaransar (Rajasthan) 7 on 3rd, Manali 11, Chamba, Dalhousie, Dharampur, Nahan 10, Dharamsala, Chandigarh 9, Patiala, Ambala, Bilaspur, Bangana (Himachal Pradesh), Kandaghat (Himachal pradesh) 8, Malerkotla (Punjab), Tibri (Punjab), Nurpur (Himachal pradesh) 7 on 4th.

4. Land depression

4.1 *Depression of 9 September*

A low which was over Bihar plateau and adjoining Gangetic West Bengal from 5th to 7th moved slowly westnorthwest and concentrated into a depression over east Uttar Pradesh by 0000 GMT of 9th with its centre 75 km east of Allahabad. Moving slowly northwards, it lay with its centre at 1200 GMT near Sultanpur. Allahabad reported surface wind W/25 kt at this time. Then it weakened into a low moved slowly northnortheastwards and broke up over Nepal-Himalyas by 11th.

This depression caused generally widespread rain over Bihar plains and east Uttar pradesh from 8th to 10th with isolated heavy to very heavy falls. According to press reports, floods affected Gonda, Basti, Bahraich and Gorakhpur districts of Uttar Pradesh.

The notable amounts of heavy rainfall (cm)were: Elginbridge 13, Chhatnag 12, Robertganj 10 (all in Uttar Pradesh) on 8th; Balrampur (Uttar Pradesh) 16, Ayodhya (Uttar Pradesh) 15, Akbarpur (Uttar Pradesh) 13, Gonda 12, Elginbridge 11, Mohammadabad (Uttar Pradesh) 10 on 9th; Kakardarighat (Uttar Pradesh) 36, Bahraich 30, Kaiserganj 26, Elginbridge 23, Raxaul (Bihar) 22, Gonda 18, Fatehpur 14, Bansi (Uttar Pradesh), Motihari 11, Katerniaghat (Uttar Pradesh) 10 on 10th.