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# Cyclones and depressions over the Indian seas in 1983

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## 1. Chief features

The pre-monsoon season was marked by the absence of any storm in the Bay. The Arabian Sea was a storm free region during the year.

Two severe cyclonic storms, one cyclonic storm and five depressions developed over the Indian seas and the land areas of India, Bangladesh and Sri Lanka, during 1983. Of these two severe cyclonic storms and one cyclonic storm developed over the Bay of Bengal. During the monsoon season four depressions developed, one over east central Arabian Sea and adjoining Saurashtra, one in the Bay of Bengal and two over the land areas over Indo-Bangladesh region. The fifth depression formed over Sri Lanka during the post-monsoon season.

The tracks of these storms and depressions are shown in Fig. 1.

## 2. Bay of Bengal

### 2.1. *Deep depression,* 23-27 *June*

In the north-south upper air trough, a cyclonic circulation developed in the lower and middle troposphere on 22nd morning over northwest and adjoining west central Bay. By next morning a low pressure area formed over this area. It concentrated into a depression by 1800 GMT of 23rd and was centred at 17.6 deg. N, 87.5 deg. E. Further concentrating into a deep depression it moved in a westnorthwesterly direction and crossed south Orissa coast near Gopalpur on the forenoon of 25th. Continuing to move westnorthwestwards it weakened into a well marked low pressure area over west Madhya Pradesh by 27th evening.

It was declared as a depression on the basis of lower level winds of Bhubaneswar at 1800 GMT of 23rd which were at 0.6 km, NE/25 kt and at 0.9 km, E/35 kt. It intensified into a deep depression and was centred at 0300 GMT on 24th near 18.0 deg. N, 86.5 deg. E where the satellite classification was T 2.0. At 0000 GMT Visakhapatnam reported wind at 0.9 km a.s.l. northerly 30 kt. At 0000 GMT a ship with call sign *VTFY,* about 475 km to the south and another ship with call sign *ATUS* about 700 km southwest of the system reported winds 250°/35 kt and 260°/45 kt respectively indicating strong to vigorous monsoon condition over west central Bay. At 0000 GMT on the 25th morning when the system lay close to south Orissa coast, a ship with call sign *ATJY* at 17.5 deg. N, 85.0 deg. E reported wind 260°/38 kt while Gopalpur at 0300 GMT reported a northerly wind of 28 kt. At 0600 GMT the above ship again reported wind 210°/30 kt. The winds at 0.9 km a.s.l. in the Andhra-Tamil Nadu coasts were W/45-50 kt at 0000 GMT. The same morning pressure fall for past 24 hours was 5.5 hPa at Gopalpur and 4.7 hPa at Kalingapatnam, while the departures were — 8.1 hPa and — 4.2 hPa respectively. However, the coastal stations to the north of the system reported winds easterly to eastsoutheasterly 10 to 15 kt (at 0300 GMT) only. Further the satellite classification continued to be T2.0 and showed no intensification.

After crossing coast, the system weakened into a depression. At 1200 GMT winds around the system at 0.9 km a.s.l. were only of the order of 15-25 kt. However, except Machilipatnam which reported westerly wind of 48 kt the wind field at the coast to the south of the system was about 25 kt westerly. On 26th morning, the surface winds around the system were 15-20 kt and pressure departure in the depression field was of the order of — 5 to — 6 hPa. By evening, when it lay over southeast Madhya Pradesh, surface winds around the system decreased to 05 kt though the coastal winds were rather strong. At 1200 GMT surface winds reported by Cuttack, Puri, Gopalpur and Kalingapatnam were SW/20 to 25 kt. On 27th morning the system lay over central parts of Madhya Pradesh when the circulation at surface further weakened. In the evening it weakened into a well marked low pressure areas over west Madhya Pradesh.

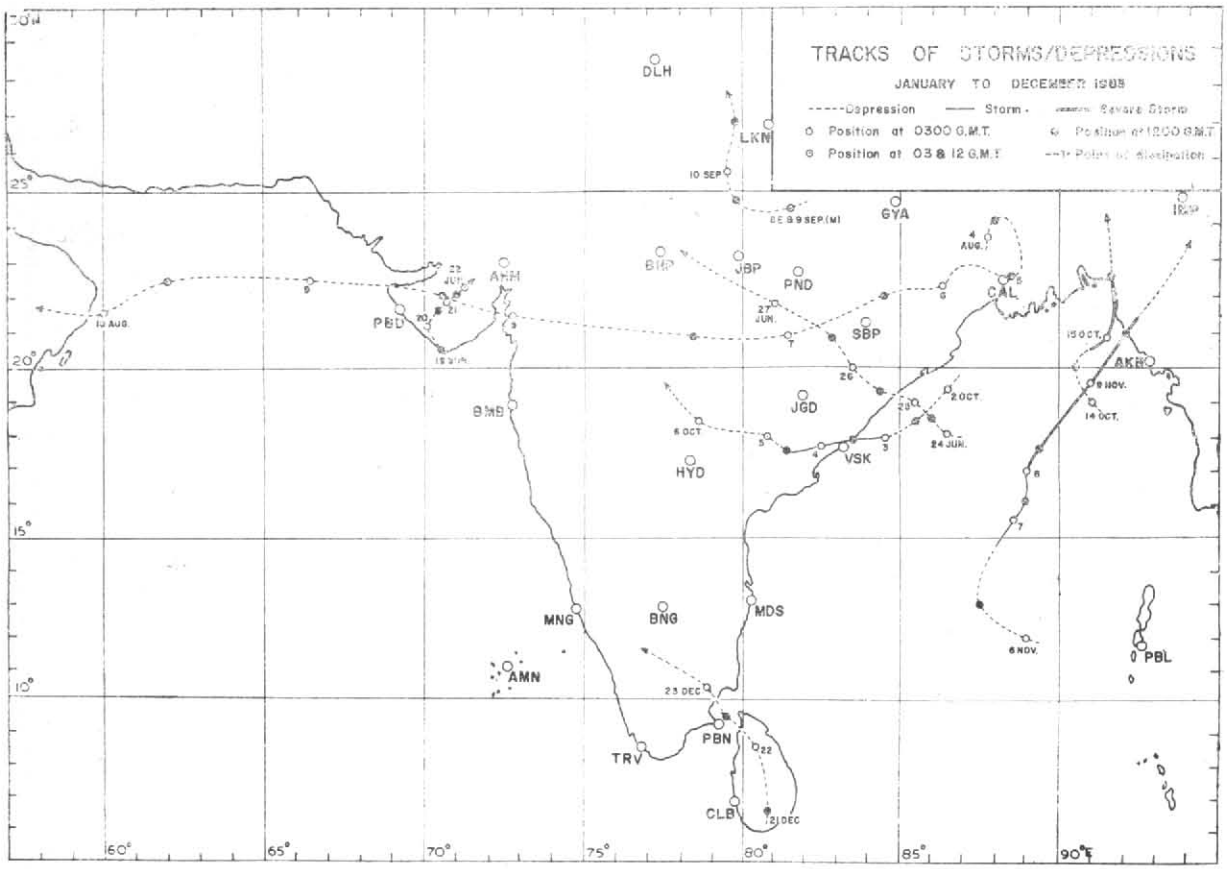


Fig. 1

This system ushered in the Bay branch of southwest monsoon in Orissa, West Bengal and Sikkim, Bihar Plateau and southeast Madhya Pradesh. Significant amounts of rainfall (in cm) in association with this system were : Baghdogra 20 on 24th; Kalingapatnam 22, Jagdalpur 20, Berhampore 19, Nowrangpur 18, Jaipeta 16, Pottangi 15 on 26th; Alibag 29, Darjeeling 16 on 27th; Raebaraeli 20, Thakurdwara 15, Darjeeling 13 on 28th.

### 2.2. *Cyclonic storm,* 2-6 *October* 1983

Under the influence if a lower and middle tropospheric circulation, a well marked low pressure area formed over and Andaman Sea and neighbourhood on the evening of 29 September. This low pressure area concentrated into a depression over northwest Bay by 2 October. Further intensifying into a cyclonic storm by 3rd morning it crossed north Andhra coast near Bheemunipatnam around 0100 IST of 4th. It weakened into a low pressure area over west Telangana and neighbourhood by 6th evening. At 0300 GMT of 2nd, when the system was declared as depression centred at 19.5 deg. N, 86.5 deg. E, Paradeep reported surface wind 090°/15 kt. The pressure fall for last 24 hours along south Orissa-north Andhra coasts was of the order of 4 to 5 hPa, the corresponding pressure departures were between *minus* 4 to 6 hPa. On the basis of 0150 GMT NOAA-8 imagery the system was inferred to have been concentrated into a depression. Bhubaneswar and Visakhapatnam reported winds NE/40 kt and NNW/10 kt respectively at 0.9 km a.s.l. at 0000 GMT. The system moved southwestwards and lay centred at 1200 GMT at 18.5 deg. N, 85.5 deg. E as a deep depression. At this stage the pressure departure was — 8 hPa and the fall for past 24 hours was 6 hPa at Kalingapatnam. The winds at 0.9 km a.s.l. were E/25 kt and WNW/30 kt at Bhubaneswar and Visakhapatnam respectively, but the surface winds along the Andhra coast were of the order of 5 kt only. The satellite classification of the system was T 1.5 both on the afternoon and evening of 2nd. The system moved westsouthwestwards and lay close to north Andhra coast by 3rd morning. The Cyclone Detection Radar (CDR) at Visakhapatnam located the open eye of the system at 0030 GMT. At that time the radar fix was at 18.1 deg. N, 84.2 deg. E. In the morning on the basis of INSAT-1B imagery the system attained an intensity corresponding to T 3.0. Pressure departures in the north Andhra coast was *minus* 11 to 13 hPa and fall for the past 24 hrs was about 5.5 hPa at 0300 GMT. Though the system was of cyclonic storm intensity and very close to the coast, the surface winds of the coastal stations did not indicate so. The winds along north Andhra-south Orissa coasts were of the order of 5 to 15 kt. However, the winds at 0.9 km a.s.l. at Visakhapatnam and Machilipatnam were northerly 30 kt and westnorthwesterly 45 kt respectively. Ships in the west central Bay, located at 0300 GMT about 250-300 km east of the storm centre reported southerly winds of 15-20 kt only. The CDR at Visakhapatnam tracked the cyclone upto 0830

GMT of 3rd. The 'eye' was seen only at 0500 GMT. The unusual southerly course of the system from 2nd morning to 3rd morning could be attributed to the presence of an anticyclone over east Madhya Pradesh and neighbourhood at 300 hPa and aloft generating rather strong northeasterly steering current. Even by 1200 GMT of the 3rd the surface wind field in coastal areas did not pick up and the strength was ranging between 5 & 20 kt only. However, the storm intensity was judged to be at T 3.0. The surface wind at Waltair continued to be NNW/20-25 kt till 1800 GMT of 3rd. At 1800 GMT the pressure was 993.1 hPa and wind NNW/20 kt. By 1900 GMT these values were 991.1 hPa and WSW/20 kt respectively. These changes suggest that the storm has crossed the coast to the north of Waltair between 1800 and 1900 GMT of 3rd. Highest wind at Waltair was SW/30 kt from 2100 to 2300 GMT. At the north of the storm centre, Kalingapatnam reported easterly winds of the order of 15-20 kt from noon till 1600 GMT, which increased to E/25 kt from 1700 to 1900 GMT. The lowest pressure recorded at Waltair was 989.5 hPa and that at Kalingapatnam was 996.1 hPa at 2000 GMT.

On 4th the cyclonic storm lay over coastal Andhra Pradesh. Pressure departure on that day, in the storm field was of the order of *minus* 9 to 11 hPa and the pressure fall for past 24-hr was from 2 to 4 hPa. But the surface winds were of the order of 10-15 kt only. But at Machilipatnam at 0000 GMT the low level winds were WNW-NNW/40 kt between 0.3 and 0.9 km a.s.l. They became WSW-WNW/25 kt to 30 kt at 1200 GMT. The INSAT-1B satellite imagery of 0918 GMT, indicated weakening of the storm. The movement of the storm from 4th morning to evening was westsouthwestwards. Thereafter it moved westnorthwestwards and weakened into low pressure area over Telangana and neighbourhood by 6th evening.

Significant amounts (cm) of very heavy rainfall were : Visakhapatnam 19, Yellamanchili 18, Cheepurupalli 16 and Holalagundi 14 on 4th; Bhadrachalam town 29, Bhadrachalam Road 21, Dummagudem & Khammam 19 each, Polavaram 18, Chintalapudi 16, Narsipatnam & Yellandu 15 each, Madhira 14, Kovvur & Parkal 13 each on 5th; Nizamsagar 17, Medak & Sangareddy 14 each on 6th.

According to reports this storm claimed a death toll of 120 lives and perished about 94,000 cattle heads. Total loss to crops and property was estimated at about Rs. 520 crores. Heavy losses erratically arouse from very heavy rainfall associated with the cyclonic storm over an area which had more than 50 per cent excess rainfall in the preceding monsoon, which was active to vigorous over Andhra Pradesh towards the end of the season. About 7,000 minor irrigation tanks breached. Flood waters damaged roads of about 26,000 km in length.

### 2.3. *Severe cyclonic storm,* 14-15 *October*

The tropical storm *'Herbert'* of south China Sea crossed Vietnam coast on 9th and moved westwards across Thailand and south Burma as a low pressure area with associated cyclonic circulation extending to mid-tropospheric levels. It emerged into north Andaman Sea and adjoining Gulf of Martaban on the 12th. Thereafter moving northwestwards it concentrated into a depression centred at 0300 GMT of 14th at 19.0 deg. N, 91.0 deg. E. There the satellite classification was T 2.0. Pressure departure along Chittagong-Arakan coasts was about — 7 hPa. In the evening it intensified into deep depression where the INSAT-1B imagery indicated its intensity as T 2.5. Observations from Arakan coast were absent. Ship *ATUL* at about 175 km southwest of the system reported surface wind 240°/09 kt. Thereafter the system moved northeastwards and intensifying rather rapidly into a severe cyclonic storm lay on 15th morning very close to the north Arakan coast. Ship *ATUL* at 21.7 deg. N, 91.4 deg. E reported surface pressure of 995.0 hPa and wind 050°/46 kt. The 0210 GMT satellite imagery indicated further intensification with an assigned intensity of T 3.0. Conventional data from Burma and Chittagong coasts continued to be absent. Thereafter the storm moved northwards and lay at 1200 GMT 30 km westnorthwest of Chittagong. In the evening the assessment from satellite imagery was T 2.5 to T 3.0. Chittagong reported surface wind SW/30 kt and pressure 997 hPa. The pressure fall from past 24-hr at Chittagong was 5.6 hPa and the departure was — 11.3 hPa. Continuing to move northwards it crossed Bangla Desh coast 50 km northwest of Chittagong in the evening of 15th. Thereafter it rapidly weakened over Assam and adjacent States by next day.

The system moved along the periphery of the upper tropospheric anticyclone over southeast Asia.

This cyclone did not cause any damage in India except for isolated heavy falls in Assam and Meghalaya on 16th.

### 2.4. *Severe cyclonic storm,* 6-9 *November*

A well marked low pressure area which lay over south Andaman Sea and adjoining southeast Bay on the 5th concentrated into a depression over southeast Bay by the 6th morning. Moving northwest to northnorthwest it intensified into a cyclonic storm on 7th morning over central Bay. Thereafter moving northnortheast to northeast further intensified into a hurricane and crossed Bangla Desh coast near Cox's Bazar on 9th evening. Continuing to move northnortheastwards it rapidly weakened over west central Burma by 10th.

From the beginning of November the equatorial trough over south Bay and neighbourhood was active. Satellite imageries showed good convection over these areas. In the equatorial trough a low pressure area formed over Andaman Sea on 28 September. Moving westwards it concentrated into a depression on 6th morning over southeast Bay. Ship *ATGY* about 450 km westnorthwest of the system reported surface wind 320° /18 kt at 0600 GMT. At 1200 GMT the same ship reported surface wind 320°/18 kt. Then she was about 300 km west of the system. The satellite classification on this day was between T 1.5 and T 2.5. It moved northwestwards upto 1200 GMT of 6th and

thereafter northnortheastwards. It intensified into a cyclonic storm and was centred at 0300 GMT of 7th near 15.5 deg. N, 88.5 deg. E. Thereafter the movement of the system became rather slow till 1200 GMT. On 7th the following ship's observations were available from the storm field :

| Call sign of ship | Obsn. time (GMT) | Location | | Wind Speed | | Remarks |
|---|---|---|---|---|---|---|
| | | Lat. (°N) | Long. (°E) | Dir. (°) | Speed (kt) | |
| *VFTY* | 0000 | 17.5 | 86.7 | 040 | 30 | Overcst |
| Do. | 0600 | 16.0 | 86.1 | 040 | 30 | Do. |
| *UKJU* | 0600 | 18.0 | 90.6 | 120 | 20 | Do. and raining |
| *VFTY* | 1200 | 14.5 | 85.4 | 360 | 30 | Cloudy |
| *AJGE* | 1200 | 15.6 | 93.6 | 120 | 30 | Do. |

On this day the satellite classification on the basis of INSAT-1B imageries, was T 2.5 to T 3.0.

By 8th morning the storm further intensified into severe storm. At 0300 GMT ship *ATET* from about 350 km west of the storm reported surface wind 360°/27 kt and at 1200 GMT the same ship from about 320 km westsouthwest of the system reported wind 360°/35 kt. The satellite classification on this day was T 3.5. On this day the movement of the storm was north to northnortheast.

After 1200 GMT of 8th the storm speeded up and moved in a northeasterly direction and lay as a hurricane at 0300 GMT of 9th near 19.5 deg. N, 91.0 deg. E. The 24-hr pressure fall in the morning along north Arakan-Chittagong coasts was about 5 hPa and that of Sandheads 5.4 hPa, while the respective pressure departures were — 8 hPa and — 9.6 hPa. Ship *ATEL*, about 600 km southsouthwest and ship *ATDJ* about 620 km southsoutheast of the storm centre reported winds 330°/29 kt and 150°/27 kt respectively. The stations from Arakan coast reported winds only 5 to 10 kt. Upper air observations from Burma coast were absent. At 1200 GMT of 9th, when the system was very close to the Arakan-Chittagong coasts, the observations from the coastal areas were absent. The satellite classification of the system on 9th was T 4.0. It crossed north Arakan-Chittagong coast near Cox's Bazar by 9th evening and weakened over east central Burma and neighbourhood by next day. As per *Annual Tropical Cyclone Report*, 1983 (JTWC), the maximum wind speed of 55 kt was reached at 0000 GMT of 9th and maintained it until landfall.

This system did not affect the weather over India.

### 3. Arabian Sea

#### 3.1. *Deep depression*, 19-22 *June*

A cyclonic circulation in the lower and middle tropospheric levels, which lay over east central and adjoining southeast Arabian Sea off Karnataka coast on 15th was slowly moved northwards till the 18th. Then, within this circulation a low pressure area formed off north Maharashtra coast. Continuing to move northwards the low pressure area concentrated into a depression over Saurashtra and adjoining east central Arabian Sea in the evening of 19th. Thereafter it moved northnorthwestwards till the morning of 20th. From 20th morning to 21st morning the movement of the system was rather slow and was in a northeasterly direction. By 20th morning it further concentrated into a deep depression and lay over Saurashtra. The system practically remained over Saurashtra without any appreciable movement and weakened *in situ* by 23rd.

At 1200 GMT of 19th when the depression lay close to Veraval, Bhavnagar and Rajkot reported surface winds eastsoutheasterly, 20 kt and 15 kt respectively while Veraval reported NNW/25 kt. The system drew strong to vigorous monsoon current over Saurashtra. By 0300 GMT of 20th when it concentrated into a deep depression 4 closed isobars at an interval of 2 hPa could be drawn. Pressure fall for past 24-hr was 5.9 hPa at Porbandar while the pressure fall for past 24 hours at Rajkot was 4.5 hPa and —9 hPa in the western Saurashtra. The surface winds were at Veraval, SSW/55 kt, at Rajkot, E/20 kt and that at Porbandar was NNW/25 kt. At 1200 GMT of that day the winds at Veraval, Rajkot and Porbandar were SW/30 kt, E/25 kt and W/30 kt respectively. Pressure fall for past 24 hours at Rajkot was 4.5 hPa and the pressure departures were —3 hPa at Veraval, —6.7 hPa at Porbandar and —5.6 hPa at Rajkot. The NOAA-7 satellite imagery at 1110 GMT could reveal only vortex over Gujarat and neighbourhood the centre being ill defined. This was, perhaps, due to the pressure of intense monsoon clouds over this region.

On 21st both in the morning and evening 4 closed isobars at an interval of 2 hPa could be drawn. At 0300 GMT, the surface winds at Veraval, Rajkot and Porbandar were WSW/20 kt, E/25 kt and WNW/40 kt respectively. Pressure departures over Saurashtra were of the order of — 3 to — 8 hPa and the pressure falls for past 24-hr were 2 to 3 hPa. At 1200 GMT the winds at Veraval, Bhavnagar, Rajkot and Porbandar were WSW/20 kt, S/20 kt, ENE/20 kt and NW/20 kt respectively. *Sagar Samrat* (19.3 deg. N, 72 deg. E) reported wind WSW/30 kt indicating strong monsoon condition over east central Arabian Sea off north Maharashtra coast. Pressure falls over Saurashtra were 2 to 3 hPa and the departures were of the order of — 2 to — 8 hPa, the highest fall being at Rajkot.

But the winds on 22nd morning at Veraval, Bhavnagar, Rajkot and Porbandar were WSW/25 kt, S/25 kt, N/35 kt and WNW/20 kt respectively. The pressure departures over Saurashtra & Kutch were of the order of —2 to —6 hPa. Ship *ATKK* (20.3 deg. N, 71.0 deg. E) and *Sagar Samrat* (19.3 deg. N, 72.0 deg. E) reported westerly wind of 35 kt. As such the system was still a deep depression. By 1200 GMT the system weakened into a depression. The pressure tendencies for past 24-hr over Saurashtra were rising by as much as 5.6 hPa at Rajkot. The

winds around the system were 10-25 kt. By next day morning, the depression further weakened into a low pressure area over Saurashtra.

The system lasted for 3½ days over Saurashtra causing incessant and torrential rains. As a result almost all dams and rivers in Saurashtra region started overflowing inundating vast areas. Several flooded rivers got interconnected in the low lying Ghed area and other low-lying parts of Junagadh district. Calamity mainly hit 5 districts of Saurashtra, namely, Junagadh, Amreli, Jamnagar, Rajkot and Bhavnagar, worst hit being the Junagadh district. It was reported that the number of human lives lost due to heavy rains/floods were 594 with 1 missing, of these Junagadh district accounts for the loss of 558 lives. Total number of villages affected were 2607 with a population of 39.31 lakhs. About 17293 houses and 28977 huts collapsed. 68,894 hectares of agricultural land was washed away resulting in a loss of approx. Rs. 24 crores. Cattle heads lost were 83,768.

Significant amounts (cm) of rainfall in association with the system were : Mahuva 36, Veraval 25, Porbandar 10 on 20th; Porbandar 39, Navsari 13 on 21st; Navsari 22, Veraval 16 on 22nd; Veraval & Porbandar 21 each on 23rd; Veraval 14 on 24th.

**4. Land depression**

4.1. *Deep depression,* 4-10 *August*

Under the influence of lower and middle tropospheric circulation a well marked low pressure area formed over northwest Bay and adjoining Gangetic West Bengal on 3rd which moving northnorthwestwards concentrated into a depression over Bangladesh on 4th and lay centred at 0300 GMT about 60 km southeast of Berhampore (West Bengal). It further concentrated into a deep depression by 5th morning over Bangladesh. Thereafter moving southsouthwestwards and then westwards it travelled across central India and Gujarat State and emerged into Arabian Sea on 9th morning. Continuing to move in a westerly direction, it crossed Oman coast. The initial northward movement of the system was due to the influence of a middle and upper tropospheric trough in westerlies. As the trough moved away eastwards it came under the influence of northerly/northeasterly of upper tropospheric anticyclone over northwest India and neighbourhood by 5th which temporarily steered it southwards.

On 4th morning when the system became a depression 3 closed isobars at an interval of 2 hPa could be drawn. Winds at 0.9 km a.s.l. around the system were 15-30 kt while those on surface were 5 to 10 kt. It moved northnorthwestwards and at 1200 GMT lay westsouthwest of Berhampore. At this time maximum pressure fall in the field was 2.6 hPa and the departure was — 2.4 hPa.

Afterwards the system moved southwards and intensifying into a deep depression lay at 0300 GMT of 5th to eastnortheast of Calcutta. 4 closed isobars at an interval of 2 hPa could be drawn at this time and the maximum pressure fall for past 24 hrs was 3.4 hPa at Calcutta. The winds at surface level were 5-15 kt, in and around the system, which at 0.9 km a.s.l. became 20 to 30 kt. The system remained stationary till 1200 GMT of 5th.

Thereafter it moved southwestwards and lay on 6th morning about 75 km southsoutheast of Jamshedpur. The pressure fall in the field was 2 to 4 hPa and the departures were — 1 hPa to — 3 hPa. At 0.9 km a.s.l. the wind at Calcutta was ESE/25 kt. The intensification of the system was also indicated in the satellite picture. Moving westwards the system lay close to Rourkela in the evening. At this stage the winds at 0.9 km a.s.l. at Calcutta and Raipur were SE/30 kt and N/35 kt respectively. The pressure fall for past 24-hr in the area was 4 to 6 hPa. Hereafter the system rather speeded up. Continuing to move westwards it lay in the morning of 7th centred about 50 km south of Raipur. Surface level winds in the vicinity of the system were 5 to 10 kt. The pressure fall for past 24-hr over east Madhya Pradesh and adjoining east Vidarbha was 4 to 7 hPa. Departures were — 4 hPa to — 5 hPa. The circulation in the lower tropospheric levels was quite extensive. By evening the system weakened into a depression, lay over Vidarbha and neighbourhood, centred about 75 km southwest of Nagpur. Though the pressure fall over Vidarbha and neighbourhood was 4 to 6 hPa only 2 closed circular isobars at an interval of 2 hPa could be drawn at 1200 GMT. Nagpur reported at 0.9 km a.s.l. wind SE/10 kt in the evening.

On 8th morning the depression was over Gujarat region, centred at 0300 GMT near Surat. On approaching west coast the system started re-intensification. By evening, when it lay about 40 km southwest of Rajkot, it became a deep depression again. Surface winds reported at 1200 GMT by Veraval, Bhavnagar, Rajkot and Jamnagar were SW/30 kt, S/20 kt, E/15 kt and NNE/20 kt respectively. Kandla and Bhuj also reported surface winds of 20 kt from northeasterly direction. The pressure tendencies for past 24 hrs were falling and were of the orded of 8 to 11 hPa; the departures were — 6 to — 10 hPa.

Continuing its westward journey the system emerged into northeast Arabian Sea and lay centred at 0300 GMT of 9th near 22.5 deg. N, 66.5 deg. E. By evening it lay near Oman coast centred near 22.5 deg. N, 62.0 deg. E. Jiwani (Pakistan) reported surface wind, E/25 kt. Thereafter moving westsouthwestwards it lay very close to Oman coast by 10th morning. Masirah reported, at 0300 GMT surface wind NW/35 kt. It crossed Oman coast around noon and dissipated overland by next day.

During its passage across India, the system caused heavy to very heavy falls in Assam and Meghalaya, Gangetic West Bengal, Madhya Pradesh, Gujarat and Maharashtra State. In Gujarat several dams started overflowing their embankments causing flood situations. The significant amounts (cm) of rainfall were : Agartala & Kailashahar 10 each on 4th; Cherrapunji 37, Siddhi 34 on 5th; Balod 13, Gudiyari 11 on 7th; Mahabaleshwar 21, Khandwa 16, Surat 15, Daman 11 on 8th; Mahabaleshwar 17, Ratnagiri & Devgarh 12 each, Colaba 10 on 9th; Devgarh, Alibag & Santacruz 10 each; Ludhiana & Hakimpeth 8 each on 10th.

4.2. *Depression,* 8-10 *September*

A low pressure area over northwest Bay and adjoining areas of Gangetic West Bengal and Orissa, moving westnorthwestwards concentrated into a depression on the evening of 8th near Rewa. Thereafter it moved very slowly westnorthwest/northwestwards till 1200 GMT of 9th and then northwards and weakened over north Uttar Pradesh by the morning of 11th.

Under the influence of a trough in upper tropospheric easterlies the well marked low pressure area over northeast Madhya Pradesh and neighbourhood concentrated into a depression by 8th evening centred at 1200 GMT near Rewa. Satellite pictures indicated the system as a depression. The pressure fall for past 24-hr in the area was 2 to 3 hPa and the departures were of the order of — 4 hPa to — 5 hPa. The system remained stationary till 0300 GMT of next day. Thereafter moving westnorthwestwards it lay on 9th, 1200 GMT, centred close to and southwest of Khajuraho. Pressure fall for the past 24-hr in the area was 2 to 3 hPa and the departures were — 4 to — 6 hPa. Thereafter it moved northwards along the western periphery of the upper tropospheric anticyclone which was extending over Madhya Pradesh and Uttar Pradesh and lay at 0300 GMT of 10th near Orai. Continuing to move northwards it lay at 1200 GMT of 10th about 75 km northnorthwest of Kanpur. Pressure departures were of the order of — 2 to — 4 hPa.

The surface winds around the system were generally 5 to 10 kt during the period from 8th to 10th.

The system weakened over north Uttar Pradesh by next day.

Under the influence of this system there was generally widespread rainfall in plains of Uttar Pradesh and Madhya Pradesh on 3 to 4 days with isolated heavy to very heavy falls. It caused flood situation in Uttar Pradesh. Significant amounts (cm) of rainfall in association with this system were : Sagar 26, Mahroni 21, Umaria 18, Mungeli 17, Jabalpur 13 on 9th; Mahroni 27, Shivpur & Khurai 17 each, Nurpur & Jhansi 12 each on 10th; Amroha 41, Katarniaghat 18, Bahraich 13 on 11th.

4.3. *Depression,* 21-23 *December*

A low pressure area was seen over southwest Bay off Sri Lanka coast at 1200 GMT of 19th. Moving westnorthwestwards it concentrated into a depression by 1200 GMT of 21st over Sri Lanka. Thereafter it moved northnorthwestwards and crossed south Tamil Nadu coast near Adirampattinam in the early hours of 23rd and weakened over interior parts of Tamil Nadu and adjoining Kerala by evening.

The pressure fall at 0300 GMT of 20th over Sri Lanka was of the order of 1 to 3 hPa while the departure was — 6 to — 7 hPa. In the evening several stations of Sri Lanka showed the rising pressure tendency. Colombo wind at 0.9 km a.s.l. was NE/05 kt only. The depression at this time lay about 120 km southeast of Colombo. Satellite pictures indicated only an active vortex over Sri Lanka and neighbourhood whose centre was not well defined. On 22nd morning the system lay over north Sri Lanka centred at 8.5 deg. N, 80.5 deg. E. At 0300 GMT surface winds over Sri Lanka were 5 to 10 kt, but Pamban reported NNW/30 kt and ship *CIDC* near 5.8 deg. N, 81.7 deg. E reported wind SW/20 kt at 0000 GMT. The pressure tendency for past 24-hr over north Sri Lanka was rising and falling over south Tamil Nadu coast in the morning. Satellite picture at 0000 GMT indicated a quasi-circular intense convective cloud mass of 5 degree diameter over north Sri Lanka, south Tamil Nadu and adjoining southwest Bay. In the evening the depression lay over Palk strait and adjoining Tamil Nadu and Sri Lanka centred at 9.5 deg. N, 79.5 deg. E. At this time Pamban reported surface wind NNW/30 kt and Nagapattinam NNE/20 kt. However, the winds over Sri Lanka were light. The pressure tendency for past 24-hr along south Tamil Nadu coast was falling by about 2 hPa while that over Sri Lanka was rising. The pressure departure along south Tamil Nadu coast was of the order of 4 to 8 hPa. On 23rd morning (0300 GMT) when it lay over Tamil Nadu centred about 60 km southeast of Tiruchirapalli, surface winds over south Tamil Nadu were of the order of 10-15 kt. Ship *VTCX* from about 9.9 deg. N, 81.3 deg. E reported wind SSE/25 kt. Pressure departure over south Tamil Nadu was of the order of — 4 to — 6 hPa. Weakening of the system was clear from the 1350 GMT satellite imagery of 22nd. The system weakened into a low pressure area over interior Tamil Nadu and adjoining Kerala by the evening of 23rd.

This system caused scattered heavy to very heavy rainfall in Tamil Nadu from 22nd to 24th. Significant amounts (cm) of rainfall were : Nagapattinam 32, Karaikal 29, Mannargudi & Vedaranniyam 25 each, Adirampattinam 22, Pamban 20, Kumbhakonam 15, Thanjavur 14 on 22nd; Adirampattinam 39, Tiruchirapalli 26, Ariyalur 24, Kumbhakonam & Thanjavur 21 each, Vedaranniyam & Pondicherry 16 each, Cuddalore 15, Nagapattinam & Tondi 14 each on 23rd; Madras AP 14, Tambaram 12, Tirupati AP 11, Shivaganga 11 on 24th.

According to press reports the death toll was 64. Scores of villages were marooned by flood waters and thousands of acres of paddy field were submerged.