MAUSAM, 51, 3 (July 2000), 215 - 224

551.515.1 (267.64)

Cyclones and depressions over north Indian Ocean during 1999*

1. Introduction

During the year 1999, 9 cyclonic disturbances (4 Cyclonic storms and 5 depressions) formed over Indian regions. Out of these, 8 formed over north Indian Ocean (7 over the Bay of Bengal and one over the Arabian Sea) and one depression over the land.

This year, one cyclonic storm over the Bay of Bengal (25-31 October) attained the intensity of super cyclonic storm. This super cyclone was one of the most severe storms formed over the Indian Ocean and it caused very heavy damage and devastation along the coastal districts of Orissa and adjoining districts of West Bengal. Two cyclonic storms; one over the Arabian Sea (16-22 May) and another over the Bay of Bengal (15-19 October) reached the intensity of very severe cyclonic storm. Both caused damage to the coastal belt after crossing the coast.

Tracks of these systems are given in Fig. 1. The brief history and monthly distribution is given in Tables 1 and 2 respectively. In Table 3, crucial observations of ships are presented. Season-wise description of these systems is given below.

2. Disturbances formed during winter season (January and February)

During the season, a cyclonic storm formed over the Bay of Bengal (1-3 February 1999) and the details are given below:

2.1. *Cyclonic storm over the Bay of Bengal (1-3 February 1999)*

2.1.1. *Life cycle*

The well-marked low pressure area which formed over southeast Bay and neighbourhood, concentrated into a depression on 1st and was centred at 0300 UTC near Lat. 9.0°N/Long. 89.0°E, about 730 kms southeast of Chennai. It intensified into a deep depression at 0600 UTC of 2 and into a cyclonic storm at 1800 UTC of 2. It was centred near Lat. 11.5°N/Long. 86.0°E at 0300 UTC of 3. It, then, weakened into a deep depression at 0900 UTC of 3 when it was near Lat. 12. 0°N/Long. 86.0°E. It further weakened into a depression at 1200 UTC of 3 near Lat. 12.0°N/Long. 86.5°E. It weakened into a low pressure area by 1800 UTC of 3 over southwest Bay of Bengal and dissipated there.

2.1.2. *Satellite cloud features and other observations*

The system was mainly tracked by satellite imageries. Maximum intensity of T 3.0 on Dvorak's scale was reported by INSAT cloud imageries from 0000 UTC to 0300 UTC of 3.

2.1.3. *Weather and damages*

As it did not cross the coast and dissipated over the sea, no damage and adverse weather occurred over India.

3. Disturbances formed during the pre-monsoon season (March-May)

During the season, one very severe cyclonic storm formed over the Arabian Sea. Details are presented below:

3.1. *Very severe cyclonic storm over the Arabian Sea (16-22 May 1999)*

This is the only disturbance, which formed during 1999 over the Arabian Sea.

3.1.1. *Life cycle*

A well-marked low pressure area formed over Lakshadweep area and adjoining north Kerala coast on 15. It concentrated into a depression and lay centred at 1200 UTC of 16 near Lat. 12.5°N/Long. 72.0°E, about 300 kms west-southwest of Mangalore. It rapidly intensified into a cyclonic storm (estimated central pressure of 996 hPa) and lay centred at 0300 UTC of 17 near Lat. 14.5°N/Long. 70.5°E, about 350 kms westsouthwest of Panjim. It moved in a northwesterly direction and intensified into a severe cyclonic storm and lay centred at 0900 UTC of 17 near Lat. 15.0°N/Long. 69.5°E, about 670 kms southsouthwest of Veraval. It further moved in a northnorthwesterly direction and intensified into a very severe cyclonic storm (estimated central pressure of 976 hPa) and was centred at 0300 UTC of 18 near Lat. 17.0°N/Long. 67.5°E, about 500 kms southwest of Veraval. It then moved in a northerly direction and lay at 1200 UTC of 18 near Lat. 18.5°N/Long. 67.5°E, about 360 kms southwest of

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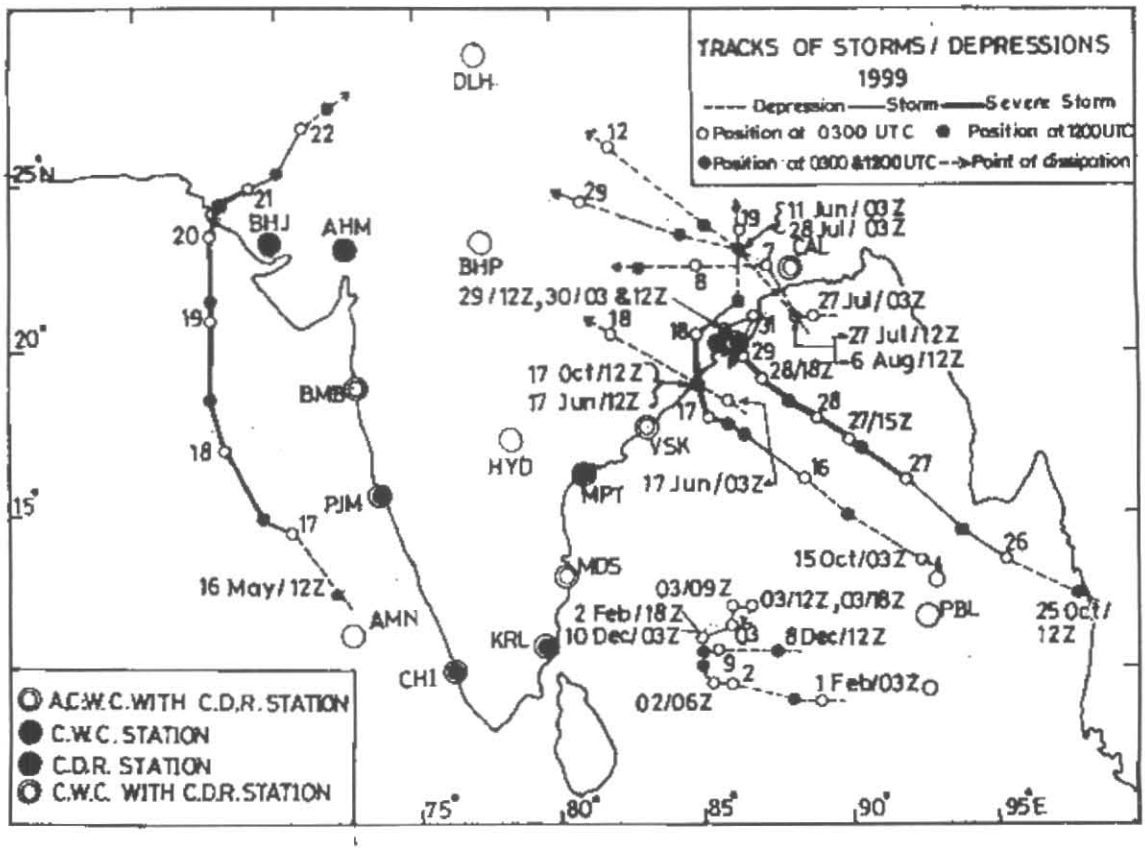

Fig. 1. Tracks of depressions / storms during 1999

TABLE 1

Brief history of cyclonic storms and depressions over the Indian seas and neighbourhood during 1999

S. No.	Type of System	Life period	Point of crossing the coast	Estimated central pressure (hPa)	Recorded max. wind	Highest "T" No. (estimated)
1.	CS	01-03 Feb	Dissipated over southwest Bay of Bengal	-	-	3.0
2.	VSCS	16-22 May	Pakistan coast, 80 kms west of Naliya	946	-	5.5
3.	D	11-12 Jun	-	-	-	-
4.	DD	17-18 Jun	Orissa coast near Gopalpur	-	-	2.0
5.	DD	27-29 Jul	West Bengal - Orissa coast	-	-	-
6.	D	06-08 Aug	West Bengal coast near Digha	-	-	-
7.	VSCS	15-19 Oct	Orissa coast close to Gopalpur	-	-	5.0
8.	Super CS	25-31 Oct	Orissa coast near Paradip	912	80 kts*	7.0
9.	D	08-10 Dec	Dissipated over southwest Bay & neighbourhood	-	-	-

D - Depression, DD - Deep depression, CS - Cyclonic storm, SCS - Severe cyclonic storm, VSCS - Very severe cyclonic storm, Super CS - Super cyclonic storm. * The wind instrument became unserviceable after recording 80 knots.

Veraval. It continued to move in a northerly direction and at 0300 UTC of 19; it lay near Lat. 21.0°N/Long. 67.5°E, about 190 kms southwest of Okha and at 1200 UTC of 19, near Lat. 21.5°N/Long. 67.5°E, about 150 kms southwest of Okha. It, then, remained practically stationary over the land very close to the coast and at 0300 UTC of 20; it lay near Lat. 23.5°N/Long. 68.5°E. It crossed Pakistan coast about 80 kms west of Naliya, between 1000 UTC and 1130 UTC of 20. It moved in a northnortheasterly direction and weakened into a cyclonic storm over southeast Pakistan and adjoining parts of Rajasthan and Kutch with its central region near Lat. 25.0°N/Long. 69.0°E at 0300 UTC of 21. It continued to move in a northnortheasterly direction and weakened into a deep depression and was centred at 0300 UTC of 22 near Lat. 27.0°N/Long. 71.0°E, about 50 kms southwest of Jaisalmer. It further weakened into a depression at 1200 UTC of 22 near Lat. 27.5°N/Long. 72.0°E and into a well-marked low pressure area over northwest Rajasthan and neighbourhood on 23.

3.1.2. *Satellite cloud features and other observations*

Maximum intensity reported by INSAT cloud imagery was T 5.5 (102 knots) on Dvorak's scale from 1000 UTC till the storm crossed the coast around 0600 UTC of 20th. The "eye" was clearly seen in the cloud imagery. The lowest estimated central pressure was 946 hPa from 1200 UTC of 19th till storm crossing the coast.

3.1.3. *Weather and damages*

From the available reports, the storm surge upto 2.5 mtrs above the normal astronomical tide was experienced over various ports along Saurashtra coast at the time of storm crossing the coast.

Widespread heavy rain occurred in Konkan and Gujrat coast from 18 to 20 May. Heavy to very heavy rain also occurred over Saurashtra & Kutch, Konkan & Goa and west Rajasthan on 21 and 22. Heavy rainfall (cms) recorded is as follows:

20 May '99 : *Saurashtra & Kutch* : Okha 9.

21 May '99 : *Saurashtra & Kutch* : Naliya 37, Bhuj, Khawda 11;
Konkan & Goa : Panjim 8.

22 May '99 : *Saurashtra & Kutch* : Khawda 12, Bhuj 10, Idar 8.

According to press reports, 453 persons (most of them were fishermen) lost their lives in Jamnagar, Mehsana and Kutch districts. Loss of cattle heads was reported as 50,448 and more than 4,500 houses were damaged in the above districts.

4. Disturbances formed during the monsoon season (June-September)

During this season, two deep depressions, one depression formed over the Bay of Bengal and one depression formed over land. Details are given below:

4.1. *Land depression over Gangetic West Bengal (11-12 June)*

4.1.1. *Life cycle*

Under the influence of an upper air cyclonic circulation, a well-marked low pressure area formed over West Bengal coast and adjoining north Bay on 10 evening. It moved in a northwesterly direction and concentrated into a depression and lay centred at 0300 UTC of 11 near Lat. 23.0°N/Long. 86.5°E, close to Purulia. It, then, moved in a westnorthwesterly direction and lay near Hazaribagh centred near Lat. 23.5°N/Long. 85.5°E at 1200 UTC of 11. It further moved in a northwesterly direction and lay centred at 0300 UTC of 12 near Lat. 26.0°N/Long. 82.0°E, about 50 kms northwest of Varanasi. It weakened into a well-marked low pressure area and lay over east Uttar Pradesh and neighbourhood on 12 evening.

4.1.2. *Satellite cloud features and other observations*

Maximum intensity of T 1.0 on Dvorak's scale was reported by INSAT cloud imageries from 0900 UTC of 10 to 0000 UTC of 11 when the system was a well-marked low pressure area over northwest Bay of Bengal. When the system crossed the west Bengal coast, satellite did not show any vortex or T-number.

4.1.3. *Weather and damages*

According to reports, 12 people died along West Bengal coast. 3,50,000 people were affected and more than 10,000 houses were damaged.

TABLE 2

Storms / depressions statistics 1999

Name of the system	Winter	Pre-monsoon			Monsoon				Post-monsoon			Total
	Jan– Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Over Bay of Bengal												
Depressions / Deep depressions	-	-	-	-	1	1	1	-	-	-	1	4
Cyclonic storms	1	-	-	-	-	-	-	-	-	-	-	1
Severe cyclonic storms	-	-	-	-	-	-	-	-	-	-	-	-
Very severe cyclonic storms	-	-	-	-	-	-	-	-	1	-	-	1
Super cyclonic storms	-	-	-	-	-	-	-	-	1	-	-	1
Total	1	-	-	-	1	1	1	-	2	-	1	7
Land depression												
Deep depressions	-	-	-	-	1	-	-	-	-	-	-	1
Over Arabian sea												
Depressions / Deep depressions	-	-	-	-	-	-	-	-	-	-	-	-
Cyclonic storms	-	-	-	-	-	-	-	-	-	-	-	-
Severe cyclonic storms	-	-	-	-	-	-	-	-	-	-	-	-
Very severe cyclonic *storms*	-	-	-	1	-	-	-	-	-	-	-	1
Super cyclonic storms	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total	1	-	-	1	2	1	1	-	2	-	1	9

TABLE 3

Crucial observations during the storm periods

Call Sign (1)	Date/Time (UTC) (2)	Latitude (°N) (3)	Longitude (°E) (4)	Direction (°) (5)	Speed (kts) (6)	PPPP (hPa) (7)
		Cyclonic storm over the Bay of Bengal (1 – 3 February)				
PGDF	010000	6.0	90.8	200	20	1007.5
ELUX	010000	5.8	82.3	340	13	1007.0
ELOX	010000	6.1	93.0	130	16	1010.0
C6LY4	011200	5.9	84.6	280	10	1006.9
ELOX	011200	6.1	95.5	110	08	1011.5
VVMD	030000	5.5	85.3	160	07	1010.6
PGUP	030000	2.9	82.3	Calm	-	1011.3
DATGKD	030600	11.0	83.7	020	18	1009.2
		Very severe cyclonic storm over the Arabian Sea (16 – 22 May)				
SHIP	161200	20.4	62.9	250	20	1003.0
C6NY5	170000	23.2	65.8	270	16	-
PGEA	171800	8.8	69.0	260	24	1007.0
PGEA	180600	8.3	71.0	230	26	1009.3
PGNE	190000	16.3	67.8	250	24	1004.8
PGNE	191200	19.1	64.5	270	24	1002.2
DIHE	191200	12.7	54.6	200	44	1004.0
DABL	191800	21.5	61.7	230	20	1001.5
DABL	210000	13.7	70.8	230	22	1007.0
VVFH	210600	14.7	72.4	260	24	1010.3
		Deep dpression over the Bay of Bengal (27– 29 July)				
VTJR	270000	18.0	84.3	250	22	997.0
VTJR	270300	17.8	89.3	240	22	998.6
VTJR	270900	17.6	89.1	270	26	997.9
VTJR	271200	17.6	89.1	270	26	998.1
		Very severe cyclonic storm over the Bay of Bengal (15 – 19 October)				
ATSS	150600	10.7	84.3	270	16	1007.4
VRUU4	150600	5.8	81.8	260	19	1010.2
VRUU4	160000	6.0	87.6	240	20	1008.3
VVKG	161200	19.6	86.9	070	30	1004.0
9VBS	170000	5.9	86.7	260	18	1007.5
VVMG	170400	19.8	86.6	060	07	1002.8
VVKG	170600	20.0	87.2	090	30	1003.0
ATUY	180400	20.2	88.0	190	25	1002.0
PCSS	181200	5.6	86.7	260	20	1005.0
C6OT	181200	5.7	80.8	270	17	1007.9
DGFA	181200	5.7	87.7	260	20	1006.5
PGCY	181200	5.8	87.1	250	20	1006.2
ATQQ	190600	15.0	83.2	270	10	1005.5
		Super cyclonic storm over the Bay of Bengal (25 – 31 October)				
VWNY	240000	3.6	100.7	240	21	1007.9
VWXG	240900	8.4	94.3	300	20	1006.6
VWXG	241200	8.8	93.9	280	20	1007.0
VWXG	250000	10.2	91.9	270	17	1007.0
DNHS	251800	5.9	94.1	240	20	1010.5
DGZG	260000	5.7	86.3	240	18	1009.0
DNES	260000	16.0	94.8	220	22	1007.6
C6FH	260000	5.9	89.2	300	13	1005.5
VWXG	260000	12.4	88.9	260	12	1004.6
VSBT	260600	6.1	93.6	230	16	1009.7
VSBT	261200	6.2	95.1	230	17	1007.4
C6OT	161200	15.4	82.8	360	09	1008.6

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
VWXG	261200	14.3	87.2	340	10	1004.1
DNES	261200	6.0	91.1	220	26	1007.6
VWXG	261800	15.1	86.2	330	10	1006.1
C6FH	270000	5.7	84.9	280	25	1004.5
VSBT	270000	5.4	97.7	Variable	05	1009.0
PGDP	270000	4.0	92.5	230	26	1008.7
VWXG	270000	15.9	85.3	330	12	1004.1
VWXG	270600	16.5	84.6	350	12	1004.6
VWXG	271200	17.2	83.9	340	09	1004.1
DQVL	281200	6.0	89.0	220	26	1008.5
DQVL	281800	5.9	86.8	220	26	1010.0
ELOX	281800	6.0	89.6	220	27	1013.0
PFE2	281800	17.1	87.0	240	36	1001.5
PFE2	290000	16.9	88.3	220	18	1003.5
VWPW	290000	5.7	88.1	210	23	1008.3
ELOX	290000	6.1	90.9	310	20	1012.3
DQVO	290600	5.8	86.3	260	20	1011.0

4.2. *Deep depression over the Bay of Bengal (17-18 June)*

4.2.1. *Life cycle*

A well-marked low pressure area formed over northwest Bay off Orissa-West Bengal coast on 16 morning. It concentrated into a depression at 0300 UTC of 17 and lay centred near Lat. 18.5°N/Long. 86.0°E. It then intensified into a deep depression at 0600 UTC of 17 and lay centred at 1200 UTC of 17 near Lat. 19.0°N/Long. 85.0°E, about 40 kms southeast of Gopalpur. It moved in a westnorthwesterly direction and crossed Orissa coast near Gopalpur at 2100 UTC of 17. It weakened into a depression and lay centred at 0300 UTC of 18 near Lat. 20.5°N/Long. 82.0°E, about 100 kms south of Raipur. It further moved in a westnorthwesterly direction and weakened into well-marked low pressure area over north Vidarbha and adjoining parts of Madhya Pradesh at 1200 UTC of 18.

4.2.2. *Satellite cloud features and other observations*

Maximum intensity of T 2.0 on Dvorak's scale was reported by INSAT cloud imageries from 0600 to 1130 UTC of 17.

4.2.3. *Weather and damages*

According to the press reports, 5 fishermen were missing. Heavy to very heavy rain occurred in coastal districts of Andhra Pradesh. Principle amounts of rainfall (cms) are given below:

17 June '99 : Kalingapatnam 9.

18 June '99 : Tekkali 20, Palasa 14, Sompeta 12, Itchapuram 9.

4.3. *Deep depression over the Bay of Bengal (27-29 July)*

4.3.1. *Life cycle*

A well-marked low pressure area formed over northwest Bay and adjoining West Bengal coast on 26 evening. It concentrated into a depression at 0300 UTC of 27 and lay centered near Lat. 21.0°N/Long. 89.0°E, about 200 kms southeast of Calcutta. It further intensified into a deep depression and lay centred at 1200 UTC of 27 near Lat. 22.0°N/Long. 88.5°E, close to Sand Heads. It crossed West Bengal-Orissa coast in the morning of 28 and lay as a deep depression at 0300 UTC of 28 near Lat. 23.0°N/Long. 86.5°E, about 50 kms southeast of Purulia. It moved in a northwesterly direction and weakened into a depression and lay at 1200 UTC of 28 near Lat. 23.5°N/Long. 84.5°E, about 50 kms northwest of Ranchi. It further moved in westnorthwesterly direction and lay centered at 0300 UTC of 29 near Lat. 24.5°N/Long. 81.0°E, very close to Satna. Subsequently, it weakened into a well-marked low pressure area in the evening of 29 over northwest Madhya Pradesh and neighbourhood.

4.3.2. *Satellite cloud features and other observations*

Satellite cloud imageries indicated some banding of clouds which indicated Low Level Circulation over northwest Bay off coastal Orissa.

4.3.3. *Weather and damages*

Heavy rainfall (cms) recorded are given below:

27 July '99 : *Orissa*: Paradip 22, Chandbali 10, Cuttack 6.

28 July '99 : *Gangetic West Bengal*: Digha 16.
Orissa: Baripada 9, Balasore 8.

29 July '99 : *Gangetic West Bengal*: Bankura 9.

4.4. *Depression over northwest Bay of Bengal (6-8 August)*

4.4.1. *Life cycle*

A well-marked low pressure area formed over northwest Bay off north Orissa-West Bengal coast on 6 morning. It concentrated into a depression and lay centered at 1200 UTC of 6 near Lat. 21.0°N/Long. 88.5°E, about 160 kms south of Calcutta. It moved in a westnorthwesterly direction and crossed West Bengal coast near Digha and lay as a depression at 0300 UTC of 7 near Lat. 22.5°N/Long. 87.5°E, close to Midnapore. The depression lay close to Jamshedpur at 1200 UTC of 7 near Lat.22.5°N/Long.86.0°E. It moved in a westnorthwesterly direction and lay centred at 0300 UTC of 8 near Lat. 22.5°N/Long. 85.0°E, about 80 kms southeast of Ambikapur and at 1200 UTC of the same day, it lay near Lat. 22.5°N/Long. 83.0°E, about 80 kms southeast of Pendra. It further moved in a westnorthwesterly direction and weakened into a well-marked low pressure area on 9 morning over northeast Madhya Pradesh and neighbourhood.

4.4.2. *Satellite cloud features and other observations*

Satellite cloud imageries indicated Low Level Circulation without any centre when the system was over northwest Bay. The system was declared as a depression on the basis of coastal observations only.

4.4.3. *Weather and damages*

Heavy rainfall (cms) reported are given below:

6 August '99 : *Gangetic West Bengal*: Digha 8.

7 August '99 : *Gangetic West Bengal*: Diamond Harbor & Midnapore 9 each, Contai & Digha 8 each.

8 August '99 : *Orissa:* Sambalpur 11, Jharasguda 10, Bolangir 7.
Sub-Himalayan West Bengal: Kalimpong 8.

5. Disturbance formed during the post-monsoon season (October-December)

During this season, one very severe cyclonic storm and one super cyclonic storm formed over the Bay of Bengal. Details are presented below:

5.1. *Very severe cyclonic storm over the Bay of Bengal (15-19 October 1999)*

5.1.1. *Life cycle*

Under the influence of an upper air cyclonic circulation, a depression formed over north Andaman Sea and adjoining parts of east-central Bay and was centered at 0300 UTC 0f 15 near Lat. 13.5°N/Long. 92.5°E, about 200 kms north of Port Blair. It rapidly intensified into a cyclonic storm and lay centred at 0300 UTC of 16 near Lat. 16.0°N/Long. 88.5°E, about 530 kms southeast of Puri. It further intensified into a severe cyclonic storm at 1500 UTC of 16 and lay centred near Lat. 17.6°N/Long. 86.0°E. It further moved in a northerly direction and intensified into a very severe cyclonic storm and lay centred at 0000 UTC of 17 near Lat. 17.7°N/Long. 86.0°E and at 0300 UTC of 17 near Lat. 18.0°N/Long. 85.5°E, at 1200 UTC of 17 near Lat. 19.0°N/Long. 85.0°E. It moved in a northnorthwesterly direction and crossed Orissa coast between 1900 and 2000 UTC of 17, close to Gopalpur. It weakened into a severe cyclonic storm at 0300 UTC of 18 and lay centered near Lat. 20.5°N/Long. 85.0°E, about 50 kms west of Bhubaneswar. Reaming practically stationary it weakened into a cyclonic storm at 0900 UTC. The cyclonic storm over Orissa then moved in a northerly direction and weakened into a deep depression at 1200 UTC of 18 and lay near Lat. 21.5°N/Long. 86.5°E. It further weakened into a depression and lay centered near Lat. 23.5°N/Long. 86.5°E at 0300 UTC of 19, very close to Purulia. The depression then weakened into a low-pressure area and lay over Bihar Plateau and adjoining

Gangetic West Bengal in the evening of 19 and on 20, it became less marked. However, associated cyclonic circulation lay over Sub-Himalayan West Bengal & Sikkim and adjoining Bihar Plains and extended upto lower levels on 20 and became less marked on 21.

5.1.2. *Satellite cloud features and radar observations*

The maximum intensity of the system reported by INSAT Cloud Imageries (ICI) on Dvorak's scale was T 4.5 from 0300 to 2200 UTC of 17. ICI also showed "eye" from 2200 UTC of 16 to 0300 UTC of 17 and the "eye" was well defined at 0000 UTC and 0300 UTC of 17. In general, vortex given by ICI was consistent particularly when the system was near Orissa coast.

The lowest estimated central pressure was 968.0 hPa before crossing the coast. Cyclone Detection Radar (CDR) Paradip reported the storm centre from 1600 UTC of 16 to 2300 UTC of 17. CDR Paradip also reported "eye" from 2200 UTC of 16 to 0000 UTC of 17. CDR Visakhapatnam reported "eye" from 1800 UTC of 16 to 2000 UTC of 17.

5.1.3. *Weather and damages*

Widespread rainfall with heavy to very heavy falls occurred over the coastal districts of Orissa on 17, 18 and 19 and over Gangetic West Bengal on 18 and 19 causing widespread water-logging in Calcutta. Tornado was reported at Kalna (Dist. Burdwan) on 18 damaging 400 kutcha houses. Storm surge of 2 to 2.5 metres was reported at Chilka Lake at the time of storm crossing the coast.

According to the reports from Relief Commissioner's Office of Govt. of West Bengal, 197 persons died, more than 8,300 cattles were lost and crops over thousand hectares of land were destroyed.

Exceptionally heavy rainfall reported (cms) are given below:

17 September '99 : *Coastal Andhra Pradesh*: Kaviti 11, Sompeta 8.

18 September '99 : *Coastal Andhra Pradesh*: Kaviti 32, Itchhapuram 30, Kanchili 18, Sompeta 16, Mandasa12.

West Bengal & Sikkim: Manmathnagar 20, Alipore 12, Cooch Behar 11.

5.2. *Super cyclonic storm over the Bay of Bengal (25-31 October 1999)*

5.2.1. *Life cycle*

A well-marked low pressure area lay over Gulf of Siam and neighbourhood on 24. Associated cyclonic circulation extended upto lower tropospheric levels. Moving westwards, it concentrated into a depression over north Andaman Sea and neighbourhood at 1200 UTC of 25 & lay near Lat. 12.5°N/Long. 98.0°E. It further moved in a westnorthwesterly direction and intensified into a cyclonic storm and lay centered at 0300 UTC of 26 near Lat. 13.5°N/Long. 95.5°E, about 350 kms northeast of Port Blair, and at 1200 UTC of 26 near Lat. 14.5°N/Long. 94.0°E. It further intensified into a severe cyclonic storm at 0300 UTC of 27 and lay centred near Lat. 16.0°N/Long. 92.0°E, about 750 kms southeast of Paradip. Moving in a northwesterly direction, it further intensified into a very severe cyclonic storm at 1500 UTC of 27 near Lat. 17.0°N/Long. 90.5°E. At 0300 UTC of 28, it was centred near Lat. 18.0°N/Long. 89.0°E and at 1200 UTC of 28 near Lat. 18.5°N/Long. 88.0°E. It became a super cyclonic storm at 1800 UTC of 28 near Lat. 19.3°N/Long. 87.0°E. At 0300 UTC of 29, it was near Lat. 19.9°N/Long. 86.7°E. It crossed Orissa coast near Paradip on 29 between 0400 and 0630 UTC. After crossing the coast, it weakened into a very severe cyclonic storm and lay centred at 1200 UTC of 29 near Lat. 20.5°N/Long. 86.0°E, about 30 kms northeast of Bhubaneswar. It remained practically stationary and further weakened into a cyclonic storm and lay centered at 0300 UTC of 30 near Lat. 20.5°N/Long. 86.0°E, very close to Bhubaneswar. It, then, weakened into a depression at 0300 UTC of 31 near Lat. 21.0°N/Long. 87.0°E, when it was very close to Chandbali. Moving in a southeasterly direction, it again entered into the sea and weakened into a well-marked low pressure area over northwest Bay and adjoining parts of north Orissa- West Bengal coast in the evening of 31. The low pressure area became less marked on 5 November near coastal Andhra Pradesh and neighbourhood.

5.2.2. *Satellite cloud features, radar and other observations*

The intensity of the system was reassessed to T 7.0 from 1800 UTC of 28 to 0300 UTC of 29. It is the most intense storm of its kind with T 7.0 as assessed on Dvorak's scale with INSAT Cloud Imagery (ICI). The earlier storm of T 7.0 was Andhra cyclone of 14-20

November 1977 where the intensity was assessed on Dvorak's scale with the help of the cloud pictures of NOAA satellite. The lowest estimated central pressure was 912 hPa at 1800 UTC of 28 till the storm crossed the coast.

The maximum northeasterly wind of 80 kts was recorded at Paradip at 0300 UTC of 29. Later, the wind instrument went out of order. Puri estimated a maximum southwesterly wind of 95 kts at 0700 UTC of 29. According to Touring Officers Report, storm surge of 9 m above astronomical tide was reported at Paradip from 0630-1600 hrs (IST) on 29 October 1999. Storm surge penetrated into the land and there was a tidal inundation upto 35 kms from the coast.

Base on ICI, the maximum sustained wind speed was estimated to be of the order of 140 kts (252 kmph) at 281800 UTC corresponding to T 7.0. The post-cyclone survey information from available sources revealed that a storm surge of 9 m above astronomical tide occurred at Paradip at the time of landfall on 29. However, the sea water inundation at CDR Paradip revealed that the storm surge near Paradip could be of the order of 7 m. This observation is close to the prediction made by IMD. Storm surge penetrated into the land and there was a tidal inundation upto 35 kms from coastline.

CDR Paradip reported radar centres and "eye" from 0800 UTC of 28 to 0200 UTC of 29. CDR Paradip also reported RMR (Radius of Maximum Reflectivity) as 10 km at 0100 UTC and 0200 UTC of 29. Radar centres reported by CDR Paradip and vortices reported by ICI agreed very well helping to fix the centres accurately.

5.2.3. *Weather and damages*

As the system was of unprecedented intensity, it caused very heavy damage and devastation along the coastal districts of Orissa and adjoining districts of West Bengal. Widespread rainfall heavy to very heavy falls and also with exceptionally heavy falls occurred over coastal Orissa and West Bengal on 29, 30 and 31 October. Exceptionally heavy to very heavy rainfall reported (cms) is as follows:

30 October '99 : Bhubaneswar 43, Anandpur 40, Akhuapada 36, Jenapur 26, Balasore 22, Najra 21, Balimundali & Jaipur 20 each, Puri 18.

31 October '99 : Anandpur 30, Akhuapada 17, Jenapur 13, Puri 12, Bhubaneswar 10.

Information received from the Govt. of Orissa are as follows :

The system caused severe damage in 12 districts of Orissa State namely Jagatsinghpur, Cuttack, Kendrapada, Jaipur, Bhadrak, Khurda, Dhenkanal, Balasore, Keonjhar, Mayurbhanj, Nayangarh, where complete break down of essential services were reported. Erasma and kuyang blocks of district Jagatsinghpur were the worst affected.

Population affected	:	129.22 Lakh
Villages affected	:	14643
Blocks affected	:	97
Crop area affected	:	18.42 Lakh hac.
Houses	:	16.49 Lakh
Loss of life	:	9887 (Jagatsinghpur – 8119, Cuttack – 471, Kendrapada – 469, Puri – 301, Jaipur – 188, Bhadrak – 98, Khurda – 91, Dhenkanai – 55, Balasore – 51, Keonjhar – 31, Mayurbhanj – 10, Nayangarh – 3).
Person missing	:	40
Person injured	:	2507
Lives stock perished	:	4.44 Lakh
Fishing boats lost	:	9085
Fishing nets lost	:	22143

According to press reports, damage caused in the districts of West Bengal are as follows :

Area affected	*Casualties / damage*
Chandipur	10,000 people affected
District south 24 Paraganas	100 houses damaged, two children died.
Tamluk & Kontai	250 fishermen missing, who later on returned.
District Midnapore (Sunderban)	Many houses damaged, 50 persons injured.

5.3. *Depression over the Bay of Bengal' (8-10 December 1999)*

5.3.1. *Life cycle*

A well-marked low-pressure area formed over southeast and adjoining east-central Bay on 8. It concentrated into a depression on 8 evening and lay

centred at 1200 UTC of 8 near Lat. 10.5°N/Long. 87.5°E, about 800 kms east of Nagapattinam. It moved in a westerly direction and lay centred at 0300 UTC of 9 near Lat. 10.5°N/Long. 85.5°E, about 600 kms east of Nagapattinam. It remained practically stationary and then moved in a northwesterly direction and lay centred at 0300 UTC of 10 near Lat.11.0°N/Long.84.5°E. It weakened into a well-marked low pressure area over southwest Bay and neighbourhood on 10 evening.

5.3.2. *Satellite cloud features and other observations*

Maximum intensity of T 1.5 was reported by INSAT cloud imageries from 1200 UTC of 8 to 0300 UTC of 10.

5.3.3. *Weather and damages*

As it did not cross the coast, no damage and adverse weather were reported.