

## Cyclones and depressions over the Indian seas and neighbourhood during 1993\*

### 1. Chief features

During 1993 there were two cyclonic storms and three depressions over the Indian seas. Of the two cyclonic storms, one each formed in the Bay of Bengal and the Arabian Sea. The remaining three systems were depressions. Two depressions formed over the Bay of Bengal and the third formed over the Commorin area of the Arabian Sea, west of Sri Lanka. Of these, four systems formed in the post-monsoon season (October-December) and one during southwest monsoon season (June-September). No system formed during the pre-monsoon season (March-May). The only system during the monsoon season was a depression during 17-19 June 1993. July, August and September were free of depression/storm. This appears to be rather unusual as per the past hundred years' climatic records. Tracks of the systems are given in Fig. 2 and a brief history is given in Table 1. Monthly frequencies are given in Table 2.

### 2. Pre-monsoon season (March-May)

No cyclonic storm or depression formed during this season. The number of such occasions have been rather few between 1877 and 1970. However, between 1971 and 1993 there were seven such years including the present one.

### 3. Monsoon season (June-September)

#### 3.1. Systems in the Bay of Bengal

##### 3.1.1. Deep depression over the Bay of the Bengal (17-19 June)

A low pressure area formed over the northwest Bay and neighbourhood on 13 morning. It became well marked over the same area on 14. Moving in a northnortheasterly direction, it concentrated into a depression on 17 morning centred near 21.5°N and 87.5°E. Moving later in a northeasterly direction it crossed the Bangladesh coast around noon of 17 and further intensified into a deep depression which lay

centred near 23.5°N and 89.5°E on the morning of 18. Continuing its northeasterly movement, it weakened into a depression and was centred near 25.5°N and 91.5°E in the morning of 19. It further weakened into a low pressure area over north Assam by 19 evening.

(i) *INSAT cloud features* — INSAT reported the vortex from 160300 UTC to 181200 UTC without any T-number.

(ii) *Rainfall* — Widespread rains with heavy falls at a few places occurred over Orissa and Gangetic West Bengal on 17 and 18 and over Nagaland, Manipur, Mizoram & Tripura, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim between 17 and 21. Under the influence of the system southwest monsoon advanced into Bihar.

(iii) *Damages* — Media reported that 6 people lost their lives and more than 50,000 people in 100 villages were reeling under the flood waters in many districts of Assam. Floods in Bangladesh were reported to have taken a toll of 12 lives.

### 4. Post-monsoon season (October-December)

#### 4.1. Systems in the Arabian Sea

##### 4.1.1. Severe cyclonic storm with a core of hurricane winds over the Arabian Sea (12-15 November 1993)

A well marked low pressure area lay over southeast Arabian Sea and neighbourhood on 12 morning. Moving northwestwards, it concentrated into depression on 12 evening with centre near 14.0°N and 67.5°E. Continuing its northwesterly movement it further intensified into a cyclonic storm on 13 morning with centre near 16.0°N and 65.0°E. Then, it recurved, moved in a northerly direction and further intensified into a severe cyclonic storm on 14 morning. It continued to intensify and became a severe cyclonic storm with a core of hurricane winds on 14 evening when it was centred near 20.5°N and 64.5°E.

\*Compiled by: U. S. De, D. S. Desai and M. R. Tikhe, Meteorological Office, Pune.

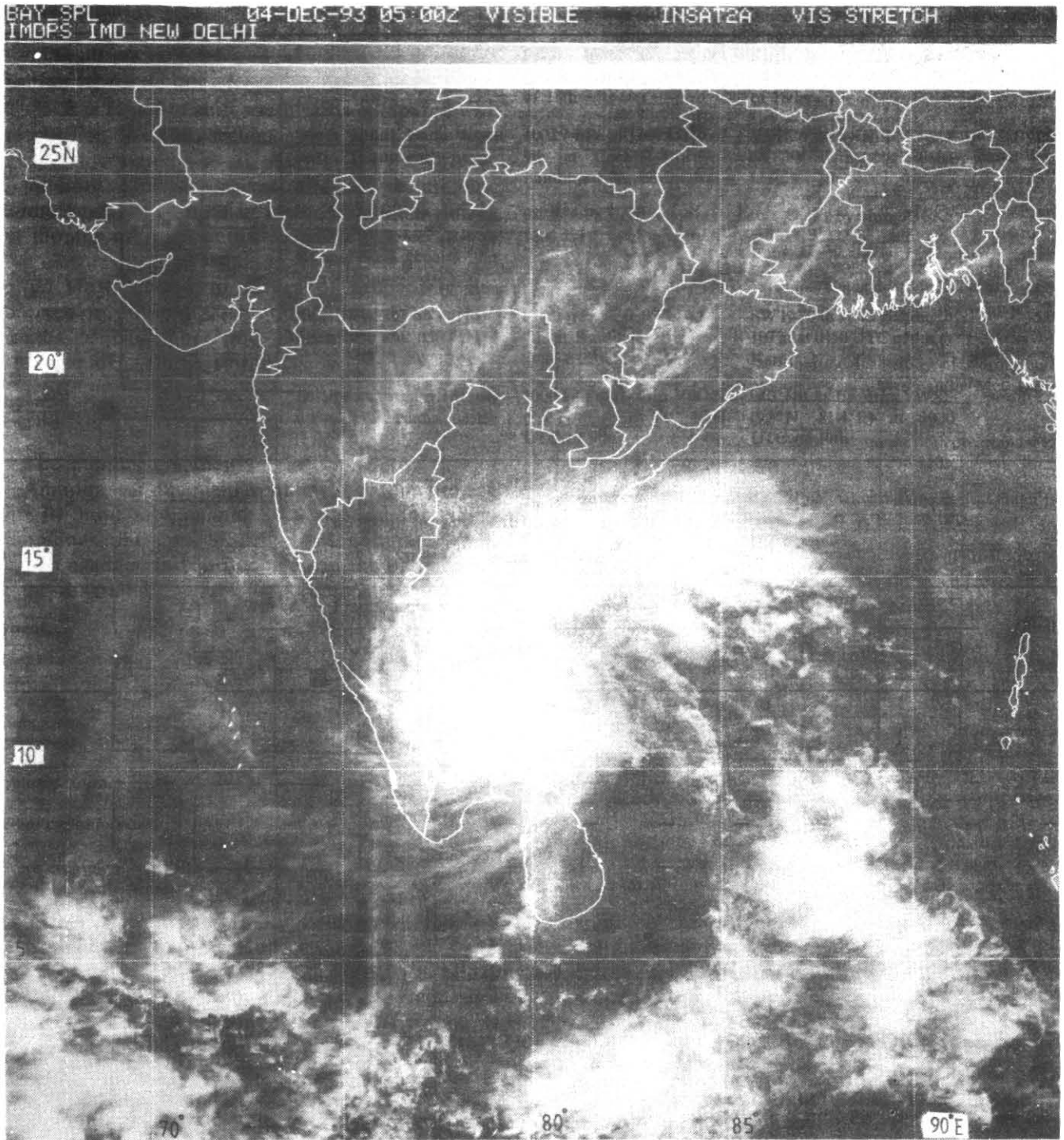


Fig. 1. INSAT-2A cloud picture of 4 December 1993 at 0500 UTC

Then, it moved rapidly in a northeasterly direction and weakened into a cyclonic storm on 15 morning centred near  $23.5^{\circ}\text{N}$  and  $67.5^{\circ}\text{E}$ . The system remained practically stationary and weakened into a deep depression on 15 evening. It further weakened into a well marked low pressure area over northeast Arabian Sea off north Gujarat-Sind coasts by 16 morning.

(i) *Pressure and winds* — Estimated central pressure of the storm was 987 hPa at 1200 UTC on 14 November. A ship *P3BK5* ( $22.2^{\circ}\text{N}$  and  $64.5^{\circ}\text{E}$ ) reported wind  $050^{\circ}/50$  kt and pressure 1007.0 hPa at 0000 UTC of 14. The same ship ( $21.6^{\circ}\text{N}$  and  $65.8^{\circ}\text{E}$ ) reported wind  $120^{\circ}/48$  kt and pressure 1001.5 hPa at 1200 UTC of 14.

(ii) *INSAT cloud features* — INSAT reported the peak intensity of T-4.0 on Dvorak's scale from 0600 UTC to 2000 UTC on 14. It also reported clearly visible eye of the system from 1400 UTC to 1800 UTC on 14.

(iii) *Radar* — Cyclone Detection Radar (CDR). Bhuj reported organised clouding and spiral bands from 0000 UTC to 1800 UTC on 15.

(iv) *Movement of the storm* — The storm recurved towards northeast through north between 0300 UTC of 13 and 0300 UTC of 14 when it came under the influence of strong upper tropospheric westerly flow. From 0300 UTC of 13 to 0300 UTC of 14 the storm moved approximately at the speed of 20 kmph in a northerly direction, from 1200 UTC of 14 to 0300 UTC of 15 the storm moved at the speed of 30 kmph in a northeasterly direction.

(v) *Rainfall and damages* — According to press reports, heavy rains occurred over the northern parts of Saurashtra & Kutch on 15. About 50 fishermen were reported missing along the north Gujarat coast.

## 5. System over Indian Ocean

### 5.1. Depression over north Indian Ocean (8-9 November)

A well marked low pressure area formed over Maldives area and neighbourhood on 7 evening. Moving in a northerly direction it concentrated into a depression over Maldives-Commorin area on 8

morning and was centred near  $6.5^{\circ}\text{N}$  and  $78.5^{\circ}\text{E}$ . Continuing its northerly movement it crossed south Tamil Nadu coast near Tuticorin in the morning of 9 and lay as a depression near  $9.0^{\circ}\text{N}$  and  $78.5^{\circ}\text{E}$ . Maintaining same intensity it slowly moved westwards and lay centred near lat.  $9.0^{\circ}\text{N}$  and long.  $77.5^{\circ}\text{E}$  by the same evening. It then weakened into a low pressure area and emerged into the southeast Arabian Sea by the morning of 10.

(i) *INSAT cloud features* — INSAT reported maximum intensity of the system as T-1.5 on Dvorak's scale on 7 and 8.

(ii) *Rainfall and damages* — Widespread rains with heavy fall at one or two places occurred over Tamil Nadu from 7 to 11 over Kerala and coastal Karnataka from 9 to 11 and over Lakshadweep area from 8 to 11. Media reported that 30 people lost their lives in Tamil Nadu due to torrential rains.

## 6. Systems in the Bay of Bengal

### 6.1. Severe cyclonic storm with a core of hurricane winds over the Bay of Bengal (1-4 December)

A low pressure area formed over south Andaman Sea and neighbourhood on 1 December, under the influence of an upper air cyclonic circulation which moved across Tennasserim coast. The low pressure area moved westwards and concentrated into a depression on the evening of 1 December with centre near  $8.0^{\circ}\text{N}$  and  $89.0^{\circ}\text{E}$ . Moving in a westnorthwesterly direction it intensified into a cyclonic storm on 2 evening. It further intensified into a severe cyclonic storm on 3 morning and became a severe cyclonic storm with a core of hurricane winds on 3 evening with its centre near lat.  $10.0^{\circ}\text{N}$  and long.  $82.0^{\circ}\text{E}$ . The system lay centred at 0300 UTC of 4 December near  $11.0^{\circ}\text{N}$  and  $80.0^{\circ}\text{E}$  very close to the north Tamil Nadu coast. The system then crossed the north Tamil Nadu coast between 0400 and 0500 UTC of 4 and weakened rapidly into a deep depression by 4 evening with centre near  $11.5^{\circ}\text{N}$  and  $78.5^{\circ}\text{E}$ . Then, it weakened further into a low pressure area over coastal Kerala and neighbourhood by 5 morning. Relevant ships' observations are given in Table 3.

(i) *Pressure and winds* — Estimated central pressure was 968 hPa at 0400 UTC of 4 when the cyclone was at its peak intensity (T-5.0). A ship *VWVK* ( $10.1^{\circ}\text{N}$ ,  $81.0^{\circ}\text{E}$ ) at 1200 UTC of 4 reported winds  $350^{\circ}\text{N}/50$  kt and pressure 1000 hPa. The High Wind Speed Recorder (HWSR) at Karaikal reported

## CYCLONES AND DEPRESSIONS OVER INDIAN SEAS

TABLE 1

Brief history of depressions and storms over Indian seas and neighbourhood during 1993

S. No.	Type of system	Life period	Point of crossing the coast	Recorded lowest pressure (hPa)	Recorded maximum wind	Highest T No. recorded
1.	DD	17-19 June	Indo-Bangladesh coast	987.6 hPa at Dhaka (Bangladesh) at 1200 UTC of 18th	SW'ly/45 kt at Khepupara (Bangladesh) at 0300 UTC of 18th	—
2.	D	8-9 Nov	South Tamil Nadu coast near TTC on early morning of 9th	1002.7 hPa at 1200 UTC of 9th at Cochi, Thiruvananthapuram & Madurai	320°/26 kt by ship ATQO (7.9°N/78.0°E) at 0600 UTC of 8th	1.5
3.	SCS (II)	12-15 Nov	Weakened before crossing Indo-Pak Border (North Gujarat-Sind coast) on 16th morning	987.0 hPa (estimated) at 1200 UTC of 14th	050°/50 kt by ship P3BK5 at 0000 UTC of 14th	4.0
4.	SCS (H)	1-4 Dec	Near Karaikal on 4th between 0400 and 0500 UTC	974.0 hPa at 0300 UTC of 4th at Karaikal	SW'ly 70 to 90 kt gusting to 107 kt at 0450 UTC of 4th at Karaikal	5.0
5.	DD	18-21 Dec	Dissipated over ocean off north Tamil Nadu coast	1000.1 hPa by ship VWXS (9.3°N/81.4°E) at 1000 UTC of 9th	040°/40 kt by ship VWXS (9.3°N, 81.4°E) at 1000 UTC of 19th	1.5

TABLE 2

Storms/depressions statistics 1993

System	Winter	Pre-monsoon		Monsoon				Post-monsoon			Total
	Jan to Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
<b>Over Bay of Bengal</b>											
Depression	—	—	—	1	—	—	—	—	1	1	3
Cyclonic storm	—	—	—	—	—	—	—	—	—	—	—
Severe cyclonic storm	—	—	—	—	—	—	—	—	—	—	—
Severe cyclonic storm with a core of hurricane winds	—	—	—	—	—	—	—	—	—	1	1
Total	—	—	—	1	—	—	—	—	1	2	4
<b>Over land</b>											
Depression	—	—	—	—	—	—	—	—	—	—	—
<b>Over Arabian Sea</b>											
Depression	—	—	—	—	—	—	—	—	—	—	—
Cyclonic storm	—	—	—	—	—	—	—	—	—	—	—
Severe cyclonic storm	—	—	—	—	—	—	—	—	—	—	—
Severe cyclonic storm with a core of hurricane winds	—	—	—	—	—	—	—	—	1	—	1
Grand total (Bay of Bengal & North Indian Ocean)	—	—	—	1	—	—	—	—	2	2	5

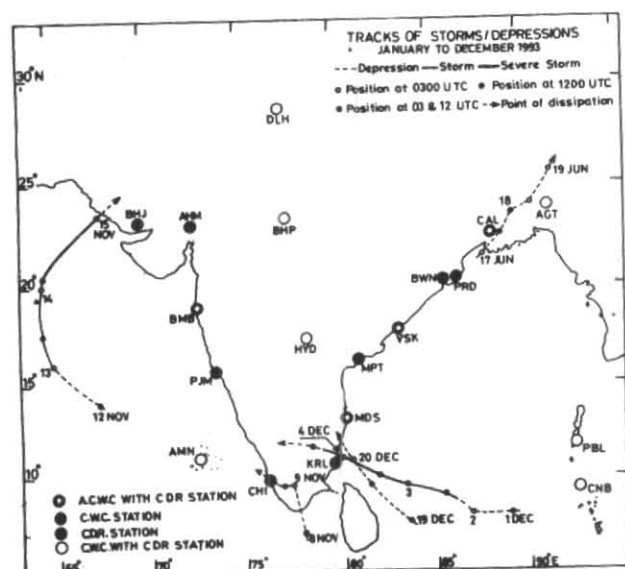


Fig. 2. Tracks of storms/depressions for the year 1993

northerly winds 60 to 75 kt gusting to 95 kt around 0800 IST and southwesterly winds 70 to 90 kt gusting to 107 kt at 1020 IST on 4. Karaikal also reported lowest sea level pressure as 974 hPa at 0300 UTC on 4 when the peripheral pressure was 1000 hPa and the pressure drop was 26 hPa. Applying modified Fletcher's formula the maximum sustained surface wind speed works out to be 72 kt. The value agrees well with the actual observations.

(ii) *INSAT cloud features* — INSAT reported the peak intensity of the system as T-5.0 on Dvorak's scale at 0500 UTC on 4. INSAT also reported "eye" of the system in 2 or 3 observations. A satellite cloud picture of the storm at 0500 UTC on 4 when "eye" was clearly seen is shown in Fig. 1.

(iii) *Radar* — Cyclone Detection Radar (CDR) at Madras and Karaikal reported "open eye" of the storm from 1800 UTC of 3 to 0400 UTC of 4 and 1000 UTC of 3 to 0600 UTC of 4 respectively. Radar, INSAT and synoptic centres agreed well, thus helping to fix the centre accurately.

(iv) *Movement of the storm* — The storm moved in a westnorthwesterly direction all through as it was steered by strong easterly winds in the middle and upper troposphere.

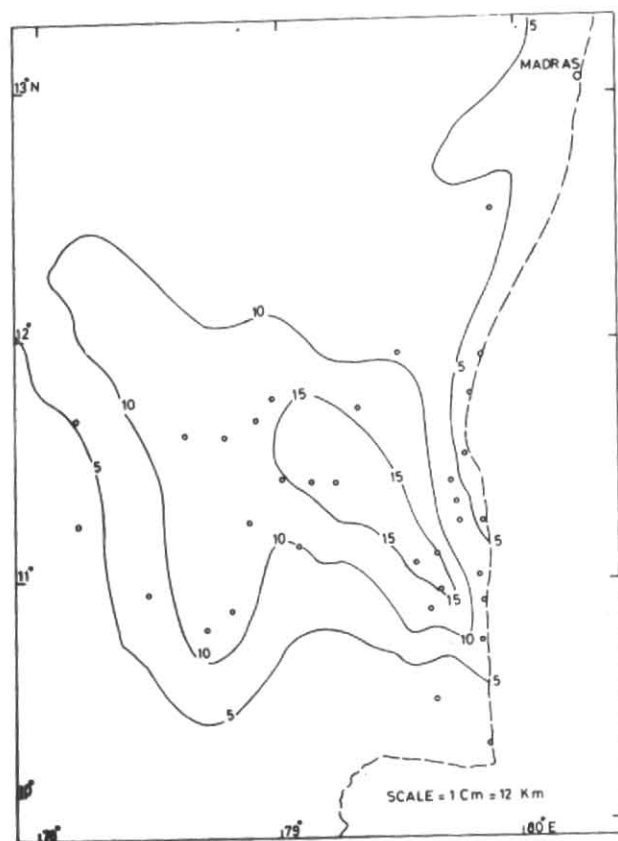


Fig. 3. Isohyetal map of Karaikal cyclone at 0300 UTC of 5 December 1993

(v) *Rainfall and damages* — The system caused widespread rains with scattered heavy falls and isolated very heavy falls over Tamil Nadu on 4 and 5. Widespread rains with isolated heavy falls also occurred over Kerala, Rayalaseema and interior Karnataka on 5, 6 and 7. According to press reports, nearly 111 people were killed due to heavy rains and floods in south Tamil Nadu. The cyclone also disrupted road and rail traffic and damaged the telecommunication system. Damage to the standing crops was also reported. Isohyetal map at 0300 UTC of 5 December 1993 is shown in Fig. 3.

#### 7. Deep depression over the Bay of Bengal (19-20 December)

A well marked low pressure area formed over the southwest Bay and neighbourhood on 18 evening. It concentrated into a depression on 19 morning and was centred near 8.5°N and 83.5°E. Moving in a northwesterly direction it intensified into a deep depression on

TABLE 3

Ship observations (1-4 December 1993)

S. No.	Call sign	Date and time (UTC)	Position		Wind		Cloud	Pressure (hPa)
			Lat. ( $^{\circ}$ N)	Long. ( $^{\circ}$ E)	Direction (deg)	Speed (kt)		
1	P3BK5	010000	5.9	88.3	270	13	Overcast	1006.4
2	VWWK	011200	5.8	80.0	170	12	5/8	1007.3
3	VWWK	020000	6.0	81.8	340	10	—	1007.8
4	P3BK5	020000	5.9	83.9	270	18	4/8	1006.0
5	QUEW	020000	5.9	87.1	050	04	—	1006.0
6	VPHW	030000	5.9	80.1	330	15	2/8	1002.7
7	HZXS	030000	6.0	88.7	240	16	Overcast	1005.4
8	HZXT	030000	6.1	94.4	230	12	Overcast	1009.7
9	GBBM	030600	5.9	89.3	110	17	7/8	1008.2
10	9KKS	030600	10.6	90.6	090	18	4/8	1008.3
11	VWWK	031200	10.1	81.0	350	50	—	1000.0
12	IIZXS	031200	5.9	85.4	250	16	4/8	1004.4
13	ATUF	040000	6.0	79.1	230	06	1/8	1000.7
14	YPIHW	040000	9.0	75.6	310	06	Overcast	1003.8
15	ATUF	040600	5.0	78.1	220	13	3/8	1007.5
16	SHIP	040600	17.5	85.7	050	18	Overcast	1011.1
17	VPHW	040600	10.2	85.0	320	06	Overcast	1005.3
18	VWWK	040600	10.0	81.7	230	28	7/8	1006.2
19	VPIHW	040600	10.2	81.5	320	06	Overcast	1005.3
20	VVMG	040600	10.0	83.8	210	25	5/8	1007.5
21	VVJV	041200	16.3	85.3	060	20	Overcast	1010.0
22	J8EQ	041200	6.0	79.5	240	12	4/8	1006.0

19 evening and was centred near  $9.5^{\circ}$ N and  $82.0^{\circ}$ E. It weakened into a depression and lay centred at 0300 UTC of 20 near  $11.0^{\circ}$ N and  $80.5^{\circ}$ E. The system then weakened further into a low pressure area off north Tamil Nadu coast and neighbourhood by the evening of 20.

(i) *Pressure and winds* — Trincomalee (in Sri Lanka) at 1200 UTC of 19 reported winds north-westerly/30 kt and pressure 1006.8 hPa. A ship *VVXX* ( $9.3^{\circ}$ N and  $81.4^{\circ}$ E) at 1200 UTC on 19 reported winds  $040^{\circ}$ /40 kt and pressure 1000.1 hPa.

Another ship *VWTS* ( $9.1^{\circ}$ N and  $81.5^{\circ}$ E) at 0300 UTC on 20 reported winds  $270^{\circ}$ /33 kt and pressure 1009.9 hPa.

(ii) *INSAT cloud features* — INSAT reported peak intensity of the system as T-1.5 on Dvorak's scale on 19 and 20.

(iii) *Rainfall and damages* — Tamil Nadu reported spells of heavy rainfall on 18 and 20. There were spells of very heavy rainfall on 22. There were no reports of damage caused by the system.