Mausam, (1994), **45**, 4, 377-388

Weather

POST-MONSOON SEASON (OCTOBER-DECEMBER 1993)*

1. Introduction

During the post-monsoon season of 1993, two cyclonic storms [one over the Arabian Sea (12-15 November) and other one over the Bay of Bengal (1-4 December)] and two depressions (one over the north Indian Ocean and other one over the Bay of Bengal) formed.

The southwest (SW) monsoon withdrew from west Rajasthan, Punjab and Jammu & Kashmir on 21 September and from the entire country by 20 October 1993. The northeast (NE) monsoon rainfall commenced over Tamil Nadu, Kerala and adjoining parts of Karnataka and Andhra Pradesh simultaneously on 20 October 1993. Monthly and seasonal rainfall amounts and their percentage departures are given in Table 1.

2. Chief features

(*i*) Two cyclonic storms, one over the Arabian Sea and the other over the Bay of Bengal, formed.

(*ii*) In association with a low pressure area which formed over Lakshadweep and north Kerala coast and its northward movement, October rainfall was more than twice the normal in Gujarat, Madhya Maharashtra, Marathwada, coastal and north interior Karnataka.

(*iii*) Northeast monsoon rains commenced over Tamil Nadu, Kerala and adjoining parts of Karnataka and Andhra Pradesh on 20 October 1993.

(*iv*) Cold wave conditions prevailed in October for 10 days in Jammu & Kashmir and in December for 17 days in Jammu & Kashmir and 5 to 7 days in Punjab and Haryana.

(*v*) Two depressions and a cyclonic storm caused torrential rains, strong winds over parts of Peninsular India. They took a toll of human lives and caused extensive damage to property there.

3. Seasonal rainfall

Seasonal rainfall was excess in 15, normal in 5, deficient in 7 and scanty in 8 meteorological subdivisions.

Rainfall was excess in Sub-Himalayan West Bengal & Sikkim, Gujarat and Maharashtra States, Telangana and Rayalaseema, Tamil Nadu, Karnataka, Kerala and Lakshadweep and was normal in Andaman & Nicobar Islands, Arunachal Pradesh, Gangetic West Bengal, Bihar plateau and coastal Andhra Pradesh. Rainfall was deficient in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Orissa, Bihar plains, east Rajasthan and Madhya Pradesh and scanty in Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir and west Rajasthan. Seasonal rainfall departures meteorological sub-divisionwise are given in Fig. 2.

4. Monthly features

4.1. *October*

4.1.1. *Withdrawal of SW monsoon* — The southwest monsoon withdrew from west Rajasthan, Punjab and Jammu & Kashmir on 21 September. It further withdrew from Himachal Pradesh, east Rajasthan and Haryana by 28 September 1993. By 6 October 1993, it withdrew from Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, Orissa and parts of Maharasthra. It later withdrew gradually from the entire country by 20 October 1993 and simultaneously northeast monsoon rains commenced over south Peninsular India.

4.1.2. *Onset of northeast monsoon* — Northeast monsoon rains commenced over Tamil Nadu, Kerala and adjoining parts of Karnataka and Andhra Pradesh on 20 October 1993.

* Compiled by : U. S. De, D. S. Desai and S. G. Bhandari, Meteorological Office, Pune.

TABLE 1

Rainfall figures (mm) for each month and season as a whole (October-December 1993)

S. No.	Sub-division	October			November			December			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1	A & N Islands	350	320	10	223	253	−12	104	171	−39	677	743	−9
2	Arunachal Pradesh	140	116	21	4	21	−82	2	11	−80	146	148	−2
3	Assam & Meghalaya	132	160	−18	7	27	−75	2	10	−83	140	197	−29
4	Naga., Mani., Mizo. & Tripura	90	160	−43	11	34	−67	0	9	−100	102	202	−50
5	SHWB & Sikkim	224	146	54	26	17	56	2	5	−65	252	167	51
6	Gangetic West Bengal	93	120	−23	27	19	40	0	3	−100	119	142	−16
7	Orissa	85	118	−28	9	29	−70	0	6	−100	94	153	−39
8	Bihar Plateau	68	83	−18	17	12	43	0	5	−100	85	99	−14
9	Bihar Plains	37	62	−40	17	9	94	0	3	−100	54	74	−27
10	East U.P.	5	49	−90	0	5	−93	0	6	−100	5	59	−91
11	Plains of west U.P.	0	34	−99	0	4	−89	0	9	−100	1	47	−99
12	Hills of west U.P.	1	59	−98	0	8	−98	0	25	−100	1	93	−99
13	Haryana, Chandigarh & Delhi	0	17	−99	1	4	−79	0	8	−100	1	29	−97
14	Punjab	0	21	−100	4	4	−12	0	15	−100	4	40	−91
15	Himachal Pradesh	0	42	−100	16	13	16	0	38	−100	16	94	−83
16	Jammu & Kashmir	0	28	−99	20	17	23	0	49	−99	21	94	−78
17	West Rajasthan	2	5	−55	0	2	−86	0	3	−100	3	9	−72
18	East Rajasthan	9	14	−36	0	3	−93	0	4	−100	9	22	−57
19	West Madhya Pradesh	22	31	−31	2	14	−83	5	7	−24	29	52	−44
20	East Madhya Pradesh	43	54	−21	0	12	−97	0	7	−100	43	73	−41
21	Gujarat Region	56	27	105	3	8	−62	0	1	−100	59	37	59
22	Saurashtra & Kutch	44	16	171	9	7	32	0	2	−100	53	25	114
23	Konkan & Goa	209	113	85	11	25	−58	4	9	−56	223	147	52
24	Madhya Maharashtra	208	71	192	12	29	−58	40	7	455	261	108	142
25	Marathwada	149	57	162	8	19	−58	43	9	397	201	85	136
26	Vidarbha	77	43	81	1	15	−94	12	15	−20	90	72	24
27	Coastal A. P.	211	193	10	68	100	−32	46	23	97	325	316	3
28	Telangana	106	75	41	1	19	−96	18	6	183	125	100	25
29	Rayalaseema	180	117	54	91	71	27	81	26	219	353	214	65
30	Tamil Nadu	227	196	16	345	195	77	199	88	125	782	479	63
31	Coastal Karnataka	342	185	85	48	67	−28	51	15	237	442	267	66
32	N. I. Karnataka	214	93	130	13	27	−53	41	8	436	268	128	110
33	S. I. Karnataka	255	151	69	30	54	−45	43	13	238	328	218	51
34	Kerala	443	293	51	169	164	3	48	43	13	660	499	32
35	Lakshadweep	131	163	−20	277	102	170	34	69	−51	441	334	32

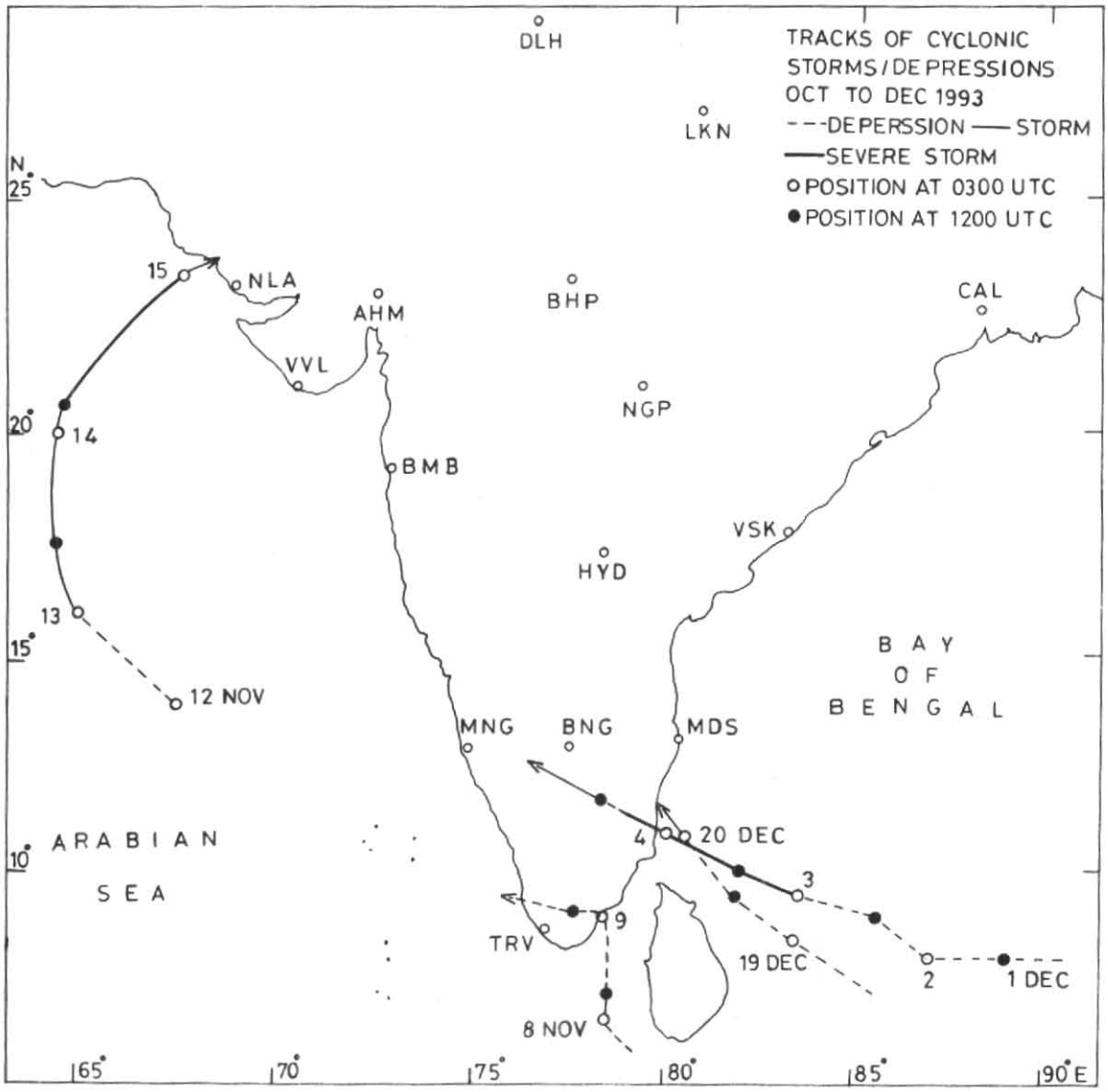

Fig. 1. Tracks of storms/depressions for the period October to December 1993

4.1.3. *Storms/depressions* — No storm/depression formed over the Arabian Sea or Bay of Bengal during the month.

4.1.4. *Weather and associated synoptic features* — The details of synoptic systems observed in the month are given in Table 3.

Southwest monsoon was active to vigorous on 11 days over Sub-Himalayan West Bengal & Sikkim and Kerala, 6 to 10 days in Madhya Maharashtra, coastal Andhra Pradesh, Tamil Nadu and Karnataka, 3 to 5 days in Gangetic West Bengal, Marathwada, Telangana and Rayalaseema and 2 days in Konkan & Goa. Northeast monsoon was active to vigorous on 2 to 3 days in Tamil Nadu and Kerala. Rain or thundershower occurred almost at all the places or at many places on 10 to 15 days in Andaman & Nicobar Islands, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Konkan & Goa and coastal Karnataka and on 4 to 9 days in Arunachal Pradesh, Orissa, Madhya Maharashtra, south interior Karnataka, Kerala and Lakshadweep.

4.1.5. *Monthly rainfall* — Monthly rainfall was excess in 14, normal in 5, deficient in 9 and scanty in 5 meteorological sub-divisions during October 1993. There was no rainfall in the sub-divisions of Punjab and Himachal Pradesh.

Rainfall was excess in Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Gujarat, Maharashtra, Andhra Pradesh, interior Karnataka and Kerala; normal in Andaman & Nicobar Islands, Assam & Meghalaya, Bihar plateau, coastal Andhra Pradesh and Tamil Nadu, deficient in Nagaland,

TABLE 2

Principal amounts of rainfall (cm)

Date (1)	October 1993 (2)	November 1993 (3)	December 1993 (4)
1	Sevoke 12, Kursela 11, Mangalvedha & Vaduj 9 each, Madhugiri 8	Nellore 10, Dundigal & Chengannur 7 each	Vedaranyam 7
2	Aravakurichi 10, Champasarai 9, Birpur, Koderu & Siddalagatte 8 each	Kasargode 14, Gaya & Tada 8 each	Madras 6, Car Nicobar 5
3	Agumbe & Vaikom 16 each, Allagadda 15, Cooch Behar 11, Mangalvedha & Karkala 10 each	Tiruvaiur 17, Asansol 8, Kolar Gold Fields 6, Bhagalpur 4	Alapuzha 5, Hut Bay 4, Minicoy 3
4	T. Narasipura 19, Chalakkudy 13, Parner & Bantwal 11 each	Tiruvaiur 9, Kasargode 6, Kavali 5	Karaikal 18, Srimusnam 15, Thiruvananthapuram 6
5	Bajpe 18, Kodungallur 9, Yaval 6, Ramtek 3	Coonoor 6, Nancowry & Piravom 3 each	Kumbakonam 28, Kavali 11, Venkatagirikota 10
6	Kayamkulam 8, Kollam & Nancowry 7 each	Minicoy 10, Thuckalay 8	Kavali 24, Daund 10, Beed & Chittoor 8 each
7	Koderu 12, Arasalu, Gharmura & Muthupet 11 each, Hut Bay 10	Senkottah 12, Minicoy 7	Kannur 20, Edlabad 5
8	Thirutala 14, Kamudhi 12, Koderu, Pargi & Subramanya 9 each, Hasimara 8	Senkottah 13, Garhshankar 5	Sivakasi 14
9	Tenali 20, Bajpe 17, Koppal 10, Sevoke & Kadur 9 each, Badvel 7	Chattrapatti 24, Parli 8, Tada 7	Nil
10	Mantralayam 28, Raichur 15, Mahbubnagar & Siriguppa 11 each, Tenali & Kothagiri 11 each	Tambaram 23, Venkatagiri 17, Satyaveedu 16, Minicoy 9	Nil
11	Jat & Kaladgi 10 each, Nilambur & Parassuramapura, 9 each, Khanitar 8, Beed 7	Coonoor 28, Thiruvananthapuram 27, Nellore 14, Agathi 9, Cuddapah 4	Nil
12	Kollidam 13, Kunnamkulam 11, Penukonda 10, Satara 6	Udayagiri 10, Periyakulam 12, Shirali 7, Punalur 4	Nil
13	Pennagaram 16, Akola 10, Devanahalli & Avanigadda 7 each, Betul 5	Mundagod 11, Ambasamudram 10, Punalur 9, Hirekerur 7	Nil
14	Devanahalli & Patoda 11 each, Subramanya 10, Maheshpur 9	Pen 9, Muthupet 5, Namakkal 4	Nil
15	Manamadurai 26, Avanigadda 19, Ambavalayal 10, Tarikkere 8	Kozhikode & Mulki 5 each, Hosdurg 3	Nil
16	Belur 14, Mulki, Puttur & Vallam 11 each, Matijuri 8	Sriperumbudur 11, Konni & Naliya 7 each, Maya Bandar 5	Nil
17	Avagadda 14, Sringeri & Poladpur 8 each, Siddapur 7	Senkottah 7, Nancowry, & Subramanya 4 each	Pamban 12
18	Tiruvaiyaru 14, Savanur 11, Kankavli 10, Balehonnur 8	Kollangode 9, Dindigul 7, Sangli 5	Tiruchendur 15, Sathankulam 11, Nancowry 9

TABLE 2 *(Contd.)*

(1)	(2)	(3)	(4)
19	Senkottah & Gudari 9 each, Nandgaonkazi & Thenmala 7 each	Thiruvananthapuram 6, Thiruvalla 5, Cherthala 4	Nil
20	Usilampatti 9, Alur 7, Jagdalpur & Rahuri 6 each	Nandgaon 4, Punalur 3	Kattumannarkoil 8
21	Nugehalli 13, Parli 12, Panambur 11, Pali 7, Sakri 6	Kollengode 9, Sirkali 5, Baramati 3	Vedaranyam 8
22	Eraniel 17, Alapuzha 12, Ankola & Vikarabad 10 each	Kayamkulam 9, Chengannur 8, Thiruvananthapuram 7	Chidambaram 21, Palayamkottai 14
23	Palakode 11, Kozhikode 9, Yelandur 8, Dharmasthala 7	Port Blair 5, Nannilam 4, Tirthuraipoondi 3	Tiruchendur 13, Pondicherry 9
24	Saswad 6, Bhivpuri 5, Osmanabad 4	Madras 11, Parangipettai 10	Vedaranyam 5
25	Lohogaon 11, Keshod 8, Ahwa & Bhira 8 each	Karaikal 19, Perungalur 17, Thiruvananthapuram 3	Nil
26	Watrap 9, Kochi 8, Thakurwadi 4	Mayiladuthurai 6, Karaikal 5	Nil
27	Eraniel 6, Nancowry 4	Mudukalathur 16, Nagapattinam 7, Minicoy 5	Nil
28	Parangipettai 8, Karaikal 5	Nancowry 9	Pamban 8
29	Prakasam & Bagade 5, Sirkali 4, Paranda 3	Nil	Vedaranyam 6
30	Vedaranyam 5, Gudur & Tirupati 4 each	Nancowry 3	Nil
31	Manimuthar 18, Sulurpet 12, Tirupati 11, Konni 8	Nil	Nil

Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar plains, Rajasthan, Madhya Pradesh and Lakshadweep; scanty in Uttar Pradesh, Haryana and Jammu & Kashmir. The significant amounts of daily rainfall (cm) during the month are given in Table 2.

4.1.6. *Temperatures* — Day temperatures were above normal or appreciably above normal on most of the days of the month over east Uttar Pradesh and Rajasthan. They were generally normal over the rest of the country.

Cold wave conditions prevailed over Kashmir on the last 10 days of the month. Night temperatures were below normal on many days over Punjab and from 21 to 25 of the month in West Bengal & Sikkim, Orissa, Bihar and east Uttar Pradesh. They were appreciably above normal on most of the days of month in Madhya Pradesh, Gujarat and Madhya Maharashtra. They were generally normal over the rest of the country.

The highest day temperature recorded during the month was 41°C at Phalodi (Rajasthan) on 2 & 3 and at Bhavnagar on 12.

4.1.7. *Disastrous weather events and associated damage* — Loss of life and damage to property were caused due to disastrous weather as follows :

Maharashtra	28 people died, 100 huts destroyed.
West Bengal	: 17 people died due to thunder bolt.
Andhra Pradesh	: 13 people died, 109 villages affected.
North Karnataka	: 13 people died, 20,000 houses were damaged.
Kerala	: 13 people died, 10 injured, widespread damage to paddy crops.

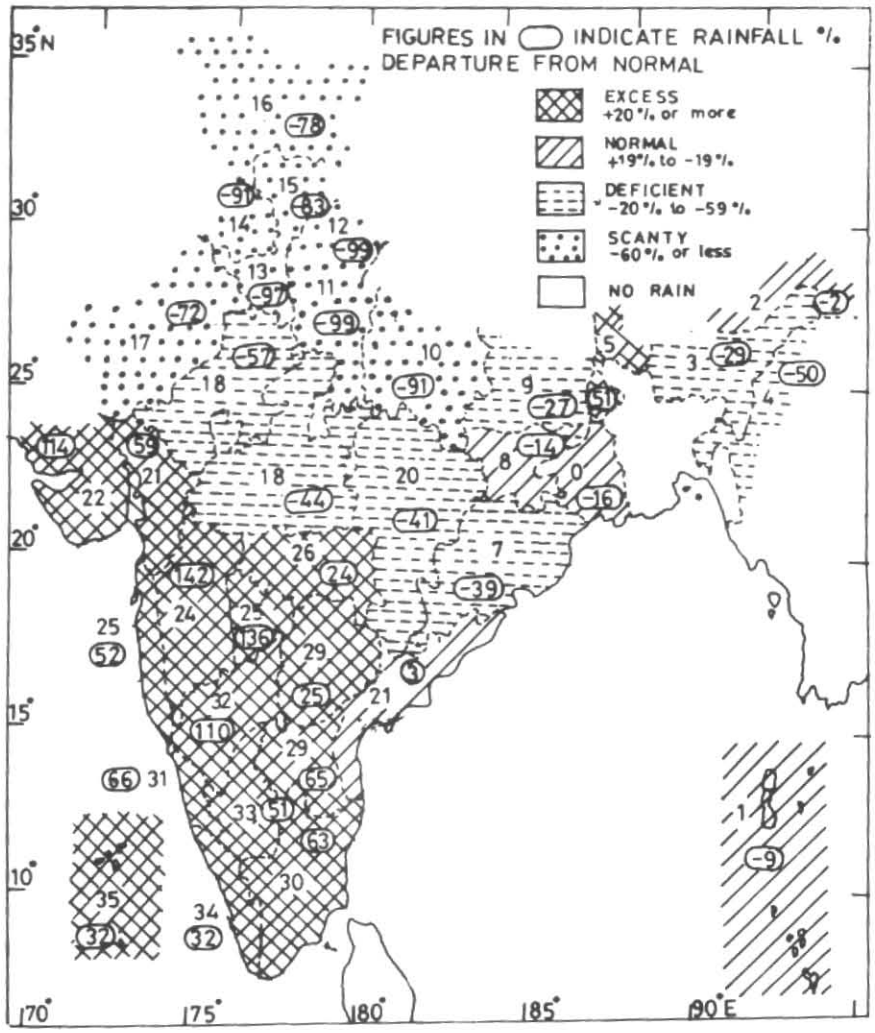

Fig. 2. Rainfall for the period 1 October to 31 December 1993

TABLE 3

Details of weather systems during October 1993

S. No.	System	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A)	*Low pressure area*					
(1)	Well marked low pressure area	5-7	West central Bay of Bengal off Andhra coast	West	Oman coast	Associated cyclonic circulation up to mid-tropospheric levels
(2)	Low pressure area	16-22	Lakshadweep and north Kerala-south Karnataka coast	North	Gujarat and adjoining Saurashtra coast	First observed as a cyclonic circulation extending up to mid-tropospheric level on 15

TABLE 3 *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(3)	Low pressure area	30-31	Southwest and adjoining west central Bay	Quasi-stationary	West central and adjoining southwest Bay off south Andhra-north Tamil Nadu coast	Merged with the trough from west central to southwest Bay off Andhra-Tamil Nadu coast
(B)	*Cyclonic circulation*					
(1)	Low tropospheric level	30 Sep-3 Oct	Tamil Nadu	West	Lakshadweep and neighbourhood	
(2)	Mid-tropospheric level	1-4	Andaman Sea	Westnorthwest	West central Bay of Bengal	Merged into the well marked low pressure area
(3)	Lower level	4-6	North Pakistan and neighbourhood	Stationary	*In situ*	
(4)	Mid tropospheric level	12-13	South Bay of Bengal off Tamil Nadu coast	Do.	Do.	*In situ*
(5)	Do.	13-15	Goa-south Maharashtra coast	Do.	*In situ*	
(6)	Lower tropospheric level	19-24	Andaman Sea	West	Southwest Bay of Bengal	Merged with cyclonic circulation No. 7
(7)	Do.	21-24	Lakshadweep and neighbourhood	North	South Maharashtra-Goa coast	
(8)	Do.	23-27	Southwest Bay off Tamil Nadu coast	West	East Rajasthan	
(9)	Do.	23-26	West Rajasthan and neighbourhood	Northeast	Do.	
(C)	*Western disturbance*					
(1)	Upper air system	7-9	North Pakistan and neighbourhood	Do.	Moved away across Jammu & Kashmir	
(2)	Do.	13-14	North Pakistan and adjoining Jammu & Kashmir	Do.	Do.	
(D)	*Troughs*					
(1)	Lower tropospheric level	29-4	Uttar Pradesh to coastal Karnataka	East	West Bengal to northwest Bay	
(2)	Lower level	4-7	Andaman sea and neighbourhood	Stationary	*In situ*	
(3)	Mid tropospheric level	8-12	South Maharashtra and coastal Karnataka	Do.	Do.	
(4)	Lower level	14-16	Lakshadweep and adjoining Kerala and coastal Karnataka	North	Gujarat coast and adjoining Saurashtra & Kutch	Associated cyclonic circulation extends up to 2.1 km asl
(5)	Do.	27 Oct-2 Nov	Off south Andhra-north Tamil Nadu coast	Quasi-stationary	*In situ*	
(6)	Mid and upper tropospheric westerlies	8-12	Along Long. 60°E north of Lat. 28°N	Northeast	Moved away	

TABLE 4

Details of weather systems during November 1993

S. No.	System	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(A)	*Cyclonic storms/depression/lows*					
(1)	Severe cyclonic storm (CHW)	12-15	Southeast Arabian Sea and adjoining Lakshadweep	First northeasterly then northerly and finally northeasterly	Northeast Arabian Sea off north Gujarat-Sindh coast	First seen as a well marked low over Maldive-Comorin area on 10
(2)	Depression	8-9	Maldive-Comorin area	First westnorth-westerly then northwesterly	Southeast Arabian Sea	It was first seen as a low pressure area over the same area on 6
(3)	Low pressure area	22-23	Southeast Bay and adjoining north Andhra coast	Stationary	*In situ*	Associated cyclonic circulation extends up to mid-tropospheric level
(B)	*Cyclonic circulations*					
(1)	Lower tropospheric level	1-4	Northcentral Orissa	Stationary	*In situ*	
(2)	Mid-tropospheric level	2-3	East Madhya Pradesh	Do.	Do.	
(3)	Do.	3-5	Central Bihar	Do.	Do.	Trough from this system extending up to Manipur
(4)	Do.	2-3	Maldive and neighbourhood	Do.	Do.	
(5)	Do.	19-21	North Maharashtra and adjoining Gujarat	West	Arabian Sea off north Maharashtra-Gujarat coast	Trough extending from this system extends up to 2.1 km asl running from Lakshadweep to Goa coast
(6)	Lower level	23-27	Southwest Bay off Sri Lanka coast	Quasi-stationary	*In situ*	
(C)	*Western disturbance*					
(1)	Upper air system	6-8	North Pakistan and neighbourhood	Eastnortheast	Moved away across Jammu & Kashmir	
(2)	Do.	18-20	Do.	Northeast	Do.	
(3)	Do.	21-23	North Pakistan and adjoining Jammu & Kashmir	Do.	Do.	
(D)	*Trough in the westerlies*					
(1)	Mid and upper tropospheric westerlies	2-7	Nepal to south coastal Andhra Pradesh	Do.	Moved away	

TABLE 4 *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(F)	*Induced cyclonic circulation*					
(1)	Lower tropospheric level	6-9	Pakistan and adjoining Punjab	Northeast	Punjab and neighbourhood	
(F)	*Troughs*					
(1)	Lower tropospheric levels	29 Oct-3 Nov	South Karnataka coast to south Kerala coast	Quasi-stationary	South Konkan coast to Lakshadweep	
(2)	Lower level	15-20	Sri Lanka and adjoining sea area	Northwest	Kerala	
(3)	Do.	16-23	Andaman Sea and neighbourhood	West	Southwest Bay off Sri Lanka coast	

4.2. *November*

4.2.1. *Storms/depressions*

(a) *Arabian Sea* — Cyclonic storm (12-15 November) over the Arabian Sea. A depression formed on 12 morning over the southeast and adjoining east central Arabian Sea. It moved in northwesterly direction and intensified into cyclonic storm on 13 morning over the east central Arabian Sea. Moving in a northerly direction, it further intensified into a severe cyclonic storm with a core of hurricane winds on 14 evening over the northern parts of east central Arabian Sea. It then recurved to northeast and rapidly weakened into a depression over the northeast Arabian Sea off the north Gujarat-Sindh coast on 15 (Fig. 1). It moved northeast and weakened into a low by 16.

(b) *North Indian Ocean* — A depression formed over Maldives-Comorin Sea area on 8 morning. Moving northwards, it crossed south Tamil Nadu coast near Tuticorin. It maintained its intensity till 9 evening and then weakened.

4.2.2. *Weather and associated synoptic features*— Details of weather systems are given in Table 4.

Northeast monsoon was fairly active over Tamil Nadu, Rayalaseema and Kerala during the entire month. Northeast monsoon was active to vigorous on 11 days in Tamil Nadu and Kerala, 4 days in Rayalaseema and 2 to 3 days in coastal Andhra Pradesh.

Rain or thundershowers have occurred either almost at all the places or at many places on 10 days in Lakshadweep, 1 to 6 days in Andaman & Nicobar Islands, Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Himachal Pradesh, Jammu & Kashmir, Tamil Nadu, coastal and south interior Karnataka. Rain or thundershowers have occurred either at a few places or at one or two places on 15 to 23 days in Andaman & Nicobar Islands, Tamil Nadu, south interior Karnataka and Kerala, 7 to 14 days in Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, Madhya Maharashtra, coastal Andhra Pradesh, Rayalaseema and coastal Karnataka and 1 to 6 days in Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar State, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, Rajasthan, Madhya Pradesh, Gujarat State, Marathwada, Vidarbha, Telangana, north interior Karnataka and Lakshadweep.

4.2.3. *Monthly rainfall* — Rainfall was excess in 9, normal in 4, deficient in 7 and scanty in 15 subdivisions.

Rainfall was excess in West Bengal & Sikkim, Bihar, Jammu & Kashmir, Saurashtra & Kutch, Rayalaseema, Tamil Nadu and Lakshadweep, normal in Andaman & Nicobar Islands, Punjab, Himachal Pradesh and Kerala, deficient in Konkan & Goa, Madhya Maharashtra, Marathwada, coastal Andhra Pradesh and Karnataka State and scanty over rest of the country.

Significant amounts of daily rainfall (cm) in the month are given in Table 2.

4.2.4. *Temperatures* — Night temperatures were appreciably to markedly above normal on most of the days of the month over Haryana, Rajasthan, Madhya

TABLE 5

Details of weather systems during December 1993

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
(A)	*Cyclonic storms/depression/lows*					
(1)	Severe cyclonic storm (CHW)	1-4	South Andaman sea and neighbourhood	Westnorthwest	Southeast Arabian Sea off Kerala-south Karnataka coast	It was first seen as a cyclonic circulation between 1.5 and 5.8 km asl over Tenasserim coast and adjoining Andaman sea
(2)	Deep depression	18-21	Southwest Bay of Bengal	Northwest	Off Tamil Nadu coast	It was first observed as a cyclonic circulation over south Arabian Sea
(3)	Low pressure area	21-24	Northwest Sri Lanka and adjoining Tamil Nadu coast	Do.	Southeast Arabian Sea	Associated cyclonic circulation extends up to lower tropospheric levels
(B)	*Induced low pressure area*	Nil	Nil	Nil	Nil	
(C)	*Cyclonic circulations*					
(1)	Mid tropospheric levels	30 Nov-3 Dec	Comorin Maldive	Northwest	South Kerala	
(2)	Upper tropospheric levels	6-10	Maldive and neighbourhood	Stationary	*In situ*	
(3)	Lower levels	12-13	West Rajasthan and neighbourhood	Northeast	East Rajasthan and neighbourhood	
(4)	Lower tropospheric levels	21-22	Southwest Bay off north Tamil Nadu coast	Stationary	*In situ*	
(5)	Do.	28-30	Kutch and neighbourhood	Northeast	Northwest Madhya Pradesh and neighbourhood	
(D)	*Western disturbance*					
(1)	Upper air system	6-8	North Pakistan and neighbourhood	Eastnortheast	Moved away across Jammu & Kashmir	
(2)	Do.	28-30	Do.	Northeast	Moved away across Himachal Pradesh	
(E)	*Induced cyclonic circulations*	Nil	Nil	Nil	Nil	
(F)	*Troughs in the westerlies*					
(1)	Mid and Upper tropospheric westerlies	30 Nov-1 Dec	Along Long. 62°E north of Lat. 25°N	Northeast	Moved away	

TABLE 5 *(Contd.)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(2)	Mid and Upper tropospheric westerlies	7-8	Along Long. 63°E north of Lat. 20°N	Eastnortheast	Do.	
(3)	Do.	28-31	At 9.6 km asl along Long. 69°E north of Lat. 20°N	Northeast	Do.	
(G)	*Troughs in low levels*					
(1)	Lower levels	9-14	Andaman sea	West	Andaman sea and adjoining southeast Bay	
(2)	Do.	14-19	Off Kerala coast	Stationary	*In situ*	
(3)	Do.	23-24	South Andaman sea and neighbourhood	West	South Andaman sea and part of south-east Bay	
(4)	Do.	24-31	Southwest Bay of Bengal	Stationary	*In situ*	

Pradesh, Gujarat and Maharashtra States. They were above normal or appreciably above normal on 7-15 days in West Bengal & Sikkim, Bihar, Uttar Pradesh, Punjab, Jammu, Andhra Pradesh and north interior Karnataka. They were generally normal over the rest of the country.

4.2.5. *Disastrous weather events and associated damage* — The Arabian Sea cyclone (12-15 November) caused heavy rains over the northern parts of Saurashtra & Kutch on 15. Due to heavy rains and high winds associated with the cyclone, about 50 fishermen were reported missing along the north Gujarat coast.

Active to vigorous monsoon activity caused heavy rains in coastal Andhra Pradesh, Rayalaseema, Tamil Nadu, south interior Karnataka and Kerala. Media reported 32 people lost their lives in Tamil Nadu. Loss of public property and utilities is estimated to be around Rs. 260 crores. Heavy rains also caused death of 3 persons in Kerala.

4.3. *December*

4.3.1. *Storms and depressions*

(a) *Bay of Bengal severe cyclonic storm (Hurricane) from 1 to 4 December 1993* — A depression formed in the evening of 1 December over the southeast Bay of Bengal. It moved in westnorthwesterly direction and intensified into a cyclonic storm on 2 evening. By the evening of 3, it further intensified into a severe cyclonic storm with a core of hurricane winds over the southwest Bay off Tamil Nadu coast. Then it crossed the north Tamil Nadu coast near Karaikal on the morning of 4 and thereafter weakened rapidly over Tamil Nadu (Fig. 1). Under the influence of this system, heavy to very heavy rainfall occurred in Tamil Nadu, Kerala, Andhra Pradesh and Karnataka States from 3 to 5 December.

(b) *Depression 19 to 20 December 1993* — A depression formed over the southwest Bay of Bengal on 19 morning. Moving in a northwesterly direction, it intensified into a deep depression on 19 evening. It weakened into a depression on 20 morning and lay off north Tamil Nadu coast. Then, it weakened further into a low off Tamil Nadu coast. Tamil Nadu reported heavy to very heavy spells of rain on 18, 19 and 22 December.

4.3.2. *Weather and associated synoptic features* — Details of synoptic features are given in Table 5.

Northeast monsoon was vigorous on 2 to 3 days in Tamil Nadu and Rayalaseema, active to vigorous on one day each in coastal Andhra Pradesh and Kerala during the last week of December. Rain or thundershowers occurred either almost at all the places or at many places on 1 to 3 days in Andaman & Nicobar Islands, Maharashtra, coastal Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Lakshadweep. Rain or thundershowers occurred at a few places or at one or two places on 13 to 24 days in Andaman & Nicobar Islands, Tamil Nadu and Kerala, on 1 to 8

days in Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, west Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Lakshadweep. Mainly dry weather prevailed over the rest of the country.

4.3.3. *Monthly rainfall* — The month's rainfall was excess in 9, normal in 1, deficient in 5 and scanty in 4 sub-divisions. The remaining 16 sub-divisions had no rainfall during the month.

Rainfall was excess in Madhya Maharashtra, Marathwada, Andhra Pradesh, Tamil Nadu and Karnataka and normal in Kerala. It was deficient in Andaman & Nicobar Islands, west Madhya Pradesh, Konkan & Goa, Lakshadweep & Vidarbha and scanty in Arunachal Pradesh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim and Jammu & Kashmir.

Significant amounts of rainfall are given in Table 2.

4.3.4. *Temperatures* — Severe cold wave conditions prevailed over Punjab and Kashmir for 2 to 3 days. Cold wave conditions prevailed over Kashmir for 14 days and 5 to 7 days over Haryana and Punjab one day over Bihar Plains and west Madhya Pradesh each. Night temperatures were appreciably below normal or below normal on most of the days in the second fortnight of the month over Orissa, Bihar, Madhya Pradesh, interior Maharashtra and Telangana.

The lowest night temperature recorded over the plains was −2°C (−4°C) at Amritsar on 24, while it was −7°C(−5°C) over the hills on 25 of the month.

4.3.5. *Disastrous weather events and associated damage* — Torrential rains and strong winds associated with the Bay storm of 1-5 December the coastal areas of Tamil Nadu suffered extensive damage to property and standing crops. The cyclone disrupted road and rail traffic and damaged the telecommunication system. According to Press report, nearly 110 people were killed and hundreds of houses collapsed. Estimated loss was around Rs. 400 crores.