

## Weather

### POST-MONSOON SEASON (OCTOBER-DECEMBER 1994)\*

#### 1. Introduction

Four cyclonic disturbances formed during the post-monsoon season of 1994. Out of these, three systems formed over the Bay of Bengal and one of them was severe cyclonic storm which crossed Tamil Nadu coast over Madras. Only one system, which was a severe cyclonic storm with a core of hurricane winds, crossed north Somalia coast formed over the Arabian Sea.

The southwest monsoon withdrew from west Rajasthan on 19 September and from west Uttar Pradesh, west Madhya Pradesh and Gujarat on 23 September. It withdrew from the entire country by 17 October. Northeast monsoon rains commenced over Tamil Nadu and adjoining states of Kerala, Karnataka and Andhra Pradesh on 18 October 1994. Monthly and seasonal rainfall amounts and their percentage departures are given in Table 1.

#### 2. Chief features

- (i) Two cyclonic storms, one over the Bay of Bengal in October and the other over the Arabian Sea in November formed during the season. The Arabian sea system moved along a low latitude of 8°N, attained the intensity of severe cyclonic storm with a core of hurricane winds and finally crossed north Somalia coast as a severe cyclonic storm. This was a unique case in the history of cyclones. Two more systems, one deep depression and one depression also formed over the Bay of Bengal during October and November respectively.
- (ii) Under the influence of a deep depression in October, rainfall was excess (more than 75%) in Vidarbha, interior Andhra Pradesh and Karnataka.
- (iii) Northeast monsoon rains commenced in Tamil Nadu and adjoining states of

Kerala, Karnataka and of Andhra Pradesh on 18 October 1994.

- (iv) In December, moderate to severe cold wave conditions prevailed for 4 to 10 days in northwest, central and eastern parts of the country.
- (v) There was heavy snowfall in Kashmir valley and Ladakh region in December.
- (vi) The severe cyclonic storm (29-31 October) which crossed Tamil Nadu coast over Madras city produced torrential rains and strong winds over Tamil Nadu and Andhra Pradesh and caused severe damage to property and crops. It also took a toll of 304 lives in Tamil Nadu and Andhra Pradesh.

#### 3. Seasonal rainfall

Seasonal rainfall was excess in 9, normal in 10, deficient in 5 and scanty in 10 meteorological subdivisions. There was no rain in west Rajasthan.

Rainfall was excess in Bihar plateau, Jammu & Kashmir, Vidarbha, Andhra Pradesh and Karnataka and was normal in Arunachal Pradesh, Assam & Meghalaya, Himachal Pradesh, east Madhya Pradesh, Maharashtra outside Vidarbha, Tamil Nadu, Kerala and Lakshadweep. Rainfall was deficient in Andaman & Nicobar Islands, West Bengal & Sikkim, Orissa and Bihar plains and was scanty in Nagaland, Manipur, Mizoram & Tripura, Uttar Pradesh, Haryana, Punjab, east Rajasthan, west Madhya Pradesh and Gujarat state. Seasonal rainfall departures in different meteorological subdivisions are given in Fig. 1.

#### 4. Monthly features

##### 4.1. October

4.1.1. *Withdrawal of southwest monsoon* — Southwest monsoon withdrew from west Rajasthan

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TABLE 1

Rainfall figures (mm) for each month and season as a whole (October-December 1994)

S. No.	Sub-division	October			November			December			Season		
		Actual	Normal	Dep.	Actual	Normal	Dep.	Actual	Normal	Dep.	Actual	Normal	Dep.
		(mm)	(mm)	(%)	(mm)	(mm)	(%)	(mm)	(mm)	(%)	(mm)	(mm)	(%)
1.	A & N Islands	195	320	-39	198	253	-22	43	171	-75	436	744	-41
2.	Arunachal Pradesh	154	116	33	3	21	-86	0	1	-100	158	148	7
3.	Assam & Meghalaya	173	154	12	6	28	-79	0	10	-100	179	192	-7
4.	Nag., Mani., Mizo. & Tripura	62	159	-61	11	34	-68	0	9	-100	73	202	-64
5.	SHWB & Sikkim	74	147	-49	8	16	-50	3	5	-40	85	168	-49
6.	Gangetic West Bengal	88	120	-27	7	19	-63	0	3	-100	95	142	-33
7.	Orissa	71	118	-40	8	27	-70	0	6	-100	79	152	-35
8.	Bihar Plateau	154	84	83	1	12	-92	0	5	-100	155	101	53
9.	Bihar Plains	41	63	-35	3	9	-67	0	3	-100	44	75	-41
10.	East U. P.	7	48	-84	0	5	-100	0	6	-100	7	59	-88
11.	Plains of East U. P.	0	34	-99	0	3	-96	1	9	-89	1	46	-98
12.	Hills of west U. P.	0	59	-99	0	8	-98	3	25	-88	3	92	-97
13.	Haryana, Chandigarh & Delhi	0	17	-99	0	4	-100	1	8	-88	1	29	-97
14.	Punjab	1	21	-94	0	4	-100	11	15	-27	12	40	-70
15.	Himachal Pradesh	5	42	-88	0	13	-99	81	38	113	86	93	-8
16.	Jammu & Kashmir	19	27	-32	1	17	-94	115	48	140	135	92	47
17.	West Rajasthan	0	6	-98	0	2	-95	0	3	-100	0	11	-100
18.	East Rajasthan	0	15	-100	1	4	-75	0	4	-100	1	23	-96
19.	West Madhya Pradesh	6	31	-80	5	14	-64	0	7	-100	11	52	-79
20.	East Madhya Pradesh	55	52	7	6	12	-50	0	7	-100	61	71	-14
21.	Gujarat Region	3	27	-88	1	8	-88	0	1	-100	4	36	-89
22.	Saurashtra & Kutch	1	16	-95	0	7	-100	0	2	-100	1	25	-96
23.	Konkan & Goa	147	113	30	3	25	-88	0	9	-100	150	147	2
24.	Madhya Maharashtra	92	71	29	17	29	-41	0	8	-100	109	108	-1
25.	Marathwada	67	57	17	33	19	74	0	9	-100	100	85	18
26.	Vidarbha	88	43	107	7	15	-53	0	15	-100	95	73	30
27.	Coastal A. P.	260	192	35	185	99	87	16	23	-30	461	314	47
28.	Telangana	174	74	134	34	19	79	0	6	-100	208	99	110
29.	Rayalaseema	222	115	93	61	72	-15	11	26	-58	294	213	38
30.	Tamil Nadu	241	195	23	250	195	28	44	89	-51	535	479	12
31.	Coastal Karnataka	339	185	83	44	67	-34	0	15	-100	383	267	43
32.	N. I. Karnataka	222	93	139	5	27	-81	0	7	-100	227	127	79
33.	S. I. Karnataka	269	150	79	35	54	-35	1	13	-92	305	217	41
34.	Kerala	449	293	53	120	164	-27	8	43	-81	577	500	15
35.	Lakshadweep	213	162	31	155	102	52	1	69	-99	369	333	11

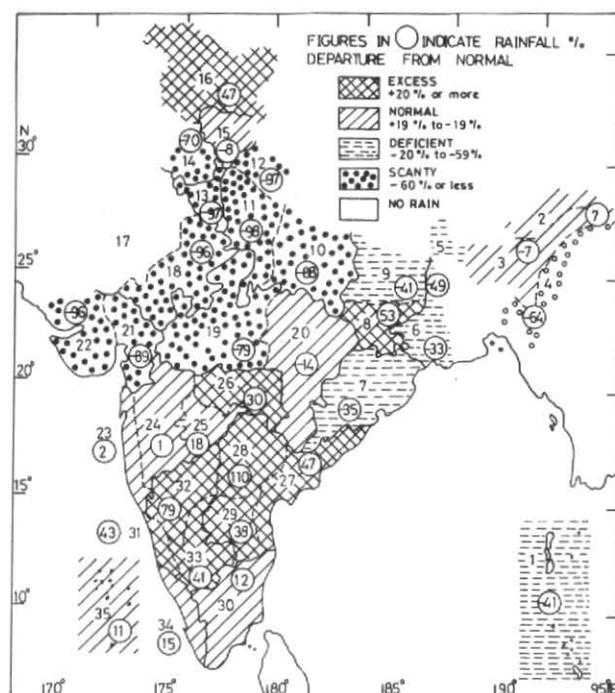


Fig. 1. Seasonal rainfall departures (%) for the period October-December 1994

on 19 September as against the normal date of 15 September. However, monsoon withdrew from west Uttar Pradesh, west Madhya Pradesh and Gujarat on 23 September, which was one week earlier than the normal date. Further, withdrawal of monsoon was rather slow. It withdrew upto  $20^{\circ}\text{N}$  by 15 October and from the entire country by 17 October.

4.1.2. *Onset of northeast monsoon* — Northeast monsoon rains commenced over Tamil Nadu and adjoining states of Kerala, Karnataka and Andhra Pradesh on 18 October 1994.

4.1.3. *Storms/depression* — Two cyclonic disturbances, one deep depression and one severe cyclonic storm formed over the Bay of Bengal during the month (Fig. 2).

(i) *Deep Depression (4 to 7 October) over the Bay of Bengal*

A well marked low pressure area formed over the southern parts of west central Bay and adjoining south Bay of Bengal on 3 evening. It concentrated into a depression on 4 evening and lay centred near  $15.5^{\circ}\text{N}/82.0^{\circ}\text{E}$ . The system moved in a northwesterly direction, intensified into a deep depression by midnight and crossed the Andhra Pradesh coast

near Machilipatnam and was centred near  $16.5^{\circ}\text{N}/80.5^{\circ}\text{E}$  on 5 morning. The system, then, moved in a north-north-westerly direction across Telangana (AP) and weakened into a depression on 6 morning. The system, then, recurved on 6th evening; moved in a north-easterly direction and lay centred about 100 km southeast of Nagpur in Vidarbha on 7 evening. Later, it weakened into a well marked low pressure area over east Madhya Pradesh and neighbourhood by 8 morning.

Under the influence of this system, widespread rains with heavy falls at a few places occurred over Andhra Pradesh, north Tamil Nadu, Karnataka and Maharashtra outside Konkan from 3 to 7. It caused a death toll of 38 and severe damages to the crops and houses due to severe floods in south Andhra Pradesh.

(ii) *Severe cyclonic storm (29 to 31 October 1994) over the Bay of Bengal*

A depression formed over the southwest Bay and neighbourhood on 29 morning. The system intensified into a deep depression on 29 evening and was centred near  $10.5^{\circ}\text{N}/84.5^{\circ}\text{E}$ . Moving in west-northwesterly direction, it further intensified into a cyclonic storm on 30 morning and into a severe cyclonic storm on 30 evening and was centred inland near  $13.2^{\circ}\text{N}/80.0^{\circ}\text{E}$  on 31 at 0300 UTC. The system crossed north Tamil Nadu coast and passed over Madras city between 0100 and 0200 UTC of 31. Moving in a north-westerly direction, the system weakened rapidly into a deep depression on 31 evening and later into a low pressure area. During the passage of the cyclonic storm widespread rains with heavy to very heavy falls occurred over the Tamil Nadu and southern parts of Andhra Pradesh. Due to heavy rains and gale winds, 235 and 69 persons died in Andhra Pradesh and Tamil Nadu respectively. Widespread damages to crops and houses were reported from these areas.

4.1.4. *Weather and associated synoptic features*—Details of weather systems are given in Table 3.

Southwest monsoon was active to vigorous on 9 days over Kerala, 5 to 7 days over Arunachal Pradesh, Assam & Meghalaya, coastal Karnataka, south interior Karnataka, 2 to 4 days over Andhra Pradesh and north interior Karnataka. Northeast monsoon was active to vigorous on 3 to 4 days over coastal Andhra Pradesh, Rayalaseema, Tamil Nadu and Kerala. Rain or thundershowers occurred almost at all the places or at many places on 6 to 11 days in Andaman & Nicobar Islands, Assam &

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TABLE 2

Principal amounts of rainfall (cm)

Date (1)	October (2)	November (3)	December (4)
1	Vaikom 8, Periakulam 7, Bapatla 6, Mandya 5	Ongole 22, Kakinada 16, Manjeri 14, Tiruppur 9, Alappuzha and Nancowrie 7 each	Nedumangad 10
2	Konni 11, Kunda Bridge 8, Kankavali 7, Gadhinglaj, Mysore 3 each	Narsapur 22, Machilipatnam 20, Haripad 19, Thiruvanamalai 10, Gopalpur 7	Aryankavu 8
3	Usillampatti 15, Gangtok 11, Raichur 10, Kozhikode 8, Khed 7, Islampur 6	Machilipatnam 22, Dharmasthala 11, Coimbatore 7, Palakkad 5, Minicoy 4	Nil
4	Kuzhithural 10, Nellore and Dum Dum 8 each, Dholal and Pali 7 each, Chitradurga 5	Punalur 12, Mysore 11, Kuttumanarkoil 8, Nellore 4, Karaikal 4	Hut Bay 3
5	Ongole 12, Kochi 10, Mandya 8, Kuisela 7, Calcutta and Bhubaneswar 4 each	Chengaleput 19, Madras 18, Punalur 8, Kundukur 6, Pondicherry 5, Mysore 3	Nil
6	Nandigama 13, Raichur 12, Guwahati 11, Mangalore and Thiruvananthapuram 10 each, Hyderabad 9, Gopalpur 7	Vandavasi 15, Pondicherry 9, Thiruvananthapuram and Kaveli 5 each, Nancowrie 3	Nil
7	Hosdurg 14, Eturnagaram 12, Kasargode 9, Adilabad and Nagpur 8 each, Kherunighat 7, Amraghat, Chottabekra and Pathri 5 each	Cheranmahadevi 20, Cherthala and Gudur 4 each, Kottayam and Jharasuguda 3	Nil
8	Pendra 23, Barki Suria and Nagpur 7 each, Sevoke 4, Karwar and Puri 3 each	Nagapattinam 11, Karaikal, Minicoy and Piravom 7 each, Kochi 3	Nurpur 4
9	Rampurhat 17, Ranchi 10, Gaya 9, Pendra 5, Visakhapatnam 4	Manimuthar 6, Chengannur and Coonoor 5 each, Nellore and Nancowrie 3 each	Srinagar 3
10	Sakaleshpur 13, Kannur 12, Dibrugarh and Thamballapalli 9 each, Vengurla 4	Tondi 19, Pondicherry 12, Madras 9, Kayamkulam 7, Nellore 3	Nil
11	Badatighat 17, Dibrugarh and Kakinada 4, Champasarai 3	Thiruvapur 9, Karaikal 5, Pondicherry 3	Nil
12	Kozhikode 12, Thrissur 9, Avinashi 6, Machilipatnam and Ratnagiri 5	Alur and Madras 11 each, Gudur 5, Minicoy and Palayamkottai 3 each	Nil
13	Priyakullam 7, Honavar and Mandya 6 each, Dantiwada 4	Chidambaram 9, Ambasamudram 7	Nil
14	Yelhanka 7, Port Blair 5, Aurangabad and Bijapur 3 each	Cherthala 3, Dindigul	Nil
15	Palacode 8, Hut Bay 5, Honavar 4, Tuljapur 3	Amini Divi 6, Amravati and Bir 4 each, Aurangabad, Hosdurg and Ratlam 3 each	Nil
16	Namakkal and Thiruvananthapuram 9 each, Hut Bay and Billoli 3 each	Nil	Nil

TABLE 2 (contd.)

(1)	(2)	(3)	(4)
17	Thrissur 14, Pune 9, Kulithalai 7	Nellore 3	Nil
18	Ottapidram 10	Nil	Nagapattinam 7, Karaikal and Vedaranyam 4 each
19	Avanigadda 11, Kangeyam 9, Chengannur 7	Pondicherry 3	Nellore and Shriperumbudur 6 each
20	Kollur 15, Panjim 13, Peermade 10, Karwar and Machilipatnam 7 each	Kondul 7, Noncowrie 3	Ponneri 7, Madras 6, Cuddalore 4
21	Dundigal 7, Tuticorin 4, Jagdalpur and Bombay 3 each	Nedumangad 5, Nancowrie 4, Nellore, Nagapattinam and Ongole 3 each	Pondicherry 18, Madras 15, Cuddalore 11
22	Gulbarga and Medak 6 each, Barsi 5, Madurai and Thrithala 4, Hut Bay 3	Nancowrie 10, Car Nicobar 8, Madras 3	Cuddalore and Madras 4 each, Nellore 3
23	Cochi, Mysore and Srivaikuntam 9 each, Hut Bay 7, Chipurapalli 6, Koragaon 4	Nil	Nil
24	Kodavaram 5, Hut Bay and Punalur 4 each	Gopalpur 5, Paradip 4, Madras 3	Bharari 4
25	Tadapatri 9, Paravur and Adiram-pattinam 7 each, Shimoga 6, Mysore 4	Aryankavu 8	Nil
26	Gadag and Shimoga 7 each, Polavaram 6, Palayamkottai 4, Cochi and Sangli 3 each	Port Blair 6, Thenmala 5	Nil
27	Pattambi 14, Bhavanisagar 12, Mysore 10, Venkatagiri 6, Pondicherry 5, Ranchi 3	Port Blair 3	Bhtinda 4, Pamban 3
28	Chengannur 9, Amini Divi 6, Nancowrie 4, Karaikal and Ongole 3	Thumba 5, Piravom 4, Alapuzha and Port Blair 3 each	Udhampur 7, Chowari, Malakpur, Pathankot and Srinagar 3 each
29	Manmdurai and Tadong 11 each, Kozha 7, Vedadri 5, Chitradurga 3	Nil	Srinagar 4
30	Perambavoor 11, Bijapur and Madras 5 each, Cuddapah and Sholapur 3 each	Nil	Nancowrie 3
31	Madras 24, Tiruvallur 18, Nancowrie 11, Nellore 8, Cochi 6	Nil	Nil

Meghalaya, Gangetic West Bengal, Madhya Maharashtra, Tamil Nadu, Karnataka, Kerala and Lakshadweep and on 1 to 5 days in Arunachal Pradesh, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Orissa, Bihar, Jammu & Kashmir, east Madhya Pradesh, Vidarbha, coastal Andhra Pradesh and Telangana.

4.1.5. *Month's rainfall* — Month's rainfall was excess in 14, normal in 3, deficient in 6 and scanty in

11 meteorological sub-divisions. There was no rain in east Rajasthan.

Rainfall was excess in Arunachal Pradesh, Bihar Plateau, Konkan & Goa, Madhya Maharashtra, Vidarbha, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala and Lakshadweep; normal in Assam & Meghalaya, east Madhya Pradesh and Marathwada; deficient in Andaman & Nicobar Islands, west Bengal & Sikkim, Orissa, Bihar plains and Jammu & Kashmir; scanty in Nagaland,

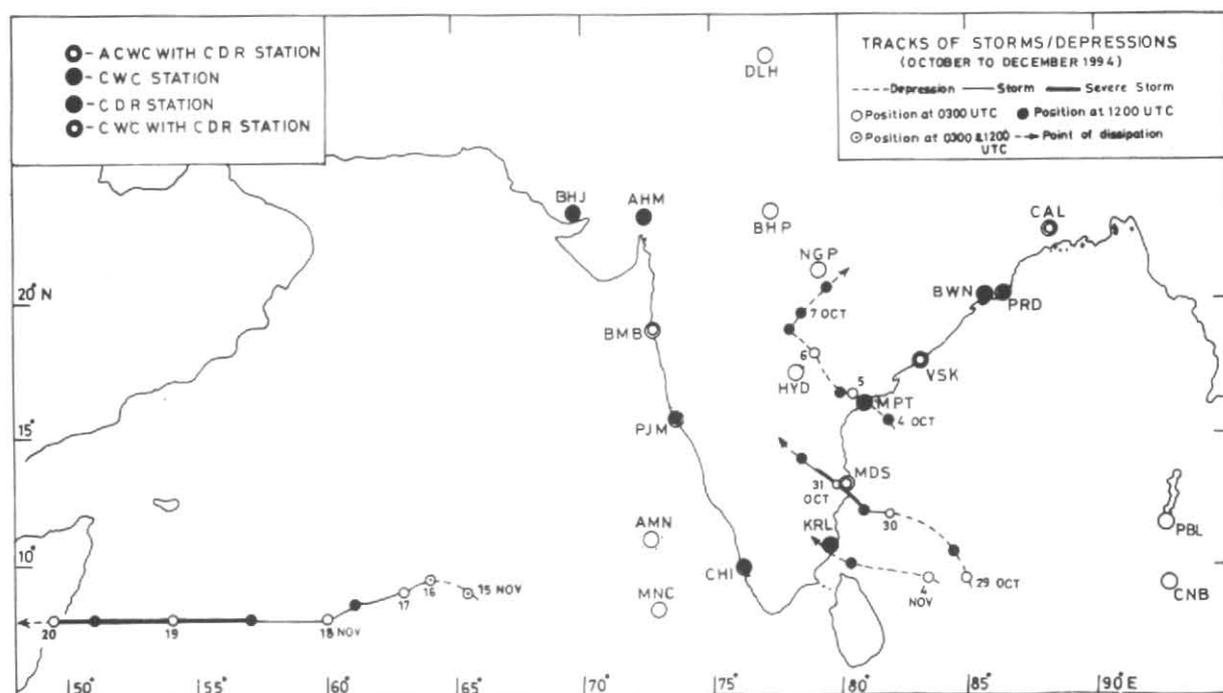


Fig. 2. Tracks of storms/depressions during the period October-December 1994

TABLE 3

Details of weather systems during October 1994

S. No.	System	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(A) Storms/depressions</b>						
(1)	Severe cyclonic storm	29-31	Southwest Bay	Northwest	South Rayalaseema and adjoining Tamil Nadu	First seen as a depression over southwest Bay
(2)	Deep depression	4-7	Southern parts of west-central Bay	Northwest upto 6 and then recurved to northeast	Meghalaya and neighbourhood	First seen as a cyclonic circulation extending upto 3.1 km asl off Andhra coast
(3)	Well marked low pressure area	19-23	Maldives and adjoining southeast Arabian Sea	Northwest	Moved away across west central Bay	Associated cyclonic circulation extended upto mid-tropospheric level
<b>(B) Cyclonic circulations</b>						
(1)	Mid-tropospheric levels	29 Sept-7 Oct	Coastal Tamil Nadu	West	Karnataka and neighbourhood	
(2)	Lower levels	11-15	Telangana and adjoining Rayalaseema	Do.	North interior Karnataka and adjoining parts of Telangana	
(3)	Do.	12-13	Maharashtra-Karnataka coast	Stationary	In situ	

TABLE 3 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(4)	Mid tropospheric levels	13-15	Southeast Arabian Sea and neighbourhood	Stationary		<i>In situ</i>
(5)	Lower tropospheric levels	15-17	Coastal Andhra Pradesh and neighbourhood	Do.		Do.
(C)	<i>Embedded cyclonic circulation</i>					
(1)	Lower Levels	29-31	Kerala coast	West		Southeast Arabian Sea and neighbourhood
(D)	<i>Troughs in the westerlies</i>					
(1)	Mid and upper tropospheric westerlies	12-15	Long. 65°E, north of Lat. 20°N	East		Long. 69°E, north of Lat. 20°N
(2)	Do.	27-29	Long. 65°E, north of Lat. 25°N	Northeast		
(E)	<i>Other troughs</i>					
(1)	Lower Levels	8-12	Karnataka-Kerala coasts	Stationary		<i>In situ</i>
(2)	Do.	14-16	Andaman sea and neighbourhood	Do.		Do.
(3)	Do.	17-18	Southwest Bay to coastal Karnataka	Stationary		Do.
(4)	Do.	22-29	Karnataka-Kerala coast	Quasi-stationary		Do.
(5)	Do.	22-27	Southwest Bay off Tamil Nadu coast	Northeast		Southwest and adjoining westcentral Bay
(F)	<i>Western disturbances</i>					
(1)	Upper air system	30 Sep-3 Oct	North Pakistan and adjoining Punjab	Do.		Moved away across Jammu & Kashmir
(2)	Do.	6-7	North Pakistan and neighbourhood	Do.		Do.
(3)	Upper air system	12-13	North Pakistan and adjoining Jammu & Kashmir	Eastnortheast		Moved away across Jammu & Kashmir
(4)	Do.	13-15	North Rajasthan and neighbourhood	Do.		Moved away across Himachal Pradesh

TABLE 4

Details of weather systems during November 1994

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
<b>(A) Cyclonic storms/depressions/low pressure area</b>						
(1)	Severe cyclonic storm with a core of hurricane winds	15-20	Southeast Arabian sea and neighbourhood	West	North Somalia	First seen as a trough of low over southeast Arabian sea
(2)	Depression	4-5	Southwest Bay	Westnorthwest	North Tamil Nadu coast	First observed as a low pressure area over southwest Bay off Tamil Nadu-Sri Lanka coast
(3)	Low pressure area	18-19	Maldiva-Comorin area	West	Southeast Arabian sea	
(4)	Do.	21-25	Comorin and neighbourhood	North	Lakshadweep and adjoining Kerala	
(5)	Well marked low pressure area	23-27	Southwest Bay and neighbourhood	East	Southwest Bay off Sri Lanka coast	First seen as a trough in the lower levels from central Bay to south Bay
<b>(B) Cyclonic circulations</b>						
(1)	Mid-tropospheric levels	8-13	East Madhya Pradesh	East	Assam and adjoining areas	
(2)	Do.	21-24	North Madhya Pradesh and adjoining Uttar Pradesh	East	Bihar and neighbourhood	
(3)	Lower levels	25-27	Lakshadweep and adjoining Maldives	Stationary	<i>In situ</i>	
<b>(C) Embedded cyclonic circulations</b>						
(1)	Lower tropospheric levels	13-15	Saurashtra & Kutch	Eastsouth-eastwards	North Madhya Maharashtra and adjoining Gujarat	
(2)	Lower levels	28-30	Lakshadweep and neighbourhood	Stationary	<i>In situ</i>	
(3)	Do	21-23	South Andaman sea and neighbourhood	Do.	Do.	
<b>(D) Western disturbances</b>						
(1)	Upper air system	4-5	North Pakistan and adjoining Jammu & Kashmir	Northeasterly	Moved away northeastwards across Jammu & Kashmir	
(2)	Do.	11-15	Do.	Do.	Moved away across Jammu & Kashmir	
(3)	Upper air system	27-29	Pakistan and neighbourhood	Eastnortheast	Do.	

TABLE 4 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
<b>(E) Trough in the westerlies</b>						
(1)	Mid and upper tropospheric level	1-3	Along Long. 77°E	West		Long. 80°E
(2)	Do.	7-11	Nepal to Madhya Maharashtra	Quasi-stationary		Nepal to north Tamil Nadu
(3)	Do.	21-30	73°E, north of 12°N	East		89°E, north of 20°N
<b>(F) Other troughs</b>						
(1)	Lower level	6-16	Southwest Bay off north Tamil Nadu-Sri Lanka coast	Northeast		Southwest Bay off Andhra-Tamil Nadu coast
(2)	Do.	19-21	Southwest Bay off north Tamil Nadu coast	West		Lakshadweep and adjoining Arabian sea Merged with low pressure area over Lakshadweep

Manipur, Mizoram & Tripura, Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, west Rajasthan, west Madhya Pradesh and Gujarat state. The significant amounts of daily rainfall (in cm) during the month are given in Table 2.

4.1.6. *Temperatures* — Day temperatures were above normal or appreciably above normal in 1st and last week of October in Himachal Pradesh, Rajasthan, Madhya Pradesh, Gujarat state and in some parts of Uttar Pradesh. They were generally normal over the rest of the country.

The highest day temperature of 40°C was recorded in Churu on 11 October.

4.1.7. *Disastrous weather events and associated damage* — Heavy rains associated with the deep depression (4 to 7 October) caused floods in parts of Karnataka, Andhra Pradesh and Vidarbha and death of 38 persons in Andhra Pradesh and 7 in north interior Karnataka. 4 persons died due to thunderbolt in Balurghat and Midnapore districts in west Bengal during 3 to 5 October.

Strong gale force winds and very heavy rainfall during the passage of severe cyclonic storm (29 to 31 October) caused heavy damage in Tamil Nadu and Andhra Pradesh. More than 30,000 huts in Tamil Nadu and more than 60,000 huts in Andhra Pradesh were damaged. More than 60,000 hectares of crop area have also been damaged in Andhra Pradesh. Total financial loss reported to be of 61

crores in Tamil Nadu and about 300 crores in Andhra Pradesh. Cyclone also claimed 69 people in Tamil Nadu and 235 in Andhra Pradesh.

#### 4.2. November

4.2.1. *Storms and depressions* — Two cyclonic disturbances; first, a depression over the Bay of Bengal and the second, a severe cyclonic storm with a core of hurricane winds over the Arabian Sea were formed during the month (Fig. 1).

(a) *Depression over the Bay of Bengal (4-15 November 1994)* — A low pressure area formed over the southwest Bay and adjoining southeast Bay on 3 and intensified into a depression over the southwest Bay on 4 morning. The system rapidly moved in a west-north-westerly direction crossed Tamil Nadu coast near Karaikal around the midnight of 4 and then weakened by 5 morning. Widespread rains with isolated heavy falls occurred over south coastal Andhra Pradesh on 3 and over Tamil Nadu from 3 to 6 November 1994.

(b) *Severe cyclonic storm with a core of hurricane winds over the Arabian Sea (15-20 November 1994)* — A depression formed over the southeast Arabian Sea on 15 morning and slowly moved west-north-west and intensified into a deep depression on 16 morning. The system further intensified into a cyclonic storm and was centred near Lat. 9.5°N/ Long. 64.0°E on 16 evening. The system, then, moved in a west-south-westerly to westerly direction

and intensified into a severe cyclonic storm with its centre near Lat.  $8.0^{\circ}\text{N}$ /Long.  $57.0^{\circ}\text{E}$  on 18 midnight (1800 UTC). It attained hurricane intensity at 0300 UTC of 19 near Lat.  $8.0^{\circ}\text{N}$ /Long.  $54.0^{\circ}\text{E}$ . The system then weakened into a severe cyclonic storm, crossed Somalia coast and further weakened into cyclonic storm on 20 morning. The system, then, rapidly weakened over Somalia.

During the initial stages of the system Lakshadweep area received widespread rains on 13, 14 and 15.

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

Northeast monsoon gave good amount of rainfall in coastal Andhra Pradesh, Telangana, Tamil Nadu and Lakshadweep during the month. Northeast monsoon was active to vigorous on 8 days in Tamil Nadu and 3 to 4 days in coastal Andhra Pradesh and Rayalaseema.

Rain or thundershowers have occurred almost at all the places or at many places on 6 to 7 days in Andaman & Nicobar Islands, Kerala and Lakshadweep and on 1 to 2 days in Orissa, Vidarbha, Telangana, Tamil Nadu and south interior Karnataka. Rain or thundershowers have occurred at a few places or at one or two places on 22 days in coastal Andhra Pradesh and Rayalaseema, on 15 to 20 days in Andaman & Nicobar Islands, Madhya Maharashtra, Marathwada, Telangana, Tamil Nadu, south interior Karnataka and Kerala, on 5 to 11 days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, Vidarbha, coastal Karnataka, north interior Karnataka and Lakshadweep and on 1 to 4 days in Gangetic West Bengal, Orissa, Bihar, east Rajasthan, Madhya Pradesh and Gujarat region.

4.2.3. *Monthly rainfall* — Rainfall was excess in 5, normal in 1, deficient in 8 and scanty in 17 meteorological sub-divisions. There was no rain in remaining 4 sub-divisions.

Rainfall was excess in Marathwada, coastal Andhra Pradesh, Telangana, Tamil Nadu and Lakshadweep, normal in Rayalaseema, deficient in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, east Madhya Pradesh, Madhya Maharashtra, Vidarbha, coastal and south interior Karnataka and Kerala, scanty in Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur,

Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar, west Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir, Rajasthan, west Madhya Pradesh, Gujarat region, Konkan & Goa and north interior Karnataka. There was no rain in east Uttar Pradesh, Haryana, Punjab and Saurashtra & Kutch. The significant amounts of daily rainfall are given in Table 2.

4.2.4. *Temperatures* — Night temperatures were 4 to  $6^{\circ}\text{C}$  below normal in Rajasthan, west Madhya Pradesh, Vidarbha and Marathwada during second week of the month and in Saurashtra during the last week of the month. It was 2 to  $4^{\circ}\text{C}$  below normal in east Rajasthan and west Madhya Pradesh during first five days of the month and in south Madhya Pradesh, Vidarbha and Telangana the third week of the month.

They were 4 to  $6^{\circ}\text{C}$  above normal in Maharashtra and north interior Karnataka in the first week and in west Rajasthan in third week of the month. They were generally normal over the rest of the country in the month.

4.2.5. *Disastrous weather events and associated damage* — As the depression (4 November) formed just 3 days after the passage of the severe cyclonic storm (29-31 October) it caused further damage to crops and property in coastal districts of Tamil Nadu and Andhra Pradesh.

Hail storm affected the eastern parts of Imphal district in Manipur and destroyed about 6,000 acres of standing paddy crops on 19 November 1994.

Arabian Sea cyclonic storm (15 to 20 November) did not cause any damage over the Indian region.

### 4.3. December

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

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

Four western disturbances, two cyclonic circulations and three induced cyclonic circulations affected the north-western parts of India. Under the influence of these systems Jammu & Kashmir and Himachal Pradesh received good amount of rain or snow during 1st, 2nd and 4th week of the month. During the last week of the month, heavy snowfall was reported in Kashmir valley and Ladakh.

TABLE 5  
Details of weather systems during December 1994

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
<b>(A) Western disturbances</b>						
(1)	Upper air system	5-8	North Afghanistan and neighbourhood	Eastnortheast	Move' away across Jammu & Kashmir	
(2)	Do.	15-16	North Pakistan and adjoining Jammu and Kashmir	Northeast	Do.	
(3)	Do.	17-20	North Pakistan and neighbourhood	Do.	Do.	
(4)	Do.	26 Dec-1 Jan	Do.	Do.	Do.	
<b>(B) Trough in the westerlies</b>						
(1)	Mid and upper troposphere	28 Dec-1 Jan	69°E, north of 15°N	Northeast	73°E, north of 29°N	
<b>(C) Other troughs</b>						
(1)	Lower levels	1-8	Kerala coast and neighbourhood	Quasi-stationary	Kerala coast and adjoining Karnataka coast	
(2)	Do.	1-3	Andaman sea and neighbourhood	Stationary	<i>In situ</i>	
(3)	Do.	5-8	South Andaman sea and neighbourhood	Do.	Do.	
(4)	Do.	9-14	Southwest Bay off Sri Lanka north Tamil Nadu coast	Do.	Do.	
(5)	Do.	15-16	Lakshadweep-Maldiva area	Do.	Do.	
(6)	Do.	15-25	Southwest Bay off Sri Lanka coast	Quasi-stationary	North Tamil Nadu coast to Commorin area	
(7)	Do.	17-19	Andaman Sea			Merged with the above system
(8)	Do.	21-25	Lakshadweep and neighbourhood	Stationary	<i>In situ</i>	
(9)	Do.	28 Dec-4 Jan	Off north Tamil Nadu coast	West	Off Sri Lanka coast	
<b>(D) Cyclonic circulations</b>						
(1)	Mid tropospheric levels	2-5	North Pakistan and neighbourhood	East	Punjab and adjoining Pakistan	

TABLE 5 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(2)	Lower Levels	10-12	Eastern parts of Bihar plains and neighbourhood	East	Sub-Himalayan West Bengal and neighbourhood	
(3)	Mid tropospheric levels	21-26	Pakistan and neighbourhood	Northeast	Moved away across Punjab and Himachal Pradesh	Persisted there with a trough aloft upto 4.5 km asl on 24
(E)	<i>Induced cyclonic circulations</i>					
(1)	Lower levels	7-8	Punjab and neighbourhood	Stationary	<i>In situ</i>	
(2)	Do.	8-10	North Pakistan and neighbourhood	East	Punjab and neighbourhood	
(3)	Do.	27-28	Southwest Rajasthan and adjoining Pakistan	East	Punjab and adjoining northwest Rajasthan	Associated cyclonic circulation extended upto lower tropospheric levels with a trough aloft upto 3.1 km asl

Rain or snow occurred almost at all the places or at many places on 5 days in Jammu & Kashmir and 3 days in Himachal Pradesh. Rain or thunder-showers occurred at many places on one day in Punjab and at a few places or at one or two places on 10 to 16 days in Andaman & Nicobar Islands, Himachal Pradesh and Tamil Nadu, on 4 to 8 days in Arunachal Pradesh, hills of west Uttar Pradesh, Haryana, Punjab, Jammu & Kashmir, coastal Andhra Pradesh, Rayalaseema, south interior Karnataka and Kerala and on 1 day in Sub-Himalayan West Bengal & Sikkim. Mainly dry weather prevailed over the rest of the country.

4.3.3. *Monthly rainfall* — Rainfall activity was very much subdued during the month. Rainfall was excess in 2, normal in nil, deficient in 5 and scanty in 7 sub-divisions. There was no rainfall in 21 sub-divisions.

Rainfall was excess in Himachal Pradesh and Jammu & Kashmir, deficient in Sub-Himalayan West Bengal & Sikkim, Punjab coastal, Andhra Pradesh, Rayalaseema and Tamil Nadu and scanty in Andaman & Nicobar Islands, west Uttar Pradesh, Haryana, south interior Karnataka, Kerala and Lakshadweep. There was no rainfall over the rest of the country. Significant amounts of rainfall in the month are given in Table. 2.

4.3.4. *Temperatures* — Moderate to severe cold wave conditions prevailed on 6 to 8 days between 11

to 21 December in the plains of west Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, Rajasthan and Saurashtra & Kutch. Cold wave conditions also prevailed over northwest, central and eastern parts of India for 3 to 4 days in last week of December. Night temperatures were appreciably below normal on 5 to 10 days in Madhya Maharashtra, Marathwada, interior Karnataka, interior Andhra Pradesh and Tamil Nadu and they were appreciably above normal for 5 to 10 days in west Rajasthan, Punjab and Haryana, Himachal Pradesh, coastal Andhra Pradesh, Rayalaseema and south interior Karnataka. It was generally normal over the rest of the country during the month. Lowest night temperature recorded over the plains was  $-1^{\circ}\text{C}$  at Churu on 11 and it was  $-5^{\circ}\text{C}$  to  $-3^{\circ}\text{C}$  over the hills on 18, 19 and 20 of the month.

4.3.5. *Disastrous weather events and associated damage* — 12 persons were killed in Rajasthan due to cold wave conditions prevailing from 11 to 14 and 22 to 25 December. 3 persons were killed in house collapse in Madras city due to heavy rains on 21 December.

According to press reports, Ladakh and Kashmir valley remained cut-off from rest of the country during the last week of the month as snow storm and hail lashed the entire region. The Jammu-Srinagar highway was under nearly ten feet deep snow. This surpassed last two decades' record.