

Weather

POST MONSOON SEASON (OCTOBER-DECEMBER 1989)*

1. Introduction

During the post monsoon season of 1989, four cyclonic disturbances developed over the Bay of Bengal and no cyclonic disturbance formed over the Arabian Sea. Out of the 4 cyclonic disturbances, 3 formed in November and one in October. One of the three systems of November was of hurricane intensity. Between the remaining two, one was deep depression and the other was a depression. The system in October was a deep depression. The tracks of these cyclonic disturbances are shown in Fig. 1.

The northeast monsoon rainfall was normal over Tamil Nadu and Kerala and deficient in Andhra Pradesh and Karnataka. The monthly and seasonal rainfall amounts and their percentage departures are given in Table 1.

For describing the monthly and seasonal rainfall, the following norms have been adopted :

- Excess : Rainfall departure + 20 per cent of normal or more.
- Normal : Rainfall departure + 19 to 6 - 19 percent of normal.
- Deficient : Rainfall departure - 20 per cent to - 59 per cent of normal and
- Scanty : Rainfall departure - 60 per cent or less of normal.

2. Chief features

- (i) Development of very intense but small core tropical cyclone in the Bay of Bengal. It was a severe cyclonic storm with a core of hurricane wind which crossed Andhra coast near Kavali and caused considerable damage to life and properties in Nellore and Prakasham districts of Andhra Pradesh.
- (ii) Withdrawal of southwest monsoon from the country by 13 October.
- (iii) Commencement of northeast monsoon over Tamil Nadu on 27 October.
- (iv) Heavy snowfall in Himachal Pradesh during the last week of December.

- (v) Widespread fog, cold wave conditions and chilly weather in some parts of north India.

3. Seasons rainfall

During this season maximum rainfall occurs in Andaman & Nicobar Islands, Tamil Nadu and Kerala, where the normal values range between 53 and 78 cm. The other sub-divisions where the normal seasonal rainfall is quite large, are the sub-divisions of northeast India, Himachal Pradesh, Jammu & Kashmir, coastal Andhra Pradesh, Rayalaseema, Karnataka and Lakshadweep.

The rainfall during the season was in excess over two, normal over eight, deficient over fourteen and scanty over eleven sub-divisions. It was excess in Arunachal Pradesh and Assam & Meghalaya and normal in Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Bihar plateau, Haryana, Himachal Pradesh, Jammu & Kashmir, Tamil Nadu and Kerala. It was deficient in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Bihar plains, hills of west Uttar Pradesh, Punjab, Konkan & Goa, Vidarbha, Andhra Pradesh, Karnataka and Lakshadweep and was scanty in Orissa, plains of Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat, Madhya Maharashtra and Marathwada.

Rainfall figures are given in Table 1.

4. October

4.1. Withdrawal of the southwest monsoon

Though the withdrawal phase of the southwest monsoon began in mid-September, it withdrew only from northwest India during that month. On 2 October it withdrew from west Uttar Pradesh, northwest Madhya Pradesh, southwest Rajasthan and north Gujarat and on 4 October it further withdrew from east Uttar Pradesh and adjoining parts of northeast Madhya Pradesh. On 5 October the monsoon further withdrew from Bihar, parts of east Madhya Pradesh (to the north of Lat. 21.5°N), southwest Madhya Pradesh, northern parts of Maharashtra and south Gujarat and on 6 October from Sub-Himalayan West Bengal & Sikkim, remaining parts of east Madhya Pradesh and Maharashtra and from northern parts of Telangana and north interior Karnataka. However, the southwest monsoon rains

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TABLE 1

Rainfall summaries for post monsoon season (October-December 1989)

Sub-divisions	Oct' 89		Nov' 89		Dec' 89		Seasonal		
	Actual (mm)	Defect (%)	Actual (mm)	Defect (%)	Actual (mm)	Defect (%)	Actual (mm)	Normal (mm)	Defect (%)
(1) A. & N. Islands	310.3	-7	253.3	1	11.5	-94	575.1	784.5	-27
(2) Arunachal Pradesh	182.3	25	84.5	190	0	-100	266.8	175.5	52
(3) Assam & Meghalaya	166.4	37	23.9	11	9.7	2	200.0	152.8	-4
(4) Nag., Mani. & Mizo.	196.0	16	4.4	-86	3.7	-45	204.1	207.4	-2
(5) S.H.W.B. & Sikkim	77.9	-49	51.4	206	8.8	44	138.1	175.6	-21
(6) G. W. st Bengal	137.0	11	3.0	-89	20.3	421	160.3	153.8	4
(7) Orissa	43.9	-69	0.7	-98	1.7	-67	46.3	182.7	-75
(8) Bihar Plateau	48.7	-41	5.9	-55	27.4	509	82.0	100.3	-18
(9) Bihar Plains	32.4	-51	2.2	-72	13.3	432	47.9	75.9	-37
(10) East Uttar Pradesh	6.3	-89	3.6	-20	15.1	132	25.0	67.3	-63
(11) Plains west U.P.	0.3	-99	3.2	-26	14.6	68	18.1	53.8	-66
(12) Hills west U.P.	10.8	-84	24.4	81	31.7	29	66.9	107.6	-38
(13) Har., Chandī. & Delhi	2.3	-89	9.8	180	18.3	97	30.4	33.6	-9
(14) Punjab	0	-100	11.2	78	20.6	50	31.8	45.6	-30
(15) Himachal Pradesh	5.0	-91	48.6	175	68.7	53	122.3	115.6	6
(16) Jammu & Kashmir	42.9	18	22.5	-31	65.3	-13	130.7	143.8	-9
(17) West Rajasthan	0.6	-90	0.5	-76	10	-71	2.1	11.8	-82
(18) East Rajasthan	0	-100	0	-99	0.6	-86	0.6	25.7	-98
(19) West Madhya Pradesh	0.2	-99	0	-99	7.0	-7	7.2	53.1	-86
(20) East Madhya Pradesh	5.5	-87	1.8	-84	15.4	85	22.7	71.1	-68
(21) Gujarat Reg., Daman, Dadra & Nagar Hav.	0.1	-99	0	-100	0	-99	0.1	27.4	-99
(22) Saurashtra, Kutch & Diu	0.1	-99	0	-100	0	-100	0.1	21.9	-99
(23) Konkan & Goa	86.1	-9	1.2	-95	0.4	-97	87.3	130.6	-33
(24) Madhya Maharashtra	26.6	-61	1.9	-93	2.5	-65	31.0	103.2	-70
(25) Marathwada	20.6	-55	0.4	-98	5.3	-68	26.3	82.9	-68
(26) Vidarbha	6.7	-86	0.1	-99	40.8	200	47.6	76.4	-38
(27) Coastal Andhra Pradesh	62.7	-67	54.5	-46	21.0	-9	138.2	313.5	-56
(28) Telangana	37.9	-50	5.9	-71	9.6	55	53.4	102.1	-48
(29) Rayalaseema	47.3	-60	64.9	-14	28.6	-1	140.8	223.1	-37
(30) T. Nadu & Pondi.	157.4	-20	195.7	-1	46.4	-50	399.5	486.6	-18
(31) Coastal Karnataka	142.5	-22	42.1	-37	0.5	-97	185.1	265.7	-30
(32) N.I. Karnataka	28.3	-70	9.8	-65	15.4	103	53.5	130.6	-59
(33) S.I. Karnataka	113.3	-25	31.4	-46	2.9	-78	147.6	222.7	-34
(34) Kerala	312.8	8	89.8	-45	6.5	-85	409.1	495.2	-17
(35) Lakshadweep	150.7	-7	50.6	-51	4.7	-93	206.0	336.0	-39

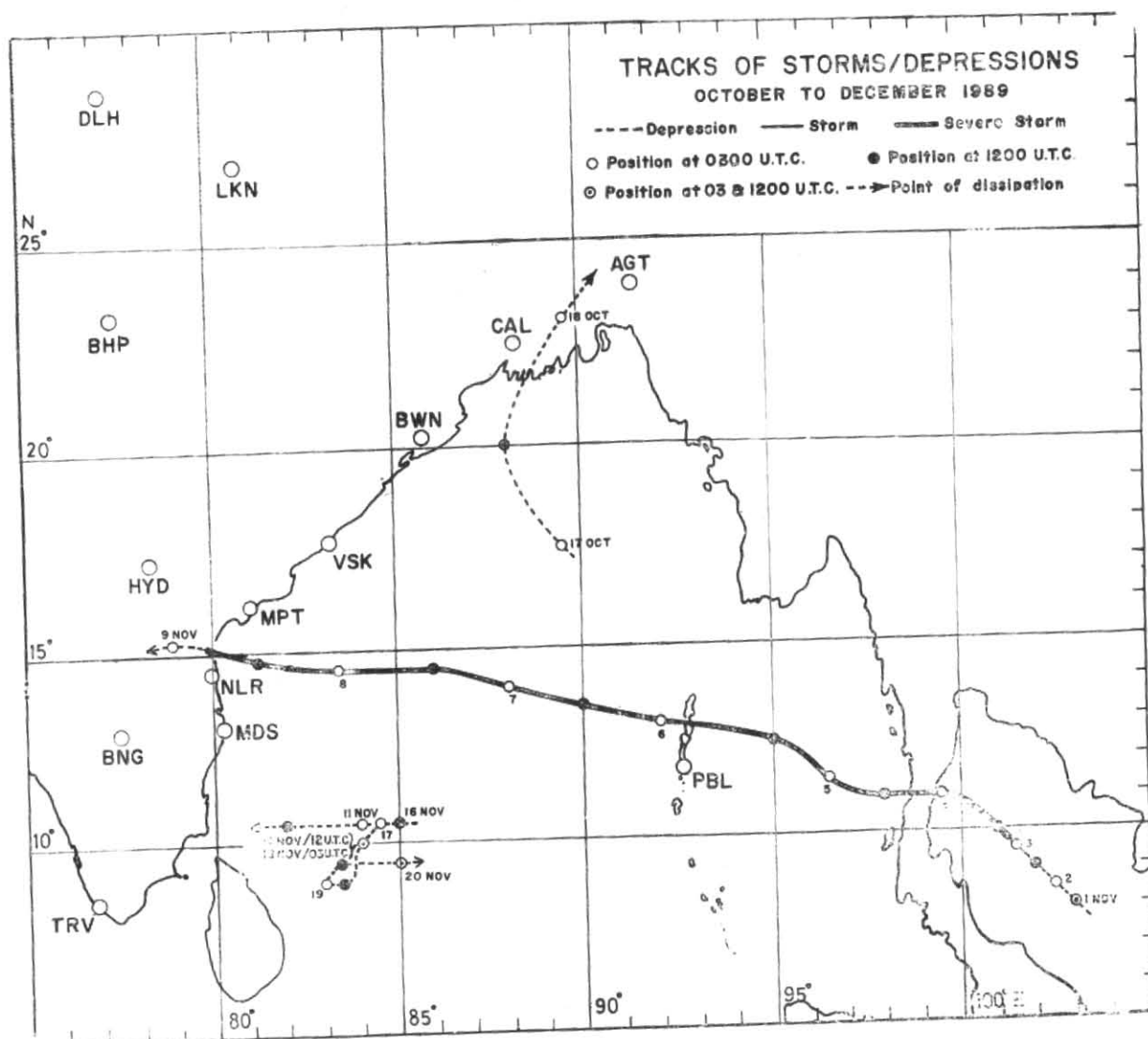


Fig. 1

continued over northeast India, till 11 October. On 13 October, the southwest monsoon withdrew from the entire country outside Tamil Nadu and Kerala.

4.2. Weather and associated synoptic features

The details of the synoptic features for the month are given in Table 2.

Besides these synoptic systems, north India was affected by two troughs in the middle and upper tropospheric westerlies during the last week of the month.

There was good thundershower activity over northeast India, Kerala and Andaman & Nicobar Islands and Lakshadweep during the month. Monsoon was active to vigorous on 8 days in Kerala and was active on 1 to 2 days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Konkan & Goa and south interior Karnataka. Rain or thundershowers occurred almost at all the places or at many places on 14 days in Andaman & Nicobar Islands on 4 to 7 days in Arunachal Pradesh,

Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura and Kerala and on 1 to 3 days in Gangetic West Bengal, east Uttar Pradesh, Jammu & Kashmir Konkan & Goa, Marathwada, Andhra Pradesh, Tamil Nadu, Karnataka and Lakshadweep. They occurred at a few places or at one or two places on 21 to 28 days in Gangetic West Bengal, Orissa and Tamil Nadu; on 10 to 18 days in Andaman & Nicobar Islands, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Bihar, Madhya Maharashtra, coastal Andhra Pradesh, coastal and south interior Karnataka and Kerala and on 2 to 8 days over the rest of the country outside plains of west Uttar Pradesh and Gujarat region, where the weather was mainly dry during the month.

4.3. October rainfall

The October normal rainfall is 10 cm or more in coastal Andhra Pradesh, Rayalaseema, Tamil Nadu, Karnataka, Kerala, Andaman & Nicobar Islands, Lakshadweep and in northeast India outside Bihar, where it ranges

TABLE 2
Details of the weather systems during October 1989

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) Depression/Low pressure area					
(1) Depression	17th-19th eve.	East central & adjoining west central & northwest Bay	NW'yly to NNE'yly	Assam & Meghalaya	First observed as cyclonic circulation over north Andaman Sea & neighbourhood on 12th
(2) Low pressure area	21st-26th eve.	Southeast & adjoining east central Bay and neighbourhood	WNW'yly to Northerly	North Bay & neighbourhood. However, associated cyclonic circulation extending to lower tropospheric levels became unimportant there on 28th	Appeared as a cyclonic circulation in the lower & middle tropospheric levels over Andaman Sea on 19th
(B) Cyclonic circulation					
(1) Lower & middle tropospheric levels	4th-9th eve.	North Andaman Sea and neighbourhood	WNW'yly to Northerly	Meghalaya & neighbourhood	
(2) Lower tropospheric levels	5th-7th	South Karnataka-north Kerala coasts	—	<i>In situ</i>	
(3) Lower & middle tropospheric levels	7th-8th eve.	Kerala and adjoining south Karnataka	—	Do.	
(4) Lower tropospheric levels	9th-11th	Tamil Nadu & neighbourhood	Westerly	North Kerala-south Karnataka coast	
(5) Lower tropospheric levels	9th-16th	West central & adjoining southwest Bay off north Tamil Nadu-south Andhra coast	WSW'yly	Moved away westwards across extreme south Peninsula & Lakshadweep area	
(6) Lower tropospheric levels	19th-21st	Lakshadweep area	—	<i>In situ</i>	
(7) Middle tropospheric levels	23rd-26th	Lakshadweep area	—	Do.	
(8) Lower tropospheric levels	26th-31st eve.	Southwest Bay & adjoining coastal Tamil Nadu	Westerly	Lakshadweep area and neighbourhood	

between 7 and 8 cm. The rainfall normals are as much high as 34 cm for Andaman & Nicobar Islands, 29 cm for Kerala, 20 cm for Tamil Nadu and 19 cm for coastal Andhra Pradesh. The rainfall during the month (Table 1) was in excess in two, normal in seven, deficient in eight and scanty in sixteen sub-divisions. There was no rain over Punjab and east Rajasthan.

The rainfall was in excess in Arunachal Pradesh and Assam & Meghalaya; normal in Andaman & Nicobar Islands, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Jammu & Kashmir, Konkan & Goa, Kerala and Lakshadweep; deficient in Sub-Himalayan West Bengal & Sikkim, Bihar, Marathwada, Telangana, Tamil Nadu, coastal and south interior Karnataka and was scanty in Orissa, Uttar Pradesh, Haryana, Himachal Pradesh, west Rajasthan, Madhya Pradesh, Gujarat, Madhya Maharashtra, Vidarbha, coastal Andhra Pradesh, Rayalaseema and north interior Karnataka.

The significant amounts of rainfall (cm) during the month were :

- 1st : Bagodar, Kuppam & K.G. Field 10 each, Bangalore AP, Bombay AP, Madikeri, Parkal & Ratnagiri 5 each, Baramati, Hut Bay & Pasighat 4 each.
- 2nd : Usilampatti 13, Harnai 10, Car Nicobar 8, Devgarh & Kondul 5 each, Gulbarga & Silchar 3 each.
- 3rd : Harnai 14, Atchanta & Koderu 9 each, Zaheerabad 7, Car Nicobar 5, Port Blair & Ratnagiri 4 each.
- 4th : Car Nicobar 8, Canning Town 6, Pune AP & Sangli 4 each, Nan-cowry & Panjim 3 each.
- 5th : Ranchi AP 7, Aruppukottai 6, Madikeri & Port Blair 5 each, Amini Divi, Calcutta & Vellore 4 each.
- 6th : Pandavapura 16, Mannarghat 7, Hassan 6, Lumding, Minicoy & Purnea 5 each, Narsapur & Trivandrum AP 4 each.
- 7th : Mankompu 17, Alleppey 15, Mulki 14, Jeypore 12, Nagamandala 8, Balasore & Kozhikode 6 each, Mangalore AP & Trivandrum AP 5 each.

- 8th : Kozhikode & Mulki 15 each, Hassan & Udipi 9 each, Madurai AP 6, Guwahati AP 5.
- 9th : Cochin AP 21, Vaikom 18, Shillong 13, Koderu, Kottayam & Pasighat 11 each, Namakkal 8, Chaparmukh, Imphal, Madras AP & Silchar 7 each, Aijal, Bangalore & Madurai AP 5 each.
- 10th : Sandheads 10, Hosdurg 9, Baripada & Pondicherry 8, Canning Town 7, Kasargode 6, Silchar 5, Balasore & Cochin AP 4 each.
- 11th : Agartala AP 18, Chaparmukh 13, Calcutta AP & Cooch Behar 7 each, Durgachak 6, Balurghat & Cannanore 5 each, Diamond Harbour 4.
- 12th : Goalpara 13, Car Nicobar 9, Purulia 6, Gulmarg 5, Nagapattinam 5, Bangalore & Poonch 4 each, Jalpaiguri & Srinagar 3 each.
- 13th : Mannarghat 9, Sulya 6, Banihal, Gulmarg, Nancowry & Trichur 5 each, Tirupattur & Quazigund 4 each, Poonch & Tisa 3 each.
- 14th : Guddalur Bazar 6, Cochin AP 5, Peermade 4, Car Nicobar, Madurai & Port Blair 3 each.
- 15th : Car Nicobar & Quilon 4 each, Port Blair & Vedaranyam 3 each.
- 16th : Paramakudi 4, Chintapalli 3.
- 17th : Calcutta AP 9, Kundul 8, Telicherry 6, Berhampore & Car Nicobar 4 each, Aijal, Cooch Behar, Diamond Harbour & Palayamkottai 3 each.
- 18th : Midnapore 8, Cochin AP & Shillong 5 each, Jalpaiguri, Kottayam & Udipi 4 each, Agartala AP, Aijal, Calcutta AP, Car Nicobar, Dibrugarh AP, Imphal, Punalur & Sagar Island 3 each.
- 19th : Shillong 13, Karaikal, Lunding & Thenmala 7 each, Dibrugarh AP 5, Hut Bay & Panambur 4 each, Agartala AP, Mysore & Tezpur 3 each.
- 20th : Nedumangad 12, Aruppukottai 11, Thumba 7, Trivandrum 6, Madurai AP & Minicoy 4 each, Kodaikanal & Punalur 3 each.
- 21st : Minicoy 11, Qilandy 8, Bantwal 6, Bangalore AP 5, Coimbatore, Madurai, Port Blair & Tondi 3 each.
- 22nd : Peermade 8, Sriviliputtur 6, Palghat 5, Trichur 4, Ramnathapuram 3.
- 23rd : Kottayam 6, Imphal, Kayamkulam & Sringeri 3 each.
- 24th : Sandheads 22, Usilampatti 15, Aruppukottai 8, Parangipettai 4, Krishnagar 3.
- 25th : Sandheads 10, Parvatipuram 7, Madurai 4, Bhagalpur, Dehri, Dharampuri & Tellicherry 3 each.
- 26th : Ponnani 11, Mannarghat 10, Coimbatore & Peermade 8 each, Cannanore 6, Manaparai 4.
- 27th : Ponneri 9, Kumbhakonam 7, Kasargode 4, Guntur, Karkala, Madurai & Madras AP 3 each.
- 28th : Konni 13, Alleppey 10, Vedaranyam 8, Quilon 7, Parangipettai 5, Trivandrum 4, Madras 3.

- 29th : Palayamkottai 13, Karkala & Hyderabad AP 7 each, Khammam 6, Bapatla & Madurai 5 each, Mangalore AP & Mysore 4 each, Agatti, Adirampattinam, Madras, Nidadavole & Vellore 3 each.
- 30th : Punalur 12, Banswada 7, Salem 6, Palayamkottai, Ramagundam, Minicoy & Yelhanka AP 4 each, Bangalore 3.
- 31st : Pamban 13, Pattambi 8, Trichur 5, Alur 4, Cuddalore & Parangipettai 3 each.

4.4. Temperature

Day temperatures were appreciably to markedly above normal on most of the days in plains of west Uttar Pradesh, Himachal Pradesh, Rajasthan and Madhya Pradesh during the first fortnight of the month. They were also appreciably above normal on most of the days in Marathwada, Vidarbha, Rayalaseema and north interior Karnataka between 8th and 20th of the month.

Night temperatures were as much as 6° C to 7° C below normal on 3 days in Jammu and 2 days in Punjab, between 16th and 19th. They were either below or appreciably below normal on most of the days in Orissa, Uttar Pradesh, Jammu, Punjab, east Madhya Pradesh, Maharashtra, Telangana, Rayalaseema and in north interior Karnataka between 16th and 25th. Appreciably to markedly above normal night temperatures prevailed over east Rajasthan between 5th and 15th.

4.5. Disastrous weather events and damages

As per press reports, seven persons were killed, hundred of houses collapsed and trains services disrupted in the three northern districts of Karnataka due to heavy rain during the first two days of the month.

5. November

5.1. Storms and depressions

During the first week of November the Kavali hurricane developed over the Gulf of Thailand. It crossed Andaman group of Islands in the early morning of 6th November. It struck south Andhra coast near Kavali around midnight of 8th November.

The depression, that developed over southwest Bay on 11 November had a short span of life. It dissipated over southwest Bay off Tamil Nadu coast.

Another deep depression (16-20 November) developed over south Bay took an unusual course and dissipated over southeast and adjoining southwest Bay.

5.2. Weather and associated synoptic features

The details of the synoptic features are given in Table 3.

Besides those systems, a trough in the middle and upper tropospheric westerlies which lay over northeast India on the first day of the month moved away eastwards by 6th November. Peninsular India was also affected by troughs in the lower tropospheric levels between 2nd and 6th, 10th and 11th and between 21st and 23rd.

TABLE 3
Details of weather systems during November 1989

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) Low pressure area/depression/cyclonic storm					
(1) Kavali hurricane	1-9 Nov.	Gulf of Thailand	WNW'ly to Westerly	South Andhra Pradesh and neighbourhood	
(2) Depression	11th only	Southwest Bay	Westerly	Southwest Bay. The remnant moved away westwards across south Peninsula & Lakshadweep by 14th	First seen as a low pressure area over south Bay on 10th evening
(3) Deep depression	16th-20th	Southwest & adjoining southeast Bay	Westerly & then Easterly	Southeast & adjoining southwest Bay. The remnant became less marked over southeast Bay & neighbourhood on 26th	
(B) Induced cyclonic circulation					
(1) Lower tropospheric levels	4th-6th	Northwest Rajasthan & neighbourhood	Easterly	Northwest Uttar Pradesh & neighbourhood	
(2) Do.	22nd-27th eve.	Do.	Easterly	Became less marked over hills of west Uttar Pradesh and neighbourhood	
(C) Western disturbance					
(1) Upper air system	2nd-4th	North Pakistan	Easterly	Jammu & Kashmir & neighbourhood	
(2) Do.	9th-13th eve.	North Pakistan	Do.	Do.	
(3) Do.	13th-16th	North Pakistan	Do.	Do.	
(4) Do.	18th-20th	North Pakistan & adjoining Jammu & Kashmir	Do.	Do.	
(5) Do.	22nd-26th	Do.	Do.	Do.	
(6) Do.	27th-28th	North Pakistan & adjoining Afghanistan	Do.	Do.	

Normal thundershower activities occurred over Andaman & Nicobar Islands, Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Rayalaseema and Tamil Nadu. Northeast monsoon was active to vigorous on 6 days over Tamil Nadu, on 3 days over Rayalaseema and on 1 day over coastal Andhra Pradesh. Rain/thundershowers occurred either almost at all the places or at many places on 9 days in Andaman & Nicobar Islands; on 3 to 4 days in Arunachal Pradesh and Kerala and on 1 to 2 days in Sub-Himalayan West Bengal & Sikkim, hills of west Uttar Pradesh, Haryana, Punjab, Jammu & Kashmir, Rayalaseema, Tamil Nadu, Karnataka & Lakshadweep. They occurred at a few places or at one or two places; on 15 to 19 days in Andaman & Nicobar Islands, coastal Andhra Pradesh, Tamil Nadu, north interior Karnataka and Kerala on 5 to 9 days in Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Himachal Pradesh, Jammu & Kashmir, Telangana

Rayalaseema, coastal and north interior Karnataka & Lakshadweep and on 1 to 3 days in rest of the country outside Bihar plains, west Rajasthan, west Madhya Pradesh, Gujarat, Marathwada and Vidarbha. However, very light rainfall occurred at one or two places on 1 to 3 days in Bihar plains, west Rajasthan, west Madhya Pradesh, Marathwada and Vidarbha.

Rain or snow occurred almost at all the places in Himachal Pradesh on 5th and 25th and at many places in Jammu & Kashmir on 4th. Though there were a number of western disturbances between 9th and 20th, the rainfall over the western Himalayas was quite subdued during this period over the area.

5.3. November rainfall

The November normal rainfall is appreciable over Andaman & Nicobar Islands (25 cm), Tamil Nadu

(20 cm) and Kerala (16 cm). It is also quite high in coastal Andhra Pradesh and Lakshadweep (10 cm). The normal rainfall over Rayalaseema, coastal and south interior Karnataka during the month lies between 6 and 8 cm.

Rainfall during the month was excess in six, normal in four, deficient in nine and scanty in fourteen subdivisions. There was no rain over Gujarat during the month.

The rainfall was in excess in Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, hills of west Uttar Pradesh, Haryana, Punjab and Himachal Pradesh; normal in Andaman & Nicobar Islands, Assam & Meghalaya, Rayalaseema and Tamil Nadu; deficient in Bihar plateau, plains of Uttar Pradesh, Jammu & Kashmir, coastal Andhra Pradesh, coastal and south interior Karnataka, Kerala and Lakshadweep and scanty in Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar plains, Rajasthan, Madhya Pradesh, Maharashtra, Telangana and north interior Karnataka.

The significant amounts (cm) of rainfall are given below :

- 1st : Karaikal & Mavelikara 7 each, Pamban 6, Madras AP & Pondicherry 5 each, Vedaranyam 4.
- 2nd : Cochin AP 8, Madras AP 6, Cuddalore & Tuticorin 5 each, Coonoor 4, Pondicherry & Tondi 3 each.
- 3rd : Tirupattur 9, Tuticorin 8, Parangipettai 5, Coonoor & Pondicherry 3 each.
- 4th : Parangipettai 13, Mavelikara 8, Coonoor 5, Cooch Behar 4, Tuticorin 3.
- 5th : Cobichettipalayam 7, Gangtok 6, Cannanore, Gulmarg, Kottayam, Madras & Palghat 5 each, Alleppey & Panambur 4 each, Amini Divi, Bedarwah, Chamba, Rapur & Suliya 3 each.
- 6th : Long Island 15, Vridhunagar 10, coimbatore AP 9, Thumba 6, Cochin AP & Tuticorin 5 each, Madurai AP, Sagar Island & Tondi 4 each.
- 7th : Palayamkottai 7, Kondul & Minicoy 3 each.
- 9th : Bapatla 17, Addanki 8, Kandukur 7, Ongole 5, Nandyal 4, Karaikal 3.
- 10th : Bapatla, Chittor, Ponneri & Tirupati AP 5 each, Madras, Pakala & Raichur 4 each, Cuddapah, Cuddalore & Kurnool 3 each.
- 11th : Batote 4, Karaikal 3.
- 12th : Madras AP 18, Karaikal 16, Chidambaram 15, Parangipettai 13, Pakala, Tambaram & Vedaranyam 12 each, Nagapattinam 11, Tirupati AP 6, Adirampattinam & Ongole 3 each.
- 13th : Namakkal 13, Usilampatti 11, Kavali, Madras & Nagapattinam 8 each, Parangipettai & Tambaram 7 each, Nellore 6, Ongole 5, Coonoor & Peermade 4 each.
- 14th : Palayamkottai 14, Hosenagara 12, Kavali & Mulki 10 each, Nellore 8, Cannanore, Coonoor and Mangalore AP 7 each, Chitradurga 6, Madras & Hut Bay 4 each.
- 15th : Parangipettai & Port Blair 9 each, Aruppukottai 7, Coonoor, Dharwad & Nancowry 4 each, Kavali & Ramanathapuram 3 each.
- 17th : Nagapattinam 7, Pondicherry & Vedaranyam 3 each.
- 18th : Cuddalore & Parangipettai 6 each, Madras AP 4, Pondicherry 3.
- 19th : Chidambaram 21, Karaikal 16, Cuddalore 13, Pondicherry & Vedaranyam 10 each, Madras 6, Kanyakumari 5, Nedumangad 4.
- 20th : Punalur 6, Konni 5, Peermade 3.
- 21st : Punalur 5, Konni 3.
- 22nd : Long Island 15, Port Blair 4.
- 23rd : Car Nicobar 12, Port Blair 3.
- 24th : Hut Bay & Port Blair 3 each.
- 25th : Kalpa 9, Shimla 8, Chandigarh AP 4, Dharamshala, Hut Bay & Mandi 3 each.
- 26th : Dharchula 6.
- 27th : Kancheepuram 5, Cuddalore 3.
- 28th : Bankura & Tambaram 3 each.
- 29th : Karaikal & Vedaranyam 3 each.
- 30th : Tirupati AP & Tiruthuraipondi 7 each, Gudur 6, Karaikal 5.

5.4. Temperature

Cold wave conditions prevailed over hills of west Uttar Pradesh between 2nd & 5th, 8th & 9th, 22nd & 24th and 29th & 30th. Cold wave conditions also prevailed over Himachal Pradesh on 5th and 6th; over Jammu & Kashmir on 7th, 8th, 16th and 28th, over Punjab, on 8th and over Arunachal Pradesh on 9th. The lowest night temperature of the month which was 2° C was recorded at Mukteswar and Dalhousie on 5 November.

Night temperatures were generally below to appreciably below normal in Orissa during the first week of the month and was so in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Bihar and plains of Uttar Pradesh between 7th and 11th. They were also below normal over Assam & Meghalaya between 22nd and 28th.

Night temperatures were appreciably to markedly above normal on most of the days between 12th and 27th in Rajasthan west Madhya Pradesh and Gujarat region and were so between 10th and 20th in Maharashtra and Telangana.

5.5. Disastrous weather events and damages

The hurricane that struck south Andhra coast near Kavali affected about 4.27 lakh population in Nellore and Prakasam districts of Andhra Pradesh. It took a toll

TABLE 4
Details of weather systems during December 1989

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) Cyclonic circulation					
(1) Lower tropospheric levels	9th-11th	Lakshadweep area	—	<i>In situ</i>	A trough from the system extended to south Maharashtra coast between 9th and 14th
Do.	14th-16th	Bangladesh & adjoining Gangetic West Bengal	—	<i>In situ</i>	
(B) Induced cyclonic circulation					
(1) Lower tropospheric levels	19th-22nd	Northwest Rajasthan & neighbourhood	Easterly	Became unimportant over Himalayas of west Uttar Pradesh & Himachal Pradesh	It induced a low pressure area over central parts of Rajasthan on 20th, which became less marked over Haryana and neighbourhood on 21st
(2) Do.	22nd-25th	Central Rajasthan	Northeasterly	Haryana & adjoining north Rajasthan	
(C) Western disturbance					
(1) Upper air system	2nd-4th	North Pakistan	Easterly	Moved away across Jammu & Kashmir & neighbourhood	
(2) Do.	6th-8th	North Pakistan	Do.	Do.	
(3) Do.	9th-13th	North Pakistan & adjoining Jammu & Kashmir	Do.	Do.	
(4) Do.	16th-19th	Do.	Do.	Do.	
(5) Do.	19th-22nd	Do.	Do.	Do.	
(6) Do.	22nd-28th	North Pakistan	Do.	Do.	
(7*) Do.	29th	Do.	Do.	Do.	*Lay over north Pakistan & adjoining Jammu & Kashmir on 31st

*Carried over to January 1990.

of 51 human lives and damaged considerable number of pucca and kutcha houses. While crossing Andaman Island it killed one person and uprooted large number of trees and electric poles in the Island. Standing crops in thousands of acres of land were affected in coastal Andhra Pradesh due to its impact. Rail services between Madras and Vijayawada came to a standstill from the night of 8th November. Tracks between Ulavapadu and Vankateswarapalam, a 40 km stretch, were blocked by uprooted trees.

6. December

6.1. Weather and associated synoptic features

The details of the synoptic systems are given in Table 4.

Besides these synoptic systems, a trough in the middle and upper tropospheric westerlies between 5th and 9th affected the plains of north India and adjoining parts of central India. A trough in the lower levels affected weather over Andaman & Nicobar Islands between 1st and 3rd and another trough in the same level over southwest Bay off Tamil Nadu-south Andhra coast affected weather over Tamil Nadu and coastal Andhra Pradesh during the period from 10th to 19th of this month.

Northeast monsoon was vigorous over Rayalaseema on 2nd and was active over Tamil Nadu from 2nd to 4th.

Rainfall occurred at a few places or at one or two places over Tamil Nadu almost throughout the month. Rainfall over the rest of the Peninsular India occurred in four spells, *i.e.*, between 1st and 4th, between 11th and 13th, between 20th and 23rd and between 28th and 31st. Rainfall occurred over Himachal Pradesh and Jammu & Kashmir in two spells, *i.e.*, between 8th and 12th and between 18th and 26th while it occurred over rest of north India between 20th and 31st. Rainfall occurred either almost at all the places or at many places on 1 to 3 days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Bihar, hills of west Uttar Pradesh, Haryana, Punjab, east Rajasthan, east Madhya Pradesh, Vidarbha, Telangana, Rayalaseema and north interior Karnataka. It occurred at a few places or at one or two places on 13 to 15 days in coastal Andhra Pradesh and Tamil Nadu and on 3 to 9 days in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Bihar, Uttar Pradesh, Madhya Pradesh, Vidarbha, Rayalaseema, coastal and south interior Karnataka and Kerala.

The first spell of rain over Himachal Pradesh and Jammu & Kashmir, occurred at one or two places on 5 days over Jammu & Kashmir and one day in Himachal Pradesh. The second spell of activity over Himachal Pradesh and Jammu & Kashmir was rather heavy rain or snowfall. It occurred either almost at all the places or at many places on 4 days over Himachal Pradesh and 2 days over Jammu & Kashmir and at one or two places on one day each over these two sub-divisions. Hills of west Uttar Pradesh reported no snowfall during this months.

Over Andaman & Nicobar Islands and Lakshadweep the rainfall activity was quite subdued. Mainly dry weather prevailed over Gujarat.

6. 2. Month's rainfall

During this month the normal rainfall is about 20 cm over Andaman & Nicobar Island and about 9 cm over Tamil Nadu. The normal rainfall lies between 4 and 8 cm over Himachal Pradesh, Jammu & Kashmir, Kerala and Lakshadweep and between 2 and 3 cm over hills of west Uttar Pradesh, coastal Andhra Pradesh and Rayalaseema.

The rainfall during the month was excess over 14, normal over 5, deficient over two and scanty over 12 sub-divisions. There was no rain over Arunachal Pradesh and Saurashtra & Kutch. Rainfall was excess over West Bengal & Sikkim, Bihar, Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, east Madhya Pradesh, Vidarbha, Telangana and north interior Karnataka; normal in Assam & Meghalaya, Jammu & Kashmir, west Madhya Pradesh, coastal Andhra Pradesh and Rayalaseema; deficient over Nagaland, Manipur, Mizoram & Tripura and Tamil Nadu and scanty over the rest of the country outside Arunachal Pradesh and Saurashtra & Kutch.

The significant amounts (cm) of rainfall during the month were :

1st : Tirupati AP 7, Gudur 6, Chidambaram & Pamban 4 each, Nancowry & Tiruchirapalli 3 each,

- 2nd : Tirupati AP 19, Madras & Sularpeta 13 each, Ponneri 9, Rapur 8, Nagapattinam 7, Nellore 5, Ongole & Pamban 4 each, Adirampattinam & Coonoor 3 each.
- 3rd : Vankatagiri 13, Ponneri 10, Kavali, Tirupati AP & Tuticorin 8 each, Tambaram 6, Coonoor & Madras 5 each, Pondicherry 4, Karaikal, Kozhikode & Vedaranyam 3 each.
- 4th : Chidambaram, Cuddalore, Mavelikara & Vedaranyam 3 each.
- 5th : Pamban 4, Chidambaram 2.
- 11th : Ponneri 2.
- 12th : Tondi 3.
- 19th : Cuddalore 4, Mayiladuthurai 2.
- 20th : Batote & Jogindernagar 5 each, Badarwah, Dharamshala, Kangara, Kukernag & Mana 3 each.
- 21st : Dumka & Mana 7 each, Joshimath 4, Chamba, Dharamshala & Katra 3 each.
- 22nd : Mana 7.
- 23rd : Una 4, Allahabad AP, Bilaspur, Dharamshala, Muzaffarpur, Shimla & Srinagar AP 3 each.
- 24th : Mana 9, Joshimath 6, Bahraich & Shajahanpur 4 each, Dalhousie & Roorkee 3 each.
- 25th : Mana 8, Faizabad 3, Dalhousie 2.
- 26th : Mana 8, Godia & Purulia 5 each, Bankura 4, Dumka, Hazaribagh, Panagarh AP and Peermade 3 each.
- 27th : North Lakhimpur & Pusad 2 each.
- 28th : Mahabubnagar 2.
- 29th : Peermade 4.
- 30th : Bijapur & Chitradurga 3 each, Akola, Bagalkote & Tumkur 2 each.
- 31st : Luxshettipet 12, Asifabad 5, Medak 4, Pusad 3, Gulbarga, Nagpur AP, Nizamabad, Osmanabad, Ramagundam & Solapur 2 each.

6.3. Temperature

Cold wave conditions prevailed over Nagaland, Manipur, Mizoram & Tripura, between 6th and 11th, over east Uttar Pradesh between 8th and 10th, over hills of west Uttar Pradesh between 1st, 4th, between 13th and 15th and between 21st and 31st, over Punjab on 5th and 16th, over Himachal Pradesh between 24th and 26th, over Jammu between 4th and 7th and between 27th and 31st and over west Rajasthan between 27th and 29th. During the period from 27th to 31st, severe cold wave conditions prevailed at a few places in Bihar.

The cold wave conditions were severe on a few days in hills of west Uttar Pradesh.

Nights were comparatively cooler in northeast India during the first fortnight of the month. Night temperatures were generally below or appreciably below normal over these areas on most nights. They were also generally below to appreciably below normal in Madhya Maharashtra, Marathwada, Vidarbha and interior Karnataka between 7th and 20th. During the last ten days of the month they were appreciably to markedly above normal in east Madhya Pradesh, Madhya Maharashtra, Marathwada, Vidarbha and in Andhra Pradesh. The lowest minimum temperature during the month was recorded at Mukteswar, which was -3°C on 25th and over plains at Varanasi, which was 2°C on 10th.

During the last week of the month day temperatures were as much as 5°C to 9°C below normal at a few

places in Bihar, east Uttar Pradesh and Punjab causing chilly weather over these areas.

6.4. *Disastrous weather events and damages*

As per Press reports, heavy snowfall in Himachal Pradesh during 21-25 December cut off Dalhousie town in Chamba district and interior areas of Shimla district from the rest of the country. Rohtang Pass a gateway to Lahaul valley, remained closed due to heavy snowfall. The Suraj Tal Lake in the Spiti valley of Himachal Pradesh froze due to sub-zero temperature and heavy snowfall. Cold wave conditions and chilly weather during the last week of the month claimed a toll of 87 lives in Bihar, 17 lives in Uttar Pradesh and 5 lives in Gujarat.