

Weather

POST MONSOON SEASON (OCTOBER-DECEMBER 1990)*

1. Introduction

During the post monsoon season of 1990 four systems developed over the Bay of Bengal and one over the Arabian Sea. Two depressions in October (7-9 Oct, 31 Oct to 4 Nov) one in November (14-18 Nov) and one in December (14-19 Dec) formed over the Bay of Bengal. One depression in November (16-17 Nov) formed over the Arabian Sea. A severe cyclonic storm (S.C.S.) formed in December over the Bay of Bengal. The tracks of these systems are shown in Fig. 1.

The northeast monsoon rainfall commenced over Kerala and Tamil Nadu and adjoining Karnataka and Andhra Pradesh on 19 October. It was either normal or excess over the region. Monthly and seasonal rainfall amounts and their percentage departures are given in Table 1.

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

- (i) Excess : Rainfall departure + 20 per cent of the normal or above,
- (ii) Normal : Rainfall departure + 19 to -19 per cent of the normal,
- (iii) Deficient : Rainfall departure - 20 to -59 per cent of the normal,
- (iv) Scanty : Rainfall departure -60 per cent or less of the normal.

2. Chief features

- (i) Formation of a S.C.S. in the Bay of Bengal in December (14-19 Dec),
- (ii) Withdrawal of SW monsoon from the country outside Tamil Nadu and Kerala by 17 October,
- (iii) Commencement of northeast monsoon rainfall over Tamil Nadu and neighbourhood on 19 October,
- (iv) Severe floods in Ganjam district (Orissa) in early November,
- (v) Heavy rain/flash floods in Nilgiri district of Tamil Nadu during the month of October,
- (vi) Snowfall over Western Himalayas during the last week of December.

3. Seasonal rainfall

Seasonal rainfall was excess in 18, normal in 11, deficient in 3 and scanty in 3 meteorological sub-divisions (Table 4). Rainfall was excess in Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Bihar Plateau, Hills of West Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, East Madhya Pradesh, Maharashtra, Andhra Pradesh and Coastal Karnataka; normal in Andaman & Nicobar Islands, Arunachal Pradesh, Assam & Meghalaya, West Madhya Pradesh, Gujarat, Tamil Nadu, Interior Karnataka, Kerala & Lakshadweep; deficient in Sub-Himalayan West Bengal & Sikkim, Bihar Plains and Plains of West Uttar Pradesh and was scanty in East Uttar Pradesh and Rajasthan.

Seasonal rainfall departures are shown in Fig. 2.

4. Monthly features

4.1. October

4.1.1. *Withdrawal of southwest monsoon*—Southwest monsoon withdrew from Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, northwest Uttar Pradesh and West Rajasthan by 28 September. After, withdrawing from Uttar Pradesh and East Rajasthan the withdrawal of monsoon slowed down due to the formation of a depression over northwest Bay of Bengal on 7 October. By 13 October, it further withdrew from East Uttar Pradesh, West Madhya Pradesh, adjoining parts of East Madhya Pradesh and Gujarat. Thereafter by 17 October, southwest monsoon withdrew from the entire country outside Tamil Nadu and Kerala.

4.1.2. *Onset of northeast monsoon*—Northeast monsoon rainfall commenced over Tamil Nadu and adjoining south coastal Andhra Pradesh on 19th October. There was spurt in rainfall activity over these areas in association with a disturbance on 19 October over southwest and adjoining West Central Bay off Tamil Nadu-South Andhra coasts. Northeast monsoon rainfall was excess or normal over the meteorological sub-division in south Peninsula.

4.1.3. *Storms/depressions*—A depression formed over northeast Bay on 7 October and crossed West Bengal coasts and weakened on 9th. The second depression formed over South Bay on 31st. It crossed north Andhra-south Orissa coast and caused very heavy rainfall over Ganjam district of Orissa resulting in severe floods in the district.

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TABLE 1
Monthly and seasonal rainfall figures (mm) for post monsoon season 1990

Sub-divisions	October 1990			November 1990			December 1990			Oct-Dec' 90		
	Actual	Normal	%	Actual	Normal	%	Actual	Normal	%	Actual	Normal	%
(1) A. & N. Islands	181	319	-43	335	253	32	119	170	-30	635	743	-15
(2) Arunachal Pradesh	137	107	29	7	35	-79	17	11	54	162	152	6
(3) Assam & Meghalaya	205	154	33	13	31	-59	8	9	-14	226	194	16
(4) Naga, Mani. Mizo.	166	160	03	69	33	110	31	9	235	265	202	31
(5) S.H.W.B. & Sikkim	95	145	-34	0	17	-99	0	5	-94	96	166	-42
(6) G. West Bengal	150	122	22	31	20	60	2	3	-47	183	145	26
(7) Orissa	205	118	73	166	30	462	2	6	-69	373	154	143
(8) Bihar Plateau	146	83	76	15	13	15	0	5	-94	161	101	59
(9) Bihar Plains	38	66	-42	0	8	-96	0	3	-97	38	77	-51
(10) East Uttar Pradesh	12	47	-75	0	5	-100	7	6	13	19	58	-68
(11) Plains-West U.P.	6	29	-80	5	5	9	19	9	107	30	43	-30
(12) Hills-West U.P.	23	51	-56	10	10	0	75	25	204	107	86	25
(13) Har. Chandt. & Delhi	7	17	-59	18	4	411	30	9	21	55	30	83
(14) Punjab	2	18	-88	4	4	-5	49	15	225	55	37	48
(15) Himachal Pradesh	10	42	-76	12	14	-16	143	40	259	165	96	72
(16) Jammu & Kashmir	18	36	-50	4	33	-88	209	75	179	231	144	60
(17) West Rajasthan	3	10	-67	0	0	-100	2	6	-63	5	16	-66
(18) East Rajasthan	9	17	-49	3	14	-76	0	5	-95	12	37	-67
(19) West Madhya Pradesh	31	32	-03	1	14	-95	12	7	68	44	53	-18
(20) East Madhya Pradesh	78	53	46	3	2	22	9	17	-50	89	73	22
(21) Gujarat Reg., Daman, Dadra & Nagar Hav.	17	25	-35	11	6	80	7	1	407	34	33	5
(22) Sau., Kutch & Diu	11	15	-23	1	5	-81	7	2	319	19	21	-10
(23) Konkan & Goa	167	111	51	27	23	17	0	8	-100	194	142	37
(24) Madhya Maharashtra	171	73	135	31	29	8	3	7	-58	205	109	89
(25) Marathwada	232	57	307	11	21	-50	7	9	-24	249	86	188
(26) Vidarbha	147	43	244	0	14	-97	15	17	-11	162	74	120
(27) Coastal A. P.	258	193	34	118	102	16	9	24	-63	385	318	21
(28) Telangana	165	85	93	11	19	-40	0	6	-100	176	111	59
(29) Rayalaseema	148	119	24	119	76	57	40	29	38	307	224	37
(30) T. Nadu & Pondi.	244	197	24	172	197	-12	50	90	-44	466	483	-4
(31) Coastal Karnataka	245	184	33	88	64	37	0	17	-100	333	266	25
(32) N.I. Karnataka	78	70	11	21	20	6	0	7	-100	99	96	3
(33) S.I. Karnataka	143	153	-6	51	51	0	2	13	-85	196	217	-10
(34) Kerala	319	290	10	160	163	-2	7	43	-84	486	495	-2
(35) Lakshadweep	162	163	-1	155	102	52	9	69	-87	326	334	-2

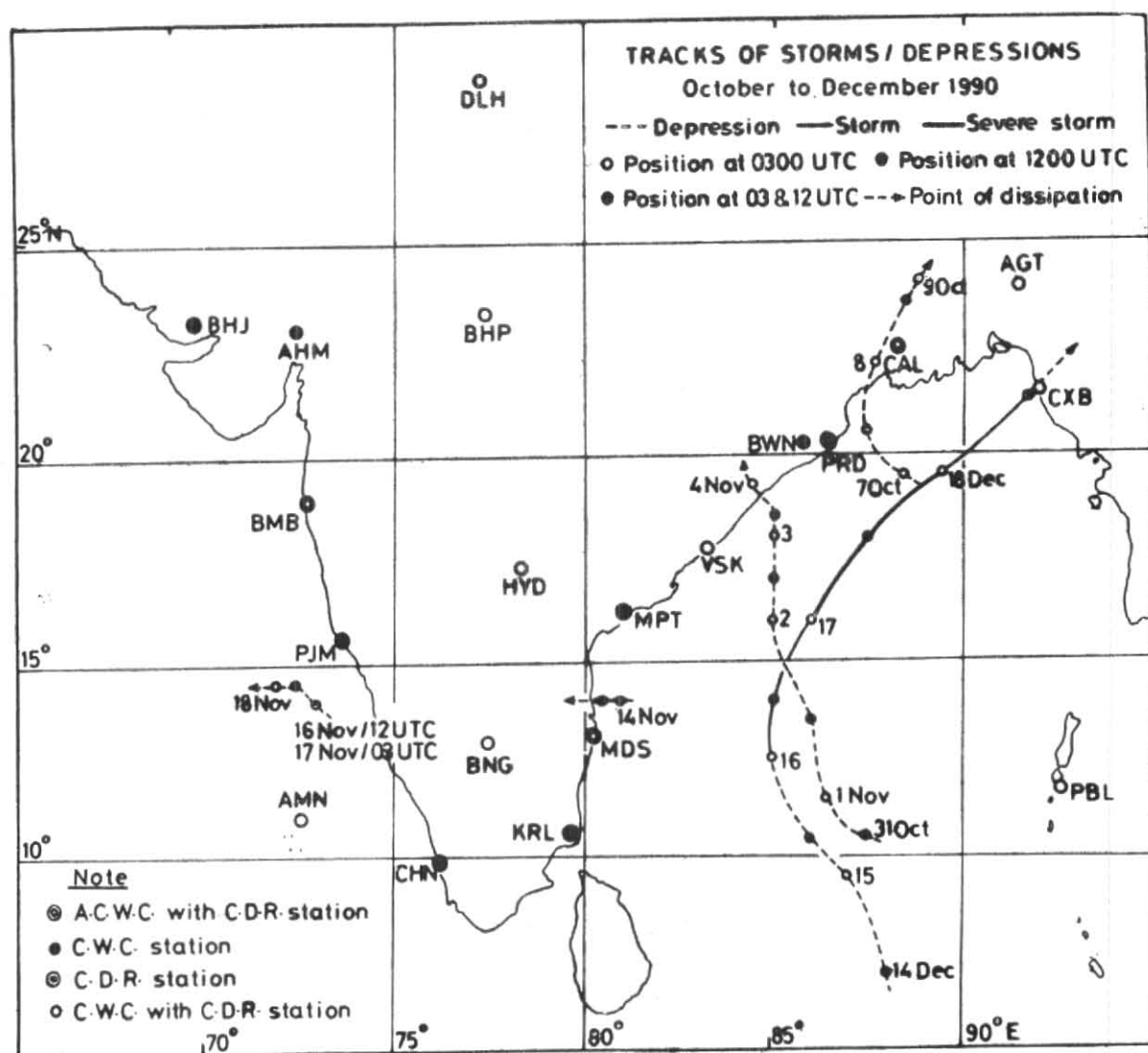


Fig. 1. Tracks of storms/depressions during October-December 1990

4.1.4. *Weather and associated synoptic features*—A northeast-southwest trough in the lower tropospheric levels running from Assam to north Konkan was observed between 7th and 9th of this month. Another trough in lower level easterlies running from Kerala to north coastal Andhra Pradesh was observed on 15th and 16th.

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

Southwest monsoon was active to vigorous on 8 to 10 days in Gangetic West Bengal and Orissa, on 3 to 6 days in Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Madhya Maharashtra, Marathwada, Coastal Andhra Pradesh and Telangana and on 1 to 2 days in East Madhya Pradesh, Konkan & Goa, Vidarbha and South Interior Karnataka. The number of active to vigorous northeast monsoon days were 8 in Tamil Nadu, 5 in south coastal Andhra Pradesh and 3 in Rayalaseema.

Rain or thundershowers occurred either almost at all the places or at many places on 16 days in Kerala,

on 11 to 12 days in Marathwada, Coastal Karnataka and Lakshadweep, on 4 to 7 days in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Bihar Plateau, East Madhya Pradesh, Konkan & Goa, Madhya Maharashtra, Vidarbha and South Interior Karnataka and on 1 to 3 days in Assam and adjacent States, Gangetic West Bengal, Orissa, Bihar Plains, Jammu & Kashmir, West Madhya Pradesh, Andhra Pradesh, Tamil Nadu and North Interior Karnataka during the month. They occurred either at a few places or at one or two places on 16 to 18 days in Bihar Plains and West Madhya Pradesh and on 4 to 8 days in Uttar Pradesh, Haryana, Punjab, East Rajasthan and Gujarat.

4.1.5. *Months rainfall*—Month's rainfall was excess in 15, normal in 6, deficient in 9, and scanty in 5 meteorological sub-divisions.

Rainfall was excess in Arunachal Pradesh, Assam & Meghalaya, Gangetic West Bengal, Orissa, Bihar Plateau, East Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Coastal Karnataka; normal in Nagaland, Manipur, Mizoram & Tripura, West

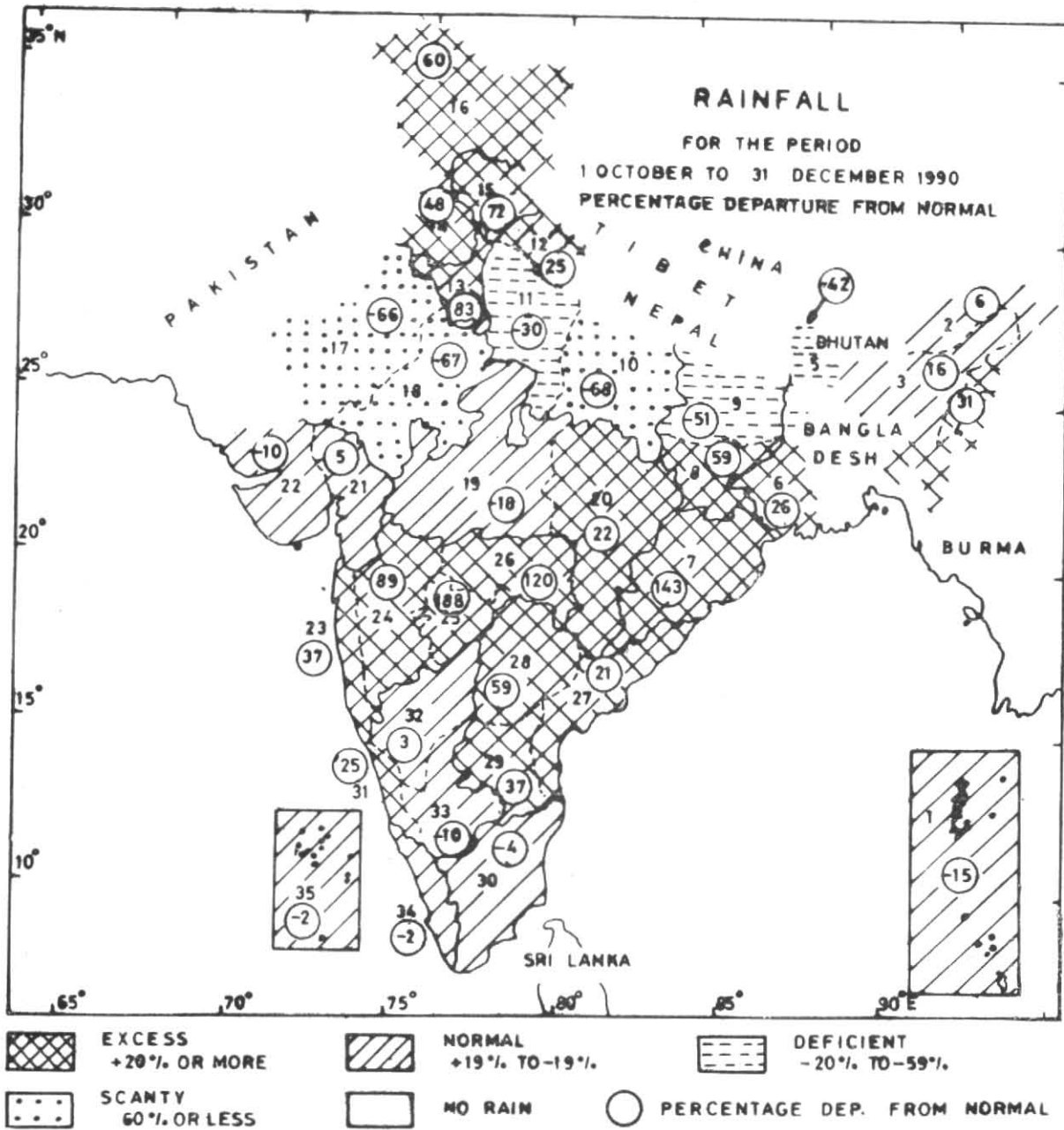


Fig. 2. Percentage departure from normal of rainfall for the period October-December 1990

TABLE 2
Details of weather systems during October 1990

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) Cyclonic storm/Depression/Low pressure area					
(1) Well marked low pressure area	1st-6th even.	Northwest & adjoining west central Bay off south Orissa-north Andhra coasts	—	Merged with the system under S. No. 2	Formed under the influence of upper air cyclonic circulation, which was observed over southwest & adjoining west central Bay off north Tamil Nadu-south Andhra coasts on 27 Sep
(2) Depression	7th-8th	Northwest Bay	NNW'ly to NNE'ly	Northwest Bangladesh and adjoining West Bengal. The remnant became unimportant over Assam & neighbourhood on 12th	Remnant of T.S. IRA moved westwards across southeast Asian countries & emerged into east central Bay as a low pressure area on 6th
(3) Low pressure area	26th-31st	Lakshadweep area & adjoining southeast Arabian Sea	Westerly	Moved away westwards	Initially seen as cyclonic circulation in lower tropospheric levels over Lakshadweep area on 23rd
(4) Deep depression*	31st eve. *Carried over to Nov.	Southeast & adjoining southwest Bay	NW'ly	—	Seen as a cyclonic circulation in the lower tropospheric levels over southwest & adjoining west central Bay off Tamil Nadu-south Andhra coasts on 27th
(B) Cyclonic circulation					
(1) Lower tropospheric levels	10th-12th	South Madhya Maharashtra & neighbourhood	Quasi-stationary	Konkan & neighbourhood	
(2) Do.	12th-15th	Southeast Madhya Pradesh & neighbourhood	N'ly	Gangetic West Bengal and neighbourhood	
(3) Do.	17th-18th	North Andaman Sea and neighbourhood	Stationary	<i>In situ</i>	
(4) Do.	19th-23rd	Southwest and adjoining west central Bay off Tamil Nadu-south Andhra coasts	Do.	Do.	
(C) Weather disturbance					
(1) Upper air system	30 Sep-3 Oct	North Pakistan and neighbourhood	Easterly	Moved away across Jammu & Kashmir and neighbourhood	
(2) Do. /Low pressure area	17th-20th	Northwest Rajasthan and neighbourhood	ENE'ly	Do.	Seen as a low pressure area over north Pakistan and adjoining Punjab on 17th
(3) Upper air system	30 Oct-2 Nov eve.	North Pakistan and neighbourhood	Easterly	Do.	

Madhya Pradesh, Interior Karnataka, Kerala & Lakshadweep; deficient in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Bihar Plains, Hills of West Uttar Pradesh, Haryana, Jammu & Kashmir, East Rajasthan and Gujarat and was scanty in Plains of Uttar Pradesh, Punjab, Himachal Pradesh and West Rajasthan (Table 4).

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

1st : Kurnool 13, Silchar 12, Jhargram 10, Aska & Baramati 9 each, Mohana & Nagarajunsagar 8 each, Arambagh & Titlagarh 7 each.

2nd : Madhira 25, Nandigama 17, Dummagudam 15, Koderu 12, Paleru 10, Bhadrachalam 8, Mahabubabad 7, Akola AP 6.

3rd : Dumka 13, Baruipur 11, Billoli & Titlagarh 9 each, Asansol & Dhone 8 each, Neemuch & Siruguppa 7 each.

4th : Sandheads 24, Jeypore 18, Contai 13, Mindapore 10, Cooch Behar & Poderu 8 each, Jabalpur & Phulbani 7 each.

5th : Rangagore 21, Jamtara & Purulia 13 each, Mohana 11, Dumka & Sonepur 9 each, Balasore, Kakdwip, Sompeta & Titlagarh 7 each.

6th	: Rajghat 9, Digha 8, Dhamtari, Hosanagara, Raipur & Sagar Island 7 each.	Udgir 10, Karaikal & Pondicherry 9 each, Cuddalore, Cochi AP & Satara 8 each, Bhagamandala & Billoli 7 each.	
7th	: Sandheads 20, Kalingapatnam 14, Nampong 13, Silchar 12, Chandrapur & Puri 10 each, Raigarh 8, Paradip 7.	28th	: Quilandy 18, Kavali 11, Aruppukottai & Kundakur 9 each, Karaikal, Kettayam & Tondi 7 each.
8th	: Sandheads 19, Purna 14, Beki Rd Bridge 12, Kohima 11, Palakonda 10, Agartala AP & Puri 8 each, Chouldaghat & Paradip 7 each.	29th	: Cuddalore 14, Alupuza 10, Kundakur & Pondicherry 8 each, Parangipettai 7, Satara 5.
9th	: Goalpara & Sandheads 19 each, Dinhat 17, Beki Rd Bridge, Sudhagad & Tenali 11 each, Shillong 10, Guwahati AP 8, Baramati 7.	30th	: Sulurpeta 18, Aruppukottai 17, Usilampatti 13, Alathur & Madras 12 each, Cuddalore, Karaikal & Tirupati AP 9 each, Bhagamandala 6.
10th	: Cherrapunji 37, Harnai 18, Mangrulpir 13, Ratnagiri 9, Kailashahar, Matizuri & Tuni 8 each, Nasik AP, Pune AP & Tezpur AP 7 each.	31st	: Madras 11, Aruppukottai 10, Madras AP & Nellore 8 each, Vadakanchery 8, Gudur 6, Nagapattinam 5.
11th	: Gangapur 21, Aurangabad AP 16, Harnai & Podili 12 each, Ahmoghagar & Kannad 11 each, Matizuri 10, Alibag & Chindwara 9 each, Malkangiri 7.		
12th	: Gangapur 20, Rahuri 13, Chitradurga & Punalur 10 each, Bolangir & Newasa 9 each, Palakonda 7.		
13th	: Ahmednagar & Siriguppa 11 each, Kharidwar 9, Hallymysore & Koderu 7 each.		
14th	: Chintalapudi & Gangavathi 10 each, Madhira 9, Molkalmura 8.		
15th	: Coonoor 17, Baltara 11, Chickmagalur 8, Khagarla & Kalingapatnam 7 each.		
16th	: Adanki & Koderu 7 each, Kailashahar 5.		
17th	: Madhalbarida 6, Narsapur & Surada 5 each.		
18th	: Aryankavu & Ambasamudram 6 each, Mangalere AP 4.		
19th	: Ponneri 6, Kottayam & Punalur 5 each, Gohar 4.		
20th	: Manjeri & Thiruvalla 10 each, Madras 9, Pamban 5.		
21st	: Punalur 9, Car Nicobar 7, Minicoy & Thiruvalla 6 each, Srivillipattur 5.		
22nd	: Rapur 14, Pamban 8, Kottayam & Punalur 7 each.		
23rd	: Venkatgiri 20, Pondicherry 17, Kasargode 15, Kandakur 11, Cuddalore & Tiruttane 10 each, Cochi AP, Rapu & Tirupati AP 9 each, Kavali 8, Kozhikode & Machilipatnam 7 each.		
24th	: Koderu 2, Ongole 21, Coonoor 11, Umar-khed 6, Machilipatnam & Visakhapatnam 5 each.		
25th	: Chinoor 18, Addanki 13, Hakimpet 11, Billoli 9, Coonoor & Shirpur 8 each, Aryankavu, Basmatnagar, Ongole & Parbhani 7 each.		
26th	: Jajuri & Malkapur 12 each, Peermade 11, Uthagamandalam 10, Agatti, Coonoor & Mangalore AP 9 each, Satara 8, Kankavali & Kottayam 7 each.		
27th	: Gajvel (Telangana) 15, Nizamsagar 14, Patoda 13, Belthangady 12, Banswada 11,		

4.1.6. *Temperature* — Day temperatures were appreciably to markedly above normal in Himachal Pradesh from 1st to 8th, in Hills of West Uttar Pradesh from 5th to 8th, in Rajasthan between 10th and 13th, in Kerala between 13th and 17th in Coastal Karnataka from 15th to 25th and in Konkan & Goa from 16th to 22nd. They were appreciably to markedly below normal in Assam & Meghalaya from 8th to 10th, in Sub-Himalayan West Bengal & Sikkim from 12th to 15th, in Madhya Maharashtra between 10th and 13th and between 25th and 27th, in Vidarbha between 11th and 14th and between 24th and 27th and on several days in Rayalaseema and Tamil Nadu between 19th and 31st. The highest day temperature in the plains was recorded at Jaisalmer and Phalodi on 11 October when maximum temperature was 40°C in both the places on this day which was 3° to 4° C above normal. In the plain Buldhana recorded the lowest day temperature, i.e., 19° C on 26 October which was 11° C below normal.

Night temperature were appreciably to markedly below normal on most of the days in Nagaland, Manipur, Mizoram & Tripura, Sub-Himalayan West Bengal & Sikkim, Hills of West Uttar Pradesh, Punjab, Jammu & Kashmir and West Rajasthan during the second half of the month and were so in Madhya Maharashtra between 17th and 19th, in Telangana between 16th and 22nd in Bihar and East Uttar Pradesh from 23rd to 31st of this month. Month's lowest night temperature in the plains was 9° C recorded at Amritsar on 23rd and at Imphal on 29th, which was 5° C to 6° C below normal. In the hills mercury touched 1° C mark on several nights at Srinagar between 23rd and 28th of this month, which was about 3° C below normal.

4.1.7. *Disastrous weather events and damages during October* — The Bay depression (7-9 October) which moved northwards across Gangetic West Bengal and adjoining Bangladesh, gave heavy rains in Orissa, West Bengal and Assam & Meghalaya. As a result, there were floods in the rivers *Subarnarekha*, *Burchahalangi*, *Jhalka* and *Kansbania* in Orissa and in the rivers *Brahmaputra* and its tributaries in Assam. As per media report floods in Balasore and Bolangir districts of Orissa submerged thousands of acres of cultivated land. Floods in the Brahmaputra valley inundated vast areas of cropped land and disrupted road communications. High floods on

TABLE 3
Details of weather systems during November 1990

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) <i>Cyclonic storm/Depression/Low pressure area</i>					
(1) Deep depression*	31 Oct-4 Nov eve.	Southeast & adjoining southwest Bay	NW'ly to N'ly	South Orissa & neighbourhood. The remnant became less marked over North Orissa & neighbourhood on 5th	*Continuation of S.No. 4 under cyclonic storm/depression/low pressure area of October
(2) Low pressure area	1st-3rd	Lakshadweep area & neighbourhood	Stationary	<i>In situ</i>	Associated cyclonic circulation extended up to 4.5 km a.s.l.
(3) Do.	7th-11th	Gangetic West Bengal & adjoining Orissa & north-west Bay	Easterly	Northeast Bay & adjoining Bangladesh	Circulation extended up to 2.1 km a.s.l.
(4) Depression	14th	West central & adjoining southwest Bay off south Andhra-north Tamil Nadu coasts	Westerly	South Rayalaseema & adjoining north Tamil Nadu. The remnant emerged into east central Arabian Sea on 15th	First observed as a low pressure area over north Andaman Sea & neighbourhood on 10th
(5) Do.	16th-18th	East central Arabian Sea off Karnataka-Goa coasts	NW'ly to W'ly	East central Arabian Sea off north Karnataka-Goa coast. The remnant became less marked over east central Arabian Sea on 21st	
(6) Low pressure area	16th-25th	Southeast Bay & Adjoining north Andaman Sea	Westerly	West central Bay & adjoining coastal Andhra Pradesh	Formed under the influence of remnant of storm 'NELL', which emerged into north Andaman Sea across Tenasserim coast on 15th
(7) Do.	26th-31st	Sri Lanka & adjoining Comorin area	Do.	Southeast Arabian Sea off Lakshadweep area	Trough in the lower levels extended from the system to south Maharashtra coast to couple of days
(B) <i>Cyclonic circulation</i>					
(1) Lower tropospheric levels	6th-8th	East central Arabian Sea off Maharashtra coast	Stationary	<i>In situ</i>	
(C) <i>Western disturbance</i>					
(1) Upper air system	19th-25th	North Pakistan and neighbourhood	Easterly	Moved away across Himachal Pradesh and adjoining Hills of West Uttar Pradesh	

9 October submerged National Highway 37 between Dhupdhara and Rangjuli in lower Assam. Torrential rain/floods during 8-10 October affected Calcutta and neighbourhood and most of the districts in Gangetic West Bengal. It submerged 938 villages in Nadia district and 48 villages in Howrah district. Landslides in Garo hills of Meghalaya claimed 6 lives. About 16 persons lost their lives in floods in Assam & Meghalaya.

Also heavy rain in Marathwada region of Maharashtra during the second week damaged about one lakh dwelling units and crops in over 55,000 hectares of land. It also caused heavy damage to roads. Heavy rains in Nilgiri district of Tamil Nadu during the last week of the month caused landslides and flash floods disrupting surface transport services in the area. There was heavy rain in Madras on the last two days of the month, which submerged low lying areas in the city. Floods/heavy rain claimed 47 lives in Nilgiris district and 15 lives in Madras city.

4.2. November

4.2.1. *Storms and depressions*—Two depressions—formed during the middle of November, one in the west central and adjoining southwest Bay off north Tamil Nadu-south Andhra coast and another in the east central Arabian Sea off north Karnataka-Goa coast. The first depression gave heavy to very heavy rainfall in south coastal Andhra Pradesh and in Karnataka, while the second depression did not give heavy rainfall over the mainland.

4.2.2. *Weather and associated synoptic features*—A trough in the middle and upper tropospheric westerlies was seen from north Pakistan to Saurashtra & Kutch on 20th of this month. The southern end of the trough slightly moved eastwards over Madhya Maharashtra on 22nd. The trough became less marked on 23rd.

The details of the other synoptic feature of the month are given in Table 3.

TABLE 4
Details of weather systems during December 1990

Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(A) Cyclonic storm/Depression/Low pressure area					
(1) Severe cyclonic storm	14th-18th eve.	Southeast Bay	NNW'ly to NE'ly	Central Burma and adjoining Bangladesh. The remnant became less marked on 19th	Initially observed as a low pressure area over southeast Bay and adjoining Andaman Sea on 13th
(B) Cyclonic circulation					
(1) Lower levels	8th-10th	Gujarat region and neighbourhood	Easterly	North Maharashtra and neighbourhood	
(C) Western disturbance					
(1) Upper air system	4th-6th	North Pakistan and neighbourhood	Do.	Moved away across Jammu & Kashmir & neighbourhood	
(2) Do.	9th-13th	Do.	Do.	Do.	
(3) Do.	13th-18th	Northeast Afghanistan & adjoining north Pakistan	Do.	Do.	
(4) Do.	19th-22nd eve.	North Pakistan & neighbourhood	Do.	Do.	
(5) Do.	23rd-25th	Do.	Do.	Do.	
(6) Do.	24th-27th eve.	Northeast Afghanistan & adjoining north Pakistan	Do.	Do.	
(7) Do.	27th-2nd Dec Jan	East Afghanistan & adjoining north Pakistan	Do.	Do.	Seen as a well marked low pressure area over north Pakistan & adjoining Punjab and north Rajasthan on 28th which became less marked on 30th evening there
(D) Induced cyclonic circulation					
(1) Lower tropospheric levels	8th-11th	North Rajasthan & adjoining Haryana	Do.	Haryana & neighbourhood	

Northeast monsoon was active to vigorous over Kerala during the first four days of the month. It was also active to vigorous on one to two days in Rayalaseema and Tamil Nadu during the same period. Northeast monsoon again became active to vigorous over south coastal Andhra Pradesh from 23rd to 26th, over Tamil Nadu on 26th and 27th and over Rayalaseema on 27th.

Rain or thundershowers occurred either almost at all the places or at many places on 15 days in Andaman & Nicobar Islands, on 5 to 6 days in Orissa, Kerala & Lakshadweep and on 1 to 3 days in Nagaland, Manipur, Mizoram & Tripura, Hills of West Uttar Pradesh and Haryana, Coastal Andhra Pradesh, Rayalaseema, Coastal and South Interior Karnataka. They occurred at a few places or at one or two places on 20 to 23 days in Tamil Nadu and Kerala, on 13 to 17 days in Andaman & Nicobar Islands, Gangetic West Bengal, Madhya Maharashtra and Coastal Andhra Pradesh and 3 to 10 days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Orissa, Bihar Plateau, West Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Konkan & Goa, Marathwada, Telangana, Rayalaseema and Karnataka. The weather over Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim and Bihar Plains, East Uttar Pradesh and East Rajasthan was

mainly dry during the month. Mainly dry weather also prevailed over West Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, West Rajasthan, West Madhya Pradesh and Gujarat during the period 2 to 19 November.

4.2.3. *Month's rainfall* — During the month rainfall was excess in 10, normal in 12, deficient in 3 and scanty in 8 meteorological sub-divisions. There was no rainfall in 2 sub-divisions.

Rainfall was excess in Andaman & Nicobar Islands, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa, Haryana, East Madhya Pradesh, Gujarat region, Rayalaseema, Coastal Karnataka and Lakshadweep; normal in Bihar Plateau, West Uttar Pradesh, Punjab, Himachal Pradesh, Konkan & Goa, Madhya Maharashtra, Coastal Andhra Pradesh, Tamil Nadu, Interior Karnataka and Kerala; deficient in Assam & Meghalaya, Marathwada and Telangana and was scanty in Arunachal Pradesh, Sub-Himalayan West Bengal & Sikkim, Bihar Plains, Jammu & Kashmir, East Rajasthan, West Madhya Pradesh, Saurashtra & Kutch and Vidarbha. There was no rain in East Uttar Pradesh and West Rajasthan (Table 5).

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

- 1st : Mavalikara 18, Sulurpet & Tiruvalla 15 each, Madras 13, Alupuza & Rajampet 11 each, Cochi AP 10, Madurai & Nellore 9 each, Venkatagiri 8, Ambasamudram & Car Nicobar 7 each.
- 2nd : Ponneri 22, Madras AP 13, Kanyakumari 12, Car Nicobar & Thiruvananthapuram AP 9 each, Amini Divi, Madurai & Nellore 8 each, Thumba 7.
- 3rd : Gopalpur 18, Puri 17, Bhubaneswar AP 14, Thiruvananthapuram 13, Varkala 12, Paradip 9, Amini Divi & Mavelikara 7 each.
- 4th : Mohana 32, Mahendragarh 17, Paradip 14, Gopalpur 13, Peermade 12, Contai 8, Kozhikode & Sagar Island 7 each.
- 5th : Durgachak 9, Contai 8, Sagar Island & Tondi 7 each.
- 6th : Digba 5, Ankhupada & Imphal 4 each.
- 7th : Champua & Contai 9 each, Paradip 6.
- 8th : Chandbali 12, Car Nicobar 6.
- 9th : Kunigal 5, Car Nicobar 4.
- 10th : Hut Bay & Kunigal 5 each.
- 11th : Kovilpatti 8, Usilampatti 6, Hut Bay 5.
- 12th : Dindigul 11, Madurai 4.
- 14th : Kunigal 5.
- 15th : Kavali 15, Ongole 13, Tirupati AP 8, Long Island 6, Anantpuram & Ponner 5 each.
- 16th : Honavar 24, Sirsi 15, Averi 8, Polur 6, Anantpur & Ongole 4 each.
- 17th : Coonoor & Shirali 10 each, Honavar 7, Polur & Port Blair 5 each.
- 18th : Manjeri 7, Ramanathapuram 6, Car Nicobar 5.
- 19th : Usilampatti 9, Thiruvananthapuram 6, Satarra 5.
- 20th : Dohad 7, Pachmarhi 5, Kolhapur & Port Blair 4 each.
- 21st : New Delhi 4.
- 22nd : Okhimath 12, Bapatla 6, Car Nicobar 4.
- 23rd : Ongole 27, Ranikhet 22, Addanki 6, Bapatla 5.
- 24th : Coonoor 8, Kavali & Konni 6 each, Bandvel 5.
- 25th : Tiruvallur 10, Kurnool 6, Cuddalore & Pondicherry 5 each.
- 26th : Vedaranyam 26, Nagapattinam 12, Cuddalore 11, Pondicherry 9, Rapur 7.
- 27th : Ambasamudram 10, Ramanathapuram 9, Venkatagiri 8, Kanyakumari 6.
- 28th : Kancheepuram & Venkatagiri 9 each, Rapur 7, Minicoy 6.
- 29th : Kondul 13.

4.2.4. *Temperature* — During the month the nights were generally warmer in the country outside Sub-Himalayan West Bengal & Sikkim, Hills of West Uttar Pradesh and Jammu where they were comparatively cooler.

Cold wave conditions prevailed in the Hills of West Uttar Pradesh on 1st, 2nd and 28th. Severe cold wave conditions prevailed there on 21st and 23rd and in Kashmir on 30th. Night temperatures were appreciably below normal in Sub-Himalayan West Bengal & Sikkim from 1st to 6th and in Jammu from 24th to 30th. Appreciably below night temperatures also prevailed on 1 to 2 days in Marathwada, coastal Andhra Pradesh, Rayalaseema and in Interior Karnataka between 11th and 14th in Gangetic West Bengal and Orissa between 27th and 28th. In the high altitude area, the lowest night temperature of -3°C (dep. -2°C) was recorded at Srinagar on 25th and in the plains that was 3°C (dep -4°C) at Amritsar on 29th and 30th.

Night temperatures were appreciably to markedly above normal on most of the days of the month in East Rajasthan, East Madhya Pradesh and in Madhya Maharashtra. There were so on most of the days in Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Orissa and Bihar Plateau between 3rd and 20th and in West Madhya Pradesh, Gujarat region, Marathwada, Vidarbha, Andhra Pradesh and North Interior Karnataka between 14th and 30th. The highest night temperature was 27°C (dep $+5^{\circ}\text{C}$), which was recorded at Puri on 6th and 7th and in Ongole on 8th. The highest day temperature, 36°C (dep $+4^{\circ}\text{C}$) was recorded at Phalodi on 1st. Lowest day temperature of the month 17°C (dep -9°C) in the plains was recorded at Patiala on 27 and 6°C (dep -9°C) in the hills, recorded at Mukteswar on 22nd.

4.2.5. *Disastrous weather events and damages during November* — The depression that crossed coast near Gopalpur caused heavy to very heavy rainfall in Puri, Cuttack and Ganjam district of Orissa for a couple of days. It caused serious floods in Ganjam district. Floods in rivers *Rushikulva* and *Bedenadi* affected a population of 6.5 lakhs in 753 villages in the district. As per reports it claimed more than 100 human lives, 28,000 cattle heads and inundated 80,000 hectares of cropped land. *Rushikulva* bridge between Berhampur and Aska was washed away. Aska town was virtually under flood waters for some time. In Aska and Saroda towns thousand of houses were washed away by flood waters. Heavy rain also claimed 6 human lives in Puri district.

4.3. December

4.3.1. *Storms & depressions* — During mid-December a severe cyclonic storm developed over the Bay of Bengal. Moving in a north to northeasterly direction the storm weakened into a depression over northeast Bay off Bangladesh coast and crossed coast near Cox's Bazar and weakened rapidly.

4.3.2. *Weather and associated synoptic features* — A trough in the lower levels, which was observed over southwest Bay off Tamil Nadu-Sri Lanka coasts on 10th moved westwards across south Peninsula and became less marked over southwest Arabian Sea off Kerala coast on 15th. The details of other synoptic features are given in Table 4.

Northeast monsoon was active over Tamil Nadu on 4th and 5th. Rain or thundershowers occurred almost at all the places or at many places on 5 days; in Jammu & Kashmir and on 1 to 3 days; in Andaman & Nicobar Islands, Arunachal Pradesh, Gangetic West Bengal, Plains of West Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Madhya Pradesh and Vidarbha. They occurred at a few places or at one or two places on 18 days in Tamil Nadu, 14 days in Andaman & Nicobar Islands, 11 days in coastal Andhra Pradesh and 2 to 7 days in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Orissa, Plains of Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, West Rajasthan, Madhya Pradesh, Madhya Maharashtra, Marathwada, Rayalaseema, South Interior Karnataka, Kerala and Lakshadweep.

Rain or snow occurred almost at all the places in Jammu & Kashmir from 29th to 31st and in Hills of West Uttar Pradesh on 30th. It occurred at many places over Hills of West Uttar Pradesh on 31st and at one or two places over Jammu & Kashmir on 27th.

Mainly dry weather prevailed over Sub-Himalayan West Bengal & Sikkim, Bihar, East Rajasthan, Konkan & Goa, Telangana and Interior Karnataka.

4.3.3. *Month's rainfall* — In this month rainfall was excess in 12, normal in 3, deficient in 6 and scanty in 10 Met. sub-division. There was no rainfall in 4 sub-divisions. Rainfall was excess in Arunachal Pradesh, Nagaland, Manipur, Mizoram & Tripura, West Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir, West Madhya Pradesh, Gujarat and Rayalaseema; normal in Assam & Meghalaya, East Uttar Pradesh and Vidarbha; deficient in Andaman & Nicobar Islands, Gangetic West Bengal, East Madhya Pradesh, Madhya Maharashtra, Marathwada and Tamil Nadu and was scanty in Sub-Himalayan West Bengal & Sikkim, Orissa, Bihar, Rajasthan, Coastal Andhra Pradesh, South Interior Karnataka, Kerala & Lakshadweep. There was no rain in Konkan & Goa, Telangana and Coastal and North Interior Karnataka.

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

- 1st : North Lakhimpur 3.
- 2nd : Noncowry 10.
- 3rd : Pamban 5, Kanyakumari 4, Thumba 3.
- 4th : Tiruthuraipondi 6, Mannargudi & Vedaranyam 5 each, Nagapattinam 4.
- 5th : Chidambaram 11, Gudur 6, Morcompu & Tiruchirapalli 5 each, Dindigul & Tirupati AP 4 each.
- 7th : Tondi & Vedaranyam 4 each.
- 9th : Georai & Kondul 4 each, Bhopal 3.
- 10th : Nagpur AP & Pachmarhi 4 each.
- 12th : Kondul 5.
- 13th : Nancowry 4, Kondul 3.
- 15th : Car Nicobar & Hut Bay 4 each, Chamba 3.

- 16th : Adampur, Hoshiarpur & Pathankot 3 each.
- 17th : Baijnath & Kangra 3 each.
- 18th : Srivilliputtur 8, Aryankovu 3.
- 19th : Kondul 4, Imphal 3.
- 20th : Kondul 5, Car Nicobar 3.
- 21st : Car Nicobar 7, Udayagiri 3.
- 23rd : Bombay 8, Adirampattinam & Vedaranyam 3 each.
- 26th : Vedaranyam 7, Mathupet 5, Pamban 3.
- 28th : Chamba 5, Jammu AP & New Delhi 3 each.
- 29th : Srinagar 11, Jogindernagar 8, Chamba 6, Ajnala & Baijnath 5 each, Chandigarh AP, Fazilka, Hoshiarpur & Pathankot 3 each.
- 30th : Solan 10, Hindon AP, Jammu AP, Nahan & Srinagar 9 each, Shimla & Sundernagar 7 each, Dehradun, Karaikal & Tallital 6 each, Bhuntar AP & Chandigarh AP 5 each.
- 31st : Shimla 11, Kunda Bridge 10, Solan 8, Dharamsala, Dehradun & Sunni 6 each, Kangra 5, Nellore & Tiruvallur 4 each.

4.3.4. *Temperature* — Cold wave conditions prevailed on 2 to 5 days in the Hills of West Uttar Pradesh, Punjab, Himachal Pradesh and in Kashmir during the first week. Such conditions prevailed further in Himachal Pradesh on 10th, 11th, 15th, 17th, 18th and 31st; in Punjab on 22nd, 23rd and 31st; in Kashmir on 13th, in Jammu on 13th and from 22nd to 25th; in West Rajasthan on 19th, 20th, 30th and 31st and in East Rajasthan and Gujarat on 31st, being severe on 1 to 2 days in Himachal Pradesh, Kashmir and Rajasthan.

Night temperatures were below to appreciably below normal on most of the days in West Bengal & Sikkim, Orissa and Bihar between 22nd and 28th. They were appreciably to markedly above normal on most of the days in Orissa, Madhya Pradesh, Gujarat region, Madhya Maharashtra, Marathwada, Vidarbha, Coastal Andhra Pradesh, Telangana and North Interior Karnataka between 1st and 12th.

The lowest night temperature was -6°C which was recorded at Srinagar (dep -5°C) on 6th and 7th at Mt. Abu (dep -16°C) on 31st. In plains mercury dipped to -1°C at Bhuj AP (dep -9°C) on 31st.

Temperatures were abnormally low in Rajasthan and Gujarat on 30th, when they were as much as 8°C to 11°C below the normal values. On that date the day's maximum temperatures were 14°C (dep -8°C) at Ganganagar, 16°C (dep -9°C) at Jaisalmer, 17°C (dep -6°C) at Ajmer and Bikaner and 18°C (dep -11°C) at Dessa.

4.3.5. *Disastrous weather events & damages* — As per media reports cold wave over northwest India claimed 36 lives in Himachal Pradesh and Rajasthan and 1 in Madhya Pradesh. Heavy snowfall in the last week of the month disrupted road transport, power and water supply and communication links in Kashmir valley for about a week.