

Weather

MONSOON SEASON (JUNE - SEPTEMBER 1992)*

1. Introduction

The summer monsoon rainfall (June - September 1992) over the country was 93% of the seasonal normal. 32 meteorological sub-divisions received normal or excess rainfall, 3 sub-divisions had deficient rainfall. No meteorological sub-division reported scanty rainfall during the monsoon season. The seasonal rainfall departures stationwise and meteorological sub-divisionwise are given in Figs. 1 and 2.

2. Features of the monsoon

2.1. Advance of southwest monsoon

The onset of southwest monsoon over Kerala was on 5 June. It advanced northwards covering the peninsula, central and northeast India by 20 June, with a delay of 5 to 10 days. The northern limit of monsoon remained practically stationary over the northern parts of peninsula and east Uttar Pradesh from 20 June to 5 July. Thereafter the monsoon covered the entire country by 14 July, which is the normal date. Isochrones of advance of southwest monsoon are shown in Fig. 3.

2.2. Weekly performance

Percentage departures (from normal) of weekly rainfall for 18 weeks (30 May - 30 September 1992) for all meteorological sub-divisions are given in Fig. 5. Monsoon rainfall was either excess or normal for 8 to 13 weeks in 17 meteorological sub-divisions, for 5 to 7 weeks in 16 meteorological sub-divisions and for 1 to 4 weeks in 2 meteorological sub-divisions. It was scanty for 8 to 9 weeks in the 6 sub-divisions of Arunachal Pradesh, Bihar plateau, Bihar plains, east Rajasthan, Saurashtra, Kutch & Diu and Marathwada.

Between 25 June and 15 July 1992 the rainfall activity decreased significantly over the entire country. During the period from 25 June to 8 July, 26 meteorological sub-divisions received deficient or scanty rainfall and during the period from 9 to 15 July, 22 meteorological sub-divisions received deficient or scanty rainfall (Fig. 6, gives the cumulative departures of area weighted rainfall week by week for the entire season).

2.3. Monthly performance

In the month of June, the monsoon was active to vigorous for 4 to 6 days in Kerala, Karnataka, Andhra Pradesh and Maharashtra and was active for 2 to 3 days in Assam & Meghalaya, West Bengal and Madhya Pradesh. The monsoon rainfall was excess in 4, normal

in 10, deficient in 18 and scanty in 3 meteorological sub-divisions.

In the month of July, the monsoon was active to vigorous over Assam and adjoining States, West Bengal, Uttar Pradesh and east Rajasthan for 8 to 10 days and was active over Orissa, Bihar, Gujarat, Maharashtra, Karnataka and Kerala States for 4 to 6 days. The rainfall was excess in 3, normal in 13 and deficient in 18 meteorological sub-divisions. It was scanty in 1 meteorological sub-division.

In the month of August, the monsoon was active to vigorous for 8 to 12 days in most parts of the country outside northeast India where it was active for only 4 to 6 days. The rainfall was excess in 12, normal in 17, and deficient in 6 meteorological sub-divisions. No meteorological sub-division received scanty rainfall.

In the month of September, the monsoon was active to vigorous for 4 to 6 days in most of the meteorological sub-divisions outside northwest India where it was active for only 2 to 3 days. The rainfall in September was excess in 9, normal in 10 and deficient in 15 meteorological sub-divisions. It was scanty in 1 meteorological sub-division.

2.4. Seasonal performance

The seasonal total rainfall for the country as a whole was 93% of the long period average value. Out of 35 meteorological sub-divisions, the seasonal rainfall was excess (dep. + 20% or more) in 2, normal (+19% to -19%) in 30, and deficient (-20% to -59%) in 3 meteorological sub-divisions. No meteorological sub-division reported scanty rainfall. In the normal category the rainfall departures were on the negative side (between 0 & -19%) in 21 meteorological sub-divisions. The meteorological sub-divisions with deficient rainfall were: (i) Arunachal Pradesh (-39%), (ii) Bihar plains (-36%), and (iii) East Uttar Pradesh (-21%). The rainfall figures for the month and the season are given in Table 1.

2.5. Withdrawal of southwest monsoon

The southwest monsoon withdrew from west Rajasthan on 17 September and from northwest India by 20 September. By 15 October, it withdrew from the entire country outside Peninsular India. It withdrew from the Peninsular India by 18 October. The isochrones of the withdrawal of the southwest monsoon for 1992 are given in Fig. 4.

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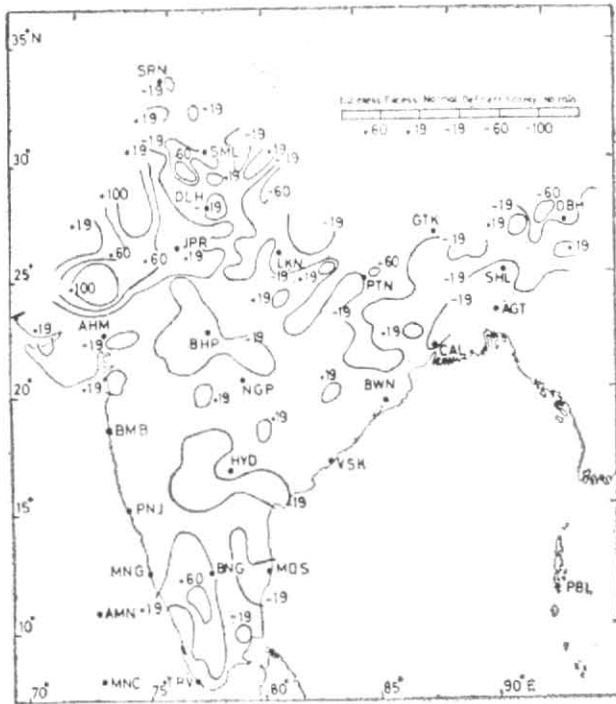


Fig. 1. Rainfall departure as percentage of normal for June-September 1992

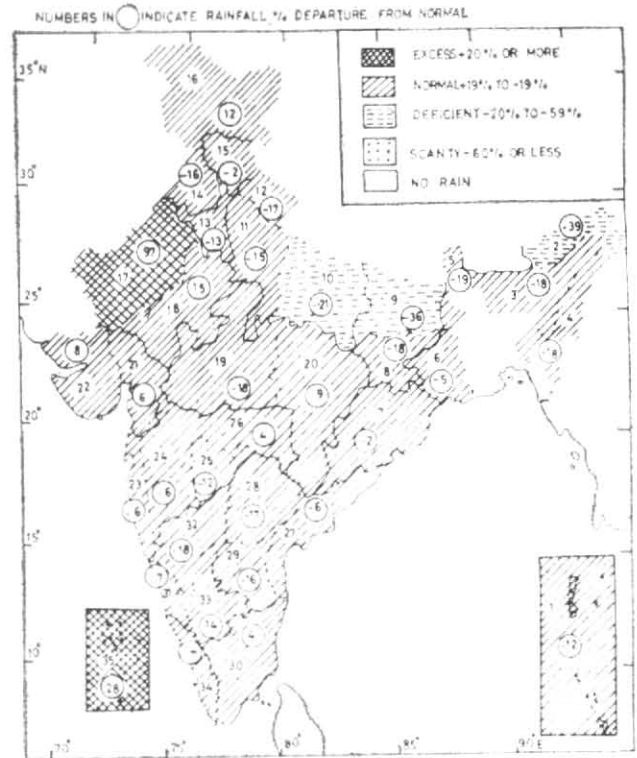


Fig. 2. Rainfall departure sub-divisionwise from normal for 1 June-30 September 1992

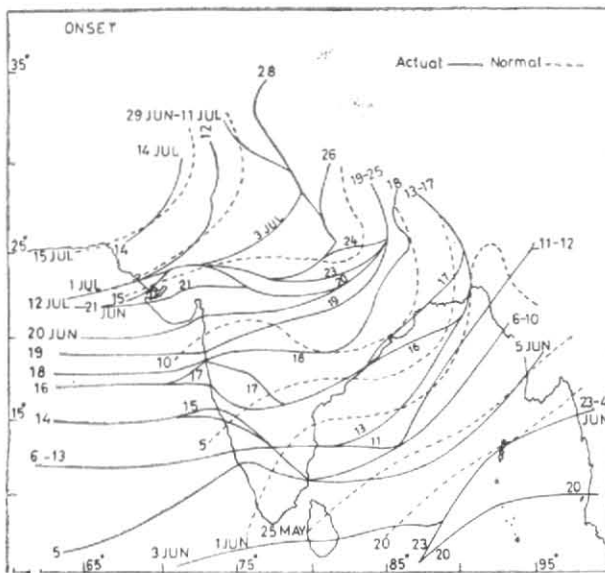


Fig. 3. Advance of southwest monsoon 1992

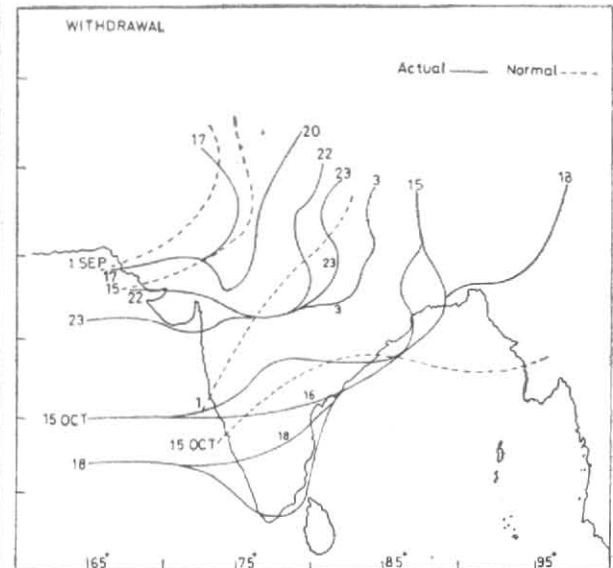


Fig. 4. Withdrawal of southwest monsoon 1992

TABLE 1
Rainfall figures (mm) for each month and season as a whole (June-September 1992)

S. No.	Sub-division	June			July			August			September			Season		
		Ac-tual	Nor-mal	% Dep.	Ac-tual	Nor-mal	% Dep.	Ac-tual	Nor-mal	% Dep.	Ac-tual	Nor-mal	% Dep.	Ac-tual	Nor-mal	% Dep.
1	Bay Islands	364	470	-23	367	357	3	334	371	-10	316	407	-22	1398	1594	-12
2	Arunachal Pradesh	233	509	-54	441	599	-27	249	425	-41	334	273	22	1116	1824	-39
3	Assam & Meghalaya	427	554	-25	465	538	-14	366	416	-12	284	330	-14	1517	1843	-18
4	Naga., Mani. & Mizo.	171	388	-56	308	414	-26	258	290	-11	285	232	23	1017	1239	-18
5	S.H.W.B. & Sikkim	271	535	-49	647	610	6	394	503	-22	259	412	-37	1674	2059	-19
6	Gangetic West Bengal	139	251	-44	329	305	8	239	313	-24	199	238	-16	1029	1083	-5
7	Orissa	198	219	-9	412	357	15	390	381	2	182	247	-26	1182	1204	-2
8	Bihar Plateau	128	191	-33	307	336	-9	269	331	-19	182	223	-18	886	1081	-18
9	Bihar Plains	81	171	-52	274	318	-14	226	313	-28	78	225	-66	659	1027	-36
10	East Uttar Pradesh	45	105	-57	261	299	-13	241	299	-20	165	195	-16	711	898	-21
11	Plains of West U. P.	25	81	-69	213	268	-21	311	269	16	112	162	-31	661	779	-15
12	Hills of West U.P.	117	170	-31	351	450	-22	443	448	-1	170	229	-26	1081	1297	-17
13	Har., Chandī. & Delhi	25	51	-50	131	173	-25	221	177	25	64	107	-40	442	509	-13
14	Punjab	32	42	-25	139	189	-26	185	168	10	63	100	-37	419	500	-16
15	Himachal Pradesh	69	97	-30	269	349	-23	437	323	35	132	159	-17	906	928	-2
16	Jammu & Kashmir	47	56	-17	74	139	-46	117	124	-6	214	84	155	452	403	12
17	West Rajasthan	8	28	-72	127	102	24	195	106	83	229	47	390	559	283	97
18	East Rajasthan	14	58	-76	174	222	-22	362	228	59	168	115	46	718	623	15
19	West Madhya Pradesh	50	114	-56	201	331	-39	381	281	36	125	195	-36	757	921	-18
20	East Madhya Pradesh	77	166	-54	285	406	-30	489	374	31	223	234	-5	1073	1179	-9
21	Gujarat Region	185	145	27	285	427	-33	350	294	19	291	182	60	1111	1049	6
22	Saurashtra, Kutch & Diu	53	89	-40	289	240	21	129	127	2	108	83	-30	580	539	8
23	Konkan & Goa	527	685	-23	779	1106	-30	1010	663	52	313	347	-10	2628	2801	-6
24	Madhya Maharashtra	154	140	10	183	271	-32	235	179	31	131	155	-15	703	745	-6
25	Marathwada	217	146	49	74	206	-64	204	187	9	139	179	-22	635	717	-12
26	Vidarbha	166	167	0	227	336	-32	511	277	85	112	201	-44	1017	980	4
27	Coastal Andhra Pradesh	60	111	-46	186	168	11	188	159	18	127	159	-20	561	598	-6
28	Telangana	145	137	6	160	243	-34	255	212	21	89	193	-54	649	784	-17
29	Rayalaseema	58	61	-5	84	79	7	93	99	-6	76	134	-43	312	372	-16
30	Tamil Nadu	61	53	14	72	75	-5	39	98	-30	143	104	38	345	331	4
31	Coastal Karnataka	937	884	6	1023	1173	-13	977	686	42	341	307	11	3278	3051	7
32	N. I. Karnataka	123	98	25	90	150	-40	122	123	-1	94	151	-38	428	522	-18
33	S. I. Karnataka	295	154	92	215	290	-26	231	205	13	158	140	13	900	788	14
34	Kerala	813	692	17	745	759	-2	504	435	16	297	247	20	2359	2133	11
35	Lakshadweep	349	307	13	389	283	37	374	192	95	95	161	-41	1207	943	28

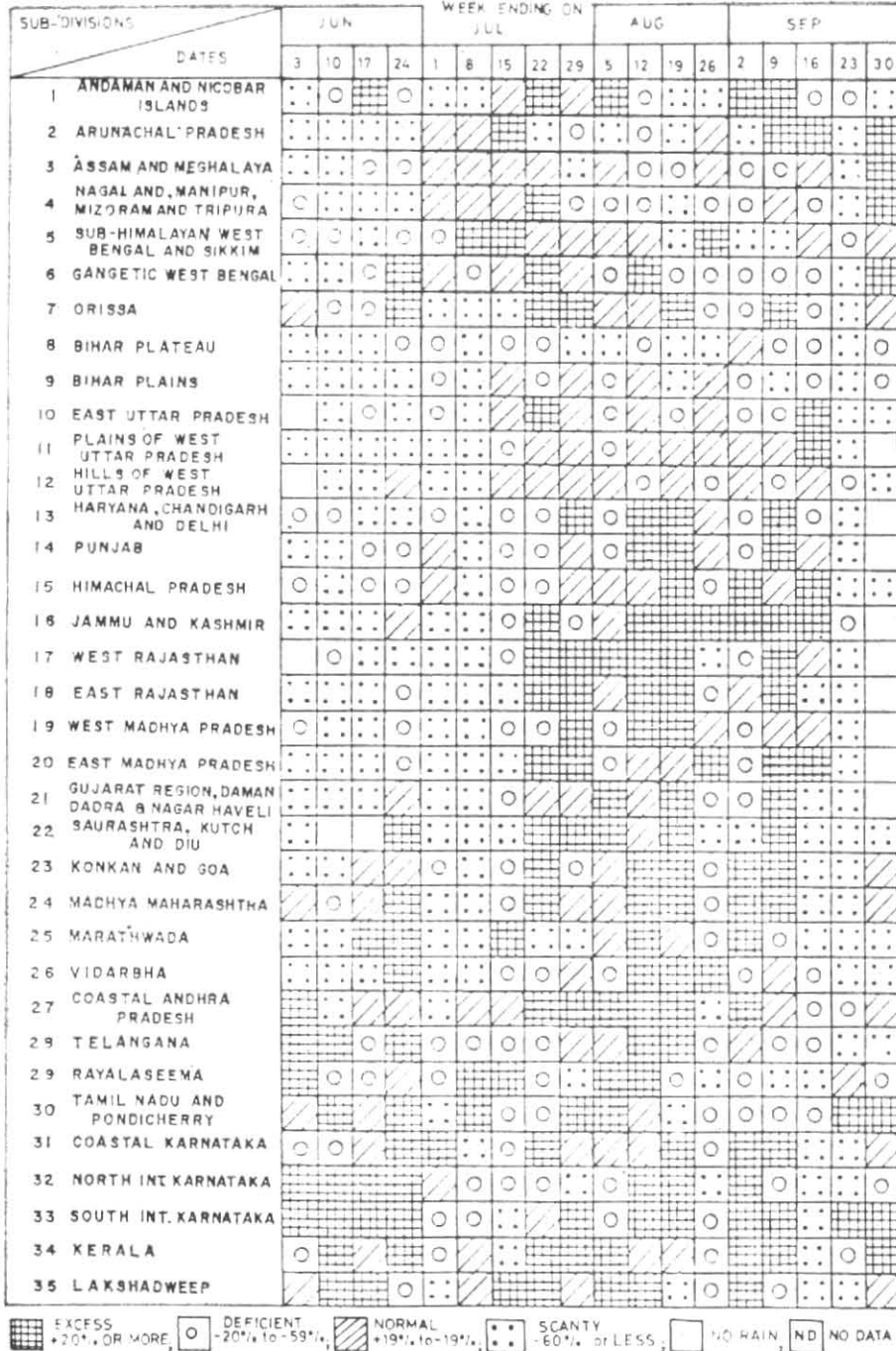


Fig. 5. Progress of monsoon week by week (1 June-30 September 1992)

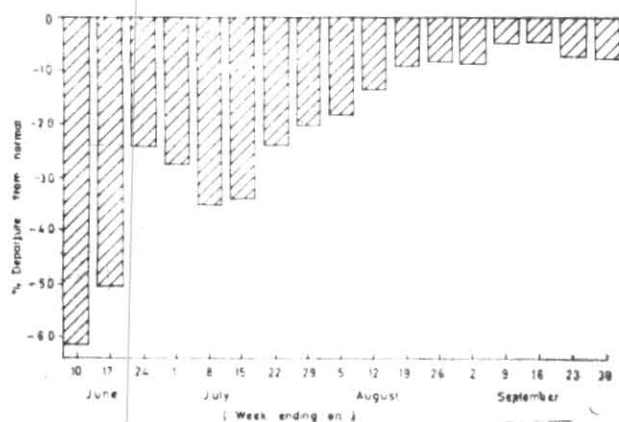


Fig. 6. Area weighted rainfall—cumulative departures (%)

3. Chief synoptic features during the monsoon

The synoptic disturbances, which affected the Indian region monthwise under different categories are given below :

System	Jun	Jul	Aug	Sep	Total
(i) Depression/deep dep./cyclonic storm	*2	1	0	0	3
(ii) Low pressure area/well marked low pressure area	0	2	6	3	11
(iii) Cyclonic circulation	12	10	9	8	39
(iv) Western disturbance	1	0	0	0	1
(v) Troughs (surface/low levels)	7	8	2	6	23
Total	22	21	17	17	77

*one system (8-12 June) was a cyclonic storm.

3.1. Depression, deep depression and cyclonic storm

There was one cyclonic storm (8 - 12 June) over the Arabian Sea and two deep depressions (17 - 20 June and 26 - 30 July) over the Bay of Bengal during the season.

The cyclonic storm over the Arabian Sea moved away in a westerly direction without causing any weather over India.

The deep depression 17-20 June formed initially as a low pressure area over the northwest Bay. Moving in a westnorthwesterly direction it concentrated into a deep depression, crossed Orissa coast on the early morning of 18 June near Puri and weakened into a low pressure area over southwest Madhya Pradesh and neighbourhood by the 21st morning. It caused widespread heavy rains with scattered heavy to very heavy falls over Orissa and isolated heavy falls over Gangetic West Bengal on 18, 19 and 20 June. Widespread rains with isolated heavy falls also occurred over Vidarbha and Telangana on 19 and 20 June.

The deep depression over the Bay (26-30 July) formed initially as a depression over northwest Bay of Bengal on the morning of 26 July. Moving in a westnorthwesterly direction it intensified into a deep depression and crossed Orissa coast near Chandbali in the same night. Moving further in a westnorthwesterly direction, it weakened into a low pressure area and merged with the seasonal

low over west Rajasthan on the 30th. In association with the system widespread rains with scattered heavy to very heavy falls occurred over Orissa from 25 to 28 July. Widespread rains with isolated heavy falls also occurred over coastal Andhra Pradesh on the 26 and 27, over Gangetic West Bengal on the 27 and 28, over east Madhya Pradesh and Vidarbha on the 27, 28 and 29 and over Gujarat and Rajasthan on the 30 and 31. Well distributed rainfall occurred over the sub-divisions lying close to the depression track.

There were no depressions in August and September. Fig. 7 shows the tracks of depressions/cyclonic storms during the season.

3.2. Low pressure area/well marked low pressure area (LPA/WMLDA)

5 well marked low pressure areas and 6 low pressure areas formed during the season. Monthwise break up of these systems is as follows :

July - 2, August - 6, and September - 3.

In association with the low pressure areas forming in August, the rainfall in the month was normal or excess over all the meteorological sub-divisions of the country except Bihar plains, east Uttar Pradesh and Tamil Nadu.

3.3. Cyclonic Circulation (CYCIR)

In all, there were 39 cyclonic circulations (each of which had a life span of at least 24 hours) forming during the season. Out of these 6 developed over the Bay of Bengal, 5 over the Arabian Sea and 28 over land areas. In July and August most of the CYCIRs formed in the monsoon trough and moved westnorthwards along the axis of the trough.

3.4. Mid-latitude trough

The number of major troughs in upper tropospheric westerlies that moved across northern India and south Indian Ocean were 14 and 17 respectively. Their monthwise frequency is as follows :

	Jun	Jul	Aug	Sep	Total
North India	4	3	3	4	14
South Indian Ocean	5	5	4	3	17

Remarks : On some occasions the trough over northern India extended as far south as 25°N while the trough over the south Indian Ocean extended as far north as 20° S.

3.5. Westerly jet

Sub-tropical westerly jet was seen over Delhi on 1 June, when winds of 250°/120 kt at 139 hPa level were reported. It persisted there till 7 June. The westerly jet was again seen over Delhi (winds 270°/70 kt at 180 hPa) on 23 September and over Lucknow (winds 250°/60 kt at 186 hPa) on 21 September.

4. Semi-permanent systems

4.1. Heat low

The heat low was observed in June, July and August. The normal position of the heat low is 28°N/68°E. The mean positions of the heat low in June and July

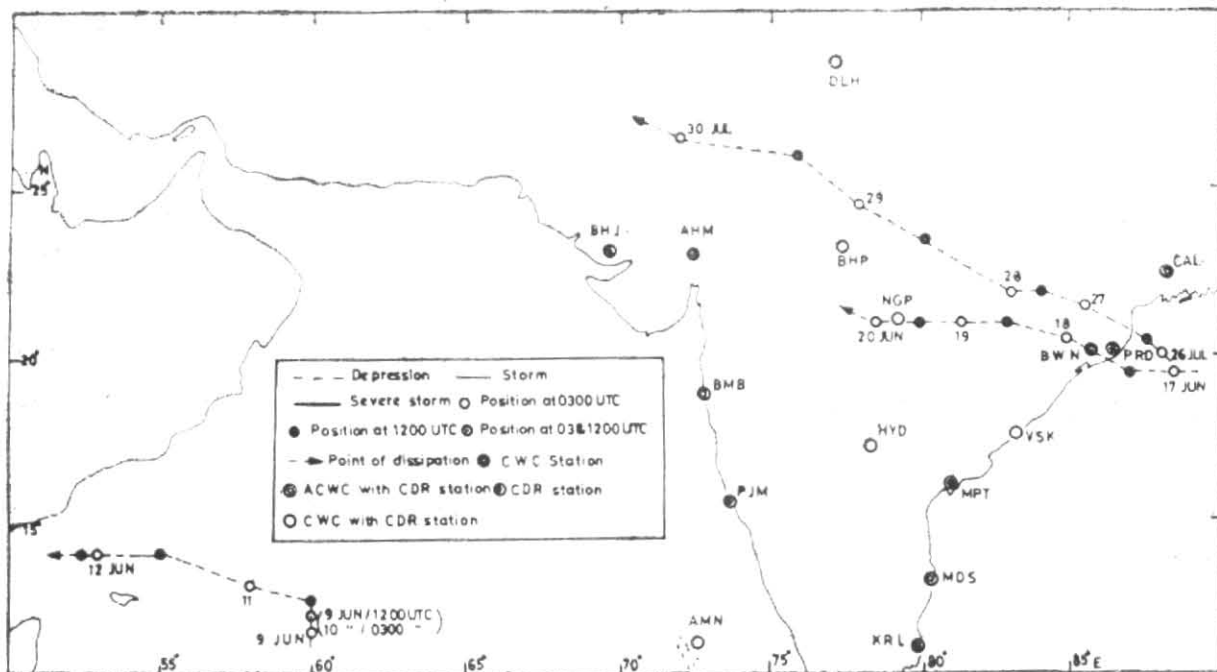


Fig. 7. Tracks of storms/depressions (June-September 1992)

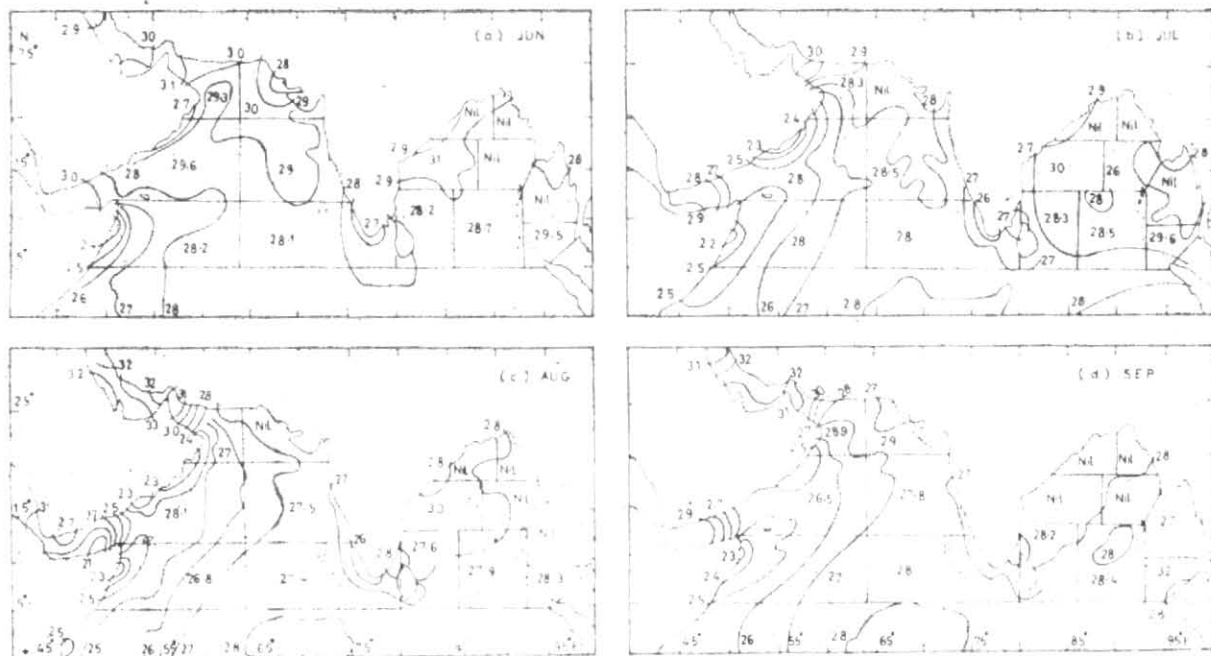


Fig. 8. Mean monthly sea surface temperature ($^{\circ}$ C) of Indian seas during monsoon 1992

TABLE 2
Wind anomalies (June - September 1992)

W/E	June					July				August				September				
	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29
Lower tropospheric westerly																		
TRV																		
850 hPa	12705	19604	23409	27417	03906	06511	00103	25108	28306	34101	17113	26708	00107	29308	31805	10005	10109	10510
700 hPa	14810	10405	26212	28416	33405	09618	08003	30406	17804	01505	15312	24708	32407	28703	30306	09706	09515	10411
BMB																		
850 hPa	02507	04805	04806	34311	29504	03106	05811	20404	25403	20303	05805	28507	29903	27705	27708	29004	34002	06812
700 hPa	08403	05209	05420	00515	31509	34109	08113	20204	27503	27204	12006	28611	—	28905	—	32407	23008	12905
NGP																		
850 hPa	07305	19804	21008	11315	28509	35501	20903	17712	28615	16111	20209	33809	33512	05804	24907	30309	35004	05406
700 hPa	21202	14002	02904	10111	24709	07301	25303	18510	27708	16209	26906	01108	00306	06805	24706	28103	29108	12207
Tropical easterly jet																		
MDS																		
200 hPa	27416	26119	30710	30412	06611	25921	11102	25806	32407	23409	28710	33211	02007	09304	05013	08805	17906	28505
TRV																		
200 hPa	24011	28730	26912	35409	11810	00110	25209	28513	03901	21609	00313	07406	12310	14706	10307	13611	18209	24108

Easterly anomalies at 850 and 700 hPa means westerlies are weaker than normal.

Westerly anomalies at 200 hPa means easterlies are weaker than normal.

The first 3 digits give direction in degree and the last 2 digits give speed in knots.

TABLE 3
Details of weather systems during June 1992

S. No.	Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Cyclonic storm	8 - 12	Lakshadweep area	Westnorth-westerly	West central Arabian Sea	3-low pressure area over Lakshadweep 9-depression near 11.5/60, deep depression on 11 M near 13/58, 11 E-cyclonic storm near 14/55, 12 M deep depression near 14/53, 12 E-depression near 14/53, 13-unimportant

TABLE 3 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
2	Deep depression	17-20 Jun	West central and adjoining northwest Bay off north Andhra-Orissa coast	West-north-westerly	Southwest Madhya Pradesh and neighbourhood	16 - trough of low north Bay, 17 - depression northwest Bay 19.5/88.5, 17 E-deep depression 19.5/87, 18-weakened depression 21/85, 20 E-weakened into well marked LOPAR over northwest Vidarbha and neighbourhood, 21M-LOPAR over southwest Madhya Pradesh and neighbourhood
3	(i) Cyclonic circulation	1 Jun	Punjab and neighbourhood in lower tropospheric levels	Stationary	<i>In Situ</i>	
	(ii) Do.	6-10	Lakshadweep in lower levels	Do.	Do.	
	(iii) Do.	6-15	Southwest Bay off Tamil Nadu coast in middle tropospheric levels	Do.	Do.	
	(iv) Do.	13-16	Lakshadweep area in lower levels	Do.	Do.	
	(v) Do.	9 Jun	East Uttar Pradesh and neighbourhood	Do.	Do.	
	(vi) Do.	12-15	Gangetic West Bengal and neighbourhood	Do.	Do.	
	(vii) Do.	15-17	Northeast Rajasthan and neighbourhood	Do.	Do.	
	(viii) Do.	22-23	Punjab and neighbourhood			
	(ix) Do.	21-23	Northwest Bay off north Orissa coast	Do.	Do.	
	(x) Do.	25-26	North Punjab and neighbourhood	Do.	Do.	
	(xi) Do.	28-29	Haryana and neighbourhood	Do.	Do.	
	(xii) Do.	30-7 Jul	North Pakistan and neighbourhood		Moved away north-eastwards across Jammu & Kashmir	
4	(i) Trough (lower levels)	1-10	Bihar plains to north Tamil Nadu through east Madhya Pradesh and Telangana	Stationary	<i>In situ</i>	
	(ii) Do.	6-8	West Uttar Pradesh to Marathwada through west Madhya Pradesh	Eastward	East Uttar Pradesh to Rayalaseema	
	(iii) Do.	10-12	East Uttar Pradesh to Madhya Maharashtra through west Madhya Pradesh	Stationary	<i>In situ</i>	
	(iv) Trough (sea level chart)	15-17	Off Goa coast to Kerala coast		Embedded cyclonic circulation over Lakshadweep off Karnataka coast up to 7.6 km asl	Became less marked on 18
	(v) Trough (lower levels)	20-24	West Central Bay off Orissa coast to north Andaman Sea	Northeast	Northeast Bay to north	Became less marked on Andaman Sea
	(vi) Do.	24-30	Northwest Rajasthan to north Bangla Desh and thence to north-east Assam	Stationary	North Punjab to Gangetic West Bengal and thence to northeast Bay	
	(vii) Trough of low (sea level chart)	30-01 Jul	Lakshadweep area off Karnataka coast	Do.	<i>In situ</i>	
5	Western disturbance	24-26	North Pakistan and adjoining Jammu & Kashmir		Moved away north-eastwards	

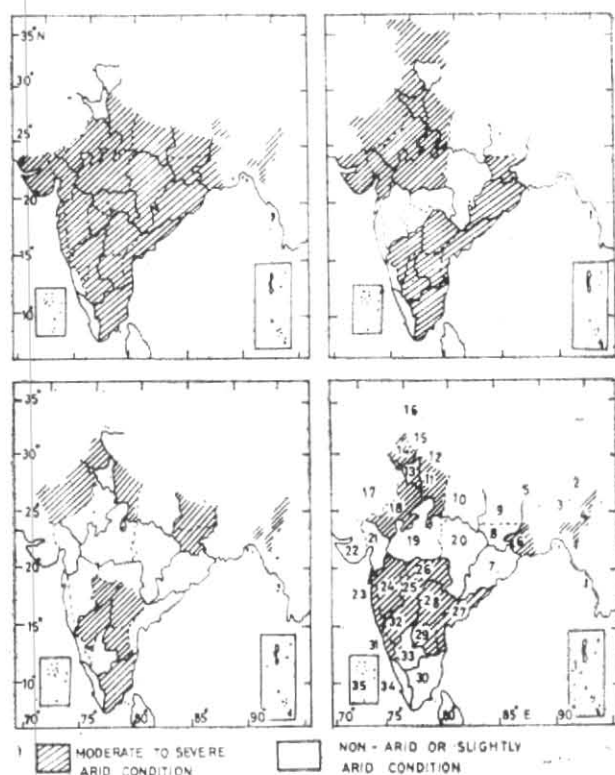


Fig. 9. Aridity conditions during 1992

were 28°N , 69.1°E and 28.2°N , 68.6°E with central pressures of 997.6 hPa and 997.2 hPa respectively. The lowest pressure of heat low was 992 hPa on 24, 26 and 27 June and 994 hPa on 19 and 25 July.

In the second fortnight of August the heat low was more intense and was situated south of its normal position.

4.2. Axis of the monsoon trough

The monsoon trough at 0.9 km asl normally runs from Ganganagar to north Bay through Allahabad in July.

The southwest monsoon was established over the entire country by 14 July and the monsoon trough was established in mid-July and it persisted till the first week of September.

The Monsoon trough was active and was south of its normal position on most of the days. Most of the low pressure areas/depressions and cyclonic circulations moved in a westnorthwesterly direction along the monsoon trough.

4.3. Cross-equatorial flow

The cross-equatorial flow was stronger in the Arabian Sea than in the Bay throughout the season. The average strength of the cross-equatorial flow in the Arabian Sea as estimated from the surface winds was of the order of 20 to 25 kt while in the Bay it was of the order of 10-15 kt. Occasionally the strength reached up to 35 to 45 kt in the Arabian Sea in July and August.

The western end of the equatorial trough in the southern hemisphere was equatorward than its normal position throughout the season.

4.4. Sea Surface Temperature (SST)

Fig. 8 gives monthly mean sea surface temperatures over the Arabian Sea and the Bay of Bengal and the corresponding normal isopleths.

In June, central and north Arabian Sea were warmer by 1°C than the normal and west central Bay was warmer by 2°C .

In July, most parts of the Bay of Bengal were warmer by 1 to 2°C .

In August, west central and northwest Arabian Sea and west central Bay of Bengal were warmer by 2°C .

In September, western parts of the Arabian Sea were warmer by 1 to 2°C .

The above assessment is tentative, as observations in all the four months of the season, are very meagre.

4.5. Tibetan anticyclone

The Tibetan anticyclone/high was established by the third week of June. It shifted southwards and also westwards by the second week of July and was intense in the second fortnight of July. In August it remained practically stationary, south of its normal position.

4.6. Tropical Easterly Jet (TEJ)

The tropical easterly jet was observed over Madras ($070^{\circ}/80$ kt at 99 hPa on 18 June) and Thiruvananthapuram ($070^{\circ}/85$ kt at 120 hPa on 17 June) during the third week of June. It persisted in the same latitudes till the third week of July. Again in the month of August and September, TEJ was seen over the above stations with wind speeds of 100 kt for one or two days. Visakhapatnam also reported 100 kt wind on some days during the fourth week of August.

5. Other features

5.1. Weekly anomaly

Weekly anomaly charts have been prepared for 850, 700 and 200 hPa levels wherein anomaly troughs and ridges have been delineated. Wind anomalies for some stations are given in Table 2.

June - July

One anomalous trough in the lower levels (850 and 700 hPa) was along 10°N on 9 June and 16 June. This moved to 19°N on 23 June and subsequently became less marked. The second anomalous trough was seen along 9°N on 7 and 14 July on 850 hPa chart only. Thereafter, it became less marked in the same location. The third anomalous trough was seen on 28 July on 850 and 700 hPa charts from 28°N , 74°E to 21°N , 90°E . Anomalous ridge was seen at 850 and 700 hPa charts along 20°N on 7 and 14 July.

No anomalous ridge at 200 hPa was seen throughout June and July. In most of the weeks almost all the stations in the Peninsular India were having anomalous westerly winds indicating a weaker easterly flow.

TABLE 4

Details of weather systems during July 1992

S. No.	Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Deep depression	26 Jul-1 Aug	Northwest Bay and neighbourhood	Westnorth-westerly	Northwest Rajasthan and adjoining Pakistan	Cyclonic circulation on 24 July. Low pressure area on 25 July and depression on 26 July near 20/88. Deep depression on 26 July E near 20.5/87.5, crossed Orissa coast near Chandbali between Paradip and Balasore on mid-night of 26. Depression over east Rajasthan near Kota (25/76) on 29 July. Well marked low over southwest Rajasthan on 30 and merged with seasonal low
2	(i) Low pressure	15 Jul	East central Arabian Sea off north Maharashtra-south Gujarat coasts	Stationary	<i>In situ</i>	Merged with well marked trough on sea level chart from south Gujarat coast to Kerala coast
	(ii) Do.	18	Northwest Bay and neighbourhood	Do.	Do.	Seen as cyclonic circulation over Gangetic West Bengal and adjoining Orissa and northwest Bay up to mid-tropospheric levels
3	(i) Cyclonic circulation	30 Jun-4 Jul	North Pakistan and neighbourhood	Northeastwards	Moved away northeastwards across Jammu & Kashmir	
	(ii) Do.	9 - 14	Punjab and adjoining Pakistan	Do.	Moved northeastwards across Jammu & Kashmir	
	(iii) Do.	10 - 12	Gangetic West Bengal and neighbourhood	Stationary	Orissa and neighbourhood	Merged with monsoon trough on sea level chart from southwest Rajasthan to south Orissa and south Madhya Pradesh and thence south-eastwards to south central Bay
	(iv) Do.	15 - 16	North Pakistan and neighbourhood	Northeastwards	Moved away northeastwards across Jammu & Kashmir	
	(v) Do.	18 - 25	Gulf of Cambay and neighbourhood	Northeast	Northeast Rajasthan and adjoining Har-yana	
	(vi) Cyclonic circulation between 1.5 and 5.8 km asl	17 - 21	Northwest Bay off Orissa coast	Stationary	<i>In situ</i>	Merged with monsoon trough
	(vii) Cyclonic circulation up to mid-tropospheric levels	19 - 21	Gangetic West Bengal and adjoining parts of Orissa and northwest Bay	Do.	Do.	Do.
	(viii) Cyclonic circulation extending up to 4.5 km asl	18	West Madhya Pradesh and neighbourhood	Stationary	<i>In situ</i>	Merged with monsoon trough at 0.9 km asl
	(ix) Cyclonic circulation extending up to mid-tropospheric levels	29 - 31	Southeast Rajasthan and neighbourhood	West to south-west	Over north Gujarat region and neighbourhood	Merged with the well marked low pressure area over northwest Rajasthan and adjoining Pakistan

TABLE 4 (Contd).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	
	(x)	Do.	29 Jul	Gulf of Siam and neighbourhood	Westerly	West central and adjoining northwest Bay	Became part of low pressure area over west central and adjoining northwest Bay
4	(i)	Trough of low on sea level chart	1-3	Maharashtra coast to Kerala coast	Stationary	<i>In situ</i>	Became less marked
	(ii)	Do.	3-15	Punjab to Gangetic West Bengal and thence southeastwards to Arakan coast	Northwest	Do.	
	(iii)	Do.	5-7	Bihar plains to north-northeast Assam	Stationary	Do.	Became less marked
	(iv)	Do.	8-31	West coast off Gujarat coast to Kerala coast	Fluctuating from Gujarat to Kerala and Karnataka to Kerala coast		Extended up to 5.8 km between 14 & 22 Jul and up to 1.5 km between 16 & 31 July
	(v)	Do.	31	North and central Bay	Stationary	<i>In situ</i>	
	(vi)	Trough (east-west) between 3.1 and 5.8 km asl	1	South Maharashtra coast to east central Bay across Orissa coast	Do.	Do.	
	(vii)	Trough (lower levels)	4-8	Northwest Bay to southwest Bay off Tamil Nadu coast	Do.	Do.	
	(viii)	Trough (east-west) between 3.1 and 5.8 km asl	9-12	From west central Bay off Andhra coast to Karnataka coast across Peninsular India	Do.	Do.	
5	(i)	Axis of monsoon trough	14	Runs from northwest Rajasthan to north Orissa across Madhya Pradesh and thence to southeastwards to east central Bay			
	(ii)	Do.	15	North Rajasthan to north Orissa across Madhya Pradesh and thence southeastwards to east central Bay			
	(iii)	Do.	16	West Rajasthan to Gangetic West Bengal and thence southeastwards to east central Bay			
	(iv)	Do.	17	West Rajasthan to Orissa across Madhya Pradesh and thence southeastwards to east central Bay			
	(v)	Do.	19	Southwest Rajasthan to Gangetic West Bengal across Madhya Pradesh and thence south-eastwards to east central Bay			
	(vi)	Do.	23	Northwest Rajasthan to Gangetic West Bengal across south Uttar Pradesh and thence southwards to east central Bay			
	(vii)	Do.	25	Anupgarh, Agra, Daulatganj and the centre of the low pressure area and then southeastwards to east central Bay			
	(viii)	Do.	26	Bikaner, Jhansi, Ambikapur, centre of depression and thence southeastwards to east central Bay			
	(ix)	Do.	27	Bikaner, Kota, Umariya, Jharsuguda centre of depression and thence southeastwards to east central Bay			
	(x)	Do.	28	Barmer, Guna, centre of depression and thence southeastwards to east central Bay			
	(xi)	Do.	29	Barmer, Guna, Pondon road, Paradeep, centre of depression and thence southeastwards to central Bay			
	(xii)	Do.	30	Jaisalmer, centre of the depression Kota, Jabalpur, Puri and thence southeastwards to east central Bay			

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TABLE 5

Details of weather systems during August 1992

S. No.	Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
1	(i) Low pressure area	2-4	West central and adjoining NW Bay	Easterly	West central and adjoining east central Bay	
	(ii) Do.	5	Saurashtra, Kutch and neighbourhood	Stationary	<i>In situ</i>	
	(iii) Well marked low pressure area	13-21	NW Bay and adjoining west central Bay off Orissa coast	Westnorth-westerly	Southwest Uttar Pradesh and neighbourhood	Well marked on 14 merged with monsoon trough
	(iv) Low pressure area	17-23	Northwest Bay off north Orissa-south Bengal coast	Northwest	Southwest Uttar Pradesh and adjoining northwest Madhya Pradesh	
	(v) Do.	26-30	Northwest Bay and neighbourhood	Westnorth-westerly	Southwest Uttar Pradesh and adjoining northeast Madhya Pradesh	
	(vi) Do.	30-4 Sep	West central Bay and neighbourhood	Do.	South Rajasthan and neighbourhood	Low Pressure area on 30. Well marked on 31 (west central Bay), crossed south Orissa coast on 1, crossed southwest Madhya Pradesh and adjoining Vidarbha on 2, crossed southeast Rajasthan and northwest Madhya Pradesh on 4 and became less marked on 5 September
2	(i) Cyclonic circulation	1-2	East Uttar Pradesh	Stationary	<i>In situ</i>	Extends up to 2.1 km asl
	(ii) Do.	2-5	South Madhya Pradesh and neighbourhood	Northwest-	-	Merged with low pressure area over Saurashtra & Kutch and neighbourhood
	(iii) Do.	2-4	Gujarat region and neighbourhood	Northwest-wards	-	Merged with low pressure area over Saurashtra & Kutch on 5 August
	(iv) Do.	2-3	Jammu & Kashmir and neighbourhood	Northeast	Moved away north-westwards	
	(v) Do.	5-8	North Tamil Nadu and neighbourhood	Northwest	Southwest Arabian Sea	
	(vi) Do.	6-13	Bangla Desh and neighbourhood	Northwest	South Rajasthan and adjoining Gujarat region.	
	(vii) Do.	22-24	Northwest Bay off Orissa coast	Northwest	Bihar plateau and neighbourhood	
	(viii) Do.	24	Gujarat region and neighbourhood	Stationary	<i>In situ</i>	
	(ix) Do.	25-26	Northeast Pakistan & adjoining Punjab	Northeast	Moved away northeastwards	
3	(i) Trough on sea level chart	1-19	West coast off Gujarat coast to Kerala coast		Oscillating north and south	
	(ii) Do.	24-31	Maharashtra coast to Kerala coast	Stationary	<i>In situ</i>	
	(iii) Monsoon trough	1-31	Passing through Patiala, Allahabad, Varanasi, Bhubaneswar and thence to north Andaman Sea through central Bay			

TABLE 6
Details of weather systems during September 1992

S. No.	Weather system	Period	Place of first location	Direction of movement	Place of dissipation	Remarks
1	(i) Well marked low pressure area	5-10	Northwest Pradesh and neighbourhood	Madhya Westnorth-west	Central Pakistan	Low pressure area (N W Madhya Pradesh) on 5, well marked LOPAR over SW Rajasthan and neighbourhood on 8, northwest Rajasthan and adjoining Pakistan on 9 and less marked on 11
	(ii) Do.	6-14	Northwest Orissa Bay	off Northwest	Central parts of east Uttar Pradesh	Cyclonic circulation over same area on 4 and 5, low pressure area on 6, well marked on 9, northwest Bay-crossed coast over Orissa and neighbourhood on 10, northeast Madhya Pradesh, central parts of east Uttar Pradesh on 11, less marked on 14 Sept. Associated cyclonic circulation up to mid-tropospheric level became less marked over north Uttar Pradesh on 16
	(iii) Low pressure area	24-28	North Bay and neighbourhood	Do.	Bihar plateau and neighbourhood	Northwest Bay and adjoining parts of West Bengal-north Orissa coast on 25
2	(i) Cyclonic circulation	1	North Konkan and adjoining parts of Gujarat region	Stationary	<i>In situ</i>	Merged with low pressure area over southwest Madhya Pradesh and adjoining Vidarbha
	(ii) Do.	2-3	Northwest Rajasthan and neighbourhood	Do.	Do.	
	(iii) Do.	3-5	North Orissa and neighbourhood	Northwest/Northnorth-west	East Madhya Pradesh and neighbourhood	Merged with monsoon trough
	(iv) Do.	10	South Uttar Pradesh and adjoining parts of north Madhya Pradesh	Stationary	<i>In situ</i>	Merged with low pressure area over Madhya Pradesh
	(v) Do.	14-15	Karnataka-south Maharashtra coast	Do.	Do.	
	(vi) Do.	14	Southeast Rajasthan and neighbourhood	Do.	Do.	
	(vii) Do.	16-18	North Pakistan and adjoining parts of Punjab	Northeast		Moved away northeastwards across Jammu & Kashmir
	(viii) Do.	20-21	Off north Maharashtra coast	Stationary	Do.	
3	(i) Westerly trough	16-17	Jammu & Kashmir to southeast Pakistan	Stationary	<i>In situ</i>	
	(ii) Trough (sea level chart)	10-12	Maharashtra coast to Kerala coast	Do.	Do.	
	(iii) Trough (lower level)	15-23	Telangana to south Tamil Nadu	Do.	Do.	
	(iv) Do.	25-26	Off southwest Bay running off south coastal Andhra Pradesh to north Tamil Nadu	Do.	Do.	
	(v) Do.	27-29	From north interior Karnataka to south Tamil Nadu with an embedded cyclonic circulation off Tamil Nadu	Do.	Do.	
	(vi) Trough (extends up to mid-tropospheric levels)	21-23	From north Bay to north Andaman Sea	Northerly		Low pressure area formed over northeast Bay on 24th

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APPENDIX I

Principal amounts of rainfall (cm)

Dae	June	July	August	September
1		Shirali 19, Peermade 17, Ramagundam 13, Karwar 10	Shirali 10, Bhubaneswar, Broach & Magra 8 each	Amraghat 14, Kangra 9, Hardwar & Kalingapatnam 7 each
2		Dundigal 12, Cherrapunji, Jagdalpur & Jalpaiguri 7 each	Ambala & Adilabad 13 each, Cuttack 11, Yeotmal 10	Latur 22, Akola 11, Ramagundam 9, Betul 7
3	Kodumudi 16, Nedumangad 15, Kochi 10, Sirsa 8	Cherrapunji 27, Chouldaghat 11, Pilani & Raipur 7 each	Hoshangabad 22, Jogindernagar 15, Alibag & Silchar 7 each	Aurangabad 19, Mukteshwar 16, Bhavnagar 9, Sagar Island 7
4		Cherrapunji 22, Hosdurg 18, Cooch Behar 8, Passighat 7	Shirali 24, Bankura 10, Balasore 9, Bhavnagar 8	Veraval 14, Churu 10, Ambikapur & Fazilka 9 each
5	Thumba 8, Panjim 7	Irinjalakuda 12, Avinashi 9, Bagdogra 8, Agartala 7	Jogindernagar 16, Harnai 14, Honavar 11, Mavelikara 7	Karimganj & Paint 14 each, Agumbe 10, Karkala 8
6	Mayanur 15, Kollam 11, Gangtok 8, Karkala 7	Cherrapunji 17, Paderu 12, Betta Japura & Mohendragarh 7 each	Jalpaiguri 25, Rupsi 12, Agumbe 8, Churu 7	Mount Abu 11, Agartala & Raipur 9 each
7	Verkala 16, Karwar 10, Cooch Behar 9, Jalpaiguri 8	Ahwa 19, Denkanikottai 16, Nandyal 11, North Lakhimpur 9	Calcutta 18, Puri & Purnea 9 each, Sidhi 8	Jogindernagar 13, Pathankot 9, Jodhpur & Nagpur 8 each
8	Kodungalur 35, Alapuzha 21, Panambur 14, Gokarna 9	Chengannur 15, Cooch Behar 11, Cherrapunji 9, Gaiendragad 8	Dharamsala 25, Khajuraho 23, Pilani & Sambalpur 9 each	Bhakudar 34, Mount Abu & Silchar 15 each, Agumbe 9
9	Vadakara 16, Thiruvananthapuram 12, Aminidivi 8, Chaliekeri 7	Ammathy 12, Ratnagiri 8, Hardwar & Vaikom 7 each	North Lakhimpur 15, Nowgong 11, Meerut 10, Mangalore 9	Jalore & Paradip 11 each, Kollam 9, Bahraich 7
10	Dundigul 17, Keonjhar & Kochi AP 8 each, Saswad 7	Peermade 11, Purnea 9, Lonavala 8, Jalpaiguri 7	S. Madhopur 12, Purulia 11, Chandbali 10, Chandigarh 8	Rajgarh 22, Kasauli 20, Aizwal & Nizamabad 7 each
11	Aska & Turaiyur 9 each, Irinjalakuda & Yelhanka 7 each	Calcutta 16, Cherrapunji & Vishakhapatnam 8 each, Lucknow 7	Mahabaleshwar 18, Erinpura Rd 14, Mangalore 10	Khowang 12, Jabalpur & Kanpur 8 each, Contai 7
12	Aminidivi 31, Agathi 8, Cherrapunji 11	Cherrapunji 15, Darjeeling 9, Narsipatnam & Minicoy 7 each	Bombay 22, Bolangir, Jalore & Khammam 10 each	Panna 24, Darjeeling & Kanpur 12 each, Jogindernagar 9
13	Enmakal 31, Cherrapunji 16, Kochi 9, Dumka 8	Passighat 10, Koderu 9, Mukteshwar 8, Bhatinda 7	Bhira 24, Muzaffarnagar & Uttnoor 10 each, Guddalur 9	Banda 19, Satna 13, Bhagalpur 9, Darjeeling 7
14	Cherrapunji 21, Udupi 16, Verkala 12, Belthangady 7	Passighat 23, Bahraich, Bagdogra & Panjim 9 each	Mahabaleshwar 27, Agumbe 16, Panjim 10, Jagdalpur 7	Bilhaul 15, Lucknow 13, Hasiarama 11, Garutha 10
15	Port Blair 8, Bapatla 7	Cooch Behar, Rupsi & Tadong 11 each, Gokarna 8	Bhira 19, Raipur 11, Darjeeling 9, Dehradun 7	Dharmapuri 7
16	Panjim 35, Karwar 15, Sawantwadi 9, Parbhani 7	Kottayam 15, Panna 12, Ratnagiri 10, Sriniketan 8	Hardwar 18, Bhillwara 13, Seoni 11, Shimla 9	Passighat 7
17	Kalinga 23, Panjim 17, Thalassery 11, Honavar 12	Mangalore 15, Purnea 14, Alibag 13, Bhubaneswar 12	Shajapur 19, Bhira 18, Jogindernagar 13	Magadi 15, Jalpaiguri 13, Dindigul 11, Tangla 8
18	Puri 25, Peermade 16, Honavar 9, Vengurla 8	Ratnagiri 29, Kaling 10, Raipen 8, Fatehpur 7	Mahabaleshwar 24, Guna 12, Midnapore 10, Bikaner 7	Vellore 12, Chamarajanagara, Mathanguri & Nugehall 7 each
19	Gokarna 27, Gadchiroli 24, Titlagarh 13, Dibrugarh 11	Mahabaleshwar 21, Ratnagiri 17, Dibrugarh & Mathura 7 each	Agumbe 25, Bolangir 16, Bhillwara 10, Jabalpur 8	Hoskote 11, Bangalore & Seroke 7 each
20	Ratnagiri 39, Parbhani 18, Pachmarhi 13, Silchar 9	Agumbe 17, Berhampore 11, Dharamsala 10, Bolangir 8	Bolangir 23, Mana 15, Madikeri 10, Kanpur 7	Sulur 7
21	Sonagadhi 41, Kannur 33, Tallital 25, Belgaum 10	Koderu 21, Bankura 18, Raigarh 16, Kalingapatnam 8	Sikar 17, Yeotmal 12, Bagdogra 8, Hamirpur 7	Ulundurpet 13, Pondicherry 9, Alapuzha 8, Salem 7
22	Naduvattam 24, Medikeri 21, Maheshwar 15, North Lakhimpur 8	Honavar 11, Bhira 10, Sambalpur & Uttar Kashi 7 each	Sambhat 19, Alipur Duar 15, Kollur 9, Kalimpong 7	Baruipur 8
23	Bankura 28, Vapi 25, Sambalpur & Tezu 8 each	Okha 17, Moradabad 13, Gazipur 10, Kollur 9	Daltanganj 13, Seoni 12, Ambikapur 8, Bagdogra 7	Bhindole & Perianaikan-Palayam 9 each, Alapuzha 7
24	Bankura 18, Murtizapur 12, Nanded 11, Calcutta 7	Agumbe 16, Taliparamba 10, Mahabaleshwar 8, Gangtok 7	Raisen 21, Cherrapunji 10, Amroha & Cooch Behar 8 each	Kangeyam 9
25	Cherrapunji 26, Darjeeling & Khodwanpur 8 each, Calcutta 7	Baripada 15, Bhira 13, Narsampet 8, Baroda 7	Dehradun 16, Pathankot & Vaidisha 13 each, Madras 7	Ulundurpet 13, Pondicherry 9, Alapuzha 8, Salem 7
26	Silchar 12, Mananthavady 11, Bagdogra 9, Bilgram 8	Peddapuram 16, Dehradun 12, Ramagundam 10, Shivpuri 9	Gazipur 14, Ambikapur 13, Jalpaiguri 9, Lumding 8	Baruipur 8
27	Kudulu & Rupsi 12 each, Agumbe 8, Bahraich 7	Agumbe 27, Hemgiri 22, Neemuch 17, Cooch Behar 12	Buxar 19, Hardwar 13, North Lakhimpur & Shimla 8 each	Usilampatti 14, Purulia 13, Dibrugarh 10, Bhubaneswar 7
28	Karkala 16, Cooch Behar 10, Taibpur 8, Calcutta 7	Angul 24, Neemuch 22, Deesa 14, Midnapore 9	Bilaspur 12, Belthangady 9, Ghazibad 8, Raunagiri 7	Jhalda 25, Purulia 16, Jamshedpur 11, Puri 7
29	Shirali 22, Damohani 13, Taliparamba 10, Etahwa 7	Raisen 18, Madikeri 10, Raikot 9, Gondia 8	Port Blair 12, Agumbe & Mirzapur 8 each, Gangtok 7	Mettupatti 16, Balurghat 14, Madurai 9, Kochi 7
30	Mangalore 16, Ponnani 15, Talaguppa 9, Cooch Behar 7	Mount Abu 13, Porbandar 11, Kohima 10, Guddalur Bazar 9	Amraghat 13, Idukki, Kodungallur and Port Blair 7 each	Nellore 18, Mangalore 10, Guwahati & Kolhapur 7 each
31		Mount Abu 26, Poshina 18, Katra 14, Dharamsala 12	Shikohabad 10, Karkala 8, Narsipatnam 7	Belgaum 9, Bombay 7

August-September

One anomalous trough was seen on 850 and 700 hPa charts west of 75°E along 25°N on 4 August and along 28°N on 11 August. On the 18th, it was running from 25°N, 73°E to 17°N, 90° E. On 8 September, one anomalous trough was seen from 25°N, 75°E to 17°N, 90°E. Anomalous ridge on 850 and 700 hPa charts was seen along 11°N on 15 September and along 19°N on 22 September.

One anomalous ridge at 200 hPa was seen along 25°N on both 25 August and 29 September. In the remaining weeks of August and September most of the anomaly winds in peninsula were westerlies.

5.2. Stratospheric features (10 hPa)

The rocket winds (flightwise) over Balasore and Thumba have been plotted and analysed for the monsoon periods June to September 1992. The following are the main features of circulation :

Balasore

Balasore data around 10 hPa were meagre during July-September. Wind regime in the vicinity of 10 hPa level was dominated by easterlies during the monsoon season. Strong easterly winds of 50 kt were noticed in the beginning of June which gradually increased to 70 kt by the end of July. The strength was maintained till the middle of August. Then it started decreasing gradually and by September it was 40 kt only.

Meridional components were practically absent.

Thumba

Strong easterly winds with speeds of around 30 kt appeared in the month of June, which decreased to westerly winds of speeds less than 10 kt in September.

The meridional components were negligible.

The temperature over Thumba at 10 hPa was found to be approximately -43°C in the beginning of June and -54°C towards the end of September.

5.3. Aridity conditions during southwest monsoon season

Moderate to severe arid conditions occurred in many meteorological sub-divisions of the country as shown in Fig 9.

The remaining meteorological sub-divisions experienced either non-arid or mild-arid conditions.

6. Systems outside India

6.1. Systems in south China Sea/west Pacific Ocean

The four monsoon months of 1992 witnessed 10 typhoons, 8 tropical storms and one tropical depression in south China Sea and west Pacific Ocean. All but two had their genesis in the western north Pacific Ocean. The remaining disturbances, viz., other one tropical storm and one tropical depression formed in the south China Sea. No system emerged into the Bay during the season 8 systems recurved northeastwards. The details of the tropical systems are given in Table 7.

TABLE 7

(a) Systems in the west Pacific during monsoon 1992

	Jun	Jul	Aug	Sep
Tropical depression	—	—	—	1
Tropical storm	1	2	4	1
Typhoon	2	1	4	3
Total	3	3	8	5
Mean (1959-1992) 34 years	2.1	4.5	6.2	5.7

(b) Systems in the south Indian Ocean west of 110°E during monsoon 1992

	Jun	Jul	Aug	Sep
Tropical depression	—	—	—	—
Tropical storm	—	—	—	1
Typhoon	—	—	—	—
Total	—	—	—	1
Mean (1985-1991) 7 years	0.3	0.3	0.1	0.7

Tropical depression < 33 kt, Tropical storm 34-63 kt,
Typhoon 64-129 kt, Super typhoon > 130 kt.

6.2. System in the southern hemisphere

Only one tropical storm formed in the south Indian Ocean in the last week of September. It moved poleward in a southwesterly direction and dissipated over the ocean itself. The details of the tropical system are given in Table 7.

The intensity of the Mascarene High was below normal by 1-2 hPa in June and by 2-3 hPa in July and above normal by 2-3 hPa in August and September. The Mascarene High was located to the east of its normal position by 5° to 10° in longitude in June and September. It was located to the west of its normal position by 5° in longitude in August. It was located near its normal position (30°S/60°E) in July.

7. Characteristic features of southwest monsoon 1992

(i) One cyclonic storm (8-12 June) over the Arabian Sea and two deep depressions (17-20 June, 26-30 July) over the Bay of Bengal formed during June and July against the normal of 6-7 depressions.

(ii) No depression formed during the months of August and September against the normal of 4-5.

(iii) In August, six low pressure areas moved across the central parts of the country and gave well distributed rainfall. 29 meteorological sub-divisions received excess or normal rainfall in August.

(iv) Three low pressure areas in September gave widespread rains with 19 meteorological sub-divisions receiving excess or normal rainfall.

(v) There was a lull in the monsoon activity over the entire country from 25 June to 10 July with subdued rainfall. The area-weighted rainfall showed rising trend

in all the weeks except these two weeks. However, sharp rise in area weighted rainfall were seen during 17-24 June and 15-22 July (Fig. 5).

(vi) Advance of southwest monsoon was not associated with any onset vortex.

(vii) Advance of southwest monsoon was delayed by about 5 to 12 days over the major parts of the country except over Rajasthan where it arrived around normal date. The northern limit of monsoon remained stationary over northern parts of the peninsula and east Uttar Pradesh from 20 June to 5 July. However, advance of monsoon over the entire country was complete by 14 July, the normal date.

(viii) Axis of the monsoon trough was generally south of its normal position.

(ix) The Tibetan anticyclone was slightly to the south of its normal position from the second fortnight of July to the middle of September.

(x) There was no typical break monsoon situation after the monsoon had advanced over the whole country.

(xi) The chronic deficient rainfall receiving areas such as west Rajasthan received excess rainfall (+97%) during the season. Gujarat State also received normal rainfall (7%) during the season.

(xii) Rain shadow regions like Tamil Nadu, Rayalaseema, north interior Karnataka, Telangana, Madhya Maharashtra and Marathwada received normal rainfall during the season while the flood prone area of northeast India received below normal rainfall with no major floods occurring in the area.

8. Damages due to floods etc during the monsoon season

Heavy rains/floods caused varying amounts of damages in the States of Gujarat, Kerala, Orissa, Maharashtra, Assam, Rajasthan, West Bengal, Jammu & Kashmir and Uttar Pradesh and affected nearly 20 million people and claimed nearly 900 human lives.

8.1. Significant spells of heavy rainfall and destructive winds

During June widespread rainfall with isolated/scattered heavy falls occurred over Kerala coast, Karnataka and Konkan on most of the days. More than 50 houses, thousands of plantations and a few fishing boats were damaged due to strong winds in Kerala during the 2nd and 3rd weeks of June.

During the 2nd fortnight of July and 1st fortnight of August and September, widespread rainfall with isolated heavy falls occurred over the west coast, interior Peninsular India, Madhya Pradesh and northeast India.

9. Significant monthly features

9.1. June

The southwest monsoon set in over Kerala on 5 June without any onset vortex. The monsoon covered the entire country by 14 July which is the normal date. Advance of monsoon over major parts of the country was delayed by 5 to 12 days.

9.1.1. Advance of monsoon

Though monsoon onset over Kerala was without any onset vortex, its advance over Peninsular India and

northeastern States was in association with a deep depression (17 to 20 June) in the Bay. Monsoon advanced rapidly over parts of northeast India between 3 and 14 July.

9.1.2. Synoptic systems

Synoptic systems that occurred during June are given in Table 3.

9.1.3. Monthly rainfall

Principal amounts of daily rainfall are given in Appendix I.

9.1.4. Temperature

Moderate heat wave conditions prevailed on 4 to 6 days in the 2nd and 3rd weeks of June over Rajasthan, plains of Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat and Maharashtra States.

9.1.5. Disastrous weather events and damages

7 people lost their lives in Kerala in the 2nd week of June due to heavy rains. 28 people lost their lives in Gujarat and 7 people in Orissa due to heavy rains during the 3rd week of June.

9.2. July

9.2.1. Synoptic systems

Details of synoptic systems are given in Table 4.

9.2.2. Monthly rainfall

Principal amounts of daily rainfall are given in Appendix I.

9.2.3. Disastrous weather events and damages during July

During the 3rd week of July, 9 persons in Bombay, 81 persons in Gujarat and 10 persons in Assam lost their lives due to heavy rains.

9.3. August

9.3.1. Synoptic systems

Details of the synoptic systems during August are given in Table 5.

9.3.2. Monthly rainfall

Principal amounts of daily rainfall are given in Appendix I.

9.3.3. Disastrous weather events and damages during August

There were no reports of damages during this month.

9.4. September

9.4.1. Synoptic systems

Details of the synoptic systems are given in Table 6.

9.4.2. Withdrawal of southwest monsoon

Details are given under para 2.5.

9.4.3. Monthly rainfall

Principal amounts of rainfall are given in Appendix I.

9.4.4. Disastrous weather events and damages

Torrential rains in the 1st week of September took a toll of 150 lives in Uttar Pradesh and 300 lives in Jammu & Kashmir.