MAUSAM, 48, 3 (July 1997), 457-487

Weather in India

MONSOON SEASON (JUNE-SEPTEMBER 1996)*

1. Introduction

The seasonal rainfall was excess or normal in 32 meteorological sub-divisions and was deficient in only 3 meteorological sub- divisions. No meteorological sub-division received scanty rainfall during the season. Two cyclonic storms formed in June, one over the Bay of Bengal and other over the Arabian Sea and only one monsoon depression over land formed in July. No depression/cyclonic storm formed in the other two months of the monsoon season of 1996. The seasonal rainfall departures, stationwise and sub-divisionwise, are given in Figs. 2 and 3.

2. Features of monsoon

2.1. *Advance of southwest monsoon*

Southwest monsoon advanced over the south Andaman Sea and adjoining southeast Bay on 17 May. By 31 May, monsoon advanced into some parts of southwest and southeast Arabian Sea, Maldives and Comorin areas, parts of Sri Lanka, some parts of west-central and parts of northeast Bay, Nagaland, Manipur, Mizoram & Tripura, parts of Assam & Meghalaya and Arunachal Pradesh. Southwest monsoon further advanced into Kerala and south Tamil Nadu, Lakshadweep, parts of southwest Bay and parts of west-central Bay on 3 June. It may be noted that, southwest monsoon advanced over Assam and adjacent states three days earlier than over Kerala as in 1995. By 12 June it advanced into Konkan, parts of north Madhya Maharashtra and Marathwada, Karnataka, Andhra Pradesh, parts of Orissa, west Bengal and eastern parts of Bihar. By 19 June it advanced into most parts of Saurashtra & Kutch, Gujarat region, south Madhya Pradesh and parts of north Madhya Pradesh. By 26 June monsoon has further advanced into parts of Rajasthan, Madhya Pradesh, Bihar, Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Jammu & Kashmir. It's advance over parts of Rajasthan was prior to that over parts of Bihar and Uttar Pradesh. Monsoon advanced into west Rajasthan and covered whole country on 30 June. Advance of southwest monsoon over Kerala was delayed by only 2 days. It's further advance along the west coast upto Mumbai, over peninsular India and also over central and eastern parts of India was around the normal date. However, its advance over northwest India and east Rajasthan was about a week earlier and over west Rajasthan was about two weeks earlier than the normal. Isochrones of advance of southwest monsoon are given in Fig. 4.

2.2. *Week-by-week rainfall distribution (1 June - 2 October 1996)*

Meteorological sub-divisionwise weekly rainfall departures (percentage departure from normal) during the period 1 June to 2 October 1996 comprising of 18 weeks are given in Fig. 1. Rainfall activity was

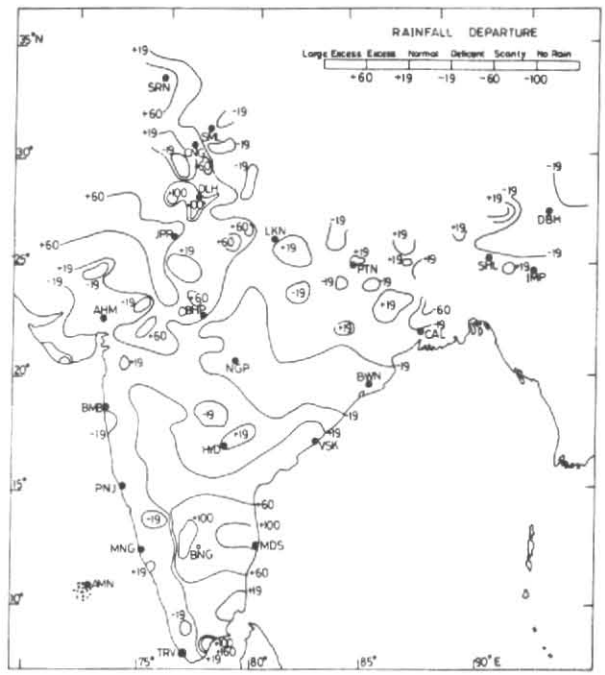


Fig. 1. Stationwise seasonal rainfall departure (%) for the period June-September 1996

*Compiled by : S.K. Dikshit, D.S. Desai and S. G. Bhandari, Meteorological Office, Pune, India

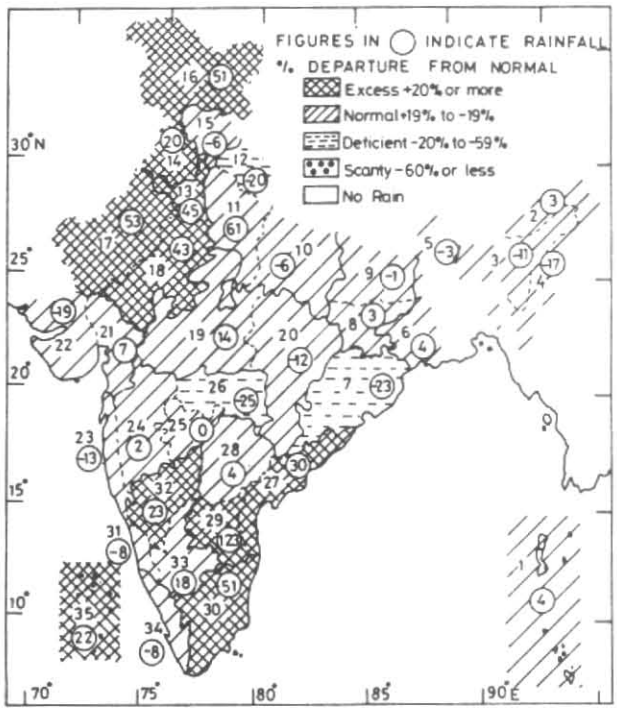


Fig. 2. Sub-divisionwise seasonal rainfall departure (%) for the period June-September 1996

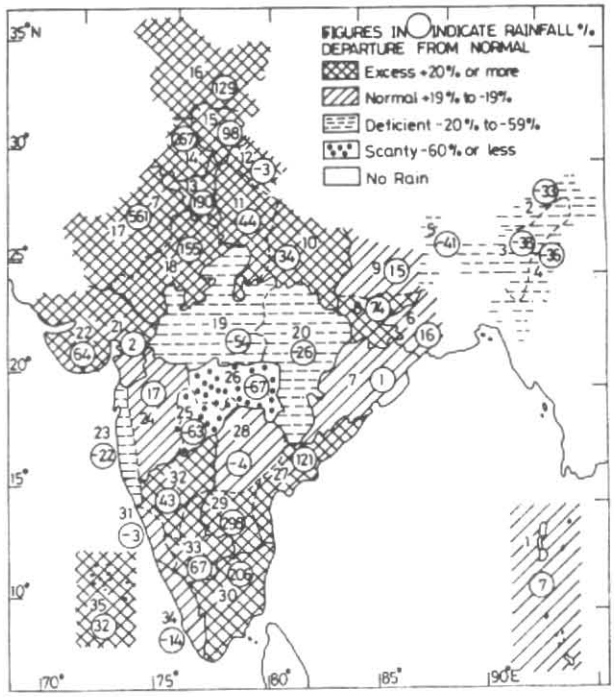


Fig. 4. Rainfall for the month of June 1996

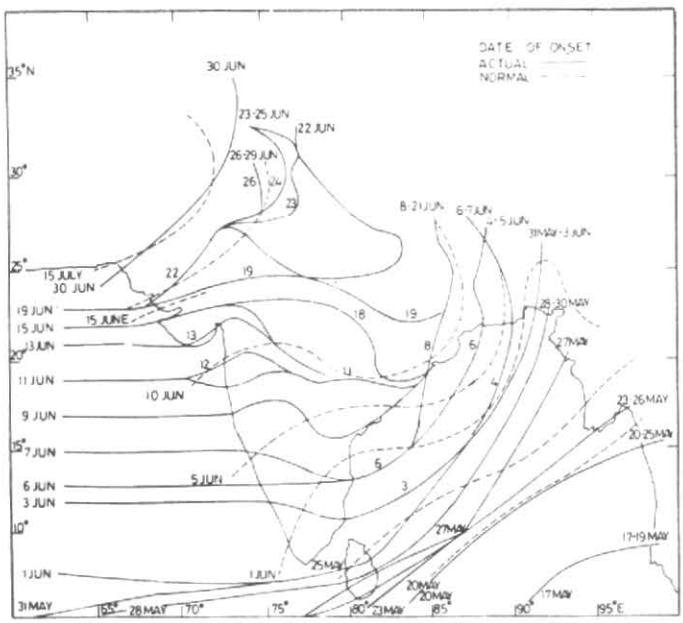


Fig. 3. Advance of southwest monsoon 1996

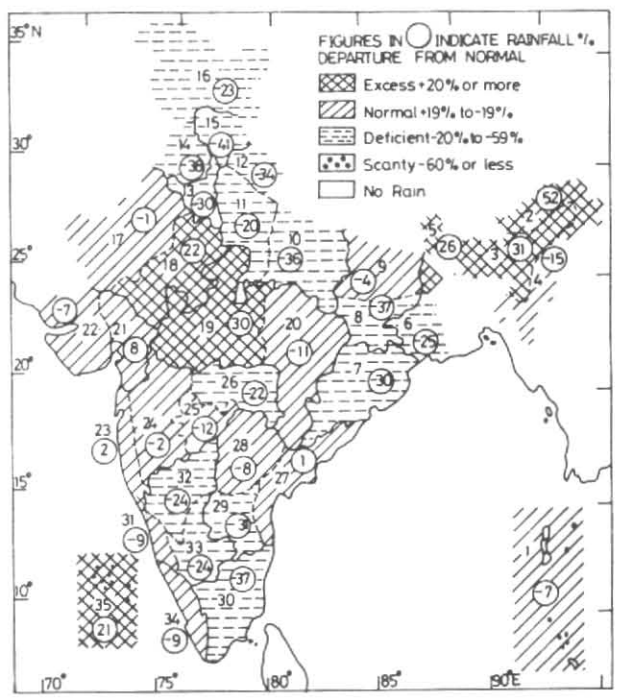


Fig. 5. Rainfall for the month of July 1996

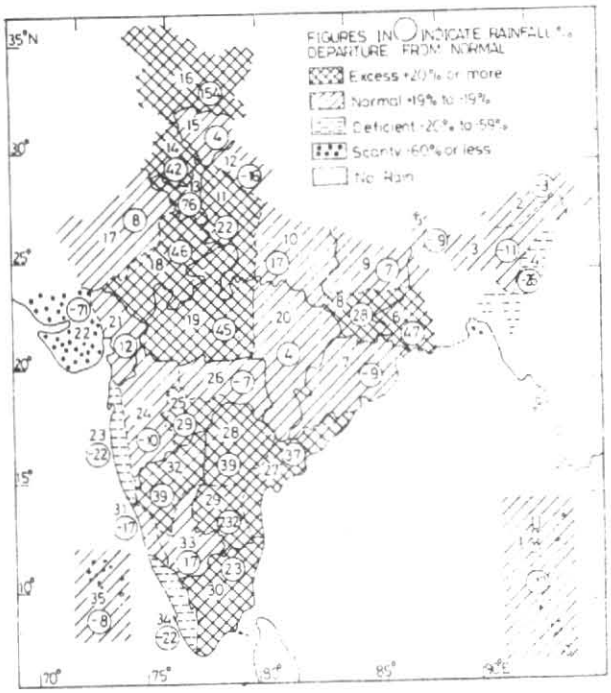


Fig. 6. Rainfall for the month of August 1996

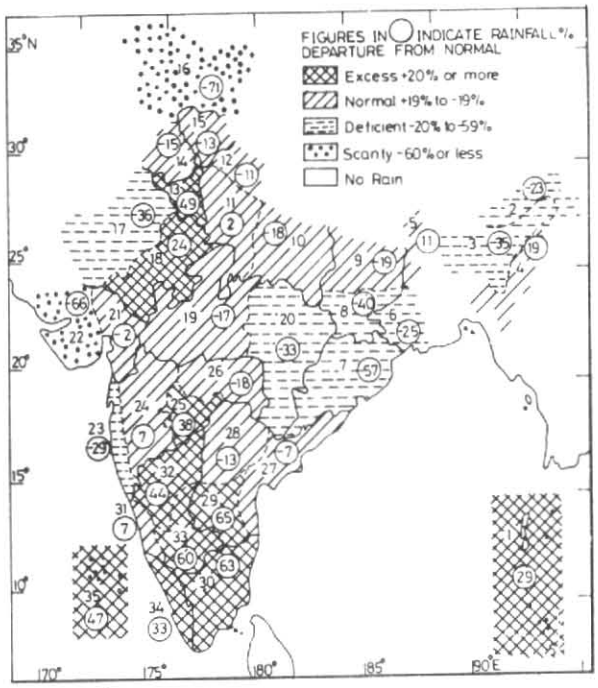


Fig. 7. Rainfall for the month of September 1996

subdued during the 1st week of June and also during the week ending on 25 September. Rainfall activity was also subdued in central and peninsular India during the week ending 3 July. Otherwise rainfall, week-by-week was well distributed. During 11 weeks nearly 50% or more meteorological sub-divisions received normal or excess rainfall and in the 5 weeks ending on 3, 10 and 31 July, 7 August and 18 September, 35% or more meteorological sub-divisions received excess or normal rainfall.

Out of a total period of 18 weeks (from 1 June to 2 October 1996), weekly rainfall was excess or normal during 10 weeks or more in Andaman & Nicobar Islands. Arunachal Pradesh, West Bengal & Sikkim, Haryana, Punjab, Jammu & Kashmir, Rajasthan, Andhra Pradesh, Tamil Nadu, interior Karnataka and Lakshadweep. Whereas, it was excess or normal during five weeks or less in Bihar plateau, hills of west Uttar Pradesh, east Madhya Pradesh and Saurashtra & Kutch.

2.3. *Month-by-month performance*

During June (Fig. 5), rainfall, was excess in 16, normal in 10, deficient in 7 and scanty in the remaining 2 meteorological sub-divisions over India.

During July (Fig. 6), rainfall was excess in 6, normal in 14 and deficient in 15 meteorological sub-divisions over India.

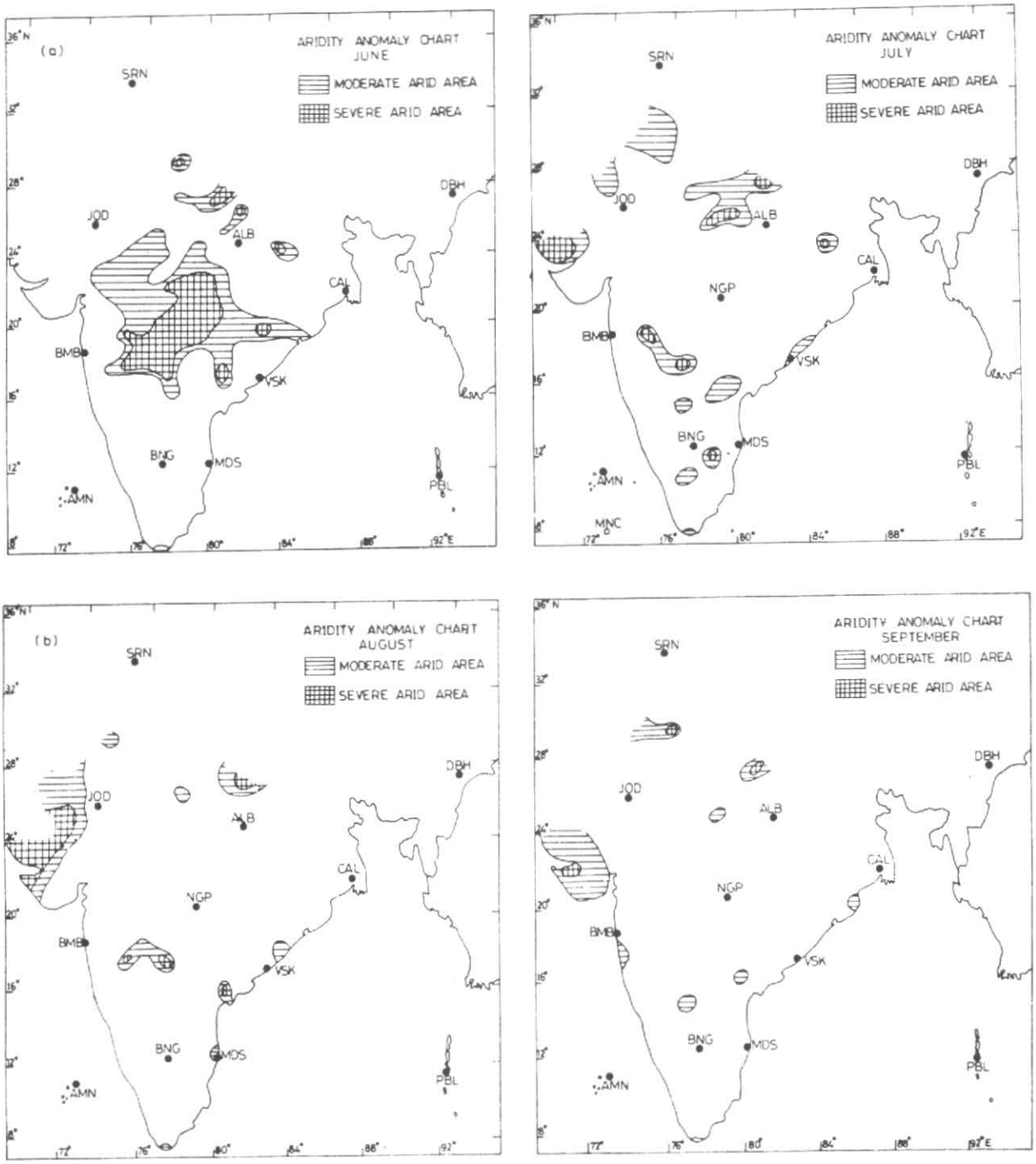
During August (Fig. 7), rainfall was excess in 14, normal in 17, deficient in 3 and scanty in one meteorological sub-division over India.

During September (Fig. 8), rainfall was excess in 10, normal in 15 and deficient in 8 and scanty in 2 meteorological sub-divisions over India.

2.4. *Seasonal performance of monsoon rainfall*

Seasonal rainfall distribution in terms of percentage departures from normal, sub-divisionwise is given in Fig. 3 and Table 9. The seasonal rainfall was excess in 10 and normal in 22 sub-divisions. It was marginally deficient in only three sub-divisions, namely; Orissa (–23%), Hills of west Uttar Pradesh (–20%) and Vidarbha (–25%).

Seasonal total rainfall for the country as a whole was normal. The country received 103% of its long period average value.



Figs. 8(a&b). Meteorological sub-divisions affected by moderate to severe aridity conditions during (a) June & July 1996 and (b) August & September 1996

2.5. *Districtwise distribution of rainfall*

Districtwise distribution of rainfall, for each state giving number of districts with excess, normal, deficient and scanty rainfall for the period 1 June to 30 September 1996 is shown in Table 2. Data were received from 396 districts (out of 415 meteorological districts). Of which 139 (35%) districts experienced excess rainfall and 187 (47%) received normal rainfall during June to September 1996.

TABLE 1

Principal amounts of rainfall (≥ 7 cm) for the months for June to September 1996

Date (1)	June (2)	July (3)	August (4)	September (5)
1	Dhubri 10, Cooch Behar & Waltair 9 each, Varkal 8	Baltara 19, Sikandarpur 16, Chottabekra 10, Panbari 9, Beki Road Bridge & Berhampore 8 each, Poladpur 7	Raipur 24, Mana 22, Jamshedpur 19, Dungarwadi 12,Varanasi 9, Panposh 8, Mohanpur 7	Dhubri 17, Bhind 16, Banbasa & Gazipur 15 each, Beki Mathanguri & Dowlaiswaram 13 each, Behar & Gwalior 8 each, Baltara 7
2	Sevoke 7	Beki Road Bridge 18, Dengraghat 14, Khalapur 13, Guwahati 9, Agartala & Bhavnagar 8 each, Gaganbavda 7	Kangsabati Dam 18, Koyna 14, Gaganbavda & Gohana 12 each, Auriya & Yeotmal 8 each, Dabri & Mani 7 each	Bhind 14, Gooty & Kanpur 12 each, Tusuma 11, Garotha 10, Guntur 8. Dengraghat & Periyakulam 7 each
3	Kozhikode 7	Hasimara 18, Saralpara 15, Thane Belapur 9, Passighat 7	Gaganbavda 11, Jirka & Mahabaleshwar 9 each, Jamsolaghat, Moga & Vihar 7 each.	Agra each Chibramau 13 each, Kattumannarkoil & Ramagundem 8 each, Jaipur & Jhansi 7 each
4	Thiruvananthapuram 10, Thuklay 8, May Bandar 7	Nancowry 17, Beri Mathanguri 16, Galgaliya 13, Upper Vaitarna 10, Mumbai 8, Chintalapudi 7	Khand 10, Gaganbarda, Mahabaleshwar & Nawashahar 7 each	Taibpur 12, Dummagudem 11, Jharsuguda & Narsapur 8 each, Cuddapah 7
5	Itanagar 9, Minicoy 9, Alapuzha 8, Sevoke 7	Nagarkata 27, Pauni 14, Mellabazar 11, Purna 7	Jodhpur 29, Dehra Dun 10, Khand 9, Adoor, Agumbe, Dhollabazar, Guna & Koyna 7 each	Kakrahi 15, Berhampore 14, Nizamsagar 10, Kuhi, Sevoke & Uthangiri 9 each, Gadag & Mhasla 8 each, Kusiary 7
6	Hut Bay & Matizuri 7 each	Birpur & Purulia 9 each, Sevoke 8	Nawashahar 16, Mellabazhar 15, Swampatna 13, Dohad 12, Mount Abu 11, Banswara, Dharamsala, Jhabua & Lanja 9 each, Minicoy 8, Agumbe, Ambone, Gazipur, Harinkhola, Nagaur & Ranchi 7 each	Sendwa 9, Banbasa, Durg & Tumkur 8 each, Passighat, Pathri & Sevoke 7 each
7	Kailkuntla 8, Gaganbavda 7	Guntur & Kondul 8 each, Guna & Latur 7 each	Kaharidwar 10, Ahmedabad & Subramanya 9 each, Chittradurga, Jamshedpur & Naraingarh 8 each, Banswara, Calcutta, Madikeri & Piravom 7 each	Pauni 19, Ottapalam 13, Rattia 12, Dohad & Narora 11 each, Ajmer & Kalingapattinam 9 each, Cooch Behar, Fetehgarh & R.S. Dam site 8 each, Alapuzha 7
8	Canning Town 8, Guhagar 7	Sindkheda 14, Almatti 12, Champasarai 10, Naraingarh, Paonta & Paravur 9 each, Amini Divi 7	Katerniaghat 15, Koyna 14, Haldwani 12, Sikandarpur 11, Nanipalsan & Peint 10 each, Chittorgarh 9, Chauldho-waghat & Koida 7 each	Colgaon & Jagadhari 14 each, Ayodhya 13, Alibag & Pathri 11 each, Cuddalore 10, Chottabekrau & Madhuban 8 each, Banbasa, Moradabad & Raigarh 7 each
9	Bangalore & Panambur 8 each	Hasimara 10, Gwalior & Madurai 9 each, Akola 7	Suri & Bilari 15 each, Sevoke 13, Lalbegiaghat, Saralpara 11, Kashipur, Mahabaleshwar & Naraingarh 9 each	Kalka 18, Ukai 15, Dharampur 12, Amalapuram, Muddebihal & Udaipur 11, Shirol & Vellore 10, Pathri 9, Khadda & Triveni 8; Banpura & Dabri 7 each

TABLE 1 (*Contd.*)

(1)	(2)	(3)	(4)	(5)
10	Koyana & Pānhala 8 each, Ghodegaon & Kondul 7 each	Dehradun 22, Barobisha 19,Ponnani 13, Malegaon 12,Panambur 10, Kozhikode, Maithan & Tezu 9 each, Ghamrur & Purulia 7 each	Jagadhari 16, Fatehpur & Nagrota Suriam 15 each, Chottabekra 14	Sankheda 21, Manali 11, Balachaur, Vallabh & Vidyanagar 10 each, Narnaul 8
11	Nagarkurnool 14, Panjim 13, Tiruvur 12, Itanagar 11, Atmakur 10, Karwar & Salem 9 each, Tiruchirapalli 7	Shardanagar 12, Kokrajhar & Sevoke 11 each, Kancheepuram, Karwar & Nangal 10, Latur 9, Dungarwadi 8, Hut Bay, Idukki, Jagadhari & Umrer 7 each	Mudibigere 11, Car Nicobar, Sevoke & Fatehpur 10 each, Dabri, Katra & Koyna 8 each, Ambone 7	Savnur 9, Kalwakurthy 8
12	Melagaon 11, Chidambaram 9, Port Blair 8, Nagapattinam 7	Hasimara 19, Saralpara & Kakardarighat 18 each, Dharavi 16, Manchikere 12, Rangagora 10, Darabassi 8, Itanagar & Idukki 7 each	Cooch Behar 17, Bdatighat 15, Basa & Katra 13 each, Saralpara & Balarampur 10 each, Bangalore 9, Itanagar & Shrungavarapukotta 8 each	Chennai 17, Watrak Dam 13, M. Kotta 11, Bagewadi & Agumbe 10 each, Mangalvedha, Parenda & Hinganghat 9 each.
13	Hosdurg 13, Panam Dam, Sinnar & Raichur 12 each, Chennai 11, Bhiwandi & Panambur 8 each, Nadaun 7	Sevoke 40, Saralpara & Kakardarighat 21 each, Rajapur 17, Nadaun 14, Bareilly 12, Tezu, Honavar & Koshikode 10 each, Taibpur & Sirsila 8 each, Gaganbavda & Tiruvuru 7 each	Khairi 20, Etawah & Jammu 19 each, Chanpatia 15, Gorakhpur & Mani 11 each, Sibsagar & Avanigadda 9 each, Bagdora & Melur 8 each, Koyna, Gaganbavda, Tikapara & Nagarjunsagar Dam 7 each	Dabri & Panambur 10 each, Amalner 9, Karwar 8, Palliakalan 7
14	Chennai 35, Mulki 33, Tada 23, Hosdurg 21, Panjim & Srikalahasti 11 each, Amritsar & Kargal 9 each, Berhampore 7	Taibpur & Kankavli 18 each, Gaganbavda 14, Karwar 9, Nancowry & Paderu 7 each	Neemsar 16, Baijnath 14, Chapra 13, Auraiya & Dholai 10 each, Dehra Dun 9, Baghdogra & Chandigarh 8 each, Mulug & Siddapur 7 each	Mumbai 17, Baijnath 12, Kheda 10, Gaganbavda 8, Pondicherry 7
15	Gokarna 38, Panjim 34, Kargal 24, Kannūr 20, Chennai 19, Porumamilla 18, Udayagiri 15, Gaganbavda 11, Berhampore, Khanitar, Kollelur & Muddebihal 8 each, Jagadhari 7	Vengurla 17, Palliakalan 14, Kakinada 13, Mancherial 11, Kinwat 9, Dhbri 8, Kaithal & Karwar 7 each	Gorakhpur 13, Avanigadda 12, Sevoke 10, Indrapur 9, Raighgarh 8, Shahjina, Mahabaleshwar, Thanjavur, & Kargal 7 each	Dungerwadi 14, Alibagh 12, Hardoi 10, Bodeli & Jagityal 9 each, Tulkapur 8, Shegaon & Gulbarga 7 each
16	Machilipatnam 20, Mudibagere 18, Rajapur 17, Chennai 11, Sevoke, Madikeri & Kannur 9 each, Kokrajhar & Gaganbavda 8 each	Kokrajhar & Barobisha 18 each, Rajapur 17, Passighat 16, Narsampet 14, Gaganbavda 13, Katangi 12, Eluru, Ankola & Derol Bridge 10 each, Agumbe 9, Kotraguda 8, Munnar 7	Hasimara & Sikandarpur 17 each, Beki Mathanguri 12, Vikarabad 10, Badaun & Rajampet 9 each, Digha & Sampla 8 each, Haripur & Parbhani 7 each	Tuljapur & Palliakalan 15 each, Mandsaur 10, Lonavala 7
17	Koida 67, Nidadavole 25, Piravom 16, Rajpur, Virajpet & Karwar 11 each, Karkarapur 8	Domohani 33, Galgalia 30, Beki Mathaguri 21, Dassighat 18, Ambone & Bhatkal 16 each, Ratnagiri 14, Dabri & Agumbe 12 each, Palliakalan 11, Ellamanchali 9, Khuldabad & Piravam 8 each, Kakrapar 7	Jogindernagar 17, Basholi & Tiruthuraipoondi 14 each, Sevoke 11, Bhagalpur 10, Lucknow & Nārora 9 each, Dibrugarh 8, Chottabekara, Japla & Agumbe 7 each	Patan 9, Barwaha & Dungerwadi 7 each

TABLE 1 (*Contd.*)

(1)	(2)	(3)	(4)	(5)
18	Gaganbavda 19, Mulki & Sringeri 17 each, Idar 16, Mhasala & Kozhikode 11 each, Kaleswaram 9, Bikaner 8, Dharampur 7	Kokrajhar 33, Kollur 19, Galgalia 18,Mathabhanga 17, Kudal 12, Passighat & Kottigehara 11 each, Mahabaleshwar 8, Vidisha 7	Passighat, Baptla & Yercaud 13 each, Hasimara, Gorakhpur & Guler 12 each, Didwana 10, Dibrugarh 9, Arogyavaram 8, Kusiary, Nagpur & Bhongir 7 each	Neamatighat 7
19	Mahabaleshwar 28, Porbandar 15, Honavar 13, Rajnandgaon 12, Bhira & Kottigehara 11 each, Piravom 9, Suratgarh & Belgaum 8 each, Long Island 7	Chepan & Dungarwadi 24 each, Uran 22, Okha 17, Taibpur 16, Mani 13, Thalasarry 11, Passighat 10, Bobilli & Srisailam 9 each, Katghora & Koppa 7 each	Avanigadda 22, Gazipur 17, Durgachak 16, Birpur & Dehra Dun 13 each, Bihubar, Kanitar & Puri 8 each, Nahan & Durg 7 each	Kangra 8, Dharamsala 7
20	New Kandla 21, Port Blair, Veraval, Mahabaleshwar & Mulki 11 each, Chhotan & Mount Abu 10 each, Kannur 9	Dungerwadi & Mulki 19 each, Basti 15, Barobisha & Rajkot 13 each, Uran 12, Mehre 10, Surat 9, Madikeri 8, Hanamkonda & Quilandy 7 each	Sagar 13, Ranchi & Tenali 10 each, Dehra Dun 9, Dhubri & Tirupati 8 each, Jaunpur, Deragopipur, Mul & Tambaram 7 each	Nil
21	Pokhran 17, Mount Abu 16, Cooch Behar, Jenapur & Amini Divi 11 each, Purulia 10, Haripad & Melabazar 8 each, Sarotary 7	Dahanu 20, Surat 19, Lonavala 14, Mulki 11, Kotputli 9, Kannur 8, Domohani, Dehra Dun, Kaleswaram & Somwarpet 7 each	Bhopal 29, Sandheads 13, Agumbe 12, Namakkal 11, Pendra & Ratnagiri 8 each, Chauldhowaghat, Naraingarh & Perur 7 each	Hut Bay 14, Neamatighat 10, Dapoli 7
22	Phalodi 21, Talcher 18, Dengra Paraghat 13, Goalpara & Shimla 10 each, Dehra Dun & Amini Divi 9 each, Sankalan, Jamshedpur, Raigarh, Honava & Hosdurg 7 each	Poladpur 27, Mahabaleshwar 23, Rengali & Veraval 18 each, Daman 15, Shirali 13, Mandsaur 10, Raigarh & Perur 8 each, Kishangarh & Sringeri 7 each	Kakrahi 21, Malda & Harinkhola 16 each, Jogindernagar 15, Udhampur 13, Jhajjar 11, Narora, Poladpur & Cuddapah 10 each, Bihubar, Sawai Madhopur & Agra 7 each	Parangipettai 14, Agartala 7
23	Nagaur 36, Srimadhopur 19, Purulia 15, Ranchi 11, Kathua 9, Bahraich 8, Khed 7	Veraval 36, Mahabaleshwar 28, Koyna 20, Kushalgarh & Agumbe 13 each, Silvasa 12, Dharamsala 11, Dharamsthala 10, Margherita & Khanapur 9 each, Perur & Raigarh 7 each	Udhampur 33, Nilokheri & Chamba 17 each, Malakpur 15, Vedaranniyam 14, Khanpur & Ramnagar 12 each, Sandheads & Gunupur 9 each, Basti 7	Bhagalpur 13, Kondut 10, Khowang 8
24	Kolputti 14, Hut Bay 12, Nurpur & Dapoli 10 each, Ranchi & Palmerganj 9 each, Rewari & Dungerwadi 8 each, Patiala 7	Banswara & Shirota 20 each, Dahanu 18, Kottighera 14, Karnal 13, Dharamsala 11	Jammu 16, Muktsar 15, Sambalpur 13, Chamba 12, Kozhikode 11, Hirekerur 10, Darauli, Jagadhari, Jagityal & Mani 9 each	Yercaud 9, Poladpur 8
25	Bayana 23, Kakrahai 22, Rewari 13, Domohani 11, Maya Bandar 9, Harikhola 8	Balasore 19, Mahabaleshwar 15, Wada 12, Sonkutch & Sringeri 10 each, Kotari & Bijapur 9 each, Bramhapuri 8, Dhramsala & Idukki 7 each	Udhampur 15, Sringeri 11, Malvan & Sangola 10 each, Purushottampur 9, Purna & Piduguraua 8 each, Bhopal & Pennagaram 7 each	Annigeri 16, Chitradurga 12, Sinner 10, Koderu & Kuppam 9 each

TABLE 1 *(Contd.)*

(1)	(2)	(3)	(4)	(5)
26	Chepan 17, Gheropara 11, Bharlipur 8, Car Nicobar & Usilampatti 7 each	Depalpur 34, Kotraguda 23, Bilaspur 12, Darjeeling & Mahabaleshwar 11 each, Ajmer 10, Kokrajhar 9, Dabupur & Dharamsala 8 each, Jamshedpur & Sringeri 7 each	Igatpuri 14, Shantiniketan & Mhasla 9 each, Long Island & Dummgudem 8 each, Kalamb 7	Dharamsala 13, Bhagamandala 11, Srikali 9, Sevoke 8, Kalapur, Dharwad, Thiruvanathapuram & Darjeeling 7 each
27	Goalpara 17, Ankinghat 14, Port Blair 11, Visakhapatnam 10, Chottabekra & Gohar 7 each	Bhopal 21, Mahabaleshwar 17, Passighat 16, Naharkatia 14, Banswara & Agume 13 each, Mani Dam & Gondia 12 each, Dharamsala 8, Sevoke & Nahan 7 each	Navapur & Vedadri 11 each, Bijapur 10, Eturunagaram 8, Port Blair, Shahabad, Sudhagad & Alur 7 each	Dapoli 9, Sankeswar & Tusuma 8 each, Shirali & Hut Bay 7 each
28	Chhatinag 13, Satna 12, Sevoke & Kahirdwar 11 each, Kokarajhar 10	Banswara 21, Mahabaleshwar 19, Dohad 18, Indore 17, Nurpur & Sagara 9 each, Ratnagiri 7	Dehra Dun 16, Sangola 15, Naraingarh, Rajapur, Paleru Bridge & Hakimpet 13 each, Bijapur 9, Akhuapada 7	Dehra Dun 22, Peerumeau 17, Ranebennur 13, Malsiras 12, Amini Divi 11, Hylakere, Panambur, Kancheepuram & Motihari 8 each
29	Kakrahi & Nawashahar 13 each, Manas 11, Gaya & Ambala 9 each, Passighat & Imphal 7 each	Mahabaleshwar 14, Harnavweir 11, Agumbe 9, Tibri & Bhiwandi 7 each	Karjat 13, Latur 12, Passighat & Sandwa 11 each, Dungerwadi 10, Palliakalan & Shirali 9 each, Champasarai, Chamba, Jammu & Agumbe 8 each, Dhollabazar, Uttar Kashi, Bemetara & Buldhana 7 each	Malda 23, Munnar & Agumbe 22 each, Puttur 19, Venkatagiri & Kota 11 each, Naduvattam 10, Hut Bay & Aizwal 9 each
30	Sikandarpur 24, Jogindernagar 13, Sevoke & Nilokheri 7 each	Mahabaleshwar 13, Bhira 12, Maya Bandar, Jogindernagar & Munnar 9 each, Belthangady & Agumbe 8 each, Shillong & Silvasa 7 each	Anibone 25, Kokrajhar & Barobisha 14 each, Galgalia, Jagadhari & Baroda 13 each, Passighat 12, Tarana 11, Bhira & Perur 10 each, Lansdawn & Sarangarh 9 each, Ahmedpur 8, Palliakalan & Shahpurkandi 7 each	Kakinada & Sunramayan 9 each
31	Nil	Pagladiya 33, Nadaun 13, Gwalior 10, Canning Town 9, Gurudaspur 8, Khed 7	Sevoke 32, Bhind 31, Jhanjarpur 21, Valsad 17, Paonta 14, Makhlishpur & Dungerwadi 10 each, Car Nicobar 9, Jia Bharati 8, Bemetara & Thane Belapur 7 each	Nil

TABLE 2

Statewise number of districts with excess, normal, deficient and scanty rainfall from 1 June to 30 September 1996 (Updated)

State/UT	Excess	Normal	Deficient	Scanty	Data inadequate	Total
Andaman & Nicobar Islands (UT)	—	1	—	—	—	1
Arunachal Pradesh	1	2	—	—	2	5
Assam	2	3	8	1	2	16
Meghalaya	—	1	—	—	1	2
Nagaland	—	—	1	—	—	1
Manipur	—	—	1	—	—	1
Mizoram	—	1	—	—	—	1
Tripura	—	1	—	—	—	1
Sikkim	—	—	1	—	—	1
West Bengal	5	10	1	—	—	16
Orissa	—	5	8	—	—	13
Bihar	3	24	8	1	3	39
Uttar Pradesh	13	32	10	1	—	56
Haryana	13	2	1	—	—	16
Chandigarh (UT)	1	—	—	—	—	1
Delhi	1	—	—	—	—	1
Punjab	6	5	1	—	—	12
Himachal Pradesh	2	9	1	—	—	12
Jammu & Kashmir	4	1	—	—	7	12
Rajasthan	23	6	—	—	1	30
Madhya Pradesh	13	21	10	—	1	45
Gujarat	4	12	2	—	1	19
Daman, Dadra & Nagar Haveli (UT)	—	—	—	—	1	1
Diu (UT)	1	—	—	—	—	1
Goa	—	1	—	—	—	1
Maharashtra	4	17	9	—	—	30
Andhra Pradesh	12	10	1	—	—	23
Tamil Nadu	17	4	1	—	—	22
Pondicherry (UT)	1	—	—	—	—	1
Karnataka	11	8	1	—	—	20
Kerala	1	11	2	—	—	14
Lakshadweep (UT)	1	—	—	—	—	1
Total	**139**	**187**	**67**	**3**	**19**	**415**
% Distribution	35%	47%	17%	1%	—	—

Total No. of districts from which data have been received = 396

2.6. *Withdrawal of southwest monsoon*

Southwest monsoon withdrew from parts of west Rajasthan on 15 September, and from east Rajasthan and rest northwest India by 21 September. Monsoon further withdrew from Gujarat State, west Madhya Pradesh and west Uttar Pradesh and some parts of Madhya Maharashtra on 24 September. Further withdrawal of southwest monsoon was rather slow. By 8 October it withdrew from Maharashtra, Madhya Pradesh, parts of Orissa, Uttar Pradesh, Bihar and West Bengal & Sikkim. It withdrew from the entire country on 11 October, about a week earlier than the normal date. Withdrawal dates of southwest monsoon are given in Fig. 12.

3. Chief synoptic features during the monsoon

The synoptic disturbances which affected the Indian monsoon region in June, July, August and September are given in Tables 3-6 respectively. A summary of these disturbances is given below :

(a) *Summary of chief synoptic features*

S.No.	Disturbances	Jun	Jul	Aug	Sep	Total
1.	Monsoon disturbances :					
	(a) Cyclonic storms (CS)/ depressions (D)	2(CS)	1(D)			3
	(b) Well marked low/low pressure area	2	5	5	4	16
	Total	4	6	5	4	19
2.	Cyclonic circulations (including embedded cyclonic circulations)	8	8	10	13	39
3.	Off-shore troughs	On most of the days from June to September				
4.	Lower level troughs	5	-	4	-	9
5.	Troughs in mid and upper tropospheric westerlies, affecting northwest India	-	-	1	-	1
6.	East ward moving circulations/western disturbances	1	-	-	1	2

(b) *Number of days of SCS, CS depressions, well marked low pressure areas, low pressure areas (LOPAR) and cyclonic circulations (cycirs) during June to September 1996*

Month	Days of SCS, CS & Depressions	Days of WM LOPARS' LOPARS	Days of cycirs	Total days of Systems	Remarks
June	8 (SCS & CS)	11	25	44	One system Day :
July	3 (Depression)	17	23	43	Any one system for one day.
August	-	12	21	33	Two systems in
September	-	17	44	61	a day will be 2
Total	11	57	113	181	system days.

Total 181 systems days during 122 calendar days of the season.

3.1. *Cyclonic storms/depressions*

Two cyclonic storms, one over the Bay of Bengal and other over the Arabian Sea formed in June and only one monsoon depression over land formed during July. Tracks of these systems are shown in Fig. 11.

3.1.1. *Cyclonic storm over the Bay of Bengal (12-16 June 1996)*

A depression formed over the southeast and adjoining southwest Bay on the evening of 12 June. It intensified into a deep depression on 13 morning, moved in a northwesterly direction and lay over southwest Bay about 200 km east of Madras on 13 evening. The system further intensified into a cyclonic storm by 14 morning, recurved in a north-northeasterly direction and lay about 70 km southeast of Kakinada on 15 June. Skirting the coast, the system further moved in a north-northeasterly direction and crossed the coast near Visakhapatnam around 0400 UTC of 16. The system then rapidly weakened into a well-marked low pressure area over north Andhra coast by the evening of 16. INSAT cloud imagery reported on Dvorak's scale maximum intensity of the system as T 2.5 from 15 evening to 16 morning.

3.1.2. *Severe cyclonic storm over the Arabian Sea (17-20 June 1996)*

A depression formed over the east-central Arabian Sea on 17 evening and intensified into a deep depression on 18 morning. The system further intensified into a

TABLE 3

Weather systems during June 1996

S. No. (1)	Weather System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
(A) *Cyclonic storms*						
1.	Severe cyclonic storm	17-21	East Arabian Sea	Northerly	Central parts of west Rajasthan	It was first observed as a cyclonic circulation (cycir) over Maharashtra coast. A well marked low pressure area formed over east central Arabian Sea on 17. It concentrated into a depression on same evening and a deep depression on 18. Further,it intensified into a cyclonic storm and moved in a northerly direction. It became severe cyclonic storm on 18 night and crossed Gujarat coast close to Diu between 0630 and 0730 hr IST of 19 and weakened into a cyclonic storm. It further weakened into a depression on 20, about 50 km southeast of Dessa. It became well marked low pressure' area over southwest Rajasthan on 20 evening and weakened into a low pressure area over Haryana and neighbourhood on 22. It became less marked on 25 over west Uttar Pradesh and adjoining Haryana
2.	Cyclonic storm	12-16	Southwest Bay and adjoining Sri Lanka coast	North-north-easterly	Madhya Pradesh and neighbourhood	Associated cycir extended upto mid-tropospheric levels. It was observed as a cycir over southwest Bay and adjoining Sri Lanka coast on 10 and a low pressure area formed over the same region on 12. It concentrated into a depression on the same evening and became deep depression on 13, about 350 km eastsoutheast of Chennai. It further intensified into a cyclonic storm on 14, moving in a northerly direction, it crossed coast around 0400 UTC of 16, very close to Visakhapatnam. It rapidly weakened into a well marked low pressure area over north Vidarbha and neighbourhood by 16 evening. On 19, it became less marked over Madhya Pradesh and neighbourhood

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(B) *Low pressure areas*						
1.	Low pressure area	9-14	Northern parts of west-central Arabian Sea and adjoining parts of east-central Arabian Sea	West-north-westerly	Saudi Arabia and adjoining parts of west-central and northwest Arabian Sea/Saudi Arabia	—
2.	Well marked low pressure area	20-26	North Bay and adjoining Bangladesh	Northwesterly	Bihar Plateau and neighbourhood	Associated cycir extended upto mid-tropospheric levels. It became less marked over Bangladesh on 17. The system was first observed as a trough in the lower levels on 18 over northeast Bay
(C) *Cyclonic circulations*						
1.	Lower tropospheric levels	31 May-10 Jun	Southeast Madhya Pradesh and neighbourhood	Quasi-stationary	Bihar and adjoining east Uttar Pradesh and Madhya Pradesh	A trough from this system to Mizoram through Bihar Plateau,Gangetic West Bengal and Tripura
2.	Do.	1-2	Madhya Maharashtra and neighbourhood	Stationary	*In situ*	—
3.	Lower levels	5-8	Punjab and neighbourhood	Easterly	Plains of west Uttar Pradesh and neighbourhood	A trough from this system extended upto Bihar Plateau on 5. It became less marked on 6
4.	Do.	7-9	Punjab, Haryana and adjoining north Rajasthan	Stationary	*In situ*	—
5	Do.	10-13	Southwest Rajasthan and neighbourhood	Easterly	Haryana and neighbourhood	Trough from this system ran to coastal Orissa on 10. On 11,to coastal Andhra Pradesh and became less marked on 12 over there
6.	Do.	26-28	South Pakistan and neighbourhood	Stationary	*In situ*	—
7.	Do.	29-30	Haryana and neighbourhood	Do.	Do.	Merged with the western disturbance
8.	(Induced) Lower tropospheric levels	30 Jun-2 Jul	Haryana and neighbourhood	Do.	Do.	—
(D) *Lower level troughs*						—
1.	East-west trough	2-3	Bihar Plateau to Arunachal Pradesh	Stationary	*In situ*	—
2.	Sea level chart	3-4	North Bay to north Andaman Sea	Do.	Do.	—

TABLE 3 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
3	Lower tropospheric levels	4-6	Bihar Plateau to Punjab and neighbourhood	Do.	Do.	—
4	Lower levels	13-14	Punjab to east Uttar Pradesh	Do.	Do.	—
5.	Lower tropospheric levels	27 Jun-6 Jul	Sub-Himalayan West Bengal to northwest Bay	Do.	Do.	—
(E) *Western disturbances*						
1.	Upper air system	30 Jun-3 Jul	North Pakistan and neighbourhood	Easterly	Moved away across Jammu & Kashmir	—

cyclonic storm and lay centered near 20.0° N/70.5°E, about 100 km south of Veraval on 18 evening. The system intensified into a severe cyclonic storm on 18 night and crossed south Gujarat coast close to Diu between 0100 and 0200 UTC of 19. Thereafter, the system weakened into a cyclonic storm by 0300 UTC of 19 and further weakened gradually over southwest Rajasthan into a well-marked low pressure area by evening of 20. Maximum intensity of the system given by INSAT imagery was T 3.5 on Dvorak's scale from 1818 UTC to 1900 UTC.

3.1.3. *Land depression (26-28 July 1996)*

A well-marked low pressure area over northwest Bay and neighbourhood moved in a northwesterly direction and concentrated into a depression over land near Daltonganj at 0300 UTC on 26. Associated cyclonic circulation was extended upto mid-tropospheric levels. The system moved in a west-northwesterly direction and weakened into a low pressure area over south Rajasthan by the evening of 28 and later merged with the seasonal trough.

3.2. *Low pressure areas/well marked low pressure areas*

During the season, 16 low pressure areas/well marked low pressure areas formed. Most of these systems were associated with cyclonic circulations in upper air. These were the main rain producing synoptic systems over the country. Monthwise break-up of these low pressure areas/well marked low pressure areas is; June-2, July-5, August-5 and September-4. The details are given in Tables 3-6.

3.3. *Cyclonic circulations (cycir)*

In all, 39 cyclonic circulations (lower levels and upper levels) formed during the season and contributed to the well-distributed rainfall over the country. The monthwise break-up of cyclonic circulations is as follows:

8 in June, 8 in July, 10 in August and 13 in September.

3.4. *Off shore trough*

During June to September 1996, the off shore trough along west coast (surface and lower levels) persisted on most of the days and this is one of the characteristic features of the southwest monsoon 1996.

From 1 to 11 June it was over Lakshadweep area off Kerala coast and from 17-25 June and 17-27 July it was from off Gujarat coast to Lakshadweep area. Between 3 and 16 July it was seen from off Maharashtra coast to Kerala coast. During the first half of August, the off shore trough lay over Karnataka-Kerala coast in later part of August, it was seen from off Maharashtra or Gujarat coast to Kerala coast. In September, it was mostly over off Maharashtra-Karnataka coast.

3.5. *Low level troughs*

In June, out of 5 lower level troughs; 3 formed over northeast India. One of them was seen over sea

TABLE 4

Weather systems during July 1996

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
(A) *Depressions*						
1.	Depression	26-29	Near Daltonganj	Initially in a northwesterly and then west-northwesterly	South Rajasthan	Associated cycir extended upto mid-tropospheric levels. It was first observed as a well marked low pressure area over northwest Bay off West Bengal coast on 25. It concentrated into a depression on 26 near Daltonganj. Moving in a northwesterly direction,it was centred 75 km northeast of Sagar on 27 morning,and about 50 km southeast of Kota on 28 morning. It was rapidly weakened into a low pressure area on 28 evening over south Rajasthan and later merged with a seasonal trough
(B) *Low pressure areas*						
1.	Low pressure area	9-10	Northwest Madhya Pradesh and adjoining west Uttar Pradesh	Stationary	*In situ*	Associated cycir extended upto 3.1 km asl. It was first observed as a cycir over northwest Madhya Pradesh and neighbourhood on 8.
2.	Do.	14-17	West-central Bay off Andhra coast	Northwesterly	Madhya Pradesh	Associated cycir extended upto mid tropospheric levels,tilting southeastwards with height. It was first observed as a cycir in lower tropospheric levels over southeast Bay and adjoining Andaman Sea. Moving in a northwesterly direction, it lay over west-central Bay off Andhra coast on 13
3.	Do.	17-20	Gujarat coast and adjoining Saurashtra	Quasi-stationary	North Gujarat region and neighbourhood	Associated cycir extended upto 3.6 km asl. A trough from this system ran to Karnataka coast and neighbourhood from 17 to 27. The system was first observed as cycir in mid-tropospheric levels on 15 over Gujarat region and neighbourhood

TABLE 4 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	Well marked low pressure area	19-25	Northwest Bay off West Bengal coast	Northerly	North Gangetic West Bengal	Associated cycir extended upto mid-tropospheric levels,tilting southwestwards with height. It was first observed as a cycir over coastal Orissa and neighbourhood on 16
5.	Do.	30 Jul-3 Aug	Northeast Bay and neighbourhood	Westerly	North Bay and neighbourhood	Associated cycir extended upto mid-tropospheric levels. Moving in a westnorthwesterly direction,it lay over northwest Madhya Pradesh on 5 August and again under the influence of this cycir a low pressure area formed over the same region on 6 August,details of which are given in August (S. No. A 2)
(C) *Cyclonic circulations*						
1.	Embedded lower levels	4-6	North Bangla Desh and neighbourhood	Stationary	*In situ*	—
2.	Mid-tropospheric levels	6-10	North Bay and neighbourhood	Northeasterly	Telangana and adjoining Marathwada	It was seen over Telangana adjoining Marathwada on 8, tilting southwestwards with height
3.	Do.	10-13	Karnataka-Goa coast	Stationary	*In situ*	—
4.	Lower tropospheric levels	11-13	Punjab and adjoining north Pakistan	Stationary	*In situ*	—
5.	Do.	13-17	North Pakistan and neighbourhood	Easterly	Punjab and neighbourhood	—
6.	Mid-tropospheric levels	20-24	Gujarat region and neighbourhood	Quasi-stationary	Gujarat coast and neighbourhood	—
7.	Upper tropospheric levels	29 Jul-1 Aug	North Bay of Bengal and neighbourhood	Stationary	*In situ*	—
8.	Do.	29-30	North Gujarat Region and neighbourhood	Do.	Do.	—
(D) *Trough*						
1.	Mid-tropospheric levels	2-6	Sub-Himalayan West Bengal to northwest Bay	Do	Do.	—

TABLE 5

Weather systems during August 1996

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
(A) *Low pressure areas*						
1.	Low pressure area	6-8	Gangetic West Bengal and neighbourhood	Quasi-stationary	Gangetic West Bengal and adjoining Bangladesh	Associated cycir extended upto 9.5 km asl on 6 and later upto mid-tropospheric levels
2.	Do.	6-8	Northwest Madhya Pradesh and neighbourhood	North-north-westerly	Haryana and neighbourhood	Associated cycir extended upto 9.5 km asl tilting southeastwards with height. It persisted over Bihar plateau and neighbourhood till 11 and merged with the monsoon trough thereafter
3.	Do.	13-15	West-central Bay and neighbourhood	Quasi- stationary	West-central Bay and adjoining Orissa and north coastal Andhra Pradesh. (merged with the seasonal trough)	Associated cycir extended upto mid-tropospheric levels, tilting southwards with height. An embedded cycir associated with the system was observed on 16. It was seen over east Madhya Pradesh and adjoining Bihar and east Uttar Pradesh with a trough aloft
4.	Well marked low pressure area	21-23	Northwest Madhya Pradesh and adjoining parts of east Rajasthan and of west Uttar Pradesh	North-north-westerly	Haryana and neighbourhood	It was first observed as cycir in mid-tropospheric levels over northern parts of Rajasthan, adjoining Haryana and parts of west Uttar Pradesh. Associated cycir extended upto mid-tropospheric levels. It persisted in the lower tropospheric levels till 24 and became less marked on 25 over northwest Rajasthan and adjoining Punjab
5.	Low pressure area	26-30	West-central Bay off north Andhra-south Orissa coast	Westerly	Eastern parts of Vidarbha and adjoining parts of southeast Madhya Pradesh	The system was first observed as a cycir over north Thailand and neighbourhood on 23,it entered into north Bay and neighbourhood on 25. Associated cycir extended upto mid-tropospheric levels,tilting southwestwards with height. The cycir moved in a northwesterly direction and became less marked on 2 September over southwest Uttar Pradesh and adjoining northwest Madhya Pradesh

TABLE 5 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(B) *Cyclonic circulations*						
1.	Lower tropospheric levels	3-5	North Pakistan and adjoining Punjab	Easterly	Punjab and neighbourhood	—
2.	Lower levels	14-19	Central Pakistan and neighbourhood	Northeasterly	Jammu & Kashmir and neighbourhood	—
3.	Lower tropospheric levels	16-18	Gujarat State and adjoining south Rajasthan	Quasi-stationary	Gujarat state	It was tilted southwards with height on 17 & 18
4.	Mid-tropospheric levels	17-19	Northern parts of Rajasthan and adjoining Haryana and parts of west Uttar Pradesh	Do.	Northern parts of Rajasthan and neighbourhood	—
5.	Lower levels	18-19	Central Pakistan and neighbourhood	Stationary	*In situ*	—
6.	Lower tropospheric levels	20-21	Punjab and adjoining parts of Pakistan	Do.	Do	—
7.	Mid-tropospheric levels	24-25	Bihar Plateau and neighbourhood	Do.	Do.	—
8.	Do.	25-27	Maharashtra coast and neighbourhood	Northerly	South Gujarat coast and neighbourhood	—
9.	Do.	25-28	South Thailand and neighbourhood	Northnorth-westerly	Gulf of Martaban and neighbourhood	—
10.	Lower tropospheric levels	27-29	Southwest Rajasthan	Quasi-stationary	Southeast Rajasthan and neighbourhood	—
(C) *Lower level troughs*						
1.	North-south trough	12-13	Central parts of Uttar Pradesh to west central Bay	Quasi-stationary	Central parts of Uttar Pradesh to west-central Bay	—
2.	Lower levels	17 (one day)	Bihar plains to Arunachal Pradesh across Sub-Himalayan West Bengal, Sikkim and Assam			—
3.	Do.	19-20	Jammu & Kashmir to northwest Madhya Pradesh	Stationary	*In situ*	—

TABLE 5 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
4.	Lower tropospheric levels	30 Aug-1 Sep	Punjab to south Uttar Pradesh	Do.	Do.	—
(D) *Troughs in westerlies*						
1.	Mid and upper tropospheric westerlies	21-23	70°E, north of 25°N	Northeasterly	74°E north of 30°N	—
(E) *Other troughs*						
1.	East-west trough (Upper tropospheric levels)	18 (one day)	From Jamnagar to Agartala through Guna and Gaya	—	—	—
2.	Mid-tropospheric levels	30-31	South Andaman Sea and adjoining southeast Bay	Quasi-stationary	Southeast Bay	—

level chart. All these troughs were stationary. The last trough (27 June - 6 July) from Sub-Himalayan West Bengal to northwest Bay resulted in the increased rainfall activity over west Bengal & Sikkim. Four low level troughs formed in August, 2 in northwest India, 2 in the eastern parts of India and were mostly stationary.

3.6. *Upper level troughs*

Number of the westerly troughs in mid and upper tropospheric levels, which moved eastwards across north India along 30°N, are given in sub-section 4.2. Out of these, only one trough at 9.5 km asl (300 hPa) in August (21-23) moved across north India and extended equatorward upto Lat. 25°N and affected weather over parts of northwest India. Media reported snowfall over the higher reaches of Jammu & Kashmir on 22 & 23 August.

3.7. *Eastwards moving circulation/western disturbance*

Two western disturbances as an upper air system moved across northwest India; one in June (30 June-3 July) and other one in September (18-21).

4. Extra-Indian systems

4.1. *Cross-equatorial flow*

Cross-equatorial flow in the Arabian Sea (15-20kt) was stronger by 10 kt than that in the Bay of Bengal during June and second half of July. It was stronger in the Bay (20-25 kt) by 10 to 15 kt during first fortnight of July and second fortnight of August. For rest of the period, the wind flow was nearly same over both the areas.

Cross-equatorial flow in the Arabian Sea was stronger than normal by about 10 kt in second half of June, second half of July, second week of August and fourth week of September. For rest of the period, it was close to normal.

Cross-equatorial flow in the Bay of Bengal was stronger than normal by 10-15 kt from second week of July to the end of August. In June and September, it was nearly normal.

4.2. *Mid-latitude troughs*

Twenty two mid (500 hPa) and 9 upper (300 hPa) tropospheric westerly troughs moved along Lat. 30°N across north India during the season. Out of these, only one at 300 hPa extended equatorwards upto 25°N and affected weather over northwest India. In southern hemisphere, 24 mid and 12 upper tropospheric westerly troughs moved along 30°S.

4.3. *Systems in south China Sea/Northwest Pacific Ocean*

There were 15 typhoons (including 3 super typhoons), 1 tropical storm (TS) and 1 tropical

TABLE 6

Weather systems during September 1996

S. No. (1)	System (2)	Period (3)	Place of first location (4)	Direction of movement (5)	Place of dissipation (6)	Remarks (7)
(A) *Low pressure areas*						
1.	Low pressure area	10-18	North Andaman Sea and neighbourhood	Northwesterly	North Bay and neighbourhood	It was first observed as a cycir over Tenassrim coast and neighbourhood on 9. Associated cycir extended upto mid-tropospheric levels,which became less marked on 18
2.	Do.	19-23	North Bay and neighbourhood	Northerly	Bangladesh and adjoining north Bay	Associated cycir extended upto lower tropospheric levels. A trough from this system extended upto 3.1 km asl from Bihar Plateau to Arunachal Pradesh on 23,from Bihar Plateau to Manipur on 25 and became less marked on 26
3.	Do.	25-28	Arakan coast and adjoining parts of northeast Bay	Northwesterly	Bihar and adjoining parts of east Uttar Pradesh	It was first observed as a cycir in mid-tropospheric levels over central parts of Thailand, associated cycir extended upto mid-tropospheric levels,which became less marked on 30. A trough associated with the cycir to east Assam was observed on 29 and 30
4.	Well marked low pressure area	28-30	Central Bay off north Andaman coast	Easterly		The system became well marked on 30 and concentrated into a depression in first week of October
(B) *Cyclonic circulations*						
1.	Mid-tropospheric levels	2-3	Coastal Tamil Nadu and neighbourhood	Stationary	*In situ*	—
2.	Lower tropospheric levels	3-5	West Rajasthan and adjoining parts of Pakistan	Stationary	Do.	—
3.	Mid-tropospheric levels	3-11	North coastal Andhra Pradesh and neighbourhood	Northwesterly	East Rajasthan and neighbourhood	A trough from this system to Tamil Nadu was observed from 5, it was seen upto south Kerala on 6,tilting westwards with height. Again it was seen upto Gujarat Region on 10
4.	Do.	4-5	North Bay and neighbourhood	Stationary	*In situ*	

TABLE 6 (*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
5.	Lower tropospheric levels	5-7	East Rajasthan and neighbourhood	Easterly	Northwest Madhya Pradesh and neighbourhood	Merged with cycir no. 3
6.	Lower levels	7-9	Southwest Rajasthan and neighbourhood	Northerly	Northwest Rajasthan and neighbourhood	Merged with cycir no. 3
7.	Upper tropospheric levels	9-15	Off south Andhra-north Tamil Nadu coast	North-northeasterly	Off Orissa coast	Merged with the low pressure area no. 2
8.	Lower tropospheric levels	11-17	Southwest Rajasthan and neighbourhood	Northerly	Punjab and adjoining parts of Pakistan	
9.	Do.	16-19	Gujarat Region and neighbourhood	Stationary	*In situ*	
10.	Do.	16-18	Bangladesh and neighbourhood	Do.	Do.	
11.	Induced cyclonic circulation (Lower tropospheric levels)	19-20	Punjab and neighbourhood	Do.	Do.	Moved away
12.	Mid-tropospheric levels	22-26	West-central Bay off Andhra coast	Quasi-stationary	Off south Andhra coast	
13.	Do.	24-27	South Maharashtra Goa coast	Stationary	*In situ*	
(C) *Western disturbance*						
1.	Upper air system	18-21	North Pakistan and neighbourhood	Northeasterly	Jammu & Kashmir and neighbourhood	Moved away northeastwards across Jammu & Kashmir

depression making 17 systems, as against 16 in the last year. The monthwise break-up is given below:

Weather systems	June	July	August	September	Total
Depression	0	0	0	1	1
TS	0	1	0	0	1
Typhoons	0	4	4	4	12
Super Typhoons	0	1	0	2	3
Total	0	6	4	7	17

4.4. *Systems in southern hemisphere*

(a) One tropical cyclone formed in the month of August in the south Indian Ocean.

(b) The intensity of Mascarene high was normal or near normal in June, July and August. Its intensity was 2 hPa below normal value (1022 hPa) in September.

In June, the Mascarene high moved about 8° to west and about 18° to east of its normal position

TABLE 7

Anomaly winds during June-September 1996

Station level	4 Jun	11 Jun	18 Jun	25 Jun	2 Jul	9 Jul	16 Jul	23 Jul	30 Jul	6 Aug	13 Aug	20 Aug	27 Aug	3 Sep	10 Sep	17 Sep	24 Sep	1 Oct
Lower tropospheric westerly - weekly wind anomalies*																		
TRV																		
850 hPa	11012	34308	29320	22608	07810	12211	28008	27114	11806	35608	30203	04705	08903	09108	07606	30003	02304	25309
700 hPa	11417	07007	28926	24207	08613	10214	28809	28213	25111	03505	27705	08609	15405	10110	10007	31806	01004	28131
BMB																		
850 hPa	35306	09906	12016	24307	19902	06907	08208	22409	28313	27207	28707	05302	02907	34009	35003	29903	29001	02907
700 hPa	24002	10312	11425	27408	03702	02916	09108	21403	28515	33105	34710	10605	08905	05005	04307	33103	20302	05104
NGP																		
850 hPa	29809	18305	11219	24408	33004	11705	13414	11105	27415	29112	31612	09703	09704	07606	14415	15506	33902	05407
700 hPa	24307	10203	09715	24112	24208	14805	14108	12907	25617	30510	28408	19103	06306	14805	16908	14106	11203	06407
Tropical easterly jet - wind anomalies**																		
MDS																		
200 hPa	35203	27313	27618	36006	07701	07209	21009	34608	03310	05009	29119	08411	33115	29003	30015	05604	08104	34408
TRV																		
200 hPa	25404	27908	35412	17505	17105	23712	24411	05206	08209	12307	22505	13306	32506	13406	30704	17405	21005	11007

*Easterly anomalies at 850 and 700 hpa mean westerlies are weaker than normal.

**Westerly anomalies at 200 hPa mean easterlies are weaker than normal.

(30°S/60° E) and in September, about 12° to east and 12° to west of its normal position. On an average, in July it shifted by 4° to 5° to west and in August by 15° to east of its normal position.

(c) The normal intensity of Australian high is around 1019-1020 hPa near Lat.28°-29° S. The intensity of Australian high was below normal by 2-3 hPa in June, July and August and by 5 hPa in September. The Australian high was near normal position in June, August and September, while it was 2° to 3° north of its normal position in July.

5. Semi-permanent systems

5.1. *Heat low*

Heat low over Afghanistan and adjoining parts of Pakistan and west Rajasthan appeared on 7 June and persisted almost in the same position till 15 June and disappeared afterwards due to the cyclonic storm over Gujarat coast. The lowest observed isobaric value of the heat low was 995 hPa on 7 and 996 hPa on 15 June.

The heat low was again seen almost on all days

TABLE 8

Statistics of spatial rainfall distribution (No. of days) for monsoon season 1996 as a whole with heavy to very heavy rainfall

S.No.	Met. sub-division	Vigorous	Active	Very heavy	Heavy	W/Fw
1.	Andaman & Nicobar Is.	-	-	-	18	78
2.	Arunachal Pradesh	1	12	2	8	37
3.	Assam & Meghalaya	1	12	9	21	43
4.	Naga., Mani., Miz. & Tripura	-	12	3	7	39
5.	S.H.W.B. & Sikkim	1	18	14	28	57
6.	Gangetic West Bengal	1	26	6	20	23
7.	Orissa	1	4	8	12	23
8.	Bihar Plateau	2	5	3	4	32
9.	Bihar Plains	2	11	11	13	27
10.	East Uttar Pradesh (U.P.)	5	15	1	10	10
11.	Plains of west (U.P.)	2	13	-	6	14
12.	Hills of west (U.P.)	-	12	2	4	33
13.	Haryana	10	7	2	12	3
14.	Punjab	7	10	2	7	7
15.	Himachal Pradesh	2	21	1	11	19
16.	Jammu & Kashmir	4	7	4	6	22
17.	West Rajasthan	-	-	3	4	9
18.	East Rajasthan	2	11	4	8	14
19.	West Madhya Pradesh	5	14	11	15	14
20.	East Madhya Pradesh	1	12	6	10	29
21.	Gujarat Region	3	13	12	9	15
22.	Saurashtra & Kutch	3	2	6	3	5
23.	Konkan & Goa	-	18	18	28	69
24.	Madhya Maharashtra	1	22	23	30	10
25.	Marathwada	8	14	1	10	8
26.	Vidarbha	-	-	1	11	38
27.	Coastal Andhra Pradesh	8	11	7	23	4
28.	Telangana	2	26	8	18	7
29.	Rayalaseema	15	6	5	12	1
30.	Tamil Nadu & Pondicherry	-	-	11	19	10
31.	Coastal Karnataka	4	21	15	34	63
32.	North interior Karnataka	10	12	5	17	3
33.	South interior Karnataka	5	19	23	19	6
34.	Kerala	3	22	11	22	49
35.	Lakshadweep	-	-	-	6	44

Heavy - more than 6.5 cm; Very heavy - more than 12.5 cm, W/Fw - Almost at all or many places

from 24 June to 4 September over Pakistan and adjoining west Rajasthan and became less marked thereafter. The lowest observed isobaric value was 990 hPa on 11 July, 992 hPa on 29 and 31 July, 991 hPa on 5 August, 995 hPa on 8 and 14 August.

5.2. *Axis of the monsoon trough*

The axis of monsoon trough (surface and 0.9 km asl) was seen at the foot hills of the Himalayas in the first week of July and established in its normal position afterwards. However, the eastern end of monsoon trough deviated from its normal position to south. On most of the days it was seen dipping into west- central Bay off Orissa-north Andhra coast except on 10 to 12 July and 28 to 30 July when it was seen along foot hills of the Himalayas.

In August also, monsoon trough was seen in its normal position or south of its normal position except during 8 to 18 August. On 8 August, it lay close to the foot hills of the Himalayas and from 9 to 18 August, its western end shifted to foot hills of the Himalayas with eastern end over north Bay. On 1 to 5 September, monsoon trough was seen along its normal position and become less marked afterwards.

5.3. *Tibetan anticylcone/high*

Tibetan anticyclone/high got established and was seen from 3rd week of June to 1st week of September at 300 hPa and almost all days from 2nd week of July to 1st week of September at 500 hPa except 17 August to 25 August). Its position at 300 hPa was 30°N/90°E and at 500 hPa was 29°N/92°E.

5.4. *Westerly jet*

Winds at 200 hPa were more than 60 kt during first week of June over Delhi and during many days of second fortnight of September over Delhi, Gorakhpur and Srinagar. Otherwise, winds were less than 60 kt at 200 hPa level over Jodhpur, Delhi, Gwalior, Lucknow, Calcutta and Guwahati throughout the season suggesting the shift of westerly jet further to the north.

5.5. *Tropical Easterly Jet (TEJ)*

Tropical Easterly Jet was observed over Port Blair from 19 July to 21 August (maximum reported wind was on 8 August of 90 kt at 113 hPa). It was seen over Madras from 19 June to 23 August (maximum reported wind was on 14 July of 110 kt at 109 hPa) and 12 September to 25 September (maximum reported wind was on 23 September of 75 kt at 115 hPa). It was seen over Thiruvananthapuram, from 11 June to 27 September except 5 to 11 September. Maximum reported wind was on 3 July of 100 kt at 117 hPa. Over Mumbai, it was seen from 29 June to 2 September (maximum reported wind was on 17 July of 110 kt at 114 hPa).

6. Sea surface temperature

Sea surface temperature (SST) over Arabian Sea and Bay of Bengal - Monthly mean SST values over the Arabian Sea and Bay of Bengal, isopleths of normal values and anomalies of SST for the months June, July, August and September are given in Figs. 10 (a-d)

The values of normal SSTs for calculating anomalies are estimated from the isopleths of normal values.

These statements are based on real time data which were sometimes not adequate in number.

7. Other features

7.1. *Weekly anomalies in monsoon circulation 1996*

Weekly anomaly charts are prepared for 850, 700 and 200 hPa levels and the corresponding anomaly troughs and ridges are marked. Weekly wind anomalies for some stations are given in Table 7.

(a) *June-July*

In these two months, two anomaly troughs were seen in the lower levels (850 and 700 hPa). First anomaly trough in lower levels was seen on 11 June along 9° N, which moved to 15° N on 18 June and on 25 June, it was seen in northwest-southeast orientation from north Rajasthan to north Bay. It moved northwards subsequently. The second anomaly trough was seen along 11° N on 16 July and it was between 14° to 20° N in northwest-southeast orientation on 23 July. On 30 July it was along 23° N and on 6 August it was seen between 22° N and 25° N and moved northwards later on. The anomaly ridge in lower levels was seen along 17° N on 2 July, along 22° N on 9 July, along 23° N on 16 July and along the foot hills of the Himalayas on 23 July.

At 200 hPa level, upto 18 June and in July upto 16, the anomaly winds over peninsula were westerlies.

For 2 July and after 16 July to 6 August, the anomaly winds over peninsular India were easterlies and only for 25 July the winds were of the variable nature.

(b) *August-September*

First anomaly trough was seen along 10°N over Bay region for the week ending on 13 August. The second trough was in northwest- southeast orientation and was seen from north Maharashtra to north Andaman Sea for the week ending on 17 September. The third anomaly trough was seen along 16° N for the week ending on 2 October. For the week ending on 3 September and 10 September, an anomaly trough is observed along the longitude 79°E, south of 22°N and along 76°E, north of 15°N respectively. Anomaly ridge was seen along 10°N for the week ending on 6 August, along 21°N for the week ending on 20 August and between 10° to 15°N for the week ending on 24 September.

At 200 hPa level for 6 and 20 August, the anomaly winds over peninsula were easterlies. For the week ending on 13 August, 27 August and for 10 September the peninsular anomaly winds were westerlies. For rest of the period during August and September, the anomaly winds were of the variable nature over the peninsular India.

7.2. *Aridity conditions during monsoon 1996*

During initial phase of the monsoon, central parts of the country and some isolated areas in northern India came under moderate to severe arid conditions. With the progress of the monsoon this condition improved considerably and by September, entire country, except Saurashtra & Kutch and some isolated areas came under non arid to mild arid conditions.

Aridity anomaly maps for June and July are given in Fig. 9(a&b) and for August and September are given in Fig. 9(c&d).

8. Characteristic features of southwest monsoon 1996

(*i*) The southwest monsoon set in over Kerala on 3 June, a delay by only two days from the normal date. Like last year, this year also onset of monsoon in northeastern regions of India was 3 days earlier to that in Kerala. No onset vortex over the Arabian Sea was associated with the onset process. Its further advance along the west-coast upto Mumbai, over peninsular India and also over central and eastern parts of India was around the normal date. Monsoon advanced into west Rajasthan and covered whole country on 30 June, about two weeks earlier than the normal. For more details, please see Sec. 2.1.

(*ii*) Two cyclonic storms; one over the Bay of Bengal (12-16 June) and other over the Arabian Sea (17-20 June) formed and caused damages over the affected regions. The cyclonic storm over the Arabian Sea helped in speedy advance of monsoon over the western regions of India.

(*iii*) Only one monsoon depression (26-28 July) that too over land formed during the season. No monsoon depression formed over the Head Bay or neighbouring sea area during June to September. This caused uneven distribution of rainfall specially over central belt of India

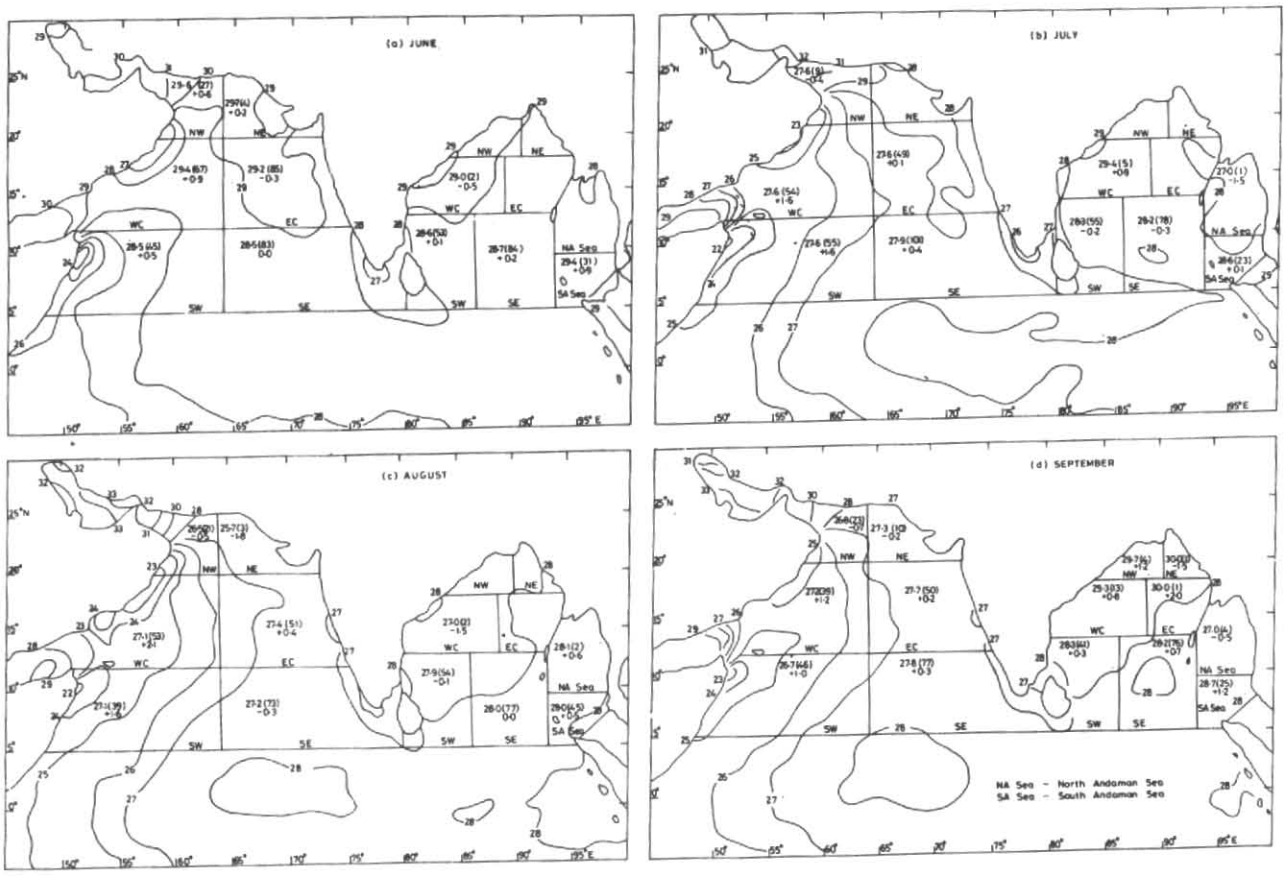
(*iv*) Sixteen low pressure areas (2 in June, 5 in July, 5 in August and 4 in September) and thirty nine upper air cyclonic circulations (8 in June, 8 in July 10 in August and 13 in September) were other synoptic systems during this monsoon season which contributed to the rainfall distribution in space and time.

(*v*) Rainfall was well distributed in space and time during the season except in 1st week of June and in the week ending on 25 September. However, rainfall was subdued in first week of July and overall there was deficiency in rainfall over the central belt, from Orissa to Vidarbha.

(*vi*) Rainfall during the monsoon season was excess in 10 sub-divisions, normal in 22 and deficient in only 3 sub-divisions. Deficiency in rainfall was marginal in Orissa (-23%), Hills of west Uttar Pradesh (–20%) and Vidarbha (–25%).

(*vii*) Out of 35, twenty five or more sub-divisions received excess or normal rainfall in the month of June, August and September. However, in July only 20 sub-divisions received excess or normal rainfall while remaining 15 had deficient rainfall. This was because monsoon trough got established in 2nd week of July only. Moreover, during first week and also on 10-12 and 28-30 July, it was close to foot hills of the Himalayas.

(*viii*) All the low pressure areas except one which formed over parts of central Arabian Sea (9-14 June)



Figs. 9(a-d). Mean monthly (June-September 1996) SST anomalies (°C) of Indian seas during SW monsoon 1996

are formed in association with upper air cyclonic circulations. Many of these low pressure systems, initially formed as an upper air cyclonic circulation and then descended to the surface as low pressure areas.

(*ix*) The seasonal trough was established by the end of the 1st week of July about a week later than the normal time. Afterwards, it was active till 1st week of September. However, the monsoon trough deviated from its normal position on number of days during 2nd week of July to mid-August. Break monsoon-like situation was present during 1st week of July and also on 10-12 and 28-30 July.

(*x*) Southwest monsoon withdrew from parts of west Rajasthan on 15 September and from east Rajasthan and rest northwest India by 21 September. By 8 October it withdrew from Maharashtra, Madhya Pradesh, parts of Orissa, Uttar Pradesh, Bihar and West Bengal. It finally withdrew from the entire country by 11 October, about a week earlier than the normal date.

(*xi*) Northeast monsoon rains commenced over Tamil Nadu and adjoining parts of Andhra Pradesh, Karnataka and Kerala on 11 October 1996 simultaneously when southeast monsoon withdrew from the above areas.

(*xii*) Northeast monsoon withdrew from Tamil Nadu and Pondicherry, Kerala and adjoining parts of Karnataka and Andhra Pradesh on 23 December 1996.

(*xiii*) Tibetan anticyclone/high got established and was well defined from third week of June to first week of September at 300 hPa level and from second week of July to first week of September except from 17 August to 25 August at 500 hPa level.

(*xiv*) The intensity of the Mascarene high was normal or near normal in June, July and August. Its intensity was 2 hPa below normal value (1022 hPa) in September.

(*xv*) Off shore trough along the west coast on the surface and/or in the lower levels persisted for most of the days.

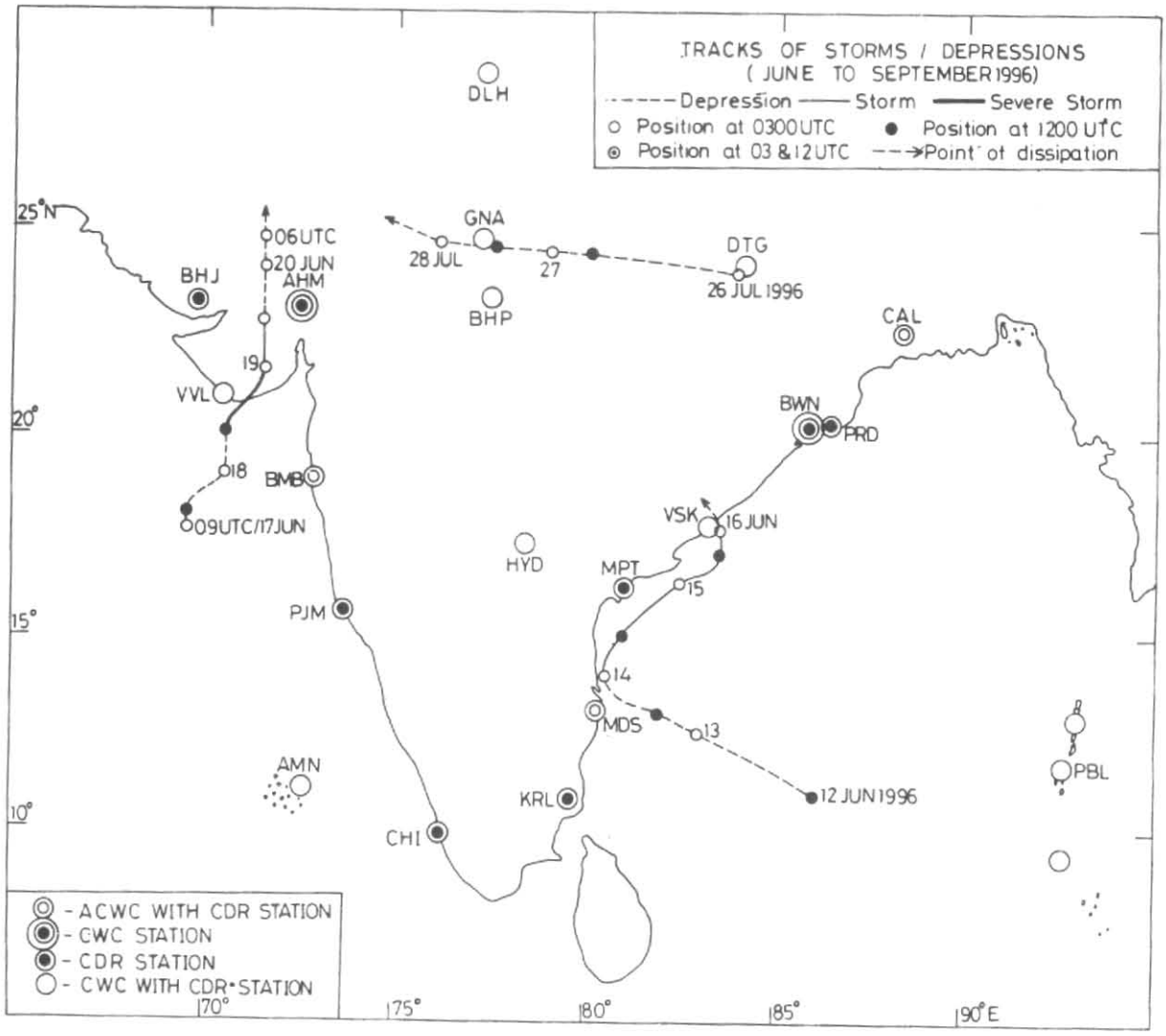


Fig. 10. Tracks of storm/depressions (June-September 1996)

(*xvi*) This year sub-divisionwise and cumulative monsoon rainfall is better than that for the last five years and is comparable to that of 1990.

9. Significant spells of heavy rains

During June, widespread rains with isolated heavy falls occurred in Andaman & Nicobar Islands, Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, coastal Karnataka and Kerala on a number of days. Widespread rains with isolated heavy falls occurred in Gangetic West Bengal, Orissa, Himachal Pradesh and west Rajasthan between 20 and 24, in east Madhya Pradesh and Gujarat between 19 and 21; in Konkan & Goa and Madhya Maharashtra between 13 and 20; in coastal Andhra Pradesh, Rayalaseema and Tamil Nadu between 11 and 17 and in Karnataka between 13 and 22 June and also in Assam & Meghalaya, Bihar, Punjab, east Rajasthan for 2 to 4 days.

During July, widespread rains with isolated heavy falls occurred in Andaman & Nicobar Islands, Arunachal Pradesh, Assam & Meghalaya, Sub-Himalayan West Bengal & Sikkim, Konkan & Goa, coastal Karnataka and Kerala on number of days. Widespread rains with isolated heavy falls also occurred in Orissa between 21 and 25; in Gujarat Region and Madhya Maharashtra between 20 and 29; in south interior Karnataka between 18 and 23; in Nagaland, Manipur, Mizoram & Tripura,

TABLE 9

Rainfall figures (mm) for each month and season as a whole (June-September 1996)

S. No.	Meteorological sub-division	June			July			August			September			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
1.	A & N Islands	504	470	7	332	357	–7	299	360	–17	529	409	29	1664	1569	4
2.	Arunachal Pradesh	365	543	–33	906	596	52	400	411	–3	225	293	–23	1896	1843	3
3.	Assam & Meghalaya	340	552	–38	740	556	31	386	433	–11	255	347	–35	1691	1897	–11
4.	Naga., Mani., Mizo & Tri.	232	363	–36	276	324	–15	221	299	–26	276	231	19	1005	1217	–17
5.	SHWB & Sikkim	315	536	–41	775	615	26	460	509	–9	474	427	11	2024	2087	–3
6.	Gangetic West Bengal	289	249	16	228	304	–25	446	303	47	180	241	–25	1143	1097	4
7.	Orissa	226	223	1	250	357	–30	322	355	–9	106	244	–57	904	1179	–23
8.	Bihar Plateau	344	198	74	227	329	–31	408	320	28	145	240	–40	1124	1087	–3
9.	Bihar Plains	195	169	15	295	307	–4	333	310	7	179	222	–19	1002	1008	–1
10.	East U.P.	139	104	34	196	306	–36	351	299	17	157	191	–18	843	900	–6
11.	Plains of West U.P.	115	80	44	212	265	–20	328	269	22	167	165	2	822	779	6
12.	Hills of West U.P.	167	172	–3	295	450	–34	374	447	–16	203	229	–11	1039	1297	–20
13.	Haryana, Chandigarh & Delhi	148	51	190	122	175	–30	315	179	76	161	108	49	746	513	45
14.	Punjab	158	43	267	118	190	–38	242	170	42	85	100	–15	603	503	20
15.	Himachal Pradesh	192	97	98	205	347	–41	332	321	4	137	157	–13	867	922	–6
16.	Jammu & Kashmir	126	65	129	140	183	–23	484	190	154	25	86	–71	775	514	51
17.	West Rajasthan	185	28	561	98	99	–2	122	112	8	27	42	–36	432	282	53
18.	East Rajasthan	146	57	156	273	224	22	333	228	46	143	115	24	895	624	43
19.	West Madhya Pradesh	53	115	–54	433	333	30	402	278	45	162	195	–17	1050	921	14
20.	East Madhya Pradesh	123	166	–26	360	405	–11	398	383	4	151	225	–33	1033	1178	–12
21.	Gujarat Region	149	146	2	461	426	8	340	304	12	177	181	–2	1127	1057	7
22.	Saurashtra & Kutch	156	95	64	207	223	–7	37	128	–71	29	85	–66	429	631	–19
23.	Konkan & Goa	542	694	–22	1114	1090	2	529	674	–22	249	350	–29	2434	2808	–13

TABLE 9 (*Contd.*)

S. No.	Meteorological sub-division	June			July			August			September			Season		
		Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)	Actual (mm)	Normal (mm)	Dep. (%)
24.	Madhya Maharashtra	164	140	17	263	268	–2	160	178	–10	167	156	7	754	742	2
25.	Marathwada	54	146	–63	179	204	–12	241	187	29	244	177	38	717	714	0
26.	Vidarbha	57	173	–67	257	330	–22	256	277	–7	151	184	–18	721	964	–25
27.	Coastal Andhra Pradesh	243	110	121	168	167	1	224	164	37	158	169	–7	793	610	30
28.	Telangana	128	134	–4	228	249	–8	306	220	39	162	186	–13	824	789	4
29.	Rayalaseema	231	58	298	59	86	–31	330	99	232	220	133	65	840	376	123
30.	Tamil Nadu	159	52	206	47	75	37	119	97	23	171	105	63	496	329	51
31.	Coastal Karnataka	842	868	–3	1051	1161	–9	559	678	–17	324	304	7	2777	3010	–8
32.	N.I. Karnataka	139	97	43	113	149	–24	170	122	39	217	150	44	639	618	23
33.	S.I. Karnataka	249	149	67	199	279	–29	216	186	17	219	136	60	883	750	18
34.	Kerala	593	688	–14	680	746	–9	338	436	–22	329	248	33	1940	2117	–8
35.	Lakshadweep	427	323	32	335	277	21	197	215	–8	230	157	47	1189	972	22

Gangetic West Bengal, Bihar Plains, west Madhya Pradesh and Telangana for 5 to 7 days and in east Uttar Pradesh, Punjab, Jammu & Kashmir, east Madhya Pradesh, Marathwada, Vidarbha, coastal Andhra Pradesh and north interior Karnataka for 2 to 4 days.

During August, widespread rains with isolated heavy falls occurred in West Bengal & Sikkim, Konkan & Goa and coastal Karnataka on many days; in Andaman and Nicobar Islands between 23 and 31, in Bihar Plains between 14 and 19, in west Madhya Pradesh between 19 and 22, in east Madhya Pradesh between 15 and 21; in Madhya Maharashtra between 25 and 30; in Telangana between 24 and 31 and in north interior Karnataka between 12 and 13; and 24 and 28. Widespread rains with isolated heavy falls also occurred in Assam & Meghalaya, Bihar Plateau, Uttar Pradesh, Haryana, Punjab, Jammu & Kashmir, Himachal Pradesh, Gujarat Region, Coastal Andhra Pradesh, Rayalaseema and south interior Karnataka for 4 to 6 days and in Orissa, Marathwada and Kerala for 2 to 3 days.

During September, widespread rains with isolated heavy falls occurred in Andaman & Nicobar Islands and coastal Karnataka on 7 to 10 days and in Haryana and Gujarat Region between 6 and 10; in Madhya Maharashtra and Marathawada between 12 and 16; in Telangana between 3 to 8 and in Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, West Bengal & Sikkim, Bihar Plateau, Himachal Pradesh, east Rajasthan, west Madhya Pradesh, Konkan & Goa, Rayalaseema, interior Karnataka and Kerala on 2 to 4 days.

9.1. *Damage due to floods etc. during monsoon season*

In 1996, northeastern states experienced floods in June and July. In the month of June, Andhra Pradesh experienced floods under the influence of the cyclonic storm. During second half of June, floods also occurred over Rajasthan and Haryana. In the second half of July, floods occurred over Rajasthan and during the 3rd week of July, floods occurred over north Bengal and Bihar. In the last week of August, Punjab experienced isolated flood.

Damages reported due to floods and heavy rains in June, July, August and September are given in sub-sections 10.1.5, 10.2.4, 10.3.4 and 10.4.4 respectively.

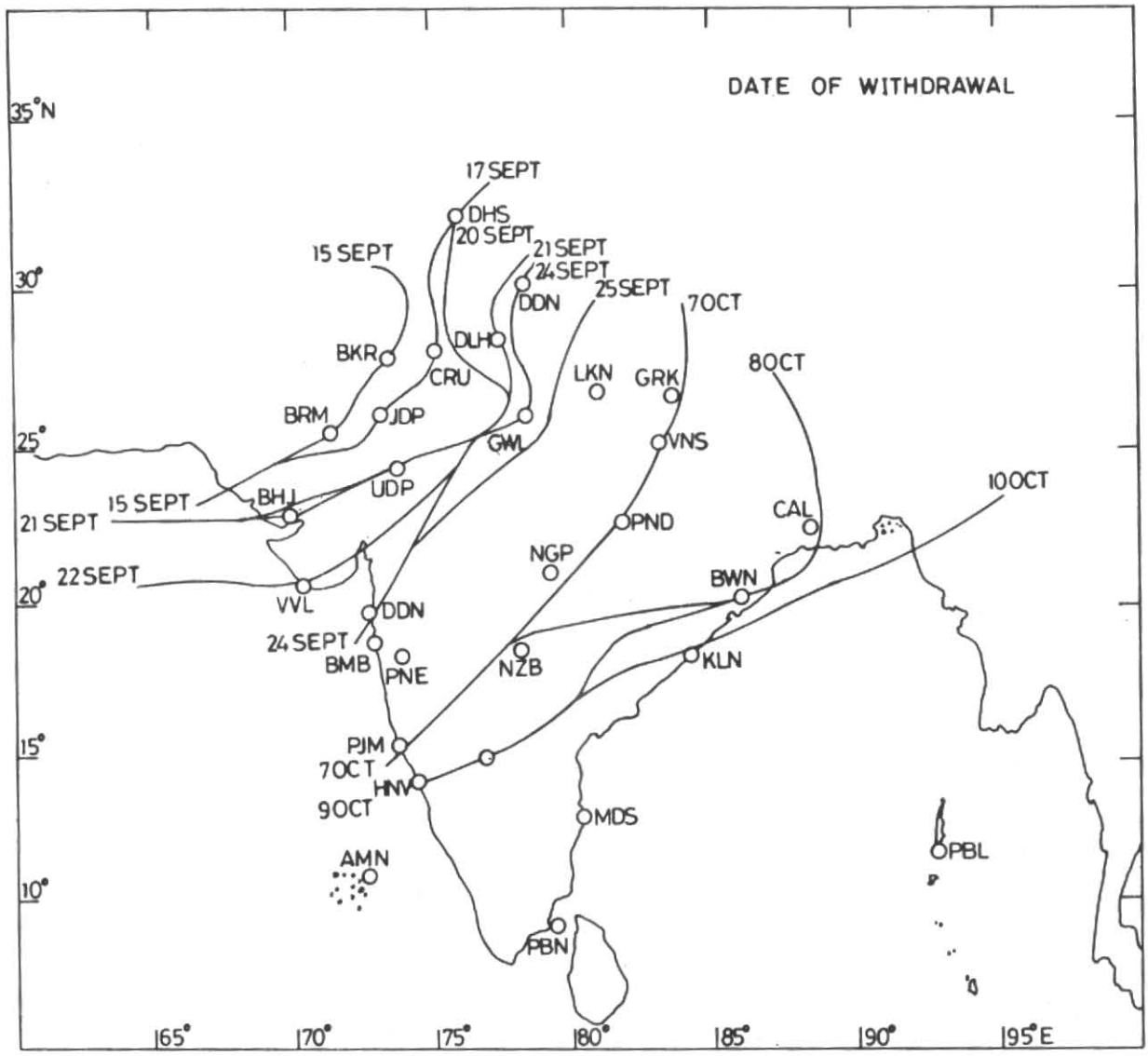


Fig. 11. Withdrawal of southwest monsoon 1996

10. Significant monthly features

10.1. *June*

10.1.1. *Temperature*

Heat wave conditions prevailed for 2 days in plains of west Uttar Pradesh and for 3 days in west Rajasthan during 1st half of June. Day temperature was markedly above normal for 2 to 3 days in east Rajasthan, Madhya Pradesh, Marathwada, Vidarbha and Rayalaseema during 1st week of the month.

Highest day temperature was 48°C at Churu (Rajasthan) on 4 June.

10.1.2. *Monthly rainfall*

Monthly rainfall is given in para 2.3. and principal amounts of rainfall are given in Table 1.

10.1.3. *Disastrous weather events and damages during June*

Bay cyclone (12-16) caused heavy damage to property and loss of life in coastal districts of north

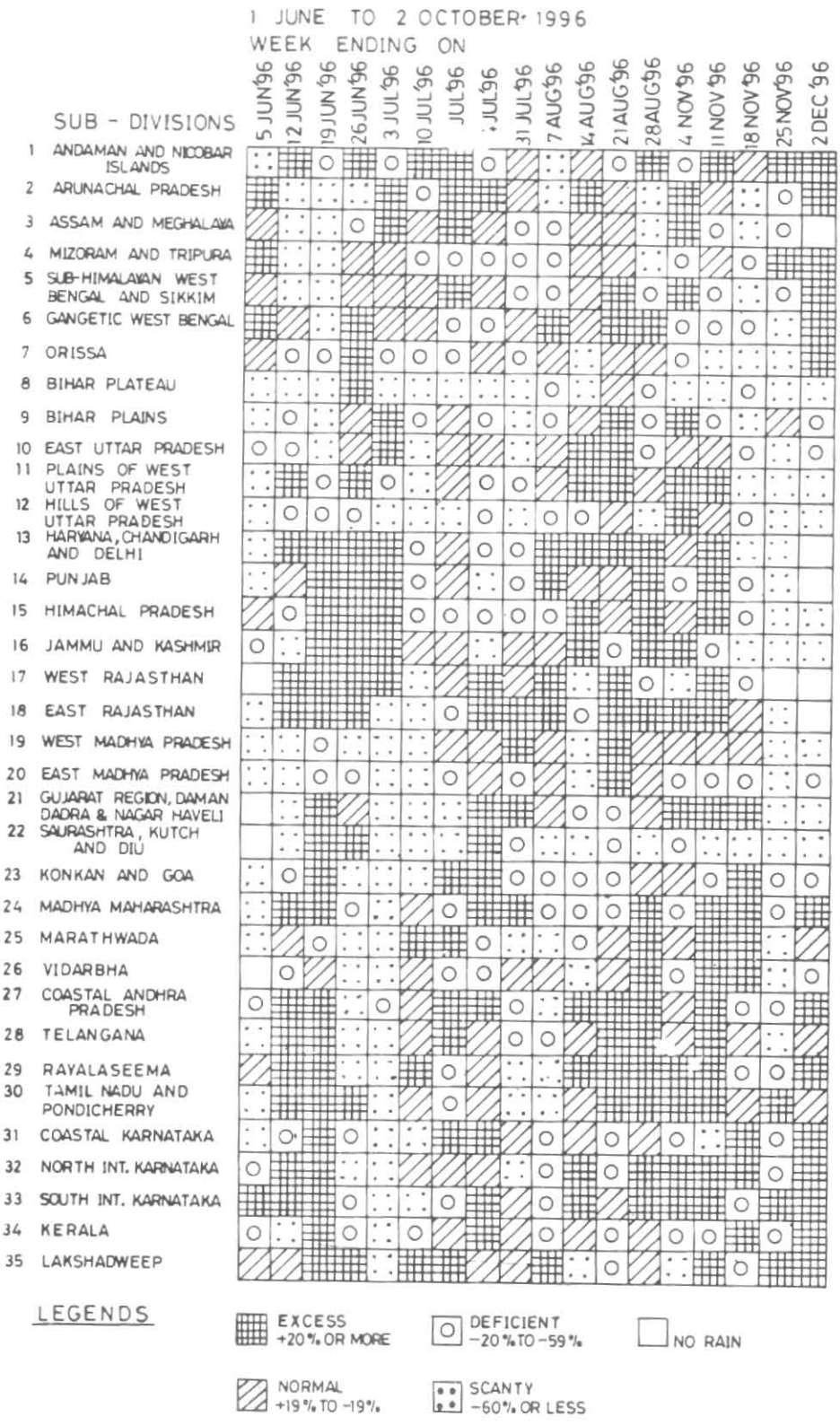


Fig. 12. Progress of southwest monsoon week-by-week (1 June to 2 October)

Tamil Nadu and Andhra Pradesh during 14 and 17 June. Coastal districts of Andhra Pradesh reported 68 human deaths, about 6000 house damages and an estimated loss of rupees 82 crores. In Tamil Nadu, 41 persons were killed, 4 fishing vessels were drowned, road and rail traffic were also badly affected

Nineteen districts of Gujarat were affected by the cyclonic storms in Arabian Sea (17-20). Deaths of about 33 human lives and 2082 cattles were reported. Fourteen people and 31 cattles were killed due to heavy rains and gale winds in Thane, Ratnagiri and Mumbai districts of north Konkan.

It is reported that, in West Bengal & Sikkim, more than one lakh people were affected and 5000 hectares of crop land was damaged due to floods during first half of June. Due to heavy rains and high winds, nine persons died in West Bengal & Sikkim and 7 persons died in west Madhya Pradesh. Heavy rains and lightning caused death of 28 people in Maharashtra and 20 people in Karnataka.

10.2. *July*

10.2.1. *Disastrous weather events during July*

According to media reports, 39 people in Jammu and Kashmir lost their lives due to floods during 1st week of July. Heavy rains and floods and landslides claimed more than 100 lives in West Bengal & Sikkim during first half of July. In Assam, more than a hundred villages and large area in Arunachal Pradesh were inundated by rising waters of rivers causing damage to property and human lives. According to press reports 15 people lost their lives due to torrential rains and collapse of civil structure in Mumbai (Konkan & Goa) on 23 July. Due to heavy rains and floods, 68 people died in Bihar, 30 in Assam, 75 in Gujarat, 5 in Madhya Pradesh and 7 in Vidarbha during 2nd half of July.

10.3. *August*

10.3.1. *Disastrous weather events and damages during August*

During last week of August, heavy rains, snowfall and landslides in Kashmir valley caused deaths of 240 Amarnath pilgrims. Around 40 people in Punjab, Haryana and Uttar Pradesh and 9 in Andhra Pradesh died due to heavy rainfall and floods. 19 persons in Andhra Pradesh, 7 in Marathwada and 2 in Assam, lost their lives due to heavy rains and floods during the week from 29 August to 4 September.

10.4. *September*

10.4.1. *Disastrous weather events and damages during September*

About 8,400 houses in West Bengal were damaged due to floods and thunderbolt in 2nd and 4th week of September. Due to lightning and thunderstorm, 5 people in Bihar and 7 in Vidarbha died. Heavy rains and floods took lives of 61 persons in Andhra Pradesh and 5 persons in Marathwada. In Karnataka, 293 houses collapsed, also 4081 houses and some bridges and roads were damaged.

Acknowledgement

Thanks are due to the participants of AMR-97 for their constructive suggestions. Valuable input from (1) DGM (Hydromet), New Delhi, (2) DGM (Sat. Met.), New Delhi (3) ADGM (R), Pune and (4) DDGM (WF), Pune is gratefully acknowledged.

Thanks are due to S/Shri M.V. Mande, H.P. Deshmukh and K.G. Pardeshi for their help in bringing out this report.