MAUSAM, **61**, 3 (July 2010), 411-454

Weather in India

MONSOON SEASON (June to September 2009)†

1. Characteristic features of southwest monsoon 2009

1.1. The seasonal rainfall over the country as a whole was 78% of its Long Period Average (LPA).

1.2. This large rainfall deficiency on a wide spatial scale, categorizes the southwest monsoon-2009 under *all India severe drought year**, preceded by 2002 & 2004.

1.3. The seasonal rainfall was 65% of its LPA over Northwest India, 80% of its LPA over central India, 94% of its LPA over South peninsula and 77% of its LPA over Northeast India.

1.4. Out of 511 meteorological districts, 217 districts (42%) received *excess* / *normal* rainfall and the remaining 294 districts (58%) received *deficient* / *scanty* rainfall during the season.

1.5. For the country as a whole, the rainfall was 53% of LPA in June, 96% of LPA in July, 73% of LPA in August and 80% of LPA in September.

2. Various aspects of southwest monsoon - 2009

2.1. *Advance of southwest monsoon*

The progress of monsoon over the country is given chronologically in Table 1 and Fig. 1.

Southwest monsoon set in over Andaman Sea around its normal date, on 20 May. It set in over Kerala on 23 May, about a week earlier than the normal onset date (1 June).

Subsequent to the onset over Kerala, a Severe Cyclonic Storm (Aila) formed over the Bay of Bengal. In association with it, the advance of monsoon over the northeastern states including West Bengal & Sikkim occurred earlier than normal. Thereafter, the cross equatorial flow became weak. After a hiatus of about a week, monsoon further advanced along the west coast and covered up to ~ Lat 17° N on 7 June. A prolonged hiatus in the further advance occurred during 8 – 20 June, which may be mainly attributed to the weak cross equatorial flow and lack of formation of low pressure systems over the Bay of Bengal. *Severe heat wave* conditions prevailed over many parts of northwest, central and adjoining eastern parts during this period.

Associated with the formation of a Depression over the Arabian Sea during 23 – 24 June, Southwest monsoon advanced as a weak current over some more parts of peninsular India and parts of central India during 21 – 27 June. The subsequent advance over the remaining parts of Gujarat, Madhya Pradesh, Chattisgarh, Orissa, West Bengal & Sikkim, Bihar, Jharkhand, east Uttar Pradesh and parts of northwest India took place in a rapid manner and by 30 June, most parts of the country, outside parts of west Rajasthan was covered by the monsoon current. On 3 July, the monsoon covered the entire country when a favourable interaction between monsoon flow and mid-latitude westerlies resulted in copious rainfall over Rajasthan. Thus the southwest monsoon covered the entire country, 12 days earlier than its normal date of 15 July.

2.2. *Weekly rainfall distribution*

Meteorological sub-division wise week by week and cumulative weekly rainfall departures (percentage departure from normal) during the SW monsoon season from 1 June 2009 to 30 September 2009 comprising of 18 weeks are given in Figs. 2 (a&b).

2.2.1. *Week by week rainfall*

The below normal rainfall period for the northeastern sub-divisions were 1–24 June, 9–22 July, 27 August – 16 September and 24- 30 September. Northern parts received mainly *scanty* rainfall for the period 4 – 24 June, 2 – 15 July, 30 July – 12 August, 20 – 26 August and 17 – 30 September. Northwest and central India received *deficient* or *scanty* rainfall during 18 June – 8 July, 30 July – 26 August and from 17 – 30 September. While the northern parts of south peninsula followed almost similar pattern as that of the central India, for the extreme southern parts, the deficiency was restricted to 23 July – 12 August.

2.2.2. *Weekly cumulative rainfall distribution*

Excluding Orissa and West Bengal & Sikkim, all other sub-divisions over the north and eastern parts of the country remained *deficient* / *scanty* all through the season. Only Jammu & Kashmir and Rajasthan became *excess* / *normal* on a few weeks over northwest India, while all

* *Definitions of terms in italics other than sub-titles are given in Appendix.*

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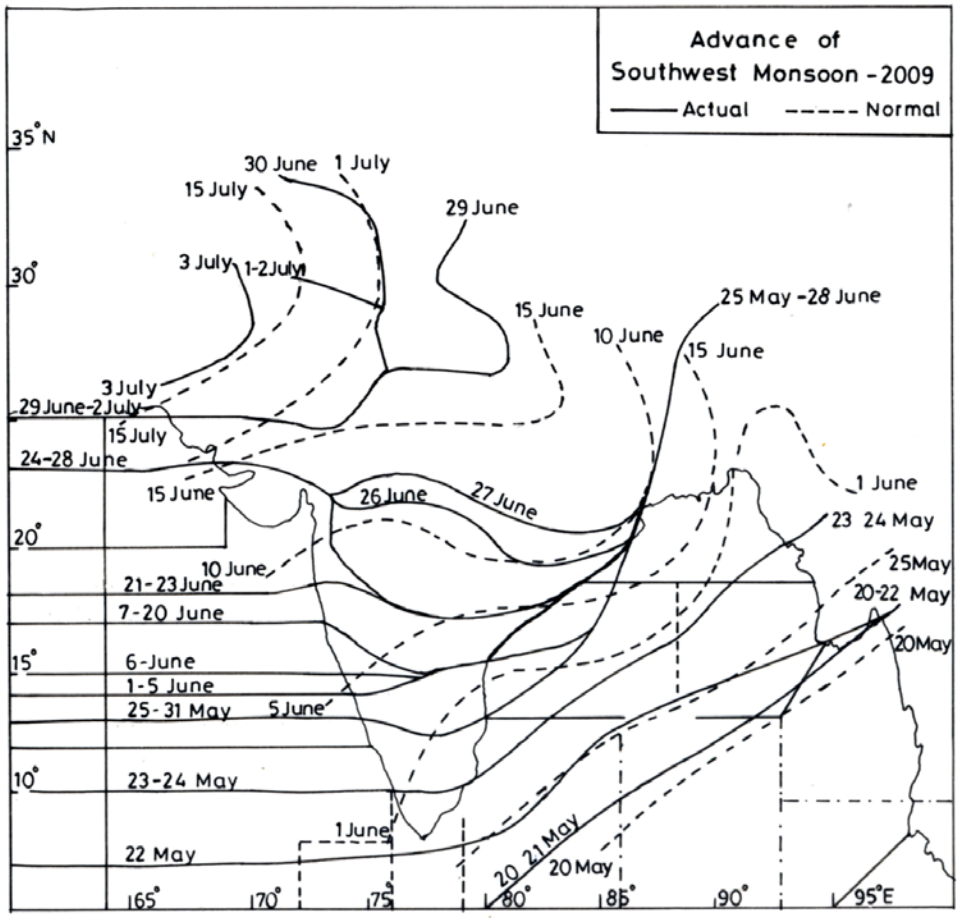


Fig. 1. Isochrones of advance of southwest monsoon 2009

other sub-divisions remained *deficient*. All sub-divisions over the central parts remained *deficient* except for a short spell comprising the last three weeks of July. The southern peninsular India excluding Andhra Pradesh received *excess* / *normal* rainfall during most parts of the season.

2.3. *Monthly rainfall distribution*

Figs. 3 - 6 show monthwise distribution of monsoon rainfall. Sub-divisionwise rainfall figures and departures for each month and season as a whole are given in Table 2.

Only 3 sub-divisions *viz*., Tamil Nadu, north Interior Karnataka and Lakshadweep remained either *normal* or *excess* all through the months.

The monthly monsoon rainfall for the country as a whole during all the 4 months was below the respective LPA. However, the rainfall during July (96% of LPA) was within the normal limit. It was 53 % of LPA in June, 73% of LPA in August and 80% of LPA in September.

The large rainfall deficiency observed over most parts of the country during June could be attributed to the prolonged hiatus in the advance over central and northern parts of the country. During July, rainfall over most of the sub-divisions along the foothills of the Himalayas and a few in the eastern parts of the peninsula were highly *deficient*. The rainfall over most of the sub-divisions along the monsoon trough zone and along the west coast was *normal* / *excess* due to the strengthening of monsoon in association with the formation and movement of synoptic scale systems from the Bay of Bengal along the monsoon trough. In August, rainfall over most of the sub-divisions along the west coast and that over northwest India and adjoining central India was highly deficient. In September,

TABLE 1

Advance of Southwest Monsoon 2009

S.No.	Date	Southwest monsoon advanced over	Northern limit of monsoon passed through
1.	20th May	Some parts of southeast Bay of Bengal and entire Andaman Sea	5/80, 9/85,12/90,14/93 & 17/97
2.	22nd May	Some parts of south Arabian sea, some more parts of southwest Bay of Bengal, entire southeast Bay of Bengal and some parts of east central Bay of Bengal	7/60, 7/70, 8/80, 12/85, 14/89 &17/97
3.	23rd May	Southwest monsoon set in over Kerala Some more parts of south Arabian sea, some parts of Kerala and south Tamil Nadu, most parts of southwest and east central Bay of Bengal and some parts of west central and northeast Bay of Bengal	10/60, 10/70, Kochi, Madurai, 13/83, 16/88 & 20/93
4.	25th May	Entire south Arabian Sea , some parts of central Arabian sea, entire Kerala , some parts of coastal Karnataka, south Interior Karnataka, most parts of Tamil Nadu, entire southwest Bay of Bengal, some more parts of west central Bay of Bengal, entire northeast Bay of Bengal, most parts of northwest Bay of Bengal, some parts of north coastal Orissa, most parts of west Bengal & Sikkim and entire northeast India	13/60, 13/70, Mangalore, Dharmapuri, Chennai, 15/83, 17/85, Paradip, Balasore, Bankura and Gangtok
5.	1st June	Some more parts of central Arabian sea, coastal and south Interior Karnataka, some parts of Rayalaseema and south coastal Andhra Pradesh and some more parts of west central Bay of Bengal	14/60, 14/70, Udupi, Anantpur, Ongole, 17/85, Paradip, Balasore, Bankura and Gangtok
6.	6th June	Some more parts of central Arabian Sea, entire coastal and south interior Karnataka, some parts of north Interior Karnataka and entire Bay of Bengal	15/60, 15/70, Karwar, Anantpur, Ongole, Kalingapatnam, Paradip, Balasore, Bankura and Gangtok
7.	7thJune	Some more parts of central Arabian sea, entire Goa, some parts of south Konkan and some more parts of north Interior Karnataka	17/60, 17/70, Ratnagiri, Gadag, Anantpur, Ongole, Kalingapatnam, Paradip, Balasore, Bankura and Gangtok
8.	21st June	Some more parts of central Arabian Sea, some parts of north Konkan, Madhya Maharashtra, most parts of Karnataka, remaining parts of Rayalaseema, some parts of Telangana and north coastal Andhra Pradesh	18/60, 18/70, Alibag, Pune, Solapur, Hyderabad, Kalingapatnam, Paradip, Balasore, Bankura and Gangtok.
9.	24th June	Entire central Arabian Sea, some parts of north Arabian sea, south Gujarat State, remaining parts of north Konkan and some more parts of Madhya Maharashtra	23/60, 23/65, Bhuj, Baroda, Nasik, Solapur, Hyderabad, Kalingapatnam, Paradip, Balasore, Bankura and Gangtok
10.	26th June	Some more parts of Gujarat region, entire Madhya Maharashtra, Marathwada, remaining parts of north Interior Karnataka, Telangana, costal Andhra Pradesh, most parts of Vidarbha, some parts of west Madhya Pradesh, Chattisgarh and some more parts of Orissa	23/60, 23/65, Bhuj, Baroda, Khandwa, Nagpur, Jagdalpur, Paradip, Balasore, Bankura and Gangtok
11.	27th June	Some more parts of Gujarat region, west Madhya Pradesh, Chattisgarh, Orissa, most parts of Vidarbha and some parts of east Madhya Pradesh	23/60, 23/65, Bhuj, Baroda, Indore, Hoshangabad, Rajnandgaon, Cuttack, Balasore, Bankura and Gangtok
12.	29th June	Entire Arabian sea, remaining parts of Gujarat state, Madhya Pradesh, Chattisgarh, Orissa, west Bengal & Sikkim, entire Bihar, Jharkhand, some parts of south Rajasthan, Uttar Pradesh and most parts of Uttarakhand	25/60, 25/65, Udaipur, Jaipur, Etawah, Lucknow, Kheri, Dehradun and Uttarkashi
13.	30th June	Remaining parts of Uttar Pradesh, Uttarakhand, entire Himachal Pradesh and Jammu & Kashmir, most parts of Haryana (including Delhi) and some parts of Punjab	25/60, 25/65, Udaipur, Jaipur, Pilani, Hissar, Ludhiana and Jammu
14.	1st July	Remaining parts of Punjab and Haryana and some more parts of Rajasthan	25/60, 25/65, Udaipur, Jaipur, Pilani, Hissar and Ganganagar
15.	3rd July	Remaining parts of Rajasthan and thus the entire country	-

Week by week rainfall during SW monsoon - 2009

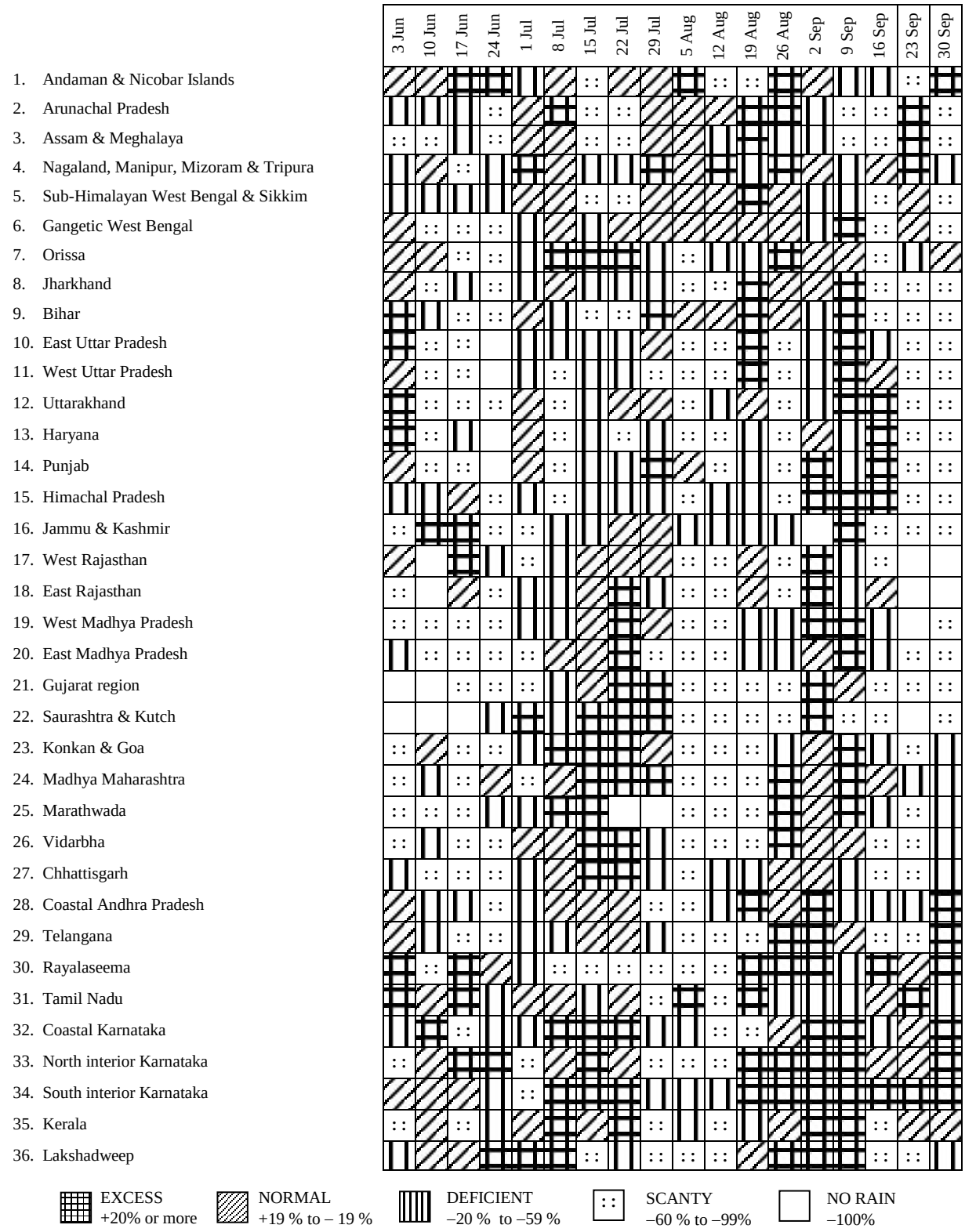


Fig. 2(a). Week by week rainfall during SW Monsoon 2009

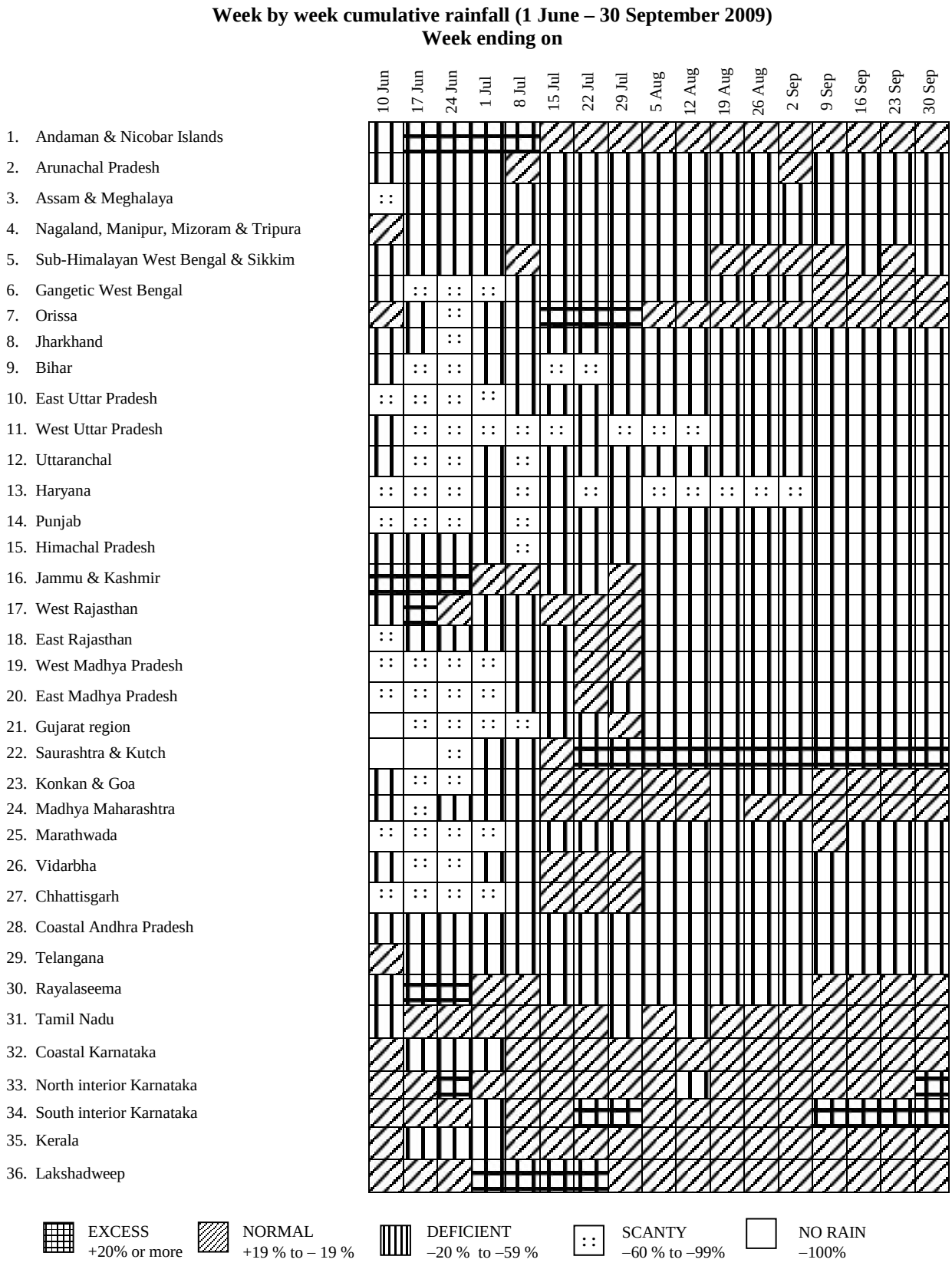


Fig. 2(b). Week by week cumulative rainfall during SW monsoon 2009 (1 June to 30 September 2009)

TABLE 2

Rainfall figures (mm) for each month and season as a whole (June – September 2009)

S. No.	Meteorological Sub-divisions	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	620	482	29	303	419	-28	385	416	-7	364	438	-17	1672	1755	-5
2.	Arunachal Pradesh	383	494	-22	485	595	-19	419	388	8	225	358	-37	1512	1835	-18
3.	Assam & Meghalaya	296	567	-48	394	563	-30	457	434	5	170	321	-47	1317	1885	-30
4.	Naga., Mani., Mizo. and Tripura	186	361	-48	294	345	-15	318	309	3	193	226	-15	991	1241	-20
5.	S. H. W. B. & Sikkim	346	496	-30	468	602	-22	545	470	16	173	388	-55	1533	1955	-22
6.	Gangetic West Bengal	70	240	-71	279	315	-11	330	312	6	294	270	9	971	1136	-15
7.	Orissa	920	206	-55	611	345	77	299	365	-18	166	249	-33	1168	1165	0
8.	Jharkhand	94	192	-51	218	336	-35	275	324	-15	252	241	4	839	1093	-23
9.	Bihar	66	173	-62	233	345	-32	319	296	8	133	226	-41	751	1039	-28
10.	East Uttar Pradesh	35	105	-66	176	309	-43	208	301	-31	145	198	-27	565	914	-38
11.	West Uttar Pradesh	14	69	-80	124	268	-54	186	286	-35	118	150	-21	442	773	-43
12.	Uttarakhand	68	164	-58	320	425	-25	313	426	-26	196	207	-6	898	1223	-27
13.	Haryana, Chandigarh & Delhi	15	43	-66	79	171	-54	56	168	-67	157	89	78	307	470	-35
14.	Punjab	10	42	-75	167	189	-12	82	169	-51	72	102	-30	331	502	-34
15.	Himachal Pradesh	37	90	-59	157	288	-46	127	262	-52	187	134	39	507	774	-34
16.	Jammu & Kashmir	59	59	1	135	186	-27	95	174	-45	49	95	-49	339	514	-34
17.	West Rajasthan	22	27	-19	89	102	-12	32	94	-66	10	41	-76	153	263	-42
18.	East Rajasthan	37	61	-39	207	224	-8	133	233	-43	53	105	-50	430	624	-31
19.	West Madhya Pradesh	52	108	-52	319	305	5	165	315	-48	122	177	-31	657	904	-27
20.	East Madhya Pradesh	36	144	-75	338	371	-9	184	382	-52	181	201	-10	738	1097	-33
21.	Gujarat region	17	123	-86	402	361	12	137	291	-53	57	160	-64	613	934	-34
22.	Saurashtra & Kutch	69	81	-15	430	195	121	103	138	-25	10	72	-86	613	486	26
23.	Konkan & Goa	330	675	-51	1326	1069	24	297	712	-58	363	347	5	2316	2802	-17
24.	Madhya Maharashtra	66	134	-51	304	238	28	146	176	-17	167	151	10	684	700	-2
25.	Marathwada	59	144	-59	150	192	-22	167	194	-14	153	174	-12	530	704	-25
26.	Vidarbha	79	167	-53	315	329	-4	175	300	-42	92	180	-49	662	976	-32
27.	Chattisgarh	43	189	-77	431	394	9	237	391	-39	84	232	-64	796	1206	-34
28.	Coastal Andhra Pradesh	54	100	-46	97	160	-39	143	154	-7	136	162	-16	430	575	-25
29.	Telangana	65	135	-52	112	242	-54	165	218	-24	155	171	-10	498	767	-35
30.	Rayalaseema	63	60	5	22	91	-76	120	97	23	185	132	40	390	381	2
31.	Tamil Nadu	34	42	-19	59	71	-17	96	90	7	126	113	12	315	316	0
32.	Coastal Karnataka	491	901	-45	1646	1188	39	497	767	-35	569	318	79	3204	3174	1
33.	North interior Karnataka	93	98	-5	119	126	-6	167	113	48	236	153	54	616	491	26
34.	South interior Karnataka	96	132	-27	323	225	43	155	164	-6	249	137	82	823	659	25
35.	Kerala	434	678	-36	927	758	22	270	447	-40	328	260	26	1959	2143	-9
36.	Lakshadweep	402	326	23	266	282	-6	185	213	-13	145	164	-12	998	985	1

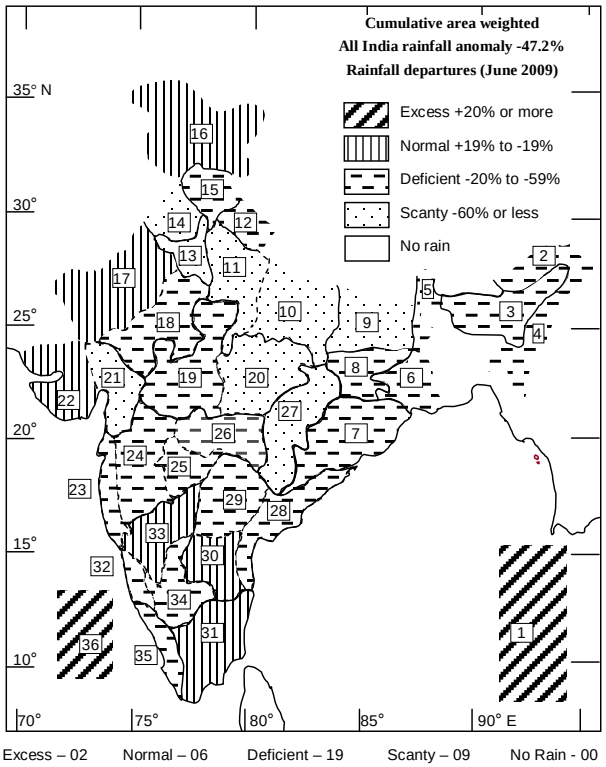


Fig. 3. Sub-divisionwise seasonal rainfall departure from normal (%) for the period (June 2009). 36 Sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	29	**7**	–55	**13**	–66	**19**	–52	**25**	–59	**31**	–19
2	–22	**8**	–51	**14**	–75	**20**	–75	**26**	–53	**32**	–45
3	–48	**9**	–62	**15**	–59	**21**	–86	**27**	–77	**33**	–5
4	–48	**10**	–66	**16**	1	**22**	–15	**28**	–46	**34**	–27
5	–30	**11**	–80	**17**	–19	**23**	–51	**29**	–52	**35**	–36
6	–71	**12**	–58	**18**	–39	**24**	–51	**30**	5	**36**	23

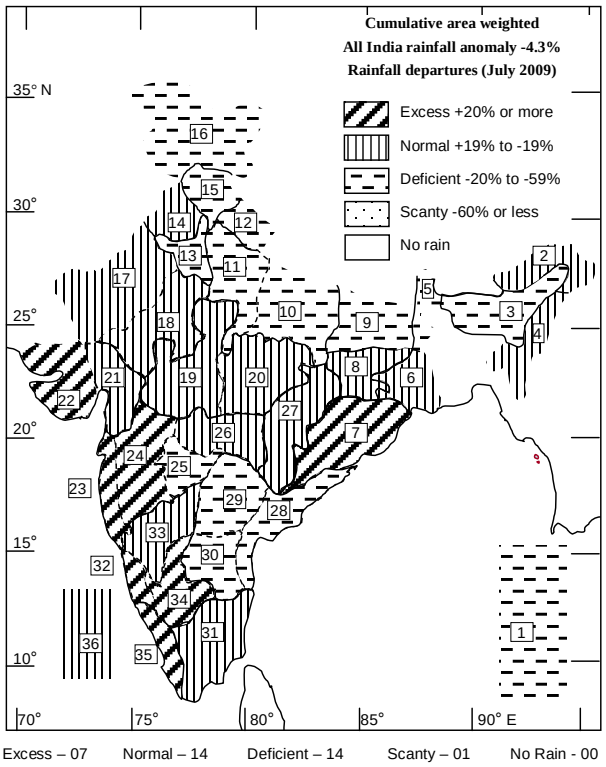


Fig. 4. Sub-divisionwise seasonal rainfall departure from normal (%) for the period (July 2009). 36 Sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	–28	**7**	77	**13**	–54	**19**	5	**25**	–22	**31**	–17
2	–19	**8**	–35	**14**	–12	**20**	–9	**26**	–4	**32**	39
3	–30	**9**	–32	**15**	–46	**21**	12	**27**	9	**33**	–6
4	–15	**10**	–43	**16**	–27	**22**	121	**28**	–39	**34**	43
5	–22	**11**	–54	**17**	–12	**23**	24	**29**	–54	**35**	22
6	–11	**12**	–25	**18**	–8	**24**	28	**30**	–76	**36**	–6

the rainfall over all sub-divisions over the south Peninsula and adjoining central India and a few sub-divisions over the northern parts was *normal*/*excess*. Rainfall over the remaining sub-divisions was *deficient*/*scanty*.

2.4. *Seasonal rainfall distribution*

Meteorological sub-divisionwise seasonal rainfall distribution in terms of percentage departures from normal is given in Fig. 7. The seasonal rainfall was *excess* in 3, *normal* in 11 and *deficient* in the remaining 22 met. sub-divisions. No sub-division reported *scanty* rainfall.

The cumulative rainfall showed large spatial disparity, with most of the sub-divisions to the north of Lat. 20° N falling under the *deficient* category (the other deficient sub-divisions are Saurashtra & Kutch, Orissa and Gangetic West Bengal). The rainfall percentage departures ranged between -43 (west Uttar Pradesh) to +26 (Saurashtra & Kutch and north interior Karnataka).

2.5. *District wise distribution of monsoon rainfall*

Out of the 511 meteorological districts for which data were available, 42% received *excess/normal* rainfall and the remaining 58% received *deficient/scanty* rainfall during the period 1 June - 30 September 2009.

Percentage of districts with *excess/normal* and *deficient/scanty* rainfall for the years 2004-2009 is given in Table 3.

2.6. *Withdrawal of southwest monsoon*

Like last 2 years, this year also there was delay in the initiation of withdrawal of southwest monsoon due to

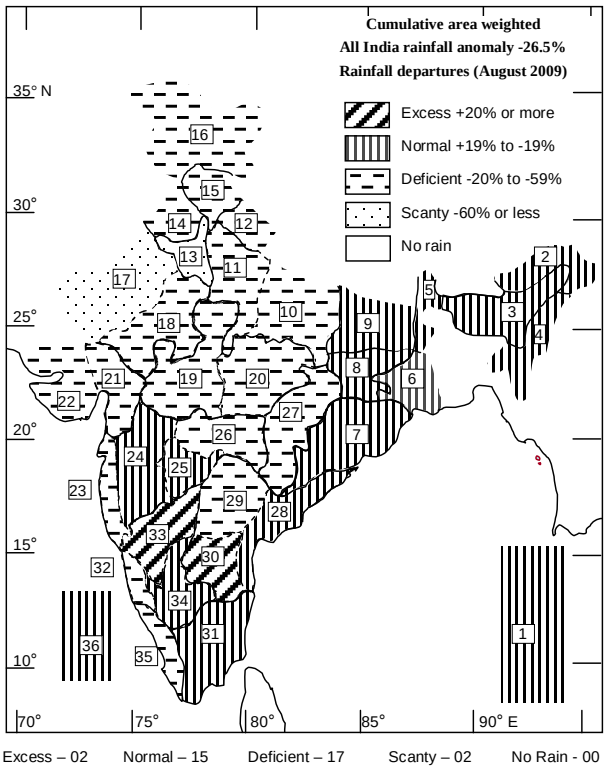


Fig. 5. Sub-divisionwise seasonal rainfall departure from normal (%) for the period (August 2009). 36 Sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	–7	**7**	–18	**13**	–67	**19**	–48	**25**	–14	**31**	7
2	8	**8**	–15	**14**	–51	**20**	–52	**26**	–42	**32**	–35
3	5	**9**	8	**15**	–52	**21**	–53	**27**	–39	**33**	48
4	3	**10**	–31	**16**	–45	**22**	–25	**28**	–7	**34**	–6
5	16	**11**	–35	**17**	–66	**23**	–58	**29**	–24	**35**	–40
6	6	**12**	–26	**18**	–43	**24**	–17	**30**	23	**36**	–13

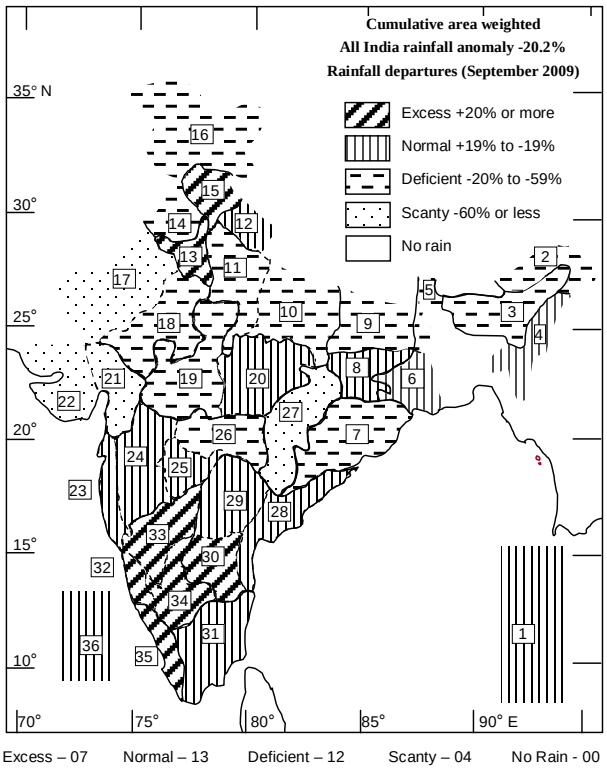


Fig. 6. Sub-divisionwise seasonal rainfall departure from normal (%) for the period (September 2009). 36 Sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	–17	**7**	–33	**13**	78	**19**	–31	**25**	–12	**31**	12
2	–37	**8**	4	**14**	–30	**20**	–10	**26**	–49	**32**	79
3	–47	**9**	–41	**15**	39	**21**	–64	**27**	–64	**33**	54
4	–15	**10**	–27	**16**	–49	**22**	–86	**28**	–16	**34**	82
5	–55	**11**	–21	**17**	–76	**23**	5	**29**	–10	**35**	26
6	9	**12**	–6	**18**	–50	**24**	10	**30**	40	**36**	–12

rainfall activity over north India in association with the mid-latitude westerly activities. The withdrawal of southwest monsoon from west Rajasthan started on 25 September (a delay of more than 3 weeks). The normal date of withdrawal to start from extreme western parts of Rajasthan is 1 September. Subsequently, it withdrew from most parts of the north western states and from the northern parts of Gujarat on 28 September.

It withdrew from most parts of north and central India on 12 October and subsequently from the northeastern states and major parts of peninsular India on 20 October.

It withdrew from the entire country, Bay of Bengal and Arabian Sea on 22 October.

The dates of withdrawal of southwest monsoon are given in Table 4. Fig. 8 gives the isochrones of withdrawal of southwest monsoon.

3. Chief synoptic features of southwest monsoon 2009

The synoptic disturbances which affected the Indian monsoon region in June, July, August and September are given in Tables 5 to 8.

3.1. *Cyclonic storms/depressions*

No Cyclonic Storm formed during the season. Monsoon Depressions were comparatively less in number (considering an average number of 2 per month). Only 4

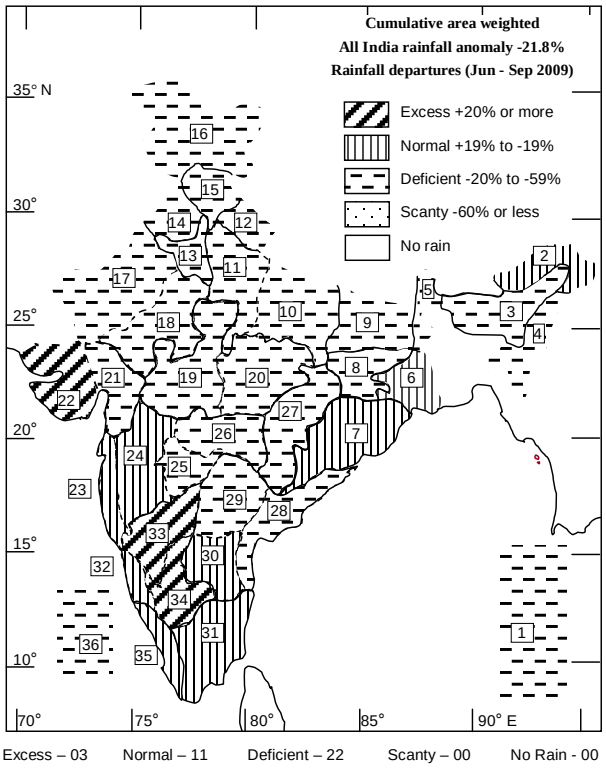


Fig. 7. Sub-divisionwise seasonal rainfall departure from normal (%) for the period (June - September 2009). 36 Sub-divisions are indicated by numbers on the map & bold letters in legend below. The rainfall anomaly values for these sub-divisions are indicated below :

1	–5	**7**	0	**13**	–35	**19**	–27	**25**	–25	**31**	0
2	–18	**8**	–23	**14**	–34	**20**	–33	**26**	–32	**32**	1
3	–30	**9**	–28	**15**	–34	**21**	–34	**27**	–34	**33**	26
4	–20	**10**	–38	**16**	–34	**22**	26	**28**	–25	**34**	25
5	–22	**11**	–43	**17**	–42	**23**	–17	**29**	–35	**35**	–9
6	–15	**12**	–27	**18**	–31	**24**	–2	**30**	2	**36**	1

Depressions formed during the season, 2 over the Bay of Bengal and 2 over the Arabian Sea. No Depression formed during August. No system developed from the remnants of the systems from the South China Sea. The systems followed climatological track, though being shorter. No system from the Bay of Bengal moved to the west of Long. 80° E as a Depression.

The tracks of the systems are shown in Fig. 9. The details are given below:

3.1.1. *Depression over the east central Arabian Sea (23-24 June 2009)*

An upper air cyclonic circulation between 2.1 & 7.6 km a.s.l. lay over the east central Arabian Sea during 19 - 21. Under its influence a low pressure area formed over the east central Arabian Sea and neighbourhood on 22. It concentrated into a Depression and lay centered at 0000 UTC of 23, near Lat. 18.0° N / Long. 71.5° E. Moving in a northerly direction, it lay centered near Lat. 19.0° N / Long. 71.5° E at 0300 UTC and lay off south Gujarat coast, close to Diu, near Lat. 20.5° N / Long. 71.0° E at 1200 UTC of 23. It crossed south Gujarat coast, near Diu, around 1400 UTC of 23 and lay over Saurashtra, about 100 km east of Porbandar (near Lat. 21.5° N / Long. 70.5° E) at 0000 UTC of 24. It weakened into a well marked low pressure area and lay over Saurashtra & Kutch and neighbourhood in the morning of 24.

TABLE 3

Percentage of districts with excess/normal and deficient/scanty rainfall

Year	Excess/Normal	Deficient/Scanty
2004	56	44
2005	72	28
2006	59	41
2007	72	28
2008	76	24
2009	42	58

3.1.2. *Depression over the northeast Arabian Sea (25 -26 June 2009)*

The above well marked low pressure area over Saurashtra & Kutch and neighbourhood lay over the coastal areas of the same region on 25. It emerged into the northeast Arabian Sea and concentrated into a Depression which lay centered at 0900 UTC of 25 near Lat. 22.5° N / Long. 68.5° E (about 50 km west northwest of Dwarka). Remaining practically stationary, it lay centered over the same region at 1200 UTC. It moved northwards during night and lay centered at 1800 UTC of 25, near Lat. 23.0° N / Long. 68.5° E. Subsequently, it weakened and lay as a well marked low pressure area over Kutch and neighbourhood at 0000 UTC of 26. It further weakened into a low pressure area over the same region on 27 morning and became less marked in the evening. However, the associated upper air cyclonic circulation lay between 1.5 & 4.5 km a.s.l. during 28 June - 1 July and became less marked on 2.

3.1.3. *Deep Depression over the northwest Bay of Bengal (20 - 21 July 2009)*

Under the influence of an upper air cyclonic circulation extending up to 7.6 km a.s.l. over the

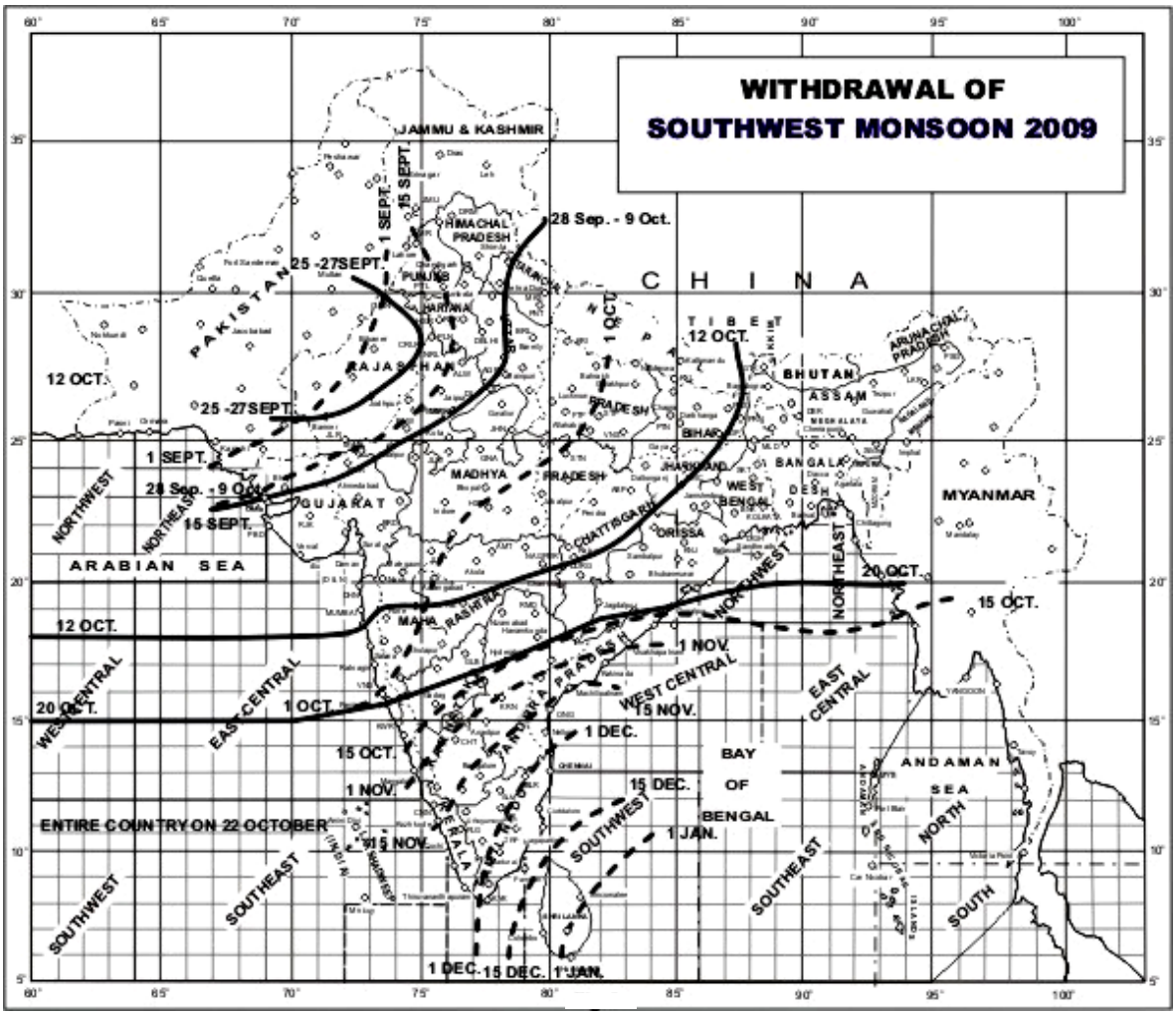


Fig. 8. Isochrones of withdrawal of southwest monsoon 2009

TABLE 4

Withdrawal of Southwest Monsoon – 2009

S. No.	Date	Southwest monsoon withdrew from	Withdrawal line passed through
1.	25th Sep	Most parts of west Rajasthan	Ganganagar, Churu, Jodhpur and Barmer
2.	28th Sep	Entire Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, most parts of Rajasthan, some parts of Uttarakhand, west Uttar Pradesh and north Gujarat	Uttarkashi, Aligarh, Sawai Madhopur, Udaipur and Naliya
3.	12th Oct	Remaining parts of Uttarakhand, Rajasthan, Gujarat state, entire Uttar Pradesh, Madhya Pradesh, most parts of Bihar, north Chattisgarh, some parts of Jharkhand and north Maharashtra State, entire north Arabian sea and some parts of central Arabian sea.	Forbesganj, Ranchi, Raigarh, Yeotmal, Ahmednagar, Alibagh, Lat. 18° N / Long. 70° E, 18° N / Long. 65° E and Lat. 18° N / Long. 60° E
4.	20th Oct	Remaining parts of Bihar, Jharkhand,Maharastra & Goa states, entire west Bengal & Sikkim and north eastern states, most parts of Orissa, Chattisgarh, some parts of north Bay of Bengal, Telangana, north interior Karnataka and some more parts of central Arabian sea	Lat. 20° N / Long. 93° E, Gopalpur, Hyderabad, Panjim, Lat. 15° N / Long. 70° E, Lat. 15° N / Long. 65° E and Lat. 15° N / Long. 60° E
5.	22nd Oct	Remaining parts of south peninsular India, Arabian Sea and Bay of Bengal	Withdrew from the entire country

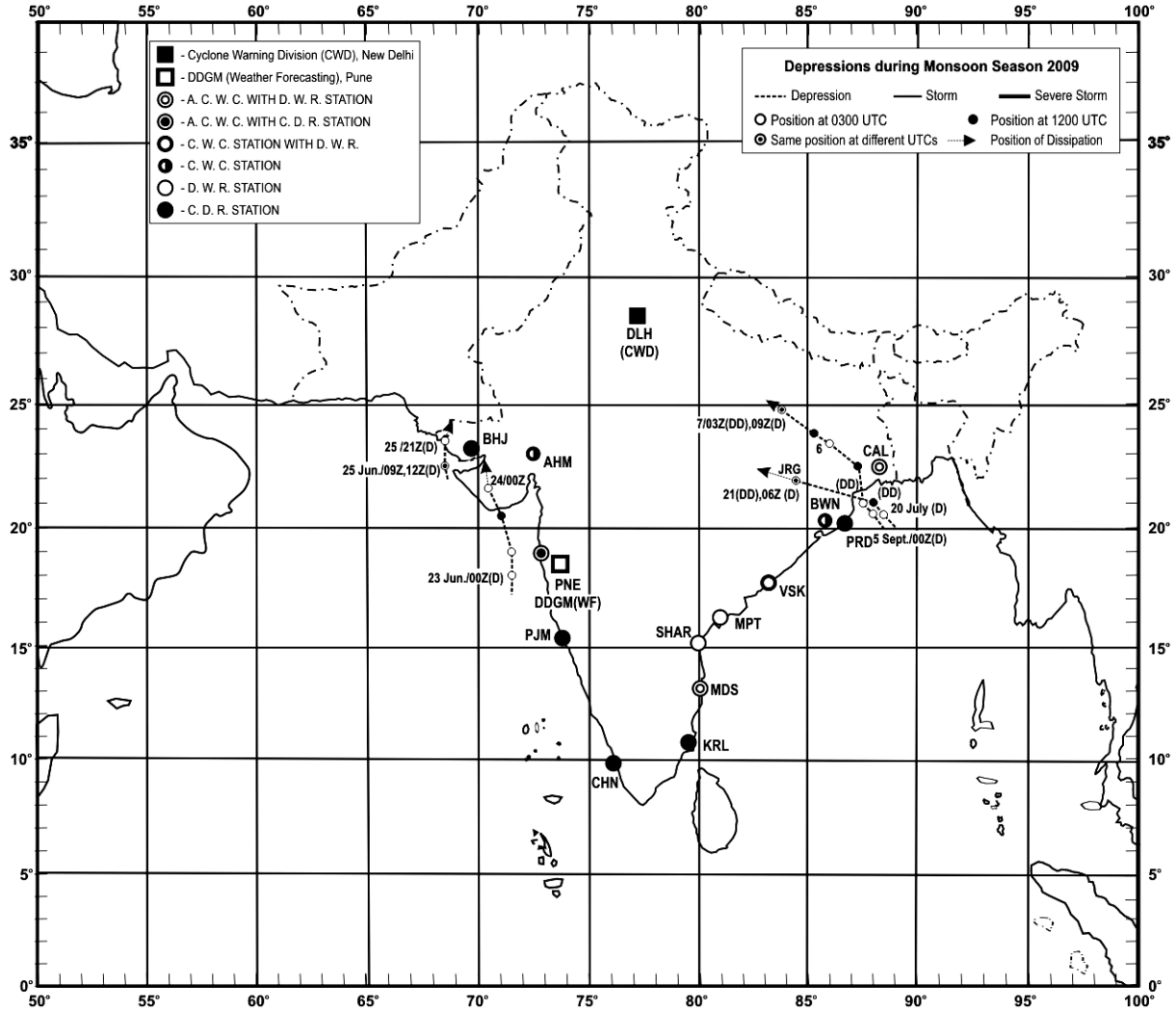


Fig. 9. Tracks of storm and depressions during southwest monsoon 2009

northwest Bay of Bengal off Orissa coast, a low pressure area formed over the northwest Bay of Bengal and adjoining coastal areas of north Orissa and West Bengal on 18 evening. It became well marked over there on 19, subsequently concentrated into a Depression over the northwest Bay of Bengal and lay centered at 0300 UTC of 20, near Lat. 21.0° N / Long. 88.5° E (about 120 km. southeast of Digha). Moving west northwestwards, it intensified into a Deep Depression and lay centered at 1200 UTC of 20, near Lat. 21.0° N / Long. 88.0° E and crossed north Orissa-West Bengal coasts between Balasore & Digha during 1600 - 1700 UTC. Continuing the west northwestward movement, it lay over north Orissa, centered close to Jharsuguda (near Lat. 20.8° N / Long. 84.5° E) at 0300 UTC of 21, remained practically stationary over there and weakened into a Depression by 0600 UTC, further into a well marked low pressure area over north Chattisgarh and neighbourhood by 0900 UTC and persisted over the same region in the evening. It lay over east Madhya Pradesh and neighbourhood on 22 morning and as a low pressure area over west Madhya Pradesh and neighbourhood in the evening. It persisted there on 23 and moved over to northwest Madhya Pradesh and adjoining southeast Rajasthan and merged with the monsoon trough on 24. However, the associated upper air cyclonic circulation extending up to lower tropospheric levels persisted there on 24, lay over west Rajasthan and neighbourhood on 25 and became less marked on 26.

TABLE 5

Details of low pressure systems for the month of June 2009

S. No. (1)	System (2)	Duration (3)	Place of first location (4)	Direction of movement (5)	Final location (6)	Remarks (7)
(**A**)	*Depressions*					
1.	Depression	23-24	Eastcentral Arabian Sea and neighbourhood	North	Saurashtra & Kutch	Details are given in the text
2.	Depression	25-26	North east Arabian sea	North	Kutch & neighbourhood	It formed from the remnants of the above system. Details are given in the text
(**B**)	*Low Pressure Area / Well marked low pressure area*					
1.	Low pressure area	4-7	Northwest Bay of Bengal and neighbourhood	East	Northeast Bay of Bengal and neighbourhood	Formed under the influence of an upper air cyclonic circulation extending up to mid-tropospheric levels over Gangetic West Bengal and neighbourhood. The low pressure area became less marked on 8
(**C**)	*Upper air cyclonic circulations*					
1.	Up to 1.5 km. a.s.l.	10	Chattisgarh and neighbourhood	Stationary	*In situ*	Became less marked on11
2.	Up to 0.9 km. a.s.l.	11-14	East Uttar Pradesh	Do	Do	Became less marked on 15
3.	Up to mid-tropospheric levels	18-21	Northeast Bay of Bengal and neighbourhood	Quasi-stationary	Central parts of Bay of Bengal and neighbourhood	Became less marked on 22
4.	Up to 3.1 km. a.s.l.	24-27	Northwest Bay of Bengal and neighbourhood	West	Gangetic west Bengal and adjoining Orissa	Became less marked on 28
5.	Between 3.1 & 7.6 km a.s.l	23-24	South Andhra Pradesh-north Tamil Nadu coasts	Stationary	*In situ*	Became less marked on 25
6.	Up to 0.9 km. a.s.l.	23-24	East Uttar Pradesh and neighbourhood	Do	Do	Became less marked on 25
7.	Up to lower tropospheric levels	26-29	North Chattisgarh and neighbourhood	West	Vidarbha and neighbourhood	Became less marked on 30
(**D**)	*Eastward moving upper air cyclonic circulations*					
1.	Up to mid-tropospheric levels	3	North Pakistan and neighbourhood	Northeast	Jammu & Kashmir and neighbourhood	Moved away on 4
2.	Do	6-8	North Pakistan and adjoining Jammu & Kashmir	Do	Do	Moved away on 9
3.	Up to 2.1 km. a.s.l.	7-8	Central Pakistan and adjoining northwest Rajasthan	Stationary	*In situ*	Became less marked on 9
4.	Up to 0.9 km a.s.l	10-12	Central Pakistan and neighbourhood	East	Punjab and neighbourhood	Became less marked on 13
5.	Up to mid-tropospheric levels	12-19	Jammu & Kashmir and adjoining North Pakistan	East northeast	Jammu & Kashmir and neighbourhood	Moved away on 20
6.	Do	26-27	North Pakistan and adjoining Jammu & Kashmir	Northeast	Do	Moved away on 28
7.	Do	30 Jun - 1 Jul	Do	Do	Do	Moved away on 2 July

TABLE 5(*Contd*.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**E**)	*Troughs in westerlies*					
1.	Lower levels	2-3	Sub-Himalayan West Bengal & Sikkim to northwest Bay of Bengal	Stationary	*In situ*	Became less marked on 4
2.	Between 3.1 & 5.8 km a.s.l.	14-21	Sub-Himalayan West Bengal & Sikkim to north Bay of Bengal	Oscillatory	Sub-Himalayan West Bengal & Sikkim to east central Bay of Bengal	It was first seen as an upper air cyclonic circulation over north Bay of Bengal and neighbourhood on 13
3.	Mid and upper tropospheric levels	15-17	Along Long. 72° E to the north of Lat. 20° N at 7.6 km a.s.l.	East northeast	Along Long. 74° E	Became less marked on 18
4.	Do	20-21	Along Long 70° E to the north of Lat. 20° N at 9.5 km a.s.l.	Northeast	-	Moved away on 22

3.1.4. *Deep Depression over the northwest Bay of Bengal (5 - 7 September 2009)*

Under the influence of the cyclonic circulation over the west central Bay of Bengal and neighbourhood, a low pressure area formed over the west central and adjoining northwest Bay of Bengal off Orissa coast on 3. It became well marked over the northwest Bay of Bengal off Orissa coast on 4. Subsequently it concentrated into a Depression and lay centered near Lat. 20.5° N / Long. 88.0° E (about 170 km southeast of Balasore) at 0000 UTC of 5. Moving northwestwards, it intensified into a Deep Depression and lay centered at 0300 UTC of 5 near Lat. 21.0° N / Long. 87.5° E (about 70 km southeast of Balasore). Then it moved northwards and crossed West Bengal coast near Digha between 0700 & 0800 UTC of 5 and lay centered at 1200 UTC, over Gangetic West Bengal, near Midnapore (centered at Lat. 22.5° N / Long. 87.3° E). It further moved in a northwesterly direction and lay over Jharkhand, centered: about 100 km north of Jamshedpur (near Lat. 23.5° N / Long. 86.0° E) at 0300 UTC and about 50 km north of Ranchi (near Lat. 23.9° N / Long. 85.3° E) at 1200 UTC of 6. Subsequently, it moved west northwestwards and lay close to Daltonganj in Jharkhand (near Lat. 24.8° N / Long. 83.7° E) at 0300 UTC of 7. It remained practically stationary over there and weakened into a Depression at 0900 UTC of 7. It further weakened into a well marked low pressure area and lay over Jharkhand and neighbourhood at 1200 UTC of 7. It moved over to northeast Madhya Pradesh and neighbourhood on 8 and lay over central parts of Madhya Pradesh and neighbourhood on 9. It lay over north Madhya Pradesh and neighbourhood on 10; over west Uttar Pradesh and neighbourhood as a well marked low pressure area in the morning and as a low pressure area in the evening of 11 and became less marked on 12.

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

Altogether 5 low pressure areas / well marked low pressure areas formed during the season. Most of them originated as upper air cyclonic circulations. Four of them formed over the Bay of Bengal and 1 over the land. Month wise breakup of the systems is 1 in June, 2 in July, 1 in August and 1 in September. The total number of low pressure areas during the past 5 years *viz*., 2004 to 2008 is 8, 6, 7, 6 & 7 respectively.

3.3. *Upper air cyclonic circulations*

There were 31 upper air cyclonic circulations (in lower and middle tropospheric levels) formed during the season.

The month wise break up of these is 7 in June, 5 in July, 8 in August and 11 in September.

3.4. *Off-shore trough*

Off-shore trough along different parts of the west coast persisted from 6 June - 9 September except during 4 June, 9 - 11 June, 18 - 21 August. It was quite feeble on many days during August & September.

TABLE 6

Details of low pressure systems for the month of July 2009

S. No. (1)	System (2)	Duration (3)	Place of first location (4)	Direction of movement (5)	Final location (6)	Remarks (7)
(**A**)	*Depressions*					
1.	Depression	20-21	Northwest Bay of Bengal off Orissa coast	West northwest	North Chattisgarh and neighbourhood	Details are given in the text
(**B**)	*Low pressure areas*					
1.	Low pressure area	6-7	Jharkhand and neighbourhood	Stationary	*In situ*	Merged with the monsoon trough on 8. The associated upper air cyclonic circulation extending up to 3.6 km a.s.l. lay over Chattisgarh and neighbourhood on 8, east Madhya Pradesh and neighbourhood on 9, west Madhya Pradesh and neighbourhood on 10 and became less marked on 11
2.	Well marked low pressure area	13-16	Northwest Bay of Bengal and neighbourhood	West	Chattisgarh and neighbourhood	Formed under the influence of an upper air cyclonic circulation. Caused the revival of monsoon activity. Merged with the monsoon trough on 17
(**C**)	*Upper air cyclonic circulations*					
1.	Between 1.5 & 5.8 km a.s.l.	3-5	Orissa and neighbourhood	Stationary	*In situ*	Merged with the circulation associated with the low pressure area over Jharkhand and neighbourhood on 6
2.	Up to 0.9 km a.s.l.	6-12	South Rajasthan and neighbourhood	Do	Do	Became less marked on 13
3.	Mid-tropospheric levels	10-19	Gujarat state and neighbourhood	Quasi Stationary	Do	Merged with the monsoon trough on 20
4.	Between 1.5 & 5.8 km. a.s.l.	10-11	Northwest Bay of Bengal and adjoining coastal areas of Orissa	Northwest	Jharkhand and neighbourhood	Became less marked on 12
5.	Up to mid-tropospheric levels	25-28	Orissa and neighbourhood	Northeast	Bangla Desh and neighbourhood	Became less marked on 29
(**D**)	*Eastward moving upper air cyclonic circulations*					
1.	Between 1.5 & 4.5 km a.s.l.	2-4	Central Pakistan and adjoining Punjab	Northeast	North Pakistan and adjoining Jammu & Kashmir	Moved away on 5
2.	Up to mid-tropospheric levels	18-20	North Pakistan and neighbourhood	Do	Jammu & Kashmir and neighbourhood	Moved away on 21
3.	Do	22-24	North Pakistan and adjoining Jammu & Kashmir	Do	Do	Moved away on 25
4.	Do	25-27	Do	Do	Do	Moved away on 28
5.	Do	27-31	North Pakistan and neighbourhood	Do	Do	Moved away on 1 August
6.	Do	30 Jul - 1 Aug	Central Pakistan and neighbourhood	Do	Do	Moved away on 2 August
(**E**)	*Troughs*					
1.	Lower levels	1-2	Sub-Himalayan West Bengal and Sikkim to North west Bay of Bengal	Quasi Stationary	Sub-Himalayan West Bengal and Sikkim to North Orissa	Became less marked on 3

TABLE 7

Details of low pressure systems for the month of August 2009

S. No. (1)	Systems (2)	Duration (3)	Place of first location (4)	Direction of movement (5)	Final Location (6)	Remarks (7)
(**A**)	*Low pressure areas*					
1.	Low pressure area	25-29	Northwest Bay of Bengal and adjoining coastal Orissa	West	Northwest Madhya Pradesh and neighbourhood	Formed under the influence of an upper air cyclonic circulation. Low pressure area became less marked on 30. The associated upper air cyclonic circulation further moved westwards up to Saurashtra & Kutch and became less marked on 1 September
(**B**)	*Upper air cyclonic circulations*					
1.	Up to mid-tropospheric levels	2-3	Northwest Bay of Bengal and neighbourhood	Stationary	*In situ*	Became less marked on 4
2.	Between 3.1 & 5.8 km a.s.l.	5-20	West Madhya Pradesh and neighbourhood	West	Saurashtra & Kutch and neighbourhood	Less marked on 21. (It had persisted over Gujarat region and neighbourhood during 9-20)
3.	Up to mid-tropospheric levels	6-20	Gangetic west Bengal and neighbourhood	Initially northeast and then northwest	Uttarakhand and neighbourhood	Became less marked on 21
4.	Do	14-16	Orissa and neighbourhood	West northwest	North Chattisgarh and neighbourhood	Became less marked on 17
5.	Up to lower tropospheric levels	17-18	Southwest Bay of Bengal off south Andhra-north Tamil Nadu coasts	Quasi Stationary	*In situ*	Became less marked on 19
6.	Between 3.1 & 5.8 km a.s.l.	17-22	Maldives-Comorin areas	West	Lakshadweep area and adjoining southeast Arabian Sea	Became less marked on 23
7.	Between 2.1 & 5.8 km a.s.l.	18-19	Konkan & Goa and neighbourhood	Stationary	*In situ*	Became less marked on 20
8.	Between 3.6 & 5.8 km a.s.l.	22-25	South Madhya Maharashtra and adjoining north Interior Karnataka	Quasi Stationary	*In situ*	Became less marked on 26
(**C**)	*Eastward moving upper air cyclonic circulations*					
1.	Up to mid-tropospheric levels	7-10	North Pakistan and neighbourhood	Northeast	Jammu & Kashmir and neighbourhood	Moved away on 11
2.	Do	10-13	Do	Do	Do	Moved away on 14
3.	Do	12-14	Do	Do	Do	Moved away on 15
4.	Do	15-18	North Pakistan and adjoining Jammu & Kashmir	Do	Do	Moved away on 19
5.	Do	16-25	North Pakistan and neighbourhood	Do	Do	Moved away on 26
6.	Do	31 Aug - 5 Sep	North Pakistan and adjoining Jammu & Kashmir	Do	Do	Moved away on 6 Sep
(**D**)	*Troughs*					
1.	At 0.9 km a.s.l.	21-22	Sub-Himalayan west Bengal & Sikkim to north Bay of Bengal	Stationary	*In situ*	Became less marked on 23

TABLE 8

Details of low pressure systems for the month of September 2009

S. No.	Systems	Duration	Place of first location	Direction of movement	Final Location	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(**A**)	*Depressions*					
1.	Deep Depression	5-7	Northwest Bay of Bengal off Orissa coast	Northwest and then west northwest	Jharkhand and neighbourhood	Details are given in the text
(**B**)	*Low pressure areas*					
1.	Well marked low pressure area	28 Sep - 3 Oct	West central Bay of Bengal and neighbourhood	West northwest	Vidarbha and neighbourhood	Formed under the influence of an upper air cyclonic circulation
(**C**)	*Upper air cyclonic circulations*					
1.	Up to lower tropospheric levels	1-4	East Uttar Pradesh and neighbourhood	Stationary	*In situ*	Became less marked on 5
2.	Up to mid-tropospheric levels	8-10	Northwest Bay of Bengal and neighbourhood	Northwest	Jharkhand and neighbourhood	Became less marked on 11
3.	Between 1.5 & 5.8 km. a.s.l.	3-4	Telangana and neighbourhood	Northwest	North Maharashtra and neighbourhood	Became less marked on 5
4.	Up to lower tropospheric levels	12-13	Do	Stationary	*In situ*	Became less marked on 14
5.	Between 1.5 & 3.6 km. a.s.l.	16-21	Coastal Tamil Nadu and neighbourhood	North	Southwest Bay of Bengal off Tamil Nadu coast	Became less marked on 22
6.	Between 2.1 & 5.8 km. a.s.l.	16-20	Coastal Orissa and neighbourhood	Northwest	Interior Orissa and adjoining north Chattisgarh	Became less marked on 21
7.	Do	13-14	West Uttar Pradesh and neighbourhood	East	East Uttar Pradesh and neighbourhood	Became less marked on 15
8.	Between 1.5 & 5.8 km. a.s.l.	17-19	Southeast Bay of Bengal and neighbourhood	Stationary	*In situ*	Became less marked on 20
9.	Between 1.5 & 3.6 km. a.s.l.	21-26	Interior Andhra Pradesh	West	East central Arabian sea off Karnataka coast	Became less marked on 27
10.	Up to lower tropospheric levels	19-22	Punjab and neighbourhood	Stationary	*In situ*	Became less marked on 23
11.	Do	24-25	Bihar and neighbourhood	Do	Do	Became less marked on 26
(**D**)	*Eastward moving upper air cyclonic circulations*					
1.	Up to mid-tropospheric levels	1-4	Punjab and adjoining northwest Rajasthan	Northeast	Punjab and neighbourhood	Became less marked on 5
2.	Do	6-12	North Pakistan and adjoining Jammu & Kashmir	Do	Jammu & Kashmir and neighbourhood	Moved away on 13
3.	Do	13-17	North Pakistan and neighbourhood	Do	Do	Moved away on 18
4.	Do	21-22	Do	Do	Do	Moved away on 23
5.	Do	22-25	Do	Do	Do	Moved away on 26
6.	Do	26-27	Do	Do	Do	Moved away on 28
7.	Do	28-30	Do	Do	Do	Moved away on 1 Oct
(**E**)	*Troughs*					
1.	Mid & upper tropospheric levels	4-5	Along Long. 75° E to the north of Lat. 25° N (at 5.8 km a.s.l.)	East northeast	Along Long. 82° E to the north of Lat. 25° N.	Moved away on 6
2.	Do	10-14	Along Long. 68° E to the north of Lat. 20° N (at 7.6 km a.s.l.)	Northeast	Along Long. 78° E to the north of Lat. 25° N	Moved away on 15
3.	Lower levels	17-24	Assam & Meghalaya to coastal Orissa	Oscillatory	Bihar to coastal Karnataka	Became less marked on 25

TABLE 9(a)

Positions of off-Shore trough during the monsoon period 2009

Date	Location
3 Jun	Karnataka – Kerala coasts
5 Jun	South Konkan & Goa to Karnataka coasts
6 - 7 Jun	South Konkan & Goa to Kerala coasts
8 Jun	South Konkan & Goa to Kerala coasts
12 - 21 Jun	Karnataka coast to Lakshadweep area
22 Jun	East central Arabian sea to Lakshadweep area
23 – 24 Jun	South Gujarat coast to Lakshadweep area
25 - 26 Jun	Centre of the well marked low pressure area over coastal Saurashtra & Kutch to Kerala coast
27 Jun	Centre of the low pressure area over Kutch & neighbourhood to Kerala coast
28 Jun - 1 Jul	North Maharashtra to Kerala coasts
2 - 12 Jul	South Gujarat to Kerala coasts
13 - 14 Jul	Maharashtra to Kerala coasts
15 Jul	South Gujarat to Kerala coasts
16 -17 Jul	South Gujarat coast to Lakshadweep area
18 – 20 Jul	South Gujarat to Kerala coasts
21 – 25 Jul	South Gujarat to Karnataka coasts
26 – 28 Jul	Maharashtra to Karnataka coasts
29 Jul – 1 Aug	Maharashtra coast to Lakshadweep area
2 – 6 Aug	Maharashtra to Kerala coasts (feeble during 4-6)
7 Aug	Maharashtra to Karnataka coasts (feeble)
8 – 9 Aug	Maharashtra coast to Lakshadweep area (feeble)
10 – 12 Aug	Maharashtra to Kerala coasts (feeble)
22 Aug	Goa coast to Lakshadweep area (feeble)
23 Aug	Goa to Kerala coasts (feeble)
24 Aug – 9 Sep	South Maharashtra to Kerala coasts (feeble during 24 August – 2 September & 8 – 9 September

TABLE 9(b)

Details of off-shore trough for the years 2004-2009

Year	Details of off – shore trough
2009	Observed along different parts of west coast from 6 June - 9 September except during 4 June, 9 - 11 June, 18 - 21 August. Was quite feeble on many days during August & September.
2008	Observed from 30 May to 17 September, except during 4 - 5 June & 18 August - 5 September. Even though present throughout the month of July, it was quite feeble during the period 13 - 24 July.
2007	Present along various parts of the west coast from 28 May to 30 September except during 4 - 7 June, 10 - 11 June and 10 - 13 September. It was feeble during many days in June and a few days during the rest of the months.
2006	Extended along different parts of the west coast from 27 May to 25 September except during 19 - 20 June, 30 - 31 August and 3 - 11 September. Had been quite feeble in June except during the first week but active in July & August.
2005	Off–shore trough observed between 5 June to 24 September except during 7 & 10 August, 22 August - 5 September, 8 - 9 September & 20 - 22 September.
2004	Off-shore trough along different parts of west coast (surface and lower levels) upto 16 September from 19 May except 27 May - 3 June, 8 - 11 June, 23 - 24 June and 29 August - 7 September.

TABLE 10

Mid and upper tropospheric westerly troughs

Atmospheric level	Jun	Jul	Aug	Sep	Total
300 hPa	04	00	00	00	4
500 hPa	08	00	00	00	8

The details of the positions of the off-shore trough are given in Table 9 (a) and that for the years 2004 to 2009 are given in Table 9(b).

3.5. *Eastward moving cyclonic circulations/Western Disturbances*

There were 25 eastward moving systems as upper air cyclonic circulations. The month wise break-up is 7 in June, 5 in July, 6 in August and 7 in September.

4. Extra Indian features

4.1. *Cross Equatorial Flow*

4.1.1. *Over the Arabian Sea*

The Cross Equatorial flow along the equatorial belt (equator to 5° N / 5° S) was stronger than normal by about 5-10 kts, during the first week of June and first week of July. It was below normal by about 5 kts during second week of June. Except these, the cross equatorial flow along the equatorial belt was close to the normal during the entire monsoon period, June - September 2009.

The surface winds over Arabian Sea to the north of 5° N were stronger than normal by 5-10 kts during all four weeks of July and second week of September 2009. They were stronger than normal by about 10-15 kts during first week of September. During the remaining part of the season they were almost normal.

4.1.2. *Over the Bay of Bengal*

The Cross Equatorial flow along the equatorial belt (equator to 5° N / 5° S) over Bay of Bengal was stronger than normal by 5-10 kts during first and second week of June, first and third week of July, first week of August and second week of September 2009. The cross equatorial flow was almost normal for the remaining period during the season.

The surface winds over the Bay of Bengal to the north of 5° N were stronger than normal by about 5-10 kts during first week of June, second and third week of July, second week of August and second and fourth weeks of September. Except these they were almost normal for the remaining period during the season.

TABLE 11

Systems in west Pacific Ocean/south China Sea

Low Pressure Systems	Jun	Jul	Aug	Sep	Total
Tropical Depression (T.D.)	00	01	00	01	**02**
Tropical Storm (T.S.)	01	02	03	03	**09**
Typhoon	01	00	02	04	**07**
Total	**02**	**03**	**05**	**08**	**18**

4.2. *Mid-Latitude troughs*

The number of troughs in westerlies affecting Indian region which penetrated south of 30° N is given in Table 10.

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

There were in all 18 low pressure systems (reaching the intensity of Tropical depression and above) in the northwest Pacific Ocean/south China Sea during June - September 2009. The month wise break-up is given in Table 11.

4.4. *Systems in southern hemisphere*

4.4.1. *Tropical storms/ depressions*

No low pressure system (Tropical Depression, Tropical Storm or Typhoon) was reported in the Southern Hemisphere during June- September 2009.

4.4.2. *Mid and upper tropospheric westerly troughs over the south Indian Ocean*

There were 17 troughs in upper air westerlies which moved across the Indian Ocean from west to east, to the north of Lat. 30° S in the Southern Hemisphere. The month wise break-up is 5 in June, 4 each in July, August & September.

4.4.3. *Mascarene HIGH*

Though the intensity of Mascarene HIGH centered at 30° S / 60° E remained near normal or slightly above normal all through the season, it was located southeast of its normal position in June, at near normal position with westward extension in July, southeast of normal with eastward extension in August and September, as has been

TABLE 12

SST anomaly indices (ENSO)

Month	Pacific SSTA (in °C)			SOI
	Nino 1+2 0° - 10° S 90° - 80° W 150° W	Nino 3 5° N - 5° S 150° - 90° W	Nino 4 5° N - 5° S 160° E	
Oct 2008	-0.2	-0.1	-0.1	1.3
Nov 2008	-0.2	-0.2	-0.3	1.5
Dec 2008	-0.2	-0.6	-0.7	1.5
Jan 2009	-0.2	-0.6	-0.7	1.2
Feb 2009	-0.1	-0.6	-0.7	1.8
Mar 2009	-0.1	-0.6	-0.3	-0.1
Apr 2009	0.5	0.0	0.0	0.7
May 2009	0.6	0.4	0.2	-0.4
Jun 2009	0.7	0.7	0.6	-0.3
Jul 2009	0.9	1.0	0.6	0.1
Aug 2009	0.8	1.0	0.8	-0.7
Sep 2009	0.3	0.8	0.8	0.3

noted from the NCEP Re-analysis data. The African Meteorological Bulletins also were in conformity with these observations *(Figures not re-produced here).*

4.5. *ENSO Phenomenon*

The phase and magnitude of ENSO can be indicated either by the sea surface temperature anomalies over the Pacific or by Southern Oscillation Index (SOI) expressed as the difference in the atmospheric surface pressure between Tahiti, an island station in the Southeast Pacific ocean and Darwin, Australia. In general, during some years an inverse relationship between ENSO and Indian summer monsoon rainfall has been observed; though there is no one-to-one correspondence between these two.

Table 12 depicts the monthly values of sea surface temperature anomaly indices for Nino 4, Nino 3 and Nino 1+2 regions and SOI for the period from October 2008 to September 2009. The NINO 1+2 index was marginally negative from October 2008 to March 2009 and then warming was noticed till July 2009 and slight cooling in September 2009. NINO 3 region remained cool from October 2008 to March 2009 and steadily warmed up till August 2009. NINO 4 showed steady cooling till Feb 2009, and then showed warming till August 2009.

SOI was 1.8 in Feb 2009, 1.5 in November and December 2008, 1.3 in October 2009 and 1.2 in January 2009.

4.6. *The Indian Ocean Dipole event (IOD) and EQUINOO characteristics during southwest monsoon 2009*

In addition to ENSO, the inter-annual variation of the Indian Summer Monsoon Rainfall (ISMR) is linked to the Equatorial Indian Ocean Oscillation (EQUINOO) also. (Gadgil *et al*., 2004). Gadgil *et al*., 2003 & 2004 showed that each drought (flood) during 1958 – 2003 was associated with unfavourable phases of both the modes. For example, the severe drought of 2002 was associated with negative phases of ENSO & EQUINOO. For June 2009 also, ENSO & EQUINOO were both unfavourable, but the magnitudes of the indices were not as large as in 2002 (Gadgil and Francis 2009).

Hence, in order to account for the large rainfall deficiency experienced in June 2009, they (the authors referred to above) propose the role of yet another additional unfavourable factor. It is suggested that the unfavourable SST gradient between the Bay of Bengal and the Equatorial East Indian Ocean (EEIO) led to

TABLE 13

Details of lowest isobaric values (hPa) of the heat low during past 5 years

Month	Year				
	2004	2005	2006	2007	2008
June	990.0(17^{th})	988.0(26^{th})	988 (26)	988.3 hPa (on 15)	991 (on 27)
July	992.0(7^{th})	988 (1^{st} & 2^{nd})	988 (1^{st} & 2^{nd})	990 hPa (on 5)	989 (on 28)
August	991.0(2^{nd})	990.0 (1^{st} & 2^{nd})	990 (1^{st} & 2^{nd})	992 hPa (on 8 & 10)	993 (on 9)
September	998.0(9^{th} & 10^{th})	996.0(1^{st})	996 (1^{st})	997 hPa (on 14 & 19)	997 (on 2)

suppression of convection over the Bay of Bengal. Similar feature was observed in June 1995, when the all India deficit for the month had been -24%.

References : Gadgil, S., Vinayachandran, P.N. and Francis, P.A., 2003, *Current Science*, **85**, 1713-1719.

Gadgil, S., Vinayachandran, P.N., Francis, P.A. and Gadgil, S., 2004, *Geophys. Res. Lett*., **31**, L12213.

Gadgil, S and Francis, P. A., 2009, *Current Science*, **97**, 9, 10 November 2009.

5. Semi-permanent systems

5.1. *Heat low*

The Heat low appeared over Pakistan and neighbouring areas during the second fortnight of May itself. However, it was not demarcated at sea level during the first half of June. Subsequently, it got established in its near normal position from 16 June. Thereafter, it was present at sea level, though diffused on many days, especially so during August and in the first week of July. It was quite diffused in September and became less marked from 11 September.

The lowest and the second lowest pressure values of the heat low were:

June : 991 hPa (on 27) and 993 hPa (on 28)

July : 989 hPa (on 28) and 991 hPa (on 7, 12, 14 & 28)

Aug : 993 hPa (on 9) and 995 hPa (on 1, 4 & 16)

Sept : 997 hPa (on 2) and 999 hPa (on 3)

Details of the lowest observed isobaric values of the Heat Low during past five years are given in Table 13.

5.2. *Axis of the monsoon trough*

The heat trough along the Gangetic plains appeared well in advance. It was present at sea level from 16 – 21 May. It re-appeared at 0.9 km a.s.l with the formation of the low pressure area over the west central Bay of Bengal on 23 May and was present all through the life cycle of the Severe Cyclonic Storm (Aila) until it's weakening over the Sub-Himalayan West Bengal & Sikkim on 26 May. The east-west trough at 0.9 km a.s.l was once again present during 28 May - 1 June, 4 - 6 June, on 25 June and then from 1 July. When it re-appeared on 1 July, after the weakening of the low pressure system over the northeast Arabian sea and adjoining Saurashtra & Kutch, a branch of it extended eastwards to northeast India.

With the southwest monsoon covering the entire country on 3 July, the axis of monsoon trough got established in its near normal position. Though it remained in the near normal position, its vertical extension was limited up to the lower tropospheric levels and southward tilt was practically absent during the period 3-16 July.

In association with the genesis of a Deep Depression over the Bay of Bengal, it was seen up to mid-tropospheric levels with a slight southward tilt with height during 17 - 22 July. Subsequently it started shifting northwards and western end remained close to the foothills of the Himalayas on 25 & 26 and thereafter the entire trough on 30 & 31 July. During most of the days in August, the monsoon trough remained north of its normal position, with the western end close to the foothills on a few days. Also, its vertical extension was limited and extended in the lower tropospheric levels on only a few days during August. Thereafter it remained in the normal or to the south of its normal position up to 12 September. Subsequent to the northward movement and weakening of a low pressure area over Uttar Pradesh, the trough shifted towards the foothills of the Himalayas during 13-19

TABLE 14

Upper air observations of TEJ

Station	Period	Maximum core wind speed (Kts)	Level (hPa)	Date/Time
Thiruvananthapuram	25 May – 28 Sep	125	150	26 July/1200 UTC
Chennai	25 May – 17 Sep	105	128 & 136	24 July / 1200 UTC & 25 July / 1200 UTC
Minicoy	26 May – 30 Sep	110	113	2 July / 1200 UTC
Port Blair	25 May – 20 Sep	110	121	30 June / 1200 UTC
Mumbai	30 Jun – 16 Aug	85	141	16 Aug / 0000 UTC

TABLE 15

Zonal wind anomalies 2009

	Week ending																	
	3/6	10/6	17/6	24/6	1/7	8/7	15/7	22/7	29/7	5/8	12/8	19/8	26/8	2/9	9/9	16/9	23/9	30/9
									TRV									
850	1.3	3.9	-5.0	-5.8	-5.0	7.4	5.8	5.2	-6.1	-4.5	-4.2	-10.5	-9.0	2.1	5.5	-3.3	-5.4	3.1
500	15.3	9.0	-8.7	-10.2	-2.9	2.7	4.9	0.5	5.1	4.2	-2.1	-16.7	-3.5	-1.1	7.8	-4.8	-2.5	10.8
200	-4.4	-3.0	10.3	12.9	8.1	-3.94	-0.6	-7.0	-18.1	-4.1	-2.1	8.6	6.3	-3.3	-3.6	-6.8	-6.4	-18.7
									MDS									
850	-1.9	7.0	-8.4	-8.2	-3.1	12.2	8.6	12.3	3.9	-0.7	-5.6	-12.4	-4.0	6.4	15.9	-9.1	-8.7	8.1
500	10.5	13.8	-4.7	2.7	-12.9	4.9	10.8	12.6	-0.21	-1.2	-1.9	-19.2	3.5	-0.8	12.6	-2.5	-8.6	11.2
200	-0.1	1.9	32.5	7.7	-8.1	-1.8	16.1	1.1	-11.3	-11.8	-18.7	-9.9	1.1	-3.7	1.9	-4.1	-10.5	-5.1
									BMB									
850	5.2	6.1	-3.3	-12.3	-4.2	-6.1	0.0	8.7	8.4	-4.2	-5.7	-5.7	-8.9	-1.4	-1.9	-4.1	-5.8	2.2
500	-2.7	0.1	1.4	-3.4	-6.0	-7.3	13.3	6.13	2.0	1.5	-8.8	-8.9	-4.3	-0.9	-3.0	11.2	-4.3	-10.6
200	-2.7	1.7	18.5	17.7	-16.5	6.2	-0.77	12.8	-0.3	-2.5	-3.3	-12.6	13.5	1.2	5.8	12.3	-2.2	0.3
									NGP									
850	15.0	5.9	2.0	-12.4	-2.3	-7.9	4.7	11.5	11.6	6.3	-4.9	-2.8	-5.1	-5.4	4.5	6.7	-1.3	-3.7
500	-1.9	4.5	11.1	-18.5	0.1	2.6	-1.8	3.8	14.3	3.7	-5.9	2.8	-6.3	-7.3	6.6	16.9	0.9	-13.2
200	-13.5	-1.8	2.9	0.8	-6.4	5.0	-11.1	-0.7	-12.1	-12.1	-10.6	-17.6	7.9	0.7	8.5	6.6	-5.4	-0.2

Note : 1. Easterly anomalies (–ve) at 850 hPa means that westerlies are weaker than normal.
2. Westerly anomalies (+ve) at 200 hPa means that easterlies are weaker than normal.

September. Subsequently it shifted back to the normal position and was seen up to 23 September.

For ready comparison, a brief data on monsoon trough in the past five years are given below:

Year	*Axis of Monsoon Trough*
2004	Established on 18 July. Less marked on 22 September.
2005	Established on 30 June. Less marked on 2 September.
2006	Established on 24 July. Less marked on 14 September.
2007	Established on 4 July. Less marked on 23 September.
2008	Established on 10 July. Less marked on 29 September.

5.3. *Tibetan Anticyclone/High*

The Tibetan Anticyclone (TA) was established in its near normal position at 300 & 200 hPa on 22 June. It was noticed up to 20 September. It remained to the northeast of its normal position on many days during August & September.

Year	*Tibetan Anticyclone*
2004	Established on 13 June. Not seen at 500 hPa during June & first half of July. Less marked on 18 September.
2005	Established on 26 June. Remained more or less at normal position in June, slightly to the south in August and north of its normal position till 27 September.
2006	Established on 7 June. Not seen at 500 and 300 hPa on most of the days during June and July. Less marked from 10 September onwards.
2007	Established on 26 June. Less marked from 15 September onwards.
2008	Established on 22 June. It was noticed up to 20 September

5.4. *Sub-Tropical Westerly Jet (STWJ)*

STWJ was seen over Srinagar and Guwahati latitudes up to 3 July. It re-appeared over Srinagar on 19 August.

The days during which the Sub-tropical Westerly Jet was observed in the past five years are given below:

Year	*Sub-Tropical Westerly Jet (STWJ)*
2004	Seen over Srinagar upto 23 June, over Ranchi until 20 June and reappeared in the first week of October.
2005	Seen over Srinagar upto 22 June, over many stations like Delhi, Lucknow, Srinagar and Lucknow during second half of July and August and over Delhi, Srinagar & Lucknow on 15, 23 and 30 September respectively.
2006	Seen over Srinagar and Delhi Latitudes upto 11 June, shifted northwards thereafter and made casual re–appearances. It was seen over Delhi and Srinagar from 29 September.
2007	Seen over Srinagar and Ranchi Latitudes upto 27 June, it re-appeared over Srinagar on 3 October and over Delhi on 7 October.
2008	STWJ was seen over Delhi and Guwahati latitudes upto 10 June. It re-appeared over Delhi on 10 September.

5.5. *Tropical Easterly Jet (TEJ)*

TEJ got established over the southern tip of Peninsular India by 25 May. The southern stations *viz*., Thiruvananthapuram, Chennai, Minicoy and Port Blair reported easterlies of 75, 65, 80 and 70 kts respectively around 100 hPa levels on 25 May. The wide latitudinal spread of the easterly jet speed winds was noticed during 25 June - 19 August. A core wind speed of 125 kts was noted over Thiruvananthapuram on 26 July. The upper air observations shown in Table 14 reveal the characteristics of the jet stream.

TABLE 16

Representative rainfall amounts (>7 cm) during June – September 2009

Date (1)	June (2)	July (3)	August (4)	September (5)
1.	Joshipur 9, Bangalore 8, Amini Divi 7	Cherrapunji 43, Vadakara 27, Quilandy 19, Kannur & Kozhikode 15 each, Williamnagar 14, Irikkur 13, Shillong 12, Mellabazar, Baliguda, Channa Kallar, Thalasserry & Hosdurg 11 each, Aluva, CIAL Kochi, Chalakudy, Sonamura & Sabroom 10 each, Rajgangpur, Sukinda, Lakkireddipalli & Karipur 9 each, Mathanguri, Mulki, Seetharamapuram, Haripad, Thodupuzha, Kanjirappally & Mannarkad 8 each, Goalpara, Jai Bharali, Nayagarh, Cherthala, Kottayam, Vaikom, Kumarakkom, Kozha, Perinthalmanna, Uluberia, Ambala, Bhatinda, Gondia & Nagpur 7 each	Agumbe 25, Neora 12, Siddapura 11, Belthangady 10, Murti, Cooch Behar, Karkala & Enamackel 9 each, Gheropara, Pattambi & Vellanikkara 8 each, Arambagh, Joypur, Puttur, Subramanya, Bhagamandala, Cherthala, Kumarakom, Thrissur & Cuddalore 7 each	Eluru 19, Gharmura 13, Kurugodu Alland 11, Sabroom, Gohar, Mulki & Holalgunda 10 each, Dharampur, Sirugappa, Patna, Kanekkal & Pathikonda 9 each, Sundernagar, Kasauli, Patiala, Subramanya, Sindhanur, Dummagudem & Verlatapuram 8 each, Nahan, Kasol, Dharamsala, Sujanpur Tira, Kandaghat, Halwara, Panambur, Kota, Udupi, Kundapura, Talikote, Agumbe, Nahan, Kahu, Hanamkonda, Luxettipet & Alur 7 each
2.	Cherrapunji & Jai Bharali NT Xing 9 each, Bhalukpong 7	Cherrapunji 30, Agumbe 18, Honavar 17, Williamnagar & Panjim 16 each, Siddapura, Vadakara & Ratnagiri 15 each, Mohitnagar & Karwar 14 each, Bhalukpong & Bhatkal 13 each, Hasimara, Shillong & Gerusoppa 11 each, Jalpaiguri, Bangiriposhi, Bolangir, Bijepur & Datia 10 each, Domohani, Bajpe, Dharmasthala, Taliparamba, Quilandy, Hirakur, Padampur & Mangalore 9 each, Basar, Ankola, Thalasserry, Irikkur, Kozhikode, Baliguda & Jagdalpur 8 each, Mathabhanga, NH 31 Bridge, Garubathan, Murti, D.P. Ghat, Mathanguri, Mulki, Mani, Shirali, Kannur, Perinthalmanna, Gudari, Sambalpur, Sonepur, Kantamal, Paikmal, Khairamal, Ambabhona, Telkoi, Cuttack & Betul 7 each	Champasari 9, Raiganj & Subramanya 8 each	Agumbe 15, Matheran 14, Alland 12, Siddapura 11, Honavar 10, Kumta & Honavar 9 each, Dharma-sthala, Subramanya, Kundapura & Kozhikode 8 each, Bhatkal, Gerusoppa, Karkala, Hissar, Kunigal, Aluva, Karipur & Hanamkonda 7 each
3.	Murti 14	Sevoke 33, Gerusoppa 29, Ratnagiri 26, Cherrapunji 25, Gaganbavada 24, Honavar 22, Garubathan & Kollur 20 each, Linganamakki 18, Hosanagara & Agumbe 17 each, Ankola 16, Siddapura, Kottigehara, Mhasla & Tala 15 each, Shirali, Karwar & Murud 14 each, Champasari, Humchadakatte & Vadakara 13 each, Lava, Sabroom, Vadakkancherry, Mandangad & Marmugoa 12 each, Manmothnagar, Kalimpong, Hasimara, Basar, Sargur, Talguppa, Bhira, Radhanagari, Mahabaleshwar & Chittorgarh 11 each, Baghdogra, Karkala, Kunnamkulam & Harnai 10 each, Salbari, Kundapura, Banavasi, Quilandy, Karipur, Kosagumda, Paikmal, Deogaon, Hindol & Alibag 9 each, Bhatkala, Bhagamandala, Tyagarthi, Thirthahalli, Sorab, Piravom, Kozhikode, Ottapalam, Alathur, Pattambi & Kota 8 each, Rampurhat, Alipurduar, Bajpe, Sringeri, Mudigere, Jayapura, Chengannur, Munnar, Irikkur, Manjeri,	Asansol 21, Lakhipur 14, Maya Bandar 13, Hatwara & Dharmanagar Amraghat 9 each, Port Blair Manas NH Xing 8, Jhargram & Sandila 7 each	Barabandi 19, Lucknow & Daman 14 each, Jalgaon 13, Dahanu 10, Safipur & Shevgaon 9 each, Gunnaur, Channa Kallar, Erandol & Ratlam 8 each, Jalaun, Shirali, Bidar, Baijnath, Jogindernagar, Dharamsala, Patti, Umbergaon, Malvan, Arnod, Chotisadri, Gwalior, Bulsar, Nanded & Shirali 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
		Perinthalmanna, Angadippuram, Chittur, Thrithala, Enamackel, Vellanikkara, Amini Divi, Jharsuguda, Kakatpur, Gop, Turekela, Bolangir, Nawapara, Dhenkanal, Rairangpur, Athgarh, Gudari & Mangalore 7 each		
4.	-	Dahanu 25, Cherrapunji 19, Daman & Ratnagiri 18 each, Gerusoppa, Vengurla, Dabolim & Gaganbavada 17 each, Kottigehara 16, Garubathan 15, Hasimara, Agumbe, Kota, Shirali & Panjim 14 each, Kollur, Kundapura, Bhatkal & Vadakara 13 each, Mudibidre, Mulki & Mani 12 each, Honavar, Manchikere, Siddapura & Bulsar 11 each, Majbat, Yellapura, Panambur, Dharmashtala & Udupi 10 each, Basar, Bajpe, Sambre, Linganamakki, Lakkavalli, Talguppa, Hosdurg, Kudulu, Binika & Dohad 9 each, Puttur, Sringeri, Jayapura, Umargaon, Hatwara, Gajoldoba, Pallahara & Harnai 8 each, Kansabati Dam, Kanksa, Ankola, Karwar, Kunnamkulam, Rengali, Mhasla & Tala 7 each	Kharagpur & Paradip 9 each, Bashirahat & Agumbe 8 each, Burdwan, Bankura & Ludhiana 7 each	Umbergaon 24, Murud 23, Mumbai 19, Alibag 17, Bhinga, Guhagar & Lanja 15 each, Dapoli, Ratnagiri & Harnai 14 each, Shrivardhan & Dahanu 13 each, Udupi, Chiplun, Malvan & Marmugoa 12 each, Panambur, Bajpe, Mhasala & Dabholim (Goa) 11 each, Bahraich, Kota, Karkala, Gerusoppa, Baijnath, Dabolim & Rajapur 10 each, Kakerdharighat, Sahajahanpur, Shirali, Nainadevi, Mehra Barsar, Khed, Vengurla, Gaganbavada, Mahabaleshwar, Gwalior & Surat 9 each, Fatehgarh, Mohmadi, Bhogaon, Nawarangpur, Mani, Puttur, Honavar, Bhagamandala & Shahuwadi 8 each, Bhinga, Baghpat, Dadupur, Channa Kallar, Naduvattam, Poladpur, Mandangad, Radhanagari, Sriniketan, Bulsar & Honavar 7 each
5.	Maya Bandar 15, Long Islands 11, Ponneri 10, Naharkatia 9, Hut Bay & Indapur 8 each, Agumbe 7	Mumbai 24, Agumbe & Vadakara 19 each, Bhagamandala 18, Kundapura & Gerusoppa 17 each, Jalpaiguri, Mohitnagar & Panjim 15 each, Kollur & Mudibidre 14 each, Hasimara, Hosanagara & Gorakhpur 13 each, Chengmari, Diana, Mulki, Shirali & Irikkur 12 each, Damohani, Garubathan, Puttur, Belthangadi, Bhatkal & Kosdurg 11 each, Alipurduar, NH 31 Bridge, Bajpe, Ankola, Bantwal, Siddapura, Kudulu & Mangalore 10 each, Nagrakata, Barobhisa, Honavar, Subramanya, Tekkali & Baghdogra 9 each, Sevoke, Karwar, Kumta, Balehonnur, Ponampet, Mudigere, Taliparamba, Mananthavady, Vythiri & Jharsuguda 8 each, Cherrapunji, Mangalore, Talguppa, Humchadakatte, Anavatti, Kannur, Thalasserry, Quilandy, Ambalavayal, Bhawanipatna & Jharsuguda 7 each	Nagarkata & Beki Road Bridge 11 each, Neora, Bhalukpong, Silchar & Dillighat 10 each, Tangla 9, Agumbe 8, Rampurhat, Chouldhowaghat, Lakhipur & Karimganj 7 each	Bhatkal & Gaganbavada 21 each, Agumbe, Sringeri & Guhagar 20 each, Haidergarh 19, Nanipalsan 18, Shirali & Channa Kallar 17 each, Kollur & Ratnagiri 14 each, Siddapura & Rajapur 13 each, Ambabhona, Karkala, Gerusoppa, Hosanagara, Alibag & Surgana 12 each, Tikabali, Binika, Thirthahalli, Kottigehara, Valparai & Lanja 11 each, Thakurdwara, Honavar, Bhagamandala, Devgad, Moradabad & Banswara 10 each, Faizabad, Rath, Junagarh, Puttur, Humchadakotte, Naduvattam, Devala, Pent & Shirpur 9 each, Nagina, Moradabad, Bargarh, Soro, Belthangady, Kumta, Sirsi, Harnai, Dapoli, Roha, Malvan, Erandol, Chopda, Amalner, Soegaon, Gangapur, Betul, Jablapur, Dharampur & Karipur 8 each, Kotdwar, Chandbali, Phulbani, Puri, Baliguda, Rajkanika, Daringibadi, Siddapura, Mani, Dharmasthala, Ankola, Kankavli, Bhira, Sawantwadi, Kudal, Chiplun, Akkalkuva, Parola, Sindkhed, Pachora, Georai, Aurangabad & Kozhikode 7 each
6.	Bhatkal 20, Thalasserry 18, Vadakara & Shirali 17 each, Kannur, Taliparamba & Vyathiri 16 each, Quilandy 15,	Bhatkal & Agumbe 18 each, Kottigehara 17. Deogarh 16, Kalasa & Irikkur 15 each, Bhagamandala, Hosanagara & Kumta 14 each, Shirali, Ankola &	Nainital 11, Mandi & Sundernagar 10 each, Kotdwar 9, Chouldhowaghat & Jalpaiguri 8 each, Khonsa 7	Bhatkal 22, Berhampore 21, Khalapur 19, Nawana 18, Midnapore 17, Kalaikunda 16, Cherrapunji & Thane 15 each,

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
	Panambur, Bajpe & Siddapura, 14 each, Irikkur 13, Alapuzha, Hosdurg & Karkala 12 each, Mancompu, Kozhikode, Nilambur, Chalakudy, Kollur, Honavar, Karwar & Bantwal 11 each, Irinjalakuda, Agathi, Kavarathi & Canacona 10 each, Mavelikara, Haripad, Kumarakkom, Mulki, Kota, Gerusoppa, Bhagamandala, Mavelikara, Haripad, Kumarakkom & Valpoi 9 each, Agumbe, Cherthala, Kudulu, Kanjirappally, Thiruvalla, Thrissur & Vellanikkara 8 each, Puttur, Belthangady, Kundapura, Champasari, Chengannur, Piravom, Peermade, Alathur, Pattambi, Thrithala, Konni, Vadakkan-cherry, Kunnamkulam & Mananthavady 7 each	Athgarh 13 each, Honavar, Bantwal, Siddapura, Sargur & Kammardi 12 each, Alipurduar, Gajoldoba, Mudibidre, Mani, Linganamakki, Thirthahalli, Mudigere, Taliparamba & Tikabali 11 each, Karwar, Belthangadi, Mangalore, Medikeri, Virajpet, Munnar, Gorakhpur & Dabholim 10 each, Mulki, Bajpe, Dharmasthala, Puttur, Kundapura, Humchadakatte, Mandira Dam, Amraoti & Mangalore 9 each, NH 31 Bridge, Kota, Napoklu, Koppa, Peermade, Kudulu, Paradip, Titlagarh & Pattamundai 8 each, Alipurduar, Khowang, Subramanya, Balehonnur, Jayapura, Talaguppa, Tyagarthi, Idukki, Hosdurg, Vadakkancherry, Kunnamkulam, Vythiri, Amini Divi, Kosagumda & Khajuraho 7 each		Channa Kallar & Diamond Harbour 14 each, Durgachack, Chaibasa & Belapur (Thane) 13 each, Agumbe & Krishnanagar 12 each, Shirpur 11, Kammardi, Jaipur, Soro, Nilgiri, Gerusoppa, Khed, Bagathi, Canning Town & Jamshedpur 10 each, AIE NH Xing, Balasore, Bhagamandala, Napoklu, Sringeri, Karjat, Panvel & Bhira 9 each, Rairangpur, Gobindpur, Valaparai, Matheran, Panjim, Bashirhat, Kolkata, Gangapur & Shegaon 8 each, Manas NH Xing, Salempur, Tiring, Jamsolaghat, Tensa, Udala, Titlagarh, Khairamal, Dharmasthala, Shirali, Honavar, Somwarpet, Kottigehara, Naduvattam, Bankura, Digha & Aurangabad 7 each
7.	Bhatkal 22, Agumbe & Panjim 20 each, Vengurla 19, Kota 18, Karwar, Kundapura, Devgad, Ratnagiri & Valpoi 17 each, Sawabtwadu 14, Siddapura & Malvan 13 each, Linganamakki, Londa, Cherthala, Vadakara, Kudal, Dabolim & Belgaum 12 each, Kollur, Honavar, Siddapura & Haripad 11 each, Karkala, Shirali, Gerusoppa, Taliparamba & Irinjalakuda 10 each, Haliyal, Yellapura, Subramanya, Sringeri, Sabroom, Chinnakallar, Kochi, Kumarakom, Enamackel, Vythiri & Kankavli 9 each, Dholai, Silchar, Gokak, Kottigehara, Sringeri, Vaikom, Idukki, Kottayam, Chiplun & Gargoti 8 each, Mulki, Dharmasthala, Bantwal, Udupi, Soundatti, Bhagamandala, Jayapura, Kammardi, Mancompu, Kannur, Irikkur, Kozha, Kozhikode, Konni, Chalakudy & Kuppady 7 each	Harnai 22, Manmothnagar 18, Belthangady & Siddapura 15 each, Bhagamandala 14, Linganamakki, Hosanagara, Mangalore, Kollur & Gerusoppa 13 each, Siddapura, Mudibidre, Bantwal, Dharmasthala, Puttur & Vythiri 12 each, Mulki, Bajpe, Man, Subramanya & Mangalore 11 each, Kumta, Agumbe & Athagarh 10 each, Humchadakatte, Talguppa, Cuttack, Binika, Telkoi & Ratnagiri 9 each, Bhatkal, Sirsi, Medikeri, Thirthahalli, Sorab, Alipingal, Bargarh, Dungarapalli, Bijepur & Ambabhona 8 each, Bhalukpong, Karkala, Karwar, Manchikere, Tyagarthi, Arasalu, Mudigere, Kammardi, Sagara, Mahabaleshwar & Panjim 7 each	Nainital 21, Banbasa & Amraghat 9 each, Kotdwad 8, Agartala, Dehra Dun, Motihari & Mandi 7 each	Gaya 17, Bankura 14, Pipli & Ranchi 13 each, Channa Kallar & Daltonganj 11 each, Dehri 8
8.	Neamatighat 14, Chinnakallar 12, Munnar 11, Enamackel & Gulbarga 10 each, Perumbavur, Thrissur, Vellanikkara & Vikarabad 9 each, Kozha 8, Valparai, Lakhipur, Dholai, Panambur, Bajpe, Aluva, CIAL Cochi & Parambikulam 7 each	Siddapura 21, Radhanagari 17, Kollur 15, Kundapura 14, Honavar & Daman 12 each, Mulki, Dharmasthala, Tezu, Rairangpur & Ratnagiri 11 each, Panambur, Kota, Karwar, Tangla, Datia, Baroda & Mahabaleshwar 10 each, Maya Bandar, Gerusoppa, Manchikere, Yellapura, Hemgiri, Vengurla & Gaganbavada 9 each, Bajpe, Mani, Jamsolaghat, Bijepur, Majbat, Halol, Nanipalsan & Mangalore 8 each, Karkala, Linganamakki, Agumbe, Humchadakatte, Kalasa, Bodhan, Barmul, Patnagarh, Jharsuguda, Bargaon, Deogaon, Vapi & Mumbai 7 each	Dehra Dun 11, Banbasa 10, Munsiyari & Dillighat 9 each, Kailashahar & Deoprayag 8 each	Umaria 16, Soro 14, Meza 12, Mirzapur & Nilgiri 9 each, Narora & Dehri 8 each, Sambhal, Munsiyari, Rewa & Sidhi 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
9.	Nagrakata 11, Chengmari & Enamackel 7 each	Vengurla 25, Radhanagari 24, Kankavli 19, Sawantwadi 18, Rajapur 15, Malvan 14, Devgad 13, Honavar, Kudal & Gargoti 12 each, Shriwardhan, Guhagarh, Valpoi, Chiplun, Lanja, Karwar & Agumbe 11 each, Harnai & Gaganbavada 10 each, Vadakara, Ottappalam, Parambikulam, Poladpur, Dabolim, Chandgad & Mauda 9 each, Munnar, Thalasserry, Quilandy, Perinthalmanna, Ratnagiri & Mangalore 8 each, Bheemgal, Nilambur, Mannarkad, Thrithala, Vadakkancherry, Panjim, Khed, Shahabad, Mahabaleshwar, Ajra, Tierra, North Lakhimpur, Ujjain, Tikamgarh & Shirali 7 each	Lakhipur & Bashirahat 9 each, Panposh & Maya Bandar 7 each	Narsinghpur 29, Parched 26, Pachmarhi 23, Jabalpur 21, Soro 17. Berhampore 13, Kolkata 12, Purala, Manmothnagar, Krishnanagar, Khirpali & Sagar 11 each, Balasore, Bagati & Dhaniakhali 10 each, Barrackpur, Uluberia, Katwa, Bashirhat, Canning Town & Balagarh 9 each, Kalpi, Cuttack, Balimundali, Bonth, Mundali & Narayanpur 8 each, Tehri, Munsiyari, Barkote, Dunda, Uttarkashi, Jajpur, Naraj, Daitari, Jubbal, Rajgarh, Nahan, Kotkhai, Arambagh, Burdwan & Nanded 7 each
10.	Mohanbari, Tadong & Dibrugarh 7 each	Vythiri & Radhanagari 22 each, Kankavali 15, Agumbe & Surat 14 each, Kudal, Chandgad & Mauda 13 each, Ajra, 12, Malvan 11, Sawantwadi, Patti, Pratapgarh & Medikeri 10 each, Devgad, Gagan-bavada & Ramtek 9 each, Darjeeling, Singlebazar, Kunda, Luxettipet, Armoor, Vadakara, Chiplun, Lanja & Seoni 8 each, Bankura, Lava, Alathur, Ambalavayal, Rajapur, Murud, Valpoi, Matheran, Panvel, Bhira, Bhiwandi, Vengurla, Murbad, Gadhinglaj, Gargoti, Ahmedabad, Deesa & New Kandla 7 each	Binika 10, Dunguripalli, Patnagarh Balrampur & Zamania 9 each, Nawarangpur & Bargarh 8 each, Gazipur & Bashirahat 7 each	Pachmarhi 19, Ambala & Gohar 13 each, Sonepat & Nainital 12 each, Ayanagar, Chandigarh, Jubbal, Banjar & Bijnore 11 each, Dharampur, Kasauli, Solan, Nagina & Nazibabad 10 each, New Delhi, Gunnaur, Naina, Devi, Kumarsain, Kandaghat & Mukteshwar 9 each, Rohru, Malvan, Mawana & Khajuraho 8 each, Ateli, Karsog, Kotkhai, Sunnibhajji, Shimla, Rampur Bushar, Arki, Sundernagar, Hamirpur, Mehre Sarsar, Patiala, Bagpatchata, Moradabad, Devband & Damoh 7 each
11.	Long Island 11, Bangalore & North Lakhimpur 9 each, Mathanguri 8, Basar, Chouldhowaghat, Gunpur, Srinivasapura, Korategere, Chinna Kallar & Goalpara 7 each	Radhanagari & Agumbe 11 each, Mahabaleshwar 10, Lanja 9, Khed 8, Mandangad, Mahad & Shriwardhan 7 each	Mundali 16, Naraj 10, Bhubaneshwar, Namsai & Karhad 7 each	Alland 29, Nuh 28, Tazawala 23, Gohana, Pataudi & Kanpur 21 each, Jind 20, Barikhas & Baheri 19 each, Kanpur 18, Jagadhari, Safidon, Sohana, Rewari & Naraingarh 17 each, Rohtak & Indiri 16 each, Dadupur & Farukhanagar 15 each, Sonipat & Gunnaur 14 each, Kandaghat, Parched & Karsog 13 each, Dharampur, Solan, Tangla & Karnal 12 each, New Delhi, Kotkhai, Jubbal, Renuka, Paonta, Bareilly & Damoh 11 each, Rajgarh, Nahan, Shimla, Kasauli, Gaganbavada, Bindki, Malihabad, Nakuran, Saharanpur & Ambala 10 each, Rohru, Elginbridge, Lucknow, Bagpath & Sagar 9 each, Sunnibhajji, Chillaghat, Fatehpur, Hasanganj, Hamirpur, Veeragattam & Dehra Dun 8 each, Gazipur, Hissar, Hanumansetu, Hardwar, Chandigarh, Bharatpur & Srungavarapukota 7 each
12.	Beki Road Bridge 13, Mathanguri 11, Mavelikara 10, Manas NH Xing & Long Island 9 each, Cherrapunji, Gowribidanur & Dharmapuri 8 each, Silchar, Tezpur,	Kharidwar, Karjat, Kalyan & Radhanagari 7 each	Diana 17, Jabalpur 16, Sagar 14, Cherrapunji 13, Neora 12, north Lakhimpur, Ulberia & Bhagamandala 10 each, Chouldhowaghat, Diamond Harbour, Hanumansetu &	Paliakalan & Shahjahanpur 16 each, Bisalpur & Julana 14 each, Banbasa & Bhiwani 13 each, Dhaurrahara, Nighasan, Pawayan & Nainital 12 each, Barikhas, Rajgarh, Kheri Lakhimpur,

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
	Bagalkote, Harur, Mancompu & Maya Bandar 7 each		Dibrugarh 9 each, Hasinara, Dhenkanal, Sukinda & Chittorgarh 8 each, Khowang 7	Bhatpurwaghat, Pantnagar, Bareilly & Kallakkurichchi 11 each, Solan, Mohamadi, Neemsar & Nagina 10 each, Husenganj & Solan 9 each, Rohtak, Jind, Samalkha, Nilokheri, Kandaghat, Dharampur, Hanumansetu, Puranpur, Pilibheet, Mukteshwar & Dehra Dun 8 each, Farukhnagar, Ambala, Naraingarh, Chandigarh, Sampla, Safidon, Banjar, Kasauli, Gohar, Sunnibhajji, Nahan Bhira, Bahraich, Katernighat, Sardanagar & Chilamattur 7 each
13.	Karimganj 12, Gingee 11	Dataganj 15, Machilisahar 12, Sambalpur & Agumbe 10 each, Baheri, Bhubaneswar, Bareilly & Naliya 9 each, Bisali, Puri & Nowgong 8 each, Maya Bandar, Palliakalan, Bareilly, Hamirpur, Amroha, Moradabad, Radhanagari, Cuttack & Surat 7 each	Chouldhowaghat 27 & Gosaigaon 25 each, Cooch Behar 21, Alipurduar 20, Mathabhanga & Cherrapunji 18 each, Barobhisa & Kokrajhar 17 each, Bhalukpong 13, AIE NH Xing, Neamatighat, Daporijo, Mohanbari & Dibrugarh 10 each, Tadong, Sibsagar, Manas NH Xing & Panbari 9 each, Gangtok, Itanagar, Beki Road Bridge, North Lakhimpur, Williamnagar, Jorhat & Akbarpur 8 each, Sevok, Baghdogra, Salbari, Dhakiajuli, Bharwain, Mangalapuram, Maduranthagam, Bikapur & Hoshangabad 7 each	-
14.	Karimganj 13, Bhalukpong 10, Dhubri, Ketty & Sethiyathope Anicut 8 each, Jia Bharali & Alangayam 7 each	Raipur 28, Radhanagari 23, Karjat & Bhira 17 each, Mahabaleshwar 16, Matheran & Mumbai 15 each, Panvel 13, Poladpur & Sudhagad 12 each, Kollengode, Khalapur, Pen, Champa & Bhavanipatna 11 each, Chandgad 10, Mahrauni & Alibag 9 each, Luxettipet, Parvathipuram, Vadakara, Quilandy, Vythirai, Murbad, Thane, Valpoi, Paud, Gondia & Bundi 8 each, Kunavaram, Taliparamba, Irikkur, Perinthalmanna, Ottappalam, Alathur, Chittur, Pattambhi, Uran & Amgaon 7 each	Anoopshar 11, Tusuma 13, Kokrajhar & Tirukkattupalli Uttarkashi 12 each, Tantloi, Thanjavur, Lalgudi, Banbasa & Pachmarhi 11 each, Joypur, Bhalukpong 10, Barobhisa, Cherrapunji & Samayapuram 9 each, Kansabati Dam, Kaliachar, Manas NH Xing, Tiraiyur & Thirupathur 8 each, Mathabhanga, Majbat, Pullambadi, Grand Anicut & Jharsuguda 7 each	Kudligi 21, Siddlaghatta 17. Penukonda 14, Bellary 13 Turuvekere 12, Kalakata & Chikaballapur 11 each, C. N. Halli 10, Arasikere, Hosakote, Tiptur & Pavagada 9 each, Channapatna 8, Shrivardhan, Ahmednagar, Ongole, Kuppam, Mysore, Periyapatna, Hesaraghatta & K. Paramathy 7 each
15.	Long Island 11, Basar 8, Panjim 7	Mahabaleshwar 41, Bhira 33, Matheran 31, Karjat & Kurkheda 30 each, Radhanagari 29, Mumbai 27, Mahad 25, Sudhagad, Poladpur, Panvel & Kalyan 23 each, Vyathiri, Roha & Paud 20 each, Dahanu & Khalapur 19 each, Mandangad 18, Murbad & Bhiwandi 17 each, Lava, Vada & Chandgad 16 each, Thane, Jawhar, Vadgaon Maval, Ajra, Gondia, Lakhandur & Katol 15 each, Mangaon, Mhasla, Deori, Nagbhir, Tirora & Medikeri 13 each, Luxettipet, Uran, Pen, Murud, Valpoi, Patan, Arjuni Morgaon, Bramhapuri, Mauda & Agumbe 12 each, Khed, Chiplun, Satara, Bhor, Shahuwadi, Kamptee, Amgaon & Pune, (Pashan) 11 each, Shahapur,	Cherrapunji 38, Williamnagar 27, Garotha 21, Baheri 16, Tozhudur, Poondi & Zamaniya 15 each, Hamirpur & Arogyavaram 14 each, Bangarpet 13, Solangiri, Vridhachalam & Deoband 12 each, Tirumangalam, Talli, Fatehgarh, Kanpur, Rath & Nainital 11 each, Bharwain 10, Bangalore, Melalathur, Pochampalli, Lalgunj, Karvi, Dhanpur, Kalpi, Hardwar & Tirupathi 9 each, Sibsagar, Naraingarh, Rayalpur, Omalur, Babaoru, Chillaghat, Banda & Amla 8 each,	Shrivardhan 11, Bapatla 10, Dharchula & Kalwakurthi 9 each, Malshiras & Siddapura 8 each, Khed, Sathenapalli, Mulki, Gerusoppa & Pune (Pashan) 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
		Dabolim, Dapoli, Gaganbavada, Panhala, Wai, Perseoni, Armori, Bhawanipatna, Veraval & Dabolim 10 each, Gargoti, Hingna, Mohadi, Gadchiroli, Tumsar, Nagpur & Ahmedabad 9 each, Sukiapokhri, Garubathan, Peermade, Nilambur, Alibag, Kankavli, Narkheda, Kalmeshwar, Gopalpur & Puri 8 each, Kalimpong, Deoband, Ambala-vayal, Sawantwadi, Karad, Khed, Ghodegaon, Jafferabad, Dhanora, Saoner, Ramtek, Sakoli, Chandbali, Bhubaneswar, Jagdalpur & Mangalore 7 each	Imphal, Hodal, Cherthala, Chengam, Barur, Rayakottah, Harur, Tirupattur, Krishnanagiri, Fatehpur, Hardoi, Shahganj, Uttarkashi, Chandbali & CIAL Kochi 7 each	
16.	AIE NH Xing 12, Ketty 9, Vengurla 8, Cherrapunji, Kokrajhar, Beki Road Bridge, Manas NH Xing, Dhubri, Tikarpara, Paralakhemundi, Panjim, Ranebennur & Yelburga 7 each	Mangrol 61, Veraval 50, Porbandar & Dahanu 44 each, Malia 42, Sutrapada & Kottigehara 32 each, Bhagamandala 31, Medikeri 27, Poonampet & Agumbe 26 each, Vyathiri 25, Humchadakatte & Jayapura 24 each, Binika 22, Vanthali, Bhantwad & Virajpet 21 each, Umbergaon & Parambikulam 20 each, Lalpur, Keshod, Dhoraji, Subramanya & Mananthavady 19 each, Ambabhona & Mahabaleshwar 18 each, Karkala & Balehonnur 17 each, Bulsar, Kalyanpur & Munnar 16 each, Baoudhgarh, Kodinar, Puttur & Linganamakki 15 each, Devban, Madhuban, Daman, Junagadh, Dharmasthala, Ambalavayal, Kuppady & Roorkee 14 each, Talcher, Vapi, Jamnagar, Joida, Lilia, Siddapura, Talaguppa, N. R, Pura & Kannur 13 each, Bonth, Rajkishorenagar, Sundergarh, Silvasa, Dhari, Kota, Somwarpet, Tyagarthi, Kammardi & Nilambur 12 each, Angul, Sihor, Maia Miyane, Yellapura, Jaglbet & Madapura 11 each, Ranawav, Mudibidre & Mani 10 each, Anand, Surat, Amreli, Talala, Kundapura, Gerusoppa, Shirali, Bhadravathi, Peermade, Idukki & Irikkur 9 each, Naharkatia, Broach, Vagra, Gandevi, Ranpur, Dhandhuka, Kadi, Jafrabad, Jetpur Mani, Bajpe, Bhira & Mangalore 8 each, Itanagar, Deogaon, Sonepur, Kantamal, Daitari, Sukinda, Becharaji, Bhiloda, Detroj, Savarkundla, Kutlana, Gondal, Bagsra, Upleta, Manavadar, Honavar, Hungund, Taliparamba, Mannarkad, Bhopal, Narsinghpur, Jabalpur & Seoni 7 each	Garubathan 24, Cherrapunji & Williamnagar 23 each, Tezu 20, Kalimpong 16, Nagina 15, Lava 14, Nagarkata & Dhanupur 13 each, Hasimara, Sevoke, Chenganari & Diana 12 each, Jalpaiguri, Khanitar, Awayia & Nandigama 11 each, Neora, Baheri & Auraiya 10 each, Mekhliganj, Sukiapokhri, Murti, Darjeeling & Bhogaon 9 each, NH 31 Bridge, Darjeeling, Barobhisa, Khonsa, Namsai, Dhakiajuli, Kokrajhar, Bharwain, Khalilabad, Ayodhya, Harrora & Bareilly 8 each, Diamond Harbour, Damohani, Gajoldoba, Tadong, Champasari, Passighat, Itanagar, AIE NH Xing, Margherita, Chillaghat, Harayia, Gunnaor, Etah, Hamirpur, Amroha & Mathura 7 each	Bangarpet & Cherrapunji 8 each, Shirur, Kundagol, Vellore & Dharmapuri 7 each
17.	Dharmasthala 15, Kumta & Almatti 8 each, Shirali 7	Vadakara 31, Kozhikode 28, Humchadakatte 26, Kottigehara 25, Pattambi 24, Quilandy 23, Vadakkancherry, Vythiri 22, Perinthalmanna, Angadippuram, Karipur, Thrithala 21, Ottappalam 20, Navsari 19, Parambikulam 18, Olpad, Kodinar each, Manjeri 17, Jalalpur, Surat, Subramanya & Mahabaleshwar 15 each, Bardoli, Sutrapada, Alathur, Kollengode & Vellanikkara 14 each, Kollur, Kannur, Thrissur & Enamackel 13 each, Belthangadi, Sulya, Thalasserry & Kunnamkulam 12 each, Palsana, Bajpe,	Cherrapunji & Fatehgarh 23 each, Dhubri 22, Kollengode & Sravanabelagola 18 each, Manas NH Xing, Williamnagar & Bisauli 16 each, Goalpara, Barpeta, Dinhata, H. B. Halli & Badaun 15 each, Kokrajhar & AIE NH Xing 14 each, Gosaigaon, Bhagamandala, Mettur Dam & Hamirpur 13 each, Cooch Behar, Koppa & Amla 12 each, Barobhisa, Beki Road Bridge,	Namsai, Chengamari & Diana 13 each, Murti & Bijanbari 8 each, Tezpur, Mathanguri, Sagardighi & Kuknoor 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
		Khanapura, Medikeri, Jayapura, Koppa, Munnar, Taliparamba, Hosdurg, Kudulu, Chittur & Mangalore 11 each, Gandevi, Songadh, Vapi, Siddapura, Sringeri, Mudigere, Kammardi & Mananthavady 10 each, Mahuwa, Dharmasthala, Madapura, Piravom, Peermade, Irikkur, Nilambur, Irinjalakuda, Ambalavayal, Kuppady & Bhira 9 each, Kamrej, Shirali, Sirsi, Napoklu, Sakaleshpura, Idukki & Mannarkad 8 each, Sagar, Jamsolaghat, Ukai, Mandvi, Vyara, Veraval, Bachau, Mani, Gerusoppa, Jagalbet, Virajpet, Talaguppa & Kayamkulam 7 each	Samayapuram, Paliakalan, Bansi, Sahaswan, Anoopshar, Bilari, Mukteshwar & Nainital 11 each, Mathungari, Panbari, Kollegal, Davengere, K. R. Pet, Thrissur, Vellanikkara, Vadipatti, Baheri & Purnea 10 each, Chanchal, NH 31 Bridge, Malda, Shirhatti, Mysore, Dindigul, Moradabad & Banbasa 9 each, Mahinagar, Panambur, Bajpe, Yelburga, Bangalore, Lalgudi, Balarampur, Bilaspur, Pithoragarh & Bangalore 8 each, Mekhliganj, Islampur, Passighat, Shillong, Dadupur, Aghar, Subramanya, Koppal, C. R. Patna, Chamarajanagar, T. Narasipura, Vadakkan-cherry, Irinjalakuda, Ulundurpet, Salem, Manama-thurai, Bhavani, Papasam, Natham, Tirukkattupalli, Kumbha-konam, Kasganj, Gunnaor, Aligadh, Amroha & Bahraich 7 each	
18.	Hut Bay 16, Shivani & Enamackel 9 each, Alland & Agathi 8 each	Lalpur 53, Parambikulam 29, Agumbe & Vadakara 27 each, Subramanya 25, Irinjalakuda 23, Talala 22, Karkala, Ranawav & Irikkur 21 each, Porbandar & Chalakudy 19 each, Kannur 18, Bhanwad & Karipur 17 each, CIAL Kochi 16, Taliparamba, Kollam, Kozhikode, Thrissur, Enamackel, Taliparamba, Kollam, Kozhikode, Thrissur & Enamackel 15 each, Malia, Mundra, Mudibidre, Dharmasthala, Puttur, Sringeri, Kottigehara, Cherthala & Perumbavur 14 each, Rajkot & Vellanikkara 13 each, Meghraj, Gerusoppa, Poonampet, Linganamakki, Vaikom, Quilandy, Vythiri & Kuppady 12 each, Mehsana, Sidhpur, Bhiloda, Medikeri, Kammardi, Aluva, Piravom, Peermade, Kottayam, Kumarakom, Perinthalmanna, Angadippuram, Mannarkad, Kunnamkulam & Mananthavady 11 each, Jalalpur, Junagarh, Mani, Virajpet, Jayapura, Mancompu, Idukki, Hosdurg, Kudulu, Vadakkancherry, Ambalavayal & Mahabaleshwar 10 each, Maya Bandar, Idar, Navsari, Udupi, Siddapura, Madapura, Somwarpet, Talaguppa, Alapuzha, Kayamkulam, Mavelikara, Thodupuzha, Kozha, Manjeri & Varkala 9 each, Kodinar, Banavasi, Mulki, Kota, Kundapura, Haripad, Punalur, Kanjirappally, Nilambur & Pattambi 8 each, Komna, Gyanpur, Vadgam, Byad, Vanthali, Jamnagar, Amreli, Jafrabad, Humchadakatte, Sakaleshwara, Ottappalam, Alathur, Thrithala, Thiruvalla, Nedumangad, Dharamsala & Mount Abu 7 each	Baheri 30, Banbasa 27, Pilibhit 20, Cherrapunji, Palliakalan & Bisalpur 19 each, Hosanagar 15, Bhinga, Bareilly & Phoolbagh 14 each, Bisauli & Hyderabad 13 each, Mukteshwar 12, Bahraich, Nabaganj & Pithora-garh 11 each, Kakardharighat, Nighasan & Amla 10 each, Raiganj, Kheri Lakhimpur & Puranpur 9 each, Mahinagar, Humchadakatte, Gonda, Chandra-deepghat, Rampur & Nainatal 8 each, Jogindernagar, Mandya, Balarampur & Pawayan 7 each	Sevoke 16, Gajoldoba 12, Khonsa 11, Sriranga-patna 10, Salbari, Athagarh & Irikkur 9 each, CIAL Cochi 8, Lakhipur, Silchar & Barobhisa 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
19.	Bhatkal 21, Honavar 18, Amini Divi 15, Panjim 10, Shirali & Kochi 9 each, Malvan 7	Krishnaprasa 28, Khandapara 26, Hindol 21, Tikabali 20, Puri 19, Tanoi 18, Narsinghpur, Rajkanika, Soro & Kollur 17 each, Daspalla & Ranpur 16 each, Kantamal, Kendrapara, Nimpara, Reguli & Kamrej 15 each, Kalinoa & Banpur 14 each, Maya Bandar, Sonepur, Bhanjnagar & Kotagarh 13 each, Alipingal, Kakatpur, Khairamal, Gandevi & Shirali 12 each, Tikarpara, Bipili, Barmul, Pattamundai & Thalasserry 11 each, Madanpur Rampur, Jaipatna, Nayagarh & Kottigehra 10 each, Paikmal, Phulbani, Gop, Paradip, Purushottampur & Perumbavur 9 each, Contai, Bhubaneshwar, Talcher, Belgaon, Chhatrapur, Chandbali, Junagarh, Bhawanipatna, Madhabarida, Wanakbori, Panjim & Porbandar 8 each, Bonth, Akhuapada, Athoarh, Mundali, Rudaigiri, Mohana, Balasinor, Porbandar, Jodia, Subramanya & Yellapura 7 each	Garubathan 18, Cherrapunji 17, Neora 16, Salbari 13, Hasimara, Chengamari & Diana 12 each, Katwa, Gajoldoba, Sevoke & Kashipur 11 each, Bagati, Champasari, Lucknow & Bareilly 10 each, Bagdogra 9, Silchar, Safipur, Baheri & Bhagalpur 8 each, Joypur, Nagarkata, Nilokheri, Batala, Belgaum, Bahraich, Neemsar, Sultanpur, Hasanganj & Akbarpur 7 each	Murti 25, Gajoldoba 23, Chinnna Kallar, Nagrakata & Tiruvaiyaru 15 each, Champasari & Salbari 14 each, Passighat, Dillighat & Neora 13 each, Chengmari 12, Dhubri & Garubathan 11 each, Belthangady 10, Sevoke, Arasikere, Kollam & Nedumangad 9 each, Baghdogra, Hasimara, Panchanahalli, Perumbavur, Manjeri & Valparai 8 each, Tezu, Cherrapunji, Chouldhowaghat, Batagaon, Lakkivalli, Chengannur, Peermade, Kottayam & K. Paramathy 7 each
20.	Kannur 18, Irinjalakuda 14, Enamackel 10, Kudulu 8, Kunnamkulam & Chalakudy 7 each	Bolangir 21, Athamalik 18, Rajkishorenagar 16, Titlagarh 15, Baliguda 14, Bhawanipatna, Belgaon, Phulbani, Ambabhona & Churk 13 each, Sonepur & Gerusoppa 12 each, Kotagarh, Paradip, Alipingal, Madanpur Rampur & Mirzapur 11 each, Daringibadi, Khairamal, Mandira Dam & Dharamsala 10 each, Soro, Koraput, Kakatpur, Malda & Bahraich 9 each, Tantloi, Binika, Rairakhol, Kendrapara, Lanjigarh, Jaipatna, Kakardharighat & Kalasa 8 each, Reamal, R. Udaigiri, Dhenkanal, Gop, Pattamundai, Parvathipuram, Honavar, Linganamakki & Daltonganj 7 each	Passighat 15, Cherrapunji & Bhiwapur 13 each, Deganga & Nagbhir 11 each, Khirpai & Koppal 10 each, Canning Town, Dahiwadi, Malegaon & Pandharkawada 9 each, Manamathnagar, Kharagpur, Khonsa, Madha, Pune, Hinganghat, Khamgaon, Telhara, Chittapur, Sedam & Bhubaneswar 8 each, Kolkata, Manas NH Xing, Mumbai, Ratnagiri, Mominabad, Bhadravathi, Jalgaon, Brahmapuri, Mangrulpir, Devarhippargi, Chandbali & Betul 7 each	Cherrapunji 11, Asansol 10, Mathanguri, Durgapur, Kuchinda & Subramanya 9 each, Channa-patna 8, Kanaksa & Arogyavaram 7 each
21.	Khonsa 15, Tezu & Jewargi 9 each, Murbad 8, Itanagar & Poladpur 7 each	Dharampur 23, Binika, 22, Sambalpur 21, Bijepur 19, Altuma, Khandapara, Hindol, Sohela, Chandbali & Hirakud 17 each, Rajkamal, Keonjhargarh, Dunguripalli, Kamakshyangar & Jabalpur 16 each, Daringibadi, Ambabhona, Bargarh & Nanipalson 15 each, Rajkanika, Ghatagaon, Swam Patna & Ahwa 14 each, Batagaon, Padampur, Bolangir, Khairamal, Rairakhol, Ranpur, Anoul, Pattamundai, Bansda, Madhuban & Narsinghpur 13 each, Jamankira, Rengali, Akhuapada, Naktideul & Palsana 12 each, Talcher, Rajkishorenagar, Sukinda, Chendipada, Sonepur, Athgarh, Nawapara, Mahuwa, Silvasa & Khambha 11 each, Tensa, Deogarh, Jaipur, Boudhgarh, Kuchinda, Athmalik & Pardi 10 each, Malda, Deogaon, Kotagarh, Reamal, Barmul, Narsinghpur, Kantamal, Bonth, Patnagarh, Jharsuguda, Hemgiri, Vapi, Bhira & Jammu 9 each, Naraj, Kendrapada, Dhenkanal, Telkoi, Cuttack, Nawanga, Kadana, Sagbara, Kamrej,	Parambikullam 15, Bhalukpong 17, Cherrapunji 14, Kokrajhar 12, Belonia 11, Panbari & Williamnagar 10 each, Passighat, AIE NH Xing, Gangavathi & Osmanabad 9 each, Manas NH Xing, Phaltan, Osmanabad, Shegaon, Nilambur & Mannarkad 8 each, Phek, Koregaon, Patur, Mettur Dam, Valparai & Challakere 7 each	Piravom Chendipada 10, Panbari & Baliguda 8 each, Bhalukpong, Nawana & Panhala 7 each

TABLE 16 (*Contd*.)

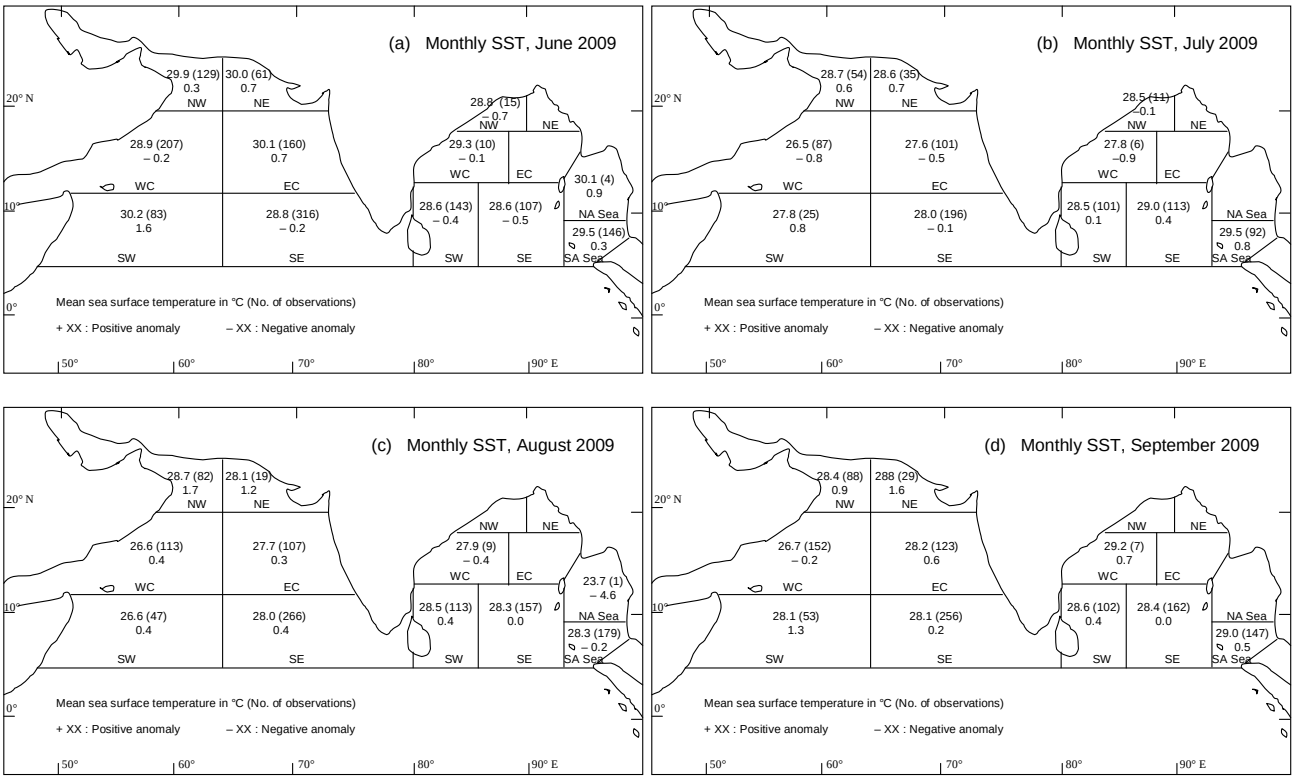
(1)	(2)	(3)	(4)	(5)
		Gogha & Mahabaleshwar 8 each, Soro, Sundergarh, Tikabali, Nilgiri, Phulbani, Komna, Dabhoi, Navsari, Jafrabad, Pathankot, Una & Allahabad 7 each		
22.	Cherrapunji 12, Maya Bandar 10, Panbari, Daporijo & Gajoldoba 9 each, Khonsa 8, Kokrajhar 7	Dediapada 33, Pachmarhi 29, Dahanu 22, Mahuwa 18, Silvasa 17, Daman, Madhbun & Vapi 16 each, Chikhli & Mahabaleshwar 15 each, Gandevi, Bansda & Bhopal 14 each, Nanipalson 13, Sagbara & Raipur 12 each, Ambabhona & Narsinghpur 11 each, Dharampur, Ahwa, Kota, Bharatpur & Bhira 10 each, Gajoldoba, Bulsar, Olpad, Jalalpur, Broach, Dharamsala, Jammu, Seoni & Broach 9 each, Udala, Pardi, Kamrej & Yellapura 8 each, Paikmal, Lav, Ukai, Navsari, Bardoli, Umbergaon, Dwarka, Kollur, Roorkee, Rawat Bhata, Hoshangabad, Indore, Ujjain & Raisen 7 each	Cherrapunji 18, Thondebavi & Gowribidanur 10 each, Sirur, Erode, Lakkavalli, Chintamani & Nilambur 8 each, Williamnagar, Aurangabad, Arsikere, Jind & New Delhi 7 each	Kalinga 16, Dharmanagar, Parisagar 12 each, Guwahati, Mundali & Subramanya 10 each, Bhalukpong 9, Hirekerur & Agumbe 8 each, Khonsa, Gharmura, Jai Bharali NIX, Manmothnagar, Kakatpur, Mangalvedha, Sandila, Koppal, Hungund, Arsikere, Hasaraghatta, Kailashahar & Tumkur 7 each
23.	Long Island 13, Dhubri & Cooch Behar 12 each, Domohani & Gajoldoba 8 each	Madhbun 33, Silvassa 29, Pardi 28, Daman & Umbergaon 27 each, Dahanu 26, Kodinar 25, Indore 24, Dharampur & Nanipalson 23 each, Vapi 22, Bharwain 21, Byad, Dwarka 19, Meghraj & Vanthali 18 each, Bulsar, Manavadar & Pachmarhi 17 each, Jalalpur, Gandevi, Ranawao, Junagadh & Mahabaleshwar 16 each, Veraval & Sutrapada 15 each, Chikhli, Ratlam & Shajapur 14 each, Palsana, Ahwa, Kutiana & Hoshangabad 13 each, Bansda, Upleta & Ujjain 12 each, Lakhipur, Bardoli, Dhansura, Valod, Navsari, Talala, Palitana, Malia & Nancowry 11 each, Mahuwa, Danta, Surat, Prantij, Dhorai & Kalyanpur 10 each, Amraghat, Kamrej, Khanpur, Dahegam, Fatepura, Vijapur, Okha, Porbandar, Jamnagar, Surat, Betul, Khandwa & Bhira 9 each, Keshod & Banswara 8 each, Vadgam, Vyara, Nagina, R. S. Dam, Idar, Kapadvanj, Barwala, Kadana, Rawat Bhata & Bhopal 7 each	Itanagar, North Lakhimpur 12, Agumbe 11, Maya Bandar 10, Sangaria 9, Amini Divi 8, Dillighat, Chouldhowaghat, Harnai, Sudhagad, Rahuri, Sirur & Patur 7 each	Bhalukpong, Bijepur, Bhor, Vaduj & Phaltan 8 each, Kailashahar, Roha, Sudhagad, Satara, Indapur, Faizabad & Hirekerur 7 each
24.	Ankola & Veraval 17 each, Long Island 11, Chiplun & Forbesganj 8 each, Maya Bandar & Porbandar 7 each	Sutrapada & Veraval 37 each, Kodinar 31, Mangrok 26, Talala 25, Ranawao & Porbandar 23 each, Umergaon, Kalok & Igatpuri 17 each, Okha & Kutiana 15 each, Silvassa & Mahabaleshwar 13 each, Madhbun, Jhandutta, Bhantwad, Lalpur, Dwarka, Jafrabad & Lodhika 12 each, Upleta & Rahapur 10 each, Nanipalson, Pardi, Keshod, Bachu, Malia, Chittorgarh & Maya Bandar 9 each, Gondal, Manvdar & Anjar 8 each, Vapi, Kadi, Dharam-pur, Mahuwa, Adampur, Jamnagar, Chotila & Dahanu 7 each	Maya Bandar 15, Port Blair & Karkala 13 each, Lonar & Mudibidre 12 each, Long Island & Hosdurg 11 each, Mangalore & Udupi 10 each, Sinner, Panambur & Agumbe 9 each, Karjat, Bhira. Bajpe, Mani, Shirali, Belthangadi, Afzalpur & Kudulu 8 each, Sakri, Alland, Kannur & Honavar 7 each	Thondebavi 11, Kalyan 10, Silchar, Vellore & Melalathur 9 each, Karimganj, Maya Bandar, Vaniyambadi, Chikkanahalli & Vikramgadh 8 each, Shiandavasi, Ambur, Arni, Shirhatti, Bangalore & Gubbi 7 each
25.	Kalyanpur 16, Okha 15, Udupi & Bhanwad 10 each, Keshod 9, Dwarka & Porbandar 8 each, Lanjigarh, Bhatkal & Veeraghattam 7 each	Abdasa & Naliya 30 each, Nakhatrana 15, Ukai 10, Mahuwa, Navsai Kalyanpur, Jamnagar, Mandvi, Jetpur Mani, Mahabaleshwar & Maya Bandar 9 each, Jalalpur, Vyara, Songadh Fort,	Agumbe 16, Belgaon (Orissa) 15, Mulki 13, Udupi 12, Gaganbavada, Warud, Kota & Athagarh 11 each, Parbhani, Malsiraj, Pune, Mangalvedha,	Kollur 14, Maya Bandar 13, Sibsagar & Port Blair 8 each, Dillighat & Siddapura 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
		Mantra & Jodia 8 each, Valod & Lalpur 7 each	Pandharkawada & Talikote 10 each, Poladpur, Pathri, Gerusoppa & Bhira 9 each, Mandangad, Sinner, Manjlegaon, Kallamb, Partur & Mudibidre 8 each, Didwana, Radhanagari, Vita, Wai, Mahabaleshwar, Pandharpur, Deoli, Panambur, Bajpe, Dharmasthala, Saroda, Mangalore, Bidar & Gulbarga 7 each	
26.	Malvan 16, Amraghat 15, Vadakara 14, Devgad & Piravom 11 each, Chouldhowaghat, Ita-nagar, Sawantwadi, Valpoi, Haripad, Aluva & Kozhikode 9 each, Silchar, Lakhipur, Mulki & Pattambi 8 each, Guhagarh, Panambur, CIAL Kochi, Karipur, Thrithala & Vadakkancherry 7 each	Basar & Mundra 11 each, Wav 9, Mahabaleshwar 8, Mahuwa, Dhanera, Khonsa, Jodia, Dwarka & Jalpaiguri 7 each	Baliguda 14, Paikmal & Kosagumda 12 each, Sumerpur 11, Gopalpur, Dharampur, Udupi & Nawrangpur 10 each, Sagbara 9, Mangrol, Navapur, Gaganbavada, Mudibidre & Dharamsala 8 each, Pratapgarh, Sirohi, Ukai, Bardoli, Chincholi, Sedam, Titlagarh, Nizamabad & Cherrapunji 7 each	Kalaikunda 11, Port Blair & Mudibidre 9 each, Hut Bay 8, Maya Bandar & Sivaganga 7 each
27.	Keshod 18, Alibag 16, Bhalukpong 15, Mangrol 13, Dahanu 12, Malvan, Mumbai & Kankavli 10 each, Mhasla & Panjim 9 each, Devgad, Kudal, Sudhagad, Dabolim, Kamrej & Bagsara 7 each	Bhagalpur 15, Guwahati 11, Purnea, Mount Abu & Jagdalpur 7 each	Nawapara & Khushalgarh 10 each, Daitari, Lanjirgarh 9, Ghatgaon, Badesar & Jambughoda 8 each, Manmothnagar, Lava, Manas NH Xing, Cherrapunji, Keonjhargarh, Tikarpara, Kandhamal, Bolangir, Sikarai & Sagbara 7 each	Port Blair 8, Thalasserry 7
28.	Malvan 17, Jalpaiguri 16, Vengurla 13, Luxettipet 11, Rajgangpur & Veeraghattam 10 each, Ratnagiri, Boath, Khanapur, Parvathipuram& Bhinga 9 each, Bargaon, Binika, Cherrapunji, Devgad, Kalingpapatnam & Guna 8 each, Bolangir, Kosagumda, Gunupur, Kudal, Rajapur, Hingoli, Nirmal, Utnoor, Visakhapatnam & Sardanagar 7 each	Fursatganj 28, Haidergarh 21, Agartala 20, Hoshiarpur, Bara-banki 19, Cherrapunji 17, Ludhiana, Faizabad, Hardoi, Bansi & Kollur 14 each, Delhi, Halwara, Elginbrigde, Biswan & Agumbe 13 each, Amb, Amethi, Musafirkhana & Bhawanipatna 12 each, Palampur & Hindon 11 each, Ghamroor, Jubbal, Bharwain, Dasuya, Chandradeepghat, Patti, Sultanpur, Patiala & Sultanpur 10 each, Golaghat, Gannaur, Jhandutta, Kasol, Malakpur, Phagwara, Lalganj, Basti, Raibareilly & Sidhapura 9 each, Safidon, Mukerian, Birdghat, Shardanagar, Pratapgarh, Dalmau, Karwar, Kathua & Bareilly 8 each, Williamnagar, Kheronighat, Bahadurgarh, Kharkhoda, Handia, Shirali, Mahabaleshwar, Katra, Gorakhpur, Hardoi, Behraich, Uluberia, Bahraich, Fatehpur, Tarabganj, Gorakhpur, Hardoi, Hanumansetu, Chandauli, Gautambudh-nagar, Sirsi, Shirali & Mahabaleshwar 7 each	Pallahara, Palsana, Hoshangabad & Raisan 10 each, Ghatgaon & Verlatapuram 8 each, Lahunipara, Jenapur, Sunyka, Salumber, Sahada,Modasa & Surat 7 each	Piravom 16, Kochi, Irrinjalkuda & Chalakudy 13 each, Aluva 9, Maya Bandar 8, Thodupuzha 7
29.	Cherrapunji 28, Sori 13, Cooch Behar & Malvan 11 each, Narsinghpur 10, Amraoti 9, Nahan, Gudari, Neamatighat, Williamnagar, Dibrugarh, Passighat, Alibag & Datia	Cherrapunji 45, Valsad 29, Jhandutta, Dharampur, Hoshiarpur, Adampur & Anandpur Sahib 15 each, Arki, Kollur & Agumbe 14 each, Hoshiarpur, Adampur, Panbari, Aghar, Kandaghat, Kasauli, Sidhapura & Karkala 13 each,	Banswara 23, Sagwara 22, Pratapgarh 20, Dhambola 19, Hamirpur & Arnodh 17 each, Sabla & Banswara 16 each, Kesarpura & Arthuna 15 each, Garhi & Galiakot 13 each,	Subramanya, Afzalpur, Gopalpur, Nawrangpur & Cuddapah 9 each, Nandyal 8, Yellapura, Honnali, Etapalli. Kosagumda & Bijepur 7 each

TABLE 16 (*Contd*.)

(1)	(2)	(3)	(4)	(5)
	8 each, Murud, Sardanagar & Yeotmal 7 each	Chandigarh 12, Mathanguri, Kahu, Nangal & Jalpaiguri 11 each, Berthin, Bhalukpong, Kandi, Mani & Taliparamba 10 each, Beki Road Bridge, Ambala, Ghamroor, Bharwain, Subramanya, Bhagamandala & Kozhikode 9 each, Bhoranj, Nadaun, Baijnath, Dehra Gopipur, Dhundhi, Baldwara, Solan, Dharmasthala & Irikkur 8 each, Dhubri, Nalbari, Puttur, Gerusoppa & Linganamakki 7 each	Deganga & Shergarh 12 each, Chickli, Bhungra, Bagidora & Danpur 11 each, Songarh 10, Hut Bay, Loharia, Veja, Aspur, Kamrej, Kadana & Ratlam 9 each, Maya Bandar, Khowang, Amb, Nithuwa, Pipalkhunte, Wanaksabori, Danta, Viramgam, Visnagar & Byad 8 each, Angul, Ambala, Chotisadri, Salumber, Abu Road, Dungerpur, Nandol, Dairakhed, Meghraj, Matar, Detroj, Godha & Indore 7 each	
30.	Cherrapunji 29, Williamnagar 25, Rairangpur 17, Passighat 13, Mathanguri 12, Sabroom, Sonamura, Chinna Kallar & Thodupuzha 10 each, Umaria 9, Shillong, Lengpui, Melur, Kanjirappally, Quilandy & Mokokchung 8 each, Agartala, AIE NH Xing, Tezu, Vadakara, Bareilly, Nazibabad, Ambala & Dharamsala 7 each	Siddapura 23, Gajoldoba, AIE NH Xing & Agumbe 19 each, Murti 16, Kota 14, Kundapura & Kudulu 13 each, Panambur 12, Garubathan, Mathanguri, Goalpara, Barpeta, Bajpe, Sringeri & Kannur 11 each, Mani & Bhagamandala 10 each, Chengmari, Chouldhowaghat, Manas NH Xing, Mudibidre & Mulki 9 each, Panbari, Rangia, Puttur, Kochi, Hosdurg, Vaikom & Vadakara 8 each, Mahinagar, Sevoke, Islampur, Gosaigaon, Linganamakki, Paravur, Taliparamba, Thalasserry & Purnea 7 each	Byad 21, Champasari 19, Mehsana 17, Idar 16, Veja & Nakhatrana 15 each, Naliya 14, Dhambola, Karian, Dhansura, Sanand & Bhuj 13 each, Gajoldoba, Vijapur, Tarapur & Rajkot 12 each, Dunderpur, Vallabh Vidyanagar & Kaira kheda 10 each, Salbari, Alipurduar, Garhi, Kadana, Himmatnagar, Deesa, Kadi, Dharoi, Detroj, Radhanpur, Vijaynagar & Mahabaleshwar 9 each, Hasimara, Ahmedabad, Olpad, Bhiloda, Pardi, Vadbagar, Hansot, Harij, Prantij, Morvi, Kohima & Bhira 8 each, Farukhnagar, Devel, Arthuna, Shahpura, Visnagar, Khedbrahma, Sojitra, Matar, Kapadvanj, Chhota Udaipur, Jambughoda, Petlad, Dhanpur, Mahuwa, Mahuda, Malia Miyane, Halwad, Veraval & Kodinar 7 each	Gerusoppa 22, Lanja 18, Soundatti 17, Ratnagiri & Pandharpur 14 each, Bhatkal & Honavar 13 each, Karwar & Jath 12 each, Almatti & Mangalvedha 11 each, Shirali, Yargatti, Bijapur, Bagewadi, Gaganbavada & Mohol 10 each, Rajapur 9, Kollur, Lakshmeswar, Muddebihal, Visakhapatnam & Mehbubnagar 8 each, Navalgund, Hungund, Ilkal, Linganamakki, Hosanagar, Agumbe, Madha & Akkalkot 7 each
31.	-	Cherrapunji 9, Agumbe 8, Gosaigaon, Passighat, Hasanpur & Karkala 7 each	Bangana 30, Joida 19, Kalyanpur 17, Naraj, Mehre & Amb 15 each, Nadaun, Phagwara, Abdasa & Jamnagar 13 each, Mundali, Lalpur & Ranawav 12 each, Malkangiri, Dehra Gopipur, Hoshiarpur, Lunkaransar, Porbandar, Kota & Gorakhpur 11 each, Rahapur, Una & Hyderabad 10 each, Hamirpur, Nakodar, Bhanwad, Kandla, Mundra, Bachau, Udupi & Gerusoppa 9 each, Ghumarwin, Ramsar & Bajpe 8 each, Cuttack, Banpur, Guler, Ghamroor, Bharwain, Nagrota Surian, Dasuya, Lakhapat, Bhuj, Ankola, Siddapura, Bahraich, Nellore, Mangalore & Agumbe 7 each	



Figs. 10(a-d). Mean SST and SST anomaly in (°C) for (a) June, (b) July, (c) August and (d) September 2009

Details of TEJ in the past five years are as follows.

Year *Tropical Easterly Jet (TEJ)*

2004 Seen from 10 May to 30 September. Maximum wind speed 180 knots at 118 hPa over Minicoy on 22 June.

2005 Seen from 6 June to 28 September. Maximum wind speed 110 kts at 198 hPa over Thiruvananthapuram on 31 July and over Chennai at 100 hPa on 8 July.

2006 Seen from 11 May to 4 October. Maximum wind speed 100 kts at 128 hPa on 1 July over Thiruvananthapuram and over Minicoy on 25 July and 31 August at 202 and 200 hPa respectively.

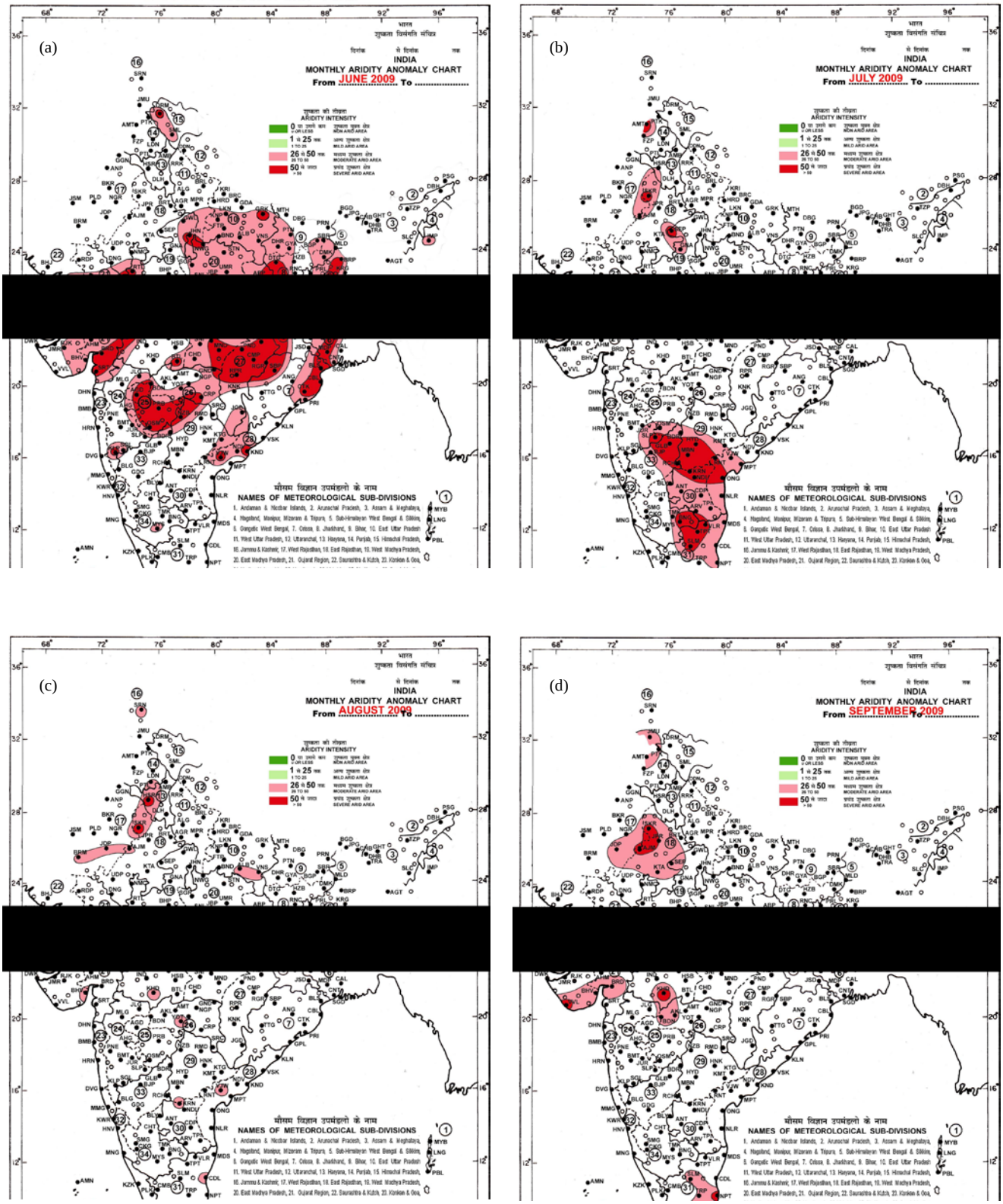
2007 Seen from 19 May to 6 October. The maximum wind speed reported was 100 kts at Thiruvananthapuram on 28 June & 16 August at Minicoy, on 17 July, 2 August & 10 September and at Port Blair, on 13 July & 7 August.

2008 Seen on a regular basis from 25 May onwards. A core wind speed of 100 kts was noted over Port Blair on a few days in June, July and September.

6. Sea Surface Temperature (SST)

Figs. 10(a-d) show the monthly mean Sea Surface Temperature values along with the anomalies in northwest, northeast, west central, southwest, southeast blocks of both the seas and also for North Andaman (NA) and South Andaman (SA) seas for the months of June, July, August and September. The normal values for each block for calculating the anomalies have been estimated from the isopleths of normal values given in the publication, "Climatic Atlas of Indian Ocean, Part-I" by Stephen Hastenrath and Peter J. Lamb.

The northwest and northeast sectors of Arabian Sea were warmer than normal having positive anomaly. The east central, southwest and southeast sectors of Arabian Sea were warmer than normal during August and September. The southwest and southeast sectors of Bay of Bengal were warmer than normal having positive anomaly



Figs. 11(a-d). Aridity anomaly chart for the month (a) June, (b) July (c) August and (d) September 2009

from July to September. All the sectors of Bay of Bengal were cooler than normal in the month of June.

7. Other features

7.1. *Monthly wind anomalies during southwest monsoon 2009*

The zonal wind anomalies observed at 4 different stations over the peninsula are given in Table 15. The monthly wind anomaly features are discussed below:

7.1.1. *June wind anomaly features*

Anomalous cyclonic circulation was seen at 850 hPa over Arunachal Pradesh, adjoining Assam & Meghalaya and anomalous anticyclonic circulation at 850 hPa over Maharashtra, Madhya Pradesh and East Gujarat extending up to 500 hPa.

7.1.2. *July wind anomaly features*

Anomalous cyclonic circulations were seen at 850 hPa, one over West Madhya Pradesh and neighborhood extending up to 700 hPa and another over Bangla Desh and neighborhood at 850 hPa, extending up to 500 hPa.

7.1.3. *August wind anomaly features*

The winds were east southeasterly over the Peninsula up to 500 hPa. Anomalous anticyclonic circulation was seen over central India at 850 hPa extending up to 500 hPa.

During the last week ending on 2 September, the ridge line at 850 hPa which had been at 13° N shifted to 15° N at 700 hPa.

7.1.4. *September wind anomaly features*

Anomalous cyclonic circulation was seen at 850 hPa over Gangetic West Bengal and adjoining NE Bay extending up to 300 hPa. Anomalous anticyclonic circulation at 850 hPa was seen over Gujarat and neighbourhood extending up to 500 hPa.

7.2. *Aridity conditions during southwest monsoon 2009*

Aridity Index (AI) is computed based on Thornthwaite's formula:

$$AI = \frac{PE - AE}{PE} \times 100$$

Where, PE is Potential Evapotranspiration, which is the loss of water vapour to atmosphere in the form of evaporation from soil and transpiration from the plants, when the supply of water is unlimited. This is the water need of the plants. AE denotes the Actual Evapotranspiration and PE – AE denote the water deficiency. PE is computed by Penman's modified equation and AE is obtained from the water balance procedure, which takes into account the water holding capacity of the soil.

The aridity anomaly is worked out by considering the difference between actual aridity and normal aridity for the month. Aridity of a particular region is decided based on the aridity anomalies, which have been classified as follows:

Aridity Anomaly	*Class*
0 or less	Non-arid
1 to 25	mild arid
26 to 50	Moderate arid
more than 50	Severe arid

Aridity Anomaly maps for June, July, August and September is shown as Figs. 11(a-d).

In June, moderate to severe arid conditions were noticed in the western, eastern and central parts with isolated pockets in northern and peninsular parts of the country.

In July, moderate and severe arid conditions reduced to some extent in the western, eastern and central parts of the country. However, some parts of peninsular India came under moderate to severe drought conditions.

In August, moderate to severe arid conditions were decreased over the peninsular part of the country.

In September, moderate and severe arid conditions were noticed in the western; west central and peninsular parts of the country.

Details of severe and moderate arid conditions which prevailed over the country during Southwest monsoon season are given below month wise:

7.2.1. *June*

7.2.1.1. *Severe Arid Areas*

Large areas of Chattisgarh and Marathwada.

Small areas of south central parts of Gujarat Region; western parts of West Madhya Pradesh and adjoining southern part of East Rajasthan; southern parts of West Uttar Pradesh and adjoining eastern part of West Madhya Pradesh; northern and southeastern parts of East Madhya Pradesh; western parts of Jharkhand; northwestern and eastern parts of Orissa; southern and central parts of Gangetic West Bengal; northern, southern and western parts of Vidarbha; northwestern parts of Telangana and adjoining northern part of North Interior Karnataka and adjoining eastern part of Madhya Maharashtra.

Isolated areas around Dharamsala (Himachal Pradesh); Gorakhpur (East Uttar Pradesh; Betul (West Madhya Pradesh); Kolhapur (Madhya Maharashtra); Vijaywada and Kakinada (Coastal Andhra Pradesh) and Kanyakumari (Tamil Nadu).

7.2.1.2. *Moderate Arid Areas*

Large areas of East Uttar Pradesh; Bihar; Jharkhand; Vidarbha and East Madhya Pradesh.

Small areas of western parts of Himachal Pradesh; western and eastern parts of west Madhya Pradesh; southern parts of west Uttar Pradesh; northwestern, eastern and southern parts of Orissa; northern, central and southern parts of Chattisgarh; northwestern and eastern parts of Telangana; northern and western parts of North Interior Karnataka; eastern, southern and northern parts of Madhya Maharashtra; southern parts of Sub-Himalayan West Bengal; northwestern and central parts of Gangetic West Bengal; central parts of Coastal Andhra Pradesh; southern parts of East Rajasthan; west central parts of Gujarat Region; southeastern parts of Saurashtra & Kutch and southern parts of Tamil Nadu.

Isolated areas around Imphal (Nagaland-Manipur-Mizoram-Tripura) and Mysore (South Interior Karnataka).

7.2.2. *July*

7.2.2.1. *Severe Arid Areas*

Small areas of central parts of Coastal Andhra Pradesh; southern parts of Telangana; north central parts of North Interior Karnataka; eastern parts of Madhya Maharashtra; northern and southern parts of Rayalaseema; northwestern parts of Tamil Nadu and eastern parts of South Interior Karnataka.

Isolated areas around Amritsar (Punjab); Sikar (West Rajasthan) and Sheopur (West Madhya Pradesh).

7.2.2.2. *Moderate Arid Areas*

Large areas of Rayalaseema and Tamil Nadu.

Small areas of northwestern parts of Punjab; western and eastern parts of East Rajasthan; eastern parts of West Rajasthan; southwestern parts of Haryana; northwestern parts of West Madhya Pradesh; central and southern parts of Coastal Andhra Pradesh; central parts of Telangana; northern and central parts of North Interior Karnataka; southern parts of Marathwada; southeastern parts of Madhya Maharashtra and eastern parts of South Interior Karnataka.

Isolated areas around Madurai and Kanyakumari (Tamil Nadu).

7.2.3. *August*

7.2.3.1. *Severe Arid Areas*

Isolated areas around Hissar (Haryana) and Sikar (East Rajasthan)

7.2.3.2. *Moderate Arid Areas*

Small areas of southeastern parts of Punjab; west central parts of Haryana; northern and western parts of East Rajasthan; south central and eastern parts of West Rajasthan and southern parts of East Uttar Pradesh.

Isolated areas around Srinagar (Jammu & Kashmir); Bhavnagar (Saurashtra & Kutch); Khandwa (West Madhya Pradesh); Yeotmal (Vidarbha); Vijayawada (Coastal Andhra Pradesh); Kurnool (Rayalaseema); Cuddalore , Madurai and Kanyakumari (Tamil Nadu).

7.2.4. *September*

7.2.4.1. *Severe Arid Areas*

Small areas of northwestern parts of East Rajasthan and adjoining eastern part of West Rajasthan.

Isolated areas around Veraval (Saurashtra & Kutch); Khandwa (West Madhya Pradesh) and Nagapattinam (Tamil Nadu).

7.2.4.2. *Moderate Arid Areas*

Large areas of East Rajasthan.

Small areas of southern parts of Jammu & Kashmir; northwestern parts of Punjab and adjoining western part of Himachal Pradesh; eastern parts of West Rajasthan;

TABLE 17

Monthwise Vigorous, Active, Extremely Heavy, Very Heavy and Heavy spells of rain (number of days) 2009

S. No.	Sub–division	June					July					August					September					Season				
		Vigorous	Active	Extra heavy rain	Very heavy rain	Heavy rain	Vigorous	Active	Extra heavy rain	Very heavy rain	Heavy rain	Vigorous	Active	Extra heavy rain	Very heavy rain	Heavy rain	Vigorous	Active	Extra heavy rain	Very heavy rain	Heavy rain	Vigorous	Active	Extra heavy rain	Very heavy rain	Heavy rain
1	A. & N. Islands	-	-	-	3	5	-	-	-	1	6	-	-	-	-	5	-	-	-	1	4	-	-	-	5	20
2	Arunachal Pradesh	-	3	-	3	7	-	3	-	1	7	1	7	-	4	7	-	4	-	2	4	1	17	-	10	25
3	Assam & Meghalaya	-	1	2	4	10	-	5	4	3	7	1	8	2	9	11	-	4	-	3	10	1	18	8	19	38
4	Naga. Mani. Mizo. & Trip.	-	3	-	-	2	1	7	-	1	3	-	6	-	3	6	-	2	-	-	2	1	18	-	4	13
5	Sub–Himalayan W B & Sikm.	-	5	-	-	6	-	8	1	6	5	1	7	1	7	9	-	1	-	3	2	1	21	2	16	22
6	Gangetic West Bengal	-	1	-	-	-	-	4	-	1	8	-	6	-	2	11	2	2	1	2	6	2	13	1	5	25
7	Orissa	-	1	-	3	6	5	8	1	4	14	-	4	-	6	13	-	5	-	5	8	5	18	1	18	41
8	Jharkhand	-	-	-	-	1	-	1	-	-	2	-	3	-	-	-	-	-	-	1	1	-	4	-	1	4
9	Bihar	-	-	-	-	-	1	2	-	1	1	-	8	-	-	2	-	1	-	1	1	1	11	-	2	4
10	East Uttar Pradesh	-	-	-	-	2	-	-	1	2	7	-	-	-	3	8	-	-	-	5	6	-	-	1	10	23
11	West Uttar Pradesh	-	-	-	-	1	-	-	-	2	4	-	-	1	3	4	-	-	-	2	6	-	-	1	7	15
12	Uttarakhand	-	-	-	-	-	-	-	-	-	-	-	-	1	1	6	-	-	-	1	6	-	-	1	2	12
13	Haryana Chnd. & Delhi	-	-	-	-	1	-	3	-	-	4	-	1	-	-	5	3	1	1	2	2	3	5	1	2	12
14	Punjab	-	-	-	-	-	2	2	-	2	2	1	1	-	1	3	1	-	-	-	3	4	3	-	3	8
15	Himachal Pradesh	-	-	-	-	1	1	3	-	2	7	1	1	-	2	7	6	-	1	2	4	8	4	1	6	19
16	Jammu & Kashmir	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
17	West Rajasthan	-	-	-	-	-	-	1	-	-	-	1	-	-	-	4	-	-	-	-	-	1	1	-	-	4
18	East Rajasthan	-	-	-	-	-	1	4	-	-	6	1	3	-	1	5	-	1	-	-	2	2	8	-	1	13
19	West Madhya Pradesh	-	-	-	-	3	2	6	1	1	4	-	5	-	-	5	-	-	-	1	3	2	11	1	2	15
20	East Madhya Pradesh	-	-	-	-	1	-	9	-	1	7	-	4	-	-	-	1	2	1	1	2	1	15	1	2	10
21	Gujarat Region #	-	-	-	-	-	3	7	2	6	7	1	2	-	1	4	-	1	-	3	3	4	10	2	10	14
22	Saurashtra & Kutch	-	-	-	2	1	5	7	5	1	8	2	-	-	2	-	-	-	-	-	-	7	7	5	5	9
23	Konkan & Goa	1	-	-	4	6	2	8	7	6	9	-	1	-	-	8	1	3	1	4	6	4	12	8	14	29
24	Madhya Maharashtra	-	-	-	-	2	1	7	1	12	9	1	2	-	-	7	1	2	-	4	7	3	11	1	16	25
25	Marathwada	-	-	-	-	1	1	3	-	-	3	3	3	-	-	5	2	4	-	-	3	6	10	-	-	12
26	Vidarbha	-	1	-	-	1	1	7	-	4	7	-	5	-	1	5	-	1	-	-	1	1	14	-	5	14
27	Chattisgarh	-	-	-	-	-	2	4	1	-	4	-	2	-	-	1	-	-	-	-	-	2	6	1	-	5
28	Coastal Andhra Pradesh	-	-	-	-	4	-	4	-	-	4	2	-	-	-	2	1	2	-	1	5	3	6	-	1	15
29	Telangana	-	1	-	-	3	-	4	-	-	5	1	3	-	-	4	1	5	-	-	2	2	13	-	-	14
30	Rayalaseema	-	-	-	-	1	-	-	-	-	1	1	-	-	-	2	2	4	-	1	3	3	4	-	1	7
31	Tamil Nadu & Puduchhery	-	-	-	-	9	-	-	-	-	1	-	-	-	2	4	-	-	-	2	6	-	-	-	4	20
32	Coastal Karnataka	-	3	-	5	4	-	15	2	12	6	-	1	-	2	7	3	7	-	4	10	3	26	2	23	27
33	North interior Karnataka	3	1	-	-	5	-	4	-	-	2	-	-	-	-	7	1	11	-	1	9	4	16	-	1	23
34	South interior Karnataka	1	-	-	-	3	4	11	3	10	6	-	-	1	4	7	2	9	-	3	10	7	20	4	17	26
35	Kerala	-	3	-	3	6	2	7	4	7	6	-	1	-	2	4	2	5	-	2	8	4	16	4	14	24
36	Lakshadweep	-	-	-	1	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4
	Total	5	23	2	28	94	34	154	33	86	175	18	84	6	56	178	29	77	5	57	145	86	338	46	227	592

TABLE 18

Dates of occurrence of heat wave/severe heat wave and various categories of maximum temperatures - June 2009

Sub-division		Dates (Number of days)						
S. No.	Name	Severe heat wave	Heat wave	Hot day	Appreciably to markedly above normal	Above normal	Appreciably to markedly below normal	Below normal
2.	Arunachal Pradesh	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3.	Assam & Meghalaya	Nil	Nil	Nil	Nil	Nil	Nil	Nil
4.	Naga., Mani, Mizo and Tri.	Nil	Nil	Nil	Nil	Nil	Nil	Nil
5.	S. H. W. B. & Sikkim	Nil	Nil	Nil	Nil	Nil	Nil	Nil
6.	Gangetic West Bengal	Nil	22. (1)	Nil	Nil	Nil	Nil	Nil
7.	Orissa	10-12, 17-22, 23-25 (12)	4, 8, 10, 14, 16, 17, 18, 20, 21, 26 (10)	Nil	2, 4, 9, 12-15, 19 (8)	1, 3, 5, 10, 12, 22 (6)	Nil	Nil
8.	Jharkhand	10, 20-25 (7)	8, 10-13, 16-20 (10)	Nil	9-15, 17-19, 24, 26, 28 (13)	7 (1)	1, 2, 5 (3)	2, 6, 7 (3)
9.	Bihar	21-24 (4)	18-23 (6)	Nil	9-11, 17-20, 24, 26, 28 (11)	7, 11-13, 15 (5)	1, 2, 5, 7 (4)	6 (1)
10.	East Uttar Pradesh	22-24 (3)	8-12, 14-25, 28 (17)	Nil	9-1, 13, 15, 16, 18, 19, 20, 26, 28 (11)	19 (1)	1, 2, 5, 7 (4)	Nil
11.	West Uttar Pradesh	24 (1)	21-26, 28 (7)	Nil	11, 13, 14, 19, 20, 28, 29 (7)	5, 6, 10, 11, 12, 15 (6)	1, 2, 7 (3)	Nil
12.	Uttarakhand	24 (1)	21, 23, 25 (3)	Nil	4, 5, 8-10, 12, 13, 19, 20, 26, 28 (11)	7, 9, 12, 16, 19 (5)	1 (1)	Nil
13.	Haryana, Chandigarh & Delhi	24, 29 (2)	25, 26 (2)	Nil	5, 11, 20, 22-24, 26 (7)	4, 6, 9-14, 21, 26 (10)	1, 2, 16-18 (5)	Nil
14.	Punjab	29 (1)	4, 5, 24, 28 (4)	Nil	5, 9, 11, 22-24, 26, 29 (8)	4, 6, 7, 10-13, 26 (8)	1, 2, 16-18 (5)	18, 25 (2)
15.	Himachal Pradesh	24, 25 (2)	23, 24, 26, 28 (4)	Nil	4-6, 12, 13, 15, 21-23, 24, 29 (11)	9, 10, 19, 20 (4)	1, 17, 18 (3)	7, 8 (2)
16.	Jammu & Kashmir	28, 29 (2)	24, 26 (2)	Nil	5, 11-13, 24-26, 29 (8)	2, 4 (2)	1, 7-9, 13-20 (12)	6, 9, 11, 21 (4)
17.	West Rajasthan	Nil	10, 12, 14, 22, 24, 26-30 (9)	Nil	20-22, 25, 26 (5)	5, 7 (2)	2, 3, 16-18 (5)	1, 4, 18, 24, 26 (5)
18.	East Rajasthan	Nil	11, 21, 26 (3)	Nil	20-26, 28 (8)	7, 9-11, 13, 14, 26 (7)	2, 15-17 (4)	3, 5, 26 (3)
19.	West Madhya Pradesh	21, 22, 25 (3)	8, 11-14, 16, 18, 19-24, 26, 28 (15)	Nil	6-15, 17, 18, 20, 24, 26 (15)	5, 9 (2)	2 (1)	2 (1)
20.	East Madhya Pradesh	10, 21-26 (7)	5, 8, 10, 12-14, 17, 18, 20-22, 26, 28 (13)	Nil	6-9, 11-14, 16-18, 20 (12)	4, 5, 9 (3)	Nil	2 (1)
21.	Gujarat Region	Nil	21 (1)	Nil	9, 12, 16, 19, 20, 22, 23 (7)	6-8, 11-15, 17, 18, 23, 28 (12)	Nil	Nil
22.	Saurashtra & Kutch	Nil	Nil	Nil	3, 9, 12, 16, 19, 20-23 (9)	1, 2, 4, 5, 7, 8, 11-14, 17, 18, 23 (13)	Nil	Nil
23.	Konkan & Goa	Nil	18 (1)	13, 16, 17 (3)	2-6, 8, 10, 11, 12, 14-20 (16)	1-4, 7, 9, 12 (7)	Nil	Nil

TABLE 18 (*Contd*.)

Sub-division		Dates (Number of days)						
S. No.	Name	Severe heat wave	Heat wave	Hot day	Appreciably to markedly above normal	Above normal	Appreciably to markedly below normal	Below normal
24.	Madhya Maharashtra	Nil	1, 16, 18, 20 (4)	Nil	1, 2, 6-8, 11, 13-15, 17-19, 21, 24 (13)	1-5, 10, 12, 20-23, (11)	Nil	Nil
25.	Marathawada	Nil	18 (1)	Nil	7, 10-19, 24, 25 (13)	2, 9, 22 (3)	8 (1)	Nil
26.	Vidarbha	11-15, 18-21, 23 (10)	10, 14, 16-20, 22-25 (11)	Nil	1, 5, 7, 10, 11, 13-16, 22, 24 (11)	1-4, 6, 9, 12 (7)	8 (1)	Nil
27.	Chattisgarh	10, 11, 19-25 (9)	6, 9-12, 16-18, 20 (9)	Nil	5, 6, 9, 12, 13, 15, 18, 19, 28 (9)	3, 4, 7, 14, 15 (5)	13 (1)	1 (1)
28.	Coastal Andhra Pradesh	5, 11, 17-19, 24 (6)	1, 3, 4, 16, 20 (5)	Nil	11, 18 (2)	1 (1)	12 (1)	Nil
29.	Telangana	18 (1)	1, 11, 14, 16, 19-21, 24 (8)	Nil	1, 10, 11, 15, 17, 18, 21, 25 (8)	3, 4, 6, 7, 20 (5)	8 (1)	Nil
30.	Rayalaseema	Nil	Nil	Nil	20 (1)	1 (1)	8, 9, 14 (3)	Nil
31.	Tamil Nadu	Nil	Nil	Nil	Nil	Nil	Nil	Nil
32.	Coastal Karnataka	Nil	Nil	Nil	4 (1)	Nil	Nil	Nil
33.	North Interior Karnataka	Nil	Nil	Nil	1, 4, 11 (3)	3, 4, 6, 17 (4)	Nil	9 (1)
34.	South Interior Karnataka	Nil	10 (1)	Nil	Nil	3 (1)	Nil	Nil
35.	Kerala	Nil	Nil	Nil	Nil	Nil	Nil	Nil

northern parts of West Madhya Pradesh; southern parts of Saurashtra& Kutch; central parts of Gujarat Region; southern parts of West Madhya Pradesh; western parts of Vidarbha and adjoining eastern part of Madhya Maharashtra and adjoining northern part of Marathwada and eastcentral parts of Tamil Nadu.

8. Significant spells of heavy rains

Amounts of heavy, very heavy and extremely heavy rainfall are given in Table 16. The number of vigorous and active days on a sub-divisional scale along with the number of days on which extremely heavy, very heavy and heavy rainfall occurred is given in Table 17.

9. Significant temperature during the season

The sluggish advance of monsoon caused the summer heating to be more pronounced this year, over the central and northern parts of the country. As is evident from Table 18, severe heat wave conditions prevailed on several days, especially over Orissa, Jharkhand, Madhya Pradesh, Chattisgarh, Vidarbha and coastal Andhra Pradesh. The dates of occurrence of heat waves and dates on which the maximum temperature remained appreciably to markedly above/below normal and above/below normal are given in Table 18. A same date appearing in two different columns of a sub-division may be reckoned as occurrence of that category over parts of the sub-divisions. Maximum temperatures were normal for the rest of the days.

The highest maximum temperature over the plains of 46.5° C was reported at Dholpur (east Rajasthan) on 23 June 2009.

Even after the monsoon covering the entire country, there had been instances of day temperatures crossing the 40° C mark mainly over the northwestern parts of the country, when the monsoon activity remained subdued during August and September.

10. Disastrous weather events and damage during monsoon months

10.1. *June*

According to media reports, heat wave took a toll 74 people (50 in Orissa, 15 in Jharkhand, 6 in Vidarbha and 3 in West Bengal). Heavy rains, floods, lightning and

TABLE 19

The meteorological aspects of severe floods during southwest monsoon 2009

S. No.	Region affected	Period	Cause	Damage	Synoptic features prevailed
1.	Assam	1 - 11 Jul	Flash floods triggered by heavy rain. The Brahmaputra River was flowing above the danger level at several places including Dibrugarh, Jorhat and Guwahati.	In the worst-hit districts of Lakhimpur, Dhemaji and Jorhat, vast tracts of land were submerged due to breaches in embankments. The situation in Lakhimpur was very grave following a breach in the 100-metre embankment and 200 villages submerged under gushing waters. Over 300,000 people have been hit by flood in the northeastern Indian state of Assam after incessant rains. One person died and 400,000 have been displaced where a rain-swollen river burst its banks, swamping hundreds of villages.	Southwest monsoon was vigorous on many days over northeast India. This active phase was the consequence of low pressure systems over the monsoon trough region.
2.	Coastal Karnataka	11 - 17 Jul	Incessant heavy rain. Vast areas of Kodagu, Bhagamandala were flooded. Cauvery River overflowed.	Bhagamandala remained cut off from the rest of the district. Vast areas, including paddy fields, at Nittur have been submerged as the Lakshmanateertha being in spate. The Cauvery flowed above the Betri Bridge, disrupting vehicular traffic. Paddy fields have been submerged in and around Bhagamandala. Cauvery water entered the Bolibane area on Napoklu-Murnad road.	Under the influence of a well marked low pressure area over the northwest Bay of Bengal and neighbourhood, the offshore trough along the west coast and a mid-tropospheric cyclonic circulation over Gujarat, the west coast received very heavy to extremely heavy rainfall.
3.	Orissa	12 - 31 Jul	Heavy rains. Water levels in the Mahanadi, Devi, Baitarani, Brahmani, Subarnarekha, Tel, Hati, Bansadhara and Rushikulya rivers were near their danger marks at several places.	Flash floods affected 10 districts of Orissa. Fifty six people lost their lives. More than 870 houses were damaged. Many trees were uprooted and road transport was badly affected. Flood waters of Bansadhara and Nagavali rivers disrupted road links between Rayagada and Koraput and Rayagada and Kalyansinghpur. As many as 10 gram panchayats in Rayagada district were cut off due to landslides. In Kalahandi district, Hati River created havoc as its water flowed four feet over the bridge at Junagarh on NH 201.Low lying areas and paddy fields in the district have been inundated by the Tel River. In coastal Ganjam district, about 6,000 people of seven villages in Bhanjanagar block marooned and several areas cut off from the rest of the state.	A Deep Depression formed over the northwest Bay of Bengal during 20 – 21 July. It crossed Orissa – West Bengal coasts between Balasore and Digha during 2130 – 2230 hrs. (IST) and moved west northwestwards across Orissa as a Depression.
4.	Bihar	1 - 4 Aug	Heavy rains over the catchments area. Bagmati River, Tilaktajpur under Runnisaidpur block in Sitamarhi .	Around 50,000 people were stranded in flood-hit Bihar as the Bagmati River, which breached its embankment and inundated nearly 200 villages in Sitamarhi and Muzaffarpur districts. The swollen Bagmati River breached its embankment in Sitamarhi district,	Monsoon trough shifted towards the foothills of the Himalayas during 30 – 31 July and heavy rains resulted over the region.

TABLE 18 (*Contd*.)

S. No.	Region affected	Period	Cause	Damage	Synoptic features prevailed
				in a stretch of 40-50 meters at Tilakrajpur area, inundating vast tracts across a number of villages.	
5.	Uttar Pradesh, Bihar	15 - 27 Aug	Release of water from barrages in Nepal and heavy rain. In two days time, over 500,000 cusecs of water have been released from Banbasa and other barrages situated near the India-Nepal border, flooding villages in Shrawasti, Sitapur, Sant Kabir Nagar, Kushinagar, Maharajganj and Bahraich districts. Shrawasti, Sitapur, Sant Kabir Nagar, Kushinagar, Maharajganj and Bahraich districts were flooded.	At least 27 people died and a million left homeless. The fatalities were caused by collapsing houses, flooding and a boat capsize. Due to incessant rains, an estimated 1 million people have been displaced in the northern regions of the state. The Mahananda River in Katihar was in spate with its embankment broken and the floods submerging 70 villages and destroying the homes of 60,000 people. In Bahraich district, rivers flowing in spate inundated as many as 185 villages affecting nearly 300,000 people.	The western end of the axis of monsoon trough remained close to the foothills of the Himalayas on many days during the week prior to this. Also, a cyclonic circulation extending up to lower tropospheric levels persisted over Uttar Pradesh and neighbourhood during 13 – 19 August.
6.	Assam	18 - 27 Aug	Incessant heavy rain. The Brahmaputra River has been flowing above the danger mark in at least eight different places in the state.	Flash floods triggered by heavy monsoon rains displaced at least 300,000 people in Assam.	Southwest monsoon was vigorous on many days over the northeastern states in the presence of a trough in the lower level westerlies over the region.
7.	West Bengal	6 - 10 Sep	The floods were caused by a heavy discharge of water from the reservoirs of the DVC following heavy rains in the catchments areas. The Kangsabati River flowed above the danger mark in East Midnapore. several villages were inundated after the Kangsabati river breached embankments	Floods in six West Bengal districts claimed six lives and affected 1.7 million people Several villages were inundated after the Kangsabati river breached embankments.	The formation and westward movement of a Deep Depression over the northwest Bay of Bengal during 5 – 7 September, caused vigorous monsoon conditions over Gangetic West Bengal.
8.	Karnataka, Andhra Pradesh states	25 Sep - 7 Oct	Heavy rains. Krishna-Godavari River basin in Andhra Pradesh and Karnataka.	The floods, described as the worst in the region in 60 years, left at least 2.5 million homeless and caused a loss of 320 billion rupees (6.7 billion dollars).At least 206 people have been killed in Karnataka alone, while the death toll in neighbouring Andhra Pradesh state had reached 63.*(This is according to the data based on media reports posted in the Dartmouth University website.)* The heaviest flood in over 100 years hit the Prakasam Barrage on Krishna River threatening several villages downstream. Several towns and villages in the state, particularly in Kurnool, Mahabubnagar and Krishna districts in Andhra Pradesh, have been inundated with the mighty Krishna River and its tributaries in spate.	A well marked low pressure area formed over the west central Bay of Bengal and neighbourhood and moved westwards across Andhra Pradesh during the period.

landslides took a toll of 92 persons (25 in Uttar Pradesh, 15 in Bihar, 13 each in Jharkhand and Gujarat, 7 in Maharashtra, 5 each in Chattisgarh and Vidarbha, 3 each in West Bengal and Karnataka, 2 in Madhya Pradesh and 1 in Kerala). Damage to property, crops and installations, uprooting of trees were reported from West Bengal, Chattisgarh, Vidarbha, Bihar, Kerala and Karnataka.

10.2. *July*

According to media reports, 2 people died due to heatstroke in Assam. Heavy rains, floods, lightning and landslides took a toll of 246 persons (74 in Karnataka, 56 in Orissa, 49 in Vidarbha, 30 in Madhya Pradesh, 10 in Assam, 9 in Chattisgarh, 6 in Uttarakhand, 4 in West Bengal, 3 in Maharashtra, 2 in Gujarat, 1 each in Bihar, Jharkhand and Andhra Pradesh). Incessant rain paralysed the normal life, caused extensive damage to agriculture and Kutcha houses in Assam, Tripura, West Bengal, Orissa, Madhya Pradesh, Chattisgarh, Maharashtra, Andhra Pradesh, Karnataka and Kerala.

10.3. *August*

According to media reports, heavy rains, floods, lightning and landslides took a toll of 191 persons (52 in Uttar Pradesh, 49 in Uttarakhand, 23 in Bihar, 21 in West Bengal, 19 in Jharkhand, 11 in Vidarbha, 9 in Assam, 4 in Karnataka, 2 in Himachal Pradesh and 1 in Madhya Pradesh). Thunder squall and heavy rain damaged many houses and standing crops and caused havoc in Assam, West Bengal, Uttar Pradesh and Delhi. Cloudburst caused damage to several buildings and bridges in Himachal Pradesh.

10.4. *September*

According to media reports, heavy rains, floods, lightning, landslides and thunder squalls took a toll of 114 persons (37 in Andhra Pradesh, 24 in Karnataka, 16 in Uttar Pradesh, 14 in Madhya Pradesh, 10 in Maharashtra, 5 in Assam, 4 in Himachal Pradesh, 3 in Vidarbha and 1 in Orissa). Incessant rain affected normal life in the National Capital and many villages were flooded due to the rise in water level of river Yamuna. Squally winds and hailstorm damaged standing paddy and fruit crops in north Kashmir. More than 1.5 lakh people were rendered homeless due to heavy rain in West Bengal.

11. The meteorological aspects of severe floods during southwest monsoon – 2009

During the southwest monsoon season 2009, many states *viz*., Assam, West Bengal, Orissa, Uttar Pradesh, Haryana, Maharashtra, Chattisgarh, Bihar, Andhra Pradesh and Karnataka experienced flood situations during various parts of the season. Incessant heavy rainfall associated with the low pressure systems including the two depressions formed over the Bay of Bengal as well as organized convective activity in the form of thunder showers were the major causes of flood.

As stated in the beginning, the southwest monsoon 2009 is categorized under all India Drought year. However, due to large temporal variability in rainfall, many of the states which had been declared as drought hit in the beginning was affected by floods during the later part of the season.

The source of the flood data provided in Table 19 is mainly from the website maintained by the Dartmouth flood observatory, supplemented with other media reports and damage reports provided by various RMCs & MCs.

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Appendix

Definitions of the terms given in '*Italics*'

Rainfall

Excess	- Percentage departure from normal rainfall is + 20% or more.
Normal	- Percentage departure from normal rainfall is between – 19 % to + 19 %.
Deficient	- Percentage departure from normal rainfall is between – 20 % to – 59 %.
Scanty	- Percentage departure from normal rainfall is between – 60 % to – 99 %.
Widespread (Most places)	- 75% or more stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

Fairly widespread (Many places) - 51% to 74% stations of a meteorological sub-division reporting at least 2.5 mm rainfall.

Heavy rain - Rainfall amount from 6.5 cm to 12.4 cm.

Very heavy rain - Rainfall amount more than 12.5 cm to 24.4 cm.

Extremely heavy rainfall - Rainfall amount more than 24.5 cm.

Exceptionally heavy - When the amount is a value near about the highest recorded rainfall at or near the station for the month or season. The highest ever recorded should be more than 12 cm.

Monsoon activity

Active - Average rainfall of a sub-division is more than 1½ to 4 times the normal with minimum 5 cm along the west coast and 3 cm elsewhere in at least two stations in the sub-division.

Vigorous - Average rainfall of a sub-division is more than 4 times or more than the normal with minimum 7 cm along the west coast and 5 cm elsewhere in at least two stations in the sub-division.

Maximum/day temperatures

According to the new criteria, since 1st March 2002, Heat Wave is declared only when the maximum temperature of a station reaches at least 40° C for plains and at least 30° C for Hilly regions.

Severe heat wave conditions - Departure of maximum temperature from normal is +6° C or more for the regions were the normal maximum temperature is more than 40° C and +7° C or more for regions were the normal maximum temperature is 40° C or less.

Heat wave conditions - Departure of maximum temperature from normal is + 4° C to + 5° C or more for the regions where the normal maximum temperature is more than 40° C and departure of maximum temperature from normal is + 5° C to + 6° C for regions where the normal maximum temperature is 40° C or less

Markedly above normal - Departure of maximum temperature from normal is between +5° C to +6° C for the regions where the normal maximum temperature is 40° C or less

Appreciably above normal - +3° C to +4° C for the regions where the normal maximum temperature is 40° C or less.

Appreciably below normal - Departure of maximum temperature from normal is – 3° C to – 4° C.

Markedly below normal - Departure of maximum temperature from normal is – 5° C or less.

Drought

All India Severe Drought Year - When the rainfall deficiency is more than 10% and when more than 40% area of the country is under drought conditions, then the year is termed as all India Severe Drought year.